

Article

# Collaboration and Gender Equity among Academic Scientists

Joya Misra <sup>1,\*</sup>, Laurel Smith-Doerr <sup>1</sup>, Nilanjana Dasgupta <sup>2</sup>, Gabriela Weaver <sup>3</sup> and Jennifer Normanly <sup>4</sup>

<sup>1</sup> Department of Sociology, University of Massachusetts, Thompson Hall, 200 Hicks Way, Amherst, MA 01003, USA; lsmithdoerr@soc.umass.edu

<sup>2</sup> Department of Psychological and Brain Sciences, University of Massachusetts, Tobin Hall, 153 Hicks Way, Amherst, MA 01003, USA; dasgupta@psych.umass.edu

<sup>3</sup> Institute for Teaching Excellence and Faculty Development, University of Massachusetts, Goodell Building, 140 Hicks Way, Amherst, MA 01003, USA; gweaver@umass.edu

<sup>4</sup> Department of Biochemistry and Molecular Biology, University of Massachusetts, Lederle Graduate Tower, 710 North Pleasant Street, Amherst, MA 01003, USA; normanly@biochem.umass.edu

\* Correspondence: misra@soc.umass.edu; Tel.: +1-413-545-5969

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**Abstract:** Universities were established as hierarchical bureaucracies that reward individual attainment in evaluating success. Yet collaboration is crucial both to 21st century science and, we argue, to advancing equity for women academic scientists. We draw from research on gender equity and on collaboration in higher education, and report on data collected on one campus. Sixteen focus group meetings were held with 85 faculty members from STEM departments, separated by faculty rank and gender (i.e., assistant professor men, full professor women). Participants were asked structured questions about the role of collaboration in research, career development, and departmental decision-making. Inductive analyses of focus group data led to the development of a theoretical model in which resources, recognition, and relationships create conditions under which collaboration is likely to produce more gender equitable outcomes for STEM faculty. Ensuring women faculty have equal access to resources is central to safeguarding their success; relationships, including mutual mentoring, inclusion and collegiality, facilitate women's careers in academia; and recognition of collaborative work bolsters women's professional advancement. We further propose that gender equity will be stronger in STEM where resources, relationships, and recognition intersect—having multiplicative rather than additive effects.

**Keywords:** collaboration; gender equity; academic STEM careers

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## 1. Introduction

Collaboration is essential to 21st century academic careers, particular for those in science, technology, engineering, and mathematics (STEM) fields, where research is more likely to be carried out in teams and collaborative grants and publications are common. As Kathrin Zippel notes, “Collaborations are crucial for academic career advancement as they further the exchange of ideas, skills, and expertise” [1]. Yet, collaboration presents a paradox to universities, which historically privilege individual attainment and expertise in the evaluation of success. A mismatch exists between the growing need for collaborative approaches and institutional structures developed in an earlier era of university life. We argue that addressing this mismatch can lead to better outcomes for faculty and their institutions, especially for the participation and advancement of women in STEM, a long-standing

challenge for universities.<sup>1</sup> Collaboration may raise particular challenges for women, while fostering collaboration may be a key way to create greater equity in university settings.

Collaboration is defined here simply but broadly as people working together to solve problems. In contrast to much previous work, our approach to collaboration expands the focus beyond collaborative research products. First, we consider how much access faculty have to resources needed for research collaboration, as well as how much recognition they receive for collaborative research. Second, we consider the relational process of career development which involves mutual mentoring within a network of faculty who share information and advise one another to advance their careers. Thus, three components of collaboration are proposed as integral to faculty success: access to resources for research collaboration, recognition given to collaborative research, and collegial collaborative engagement in career advancement.

Within *research collaboration* we focus specifically on faculty working together in STEM fields because collaborative research plays a key role in scientific discovery. Indeed, diverse groups working together are particularly effective at finding solutions to complex problems [2–4]. However, to get collaborative research off the ground, resources are necessary, such as locating possible collaborators, finding specialized but necessary equipment on-campus, sharing lab space, supplies, or personnel, and coordinating experiments across labs and fields. These much-needed resources are not accessible to all faculty members, and may reflect gender inequalities.

Independent of the mechanics of conducting collaborative research, faculty members need to receive recognition for their collaborative research in STEM fields. There is considerable ambiguity within STEM fields about how to determine whether a team member has made a substantial contribution to a project. Substantial contribution may be attributed to the first author, the last author, or the corresponding author, depending on field. However, these attributions become ambiguous if a paper led by a junior author has a senior co-author on it. In that case, readers may perceive the senior author to be the intellectual driver of the project even though the junior author is the lead. Put differently, uncertainty stems from not knowing how to weight the contributions of less senior authors and other authors whose names appear in the middle of the authorship list on a paper. The same uncertainty emerges when trying to decide how much recognition should be given to faculty members who are co-principal investigators (Co-PI), or co-investigators (Co-I) on research grants instead of the Principal Investigator (PI). These ambiguities about how to recognize individual contributions within science teams may particularly affect young investigators and women scientists to the extent that they are perceived as having less expertise and lower status.

Within *collaborative career development*, we focus on faculty mutually mentoring each other in peer relationships because career development and advancement often depends on informal acquisition of knowledge through collaborative networks with colleagues [5–7]. Collaborative career development is not a hierarchical, unidirectional traditional mentoring relationship, but one based on a relational network among faculty members, since research shows that these mutual mentoring networks are particularly effective [5,7]. While collaborative career development may be common across academic fields, it may be especially pertinent to STEM faculty who have to use their professional networks to find collaborators, specialized equipment, shared supplies, and lab space. This is where informal knowledge acquisition is critical. If collaborative career development is less accessible to women, they may be disadvantaged.

We propose that ensuring resources, recognition, and relationships for collaborative work matters for gender equity in STEM. Increasing incentives and structures that promote rather than penalize faculty working together as scholarly peers simultaneously enhances the core mission of the university, produces knowledge, and benefits women's advancement. To explore how men and women faculty

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<sup>1</sup> We posit that addressing the mismatch between collaboration and university hierarchy will also have benefits for faculty members from underrepresented racial and ethnic groups; however this paper focuses on gendered processes exclusively, given the small numbers of URM and international faculty represented in this data.

in STEM disciplines experience and understand collaboration, and its role in academic science and engineering, we conducted a study using focus group methodology with STEM faculty from a research university as participants.

To shed light on why academic collaboration might activate gender stereotypes and differentially influence career outcomes for men and women scientists and engineers we draw on expectation states theory, which argues that status plays a central role in the maintenance of inequality [8–10]. Status beliefs, or cultural stereotypes about the worthiness and competence of particular groups, influence the enactment of social hierarchies among people. In addition to status, the social context matters as well, according to expectation states theory. In contexts that are societally assumed to be men's domains, status stereotypes about gender are particularly likely to shape evaluations of women's competence. Because STEM fields are stereotyped as men's domain, status beliefs may affect how women compared to men are evaluated, rewarded, and promoted [11]. Past research shows that status beliefs influence men and women's behavior in mixed gender settings: men tend to talk more, make more task suggestions, act more assertive, and appear more influential than women [8]. Expectation states theory suggests that if women act against status expectations, others may penalize them, for example, for asserting authority or engaging in self-promoting behavior. However, it may also be the case that if a woman holds a well-recognized high status position within a professional context (e.g., Distinguished Professor of Mechanical and Industrial Engineering), her personal high status may offset gender stereotypes from being applied to evaluate her competence.

We use expectation states theory as the theoretical framework to inform our analysis of focus group data on collaboration in STEM fields. Given that STEM contexts are widely stereotyped as male domains, this provides an opportunity to examine whether social psychological processes related to status and gender stereotypes affect the extent to which women, relative to their peers who are men, gain access to institutional resources that facilitate collaboration, receive recognition for their collaborations, or receive mentorship.

## 2. Existing Research on Collaboration

Researchers have used multiple approaches to study collaboration in university environments. We review research in three areas: scholarship on research collaborations; how collaboration is evaluated; and collaborations that promote faculty development (e.g., peer mentoring). While much empirical research has focused on research collaboration (especially quantitative studies of co-authorship), in a recent comprehensive review of the literature on collaboration, Bozeman and colleagues note that while we now understand research collaboration from a bibliometric standpoint, much more qualitative research is needed on the meaning of collaboration and the informal side of collaboration, including mentoring [12]. By recording the meanings of collaboration raised in focus group interviews, and by conceptualizing collaboration more broadly than simply through co-authored publications, we contribute rich contextual evidence about the nature of collaboration in academic science and engineering and the relation between collaboration and equity.

### 2.1. Research Collaboration

Scientific, technical, and engineering innovations and discovery are increasingly driven by team-based research collaborations [2,13] and research collaboration is a strong predictor of productivity, as measured by peer-reviewed publications [14,15]. Past research on universities has identified the importance of, and strategies for, collaboration, including multi- and interdisciplinary collaboration, collaboration across institutions, and the relationship between collaboration and productivity [1,2,13–24].

Some research identifies gender differences in research collaborations. Controlling for other factors that influence collaboration, research in Europe and the U.S. suggests that women show greater preference for collaborative and interdisciplinary research, yet may have fewer collaborators and be less integrated into international research networks [1,25–33]. Men in the U.S. hold most of the

prominent leadership roles in interdisciplinary research centers [13]. When women do secure positions in university research centers with ample resources for collaborative research, their career outcomes become more comparable to that of men. In contrast, women in traditional STEM departments with fewer resources for collaborative research experience larger gender gaps in rank, career satisfaction, and research funding [34]. This evidence fits with expectation states theory which would predict that in STEM fields dominated by men, women have lower status relative to men, which makes it more difficult for them to attract collaborators or gain access to resources. Indeed men, with their more privileged status, may feel more entitled than women to access resources.

## 2.2. Valuing Collaboration

Even as team-based science has increased, the process of evaluating faculty for tenure and promotion continues to rely almost exclusively on assessment of individual performance, which may also yield gendered results [24,35,36]. Judging individual performance based on team science can be difficult because of the ambiguity of determining who is responsible for which aspects of collaborative research, as well as inconsistencies in how collaboration is defined [17,37,38]. One estimate is that half of all collaborations are not credited by formal recognition in co-authorship [39].

Ambiguities in how to document, report, and credit collaboration may be accentuated by implicit gender bias [40–43]. A growing body of research reveals the multiple ways in which gender stereotypes unintentionally, or implicitly, bias evaluations of men's and women's professional work inside and outside academia [8,44–47]. For example, studies that have found that subtle or implicit gender bias affect hiring decisions [46,48–55], how letters of recommendation are written [56–58], how grant proposals are reviewed [59,60], how manuscripts are peer-reviewed at scientific journals [61], and evaluations of professional women's competence and likeability [48,62,63]. In other words, gender biases that emerge in evaluations of academic scientists and engineers are consistent with lessons from stereotyping research: in decision-making contexts with incomplete or ambiguous information, evaluators unintentionally use stereotypes to “fill in the gaps” and draw inferences about individuals' competence and worthiness based on those stereotypes [64,65].

One classic ambiguous situation is where evaluators make inferences about how much of the intellectual work in a collaborative team of scientists was done by individual members of that team. Because people implicitly stereotype the ideal successful scientist or engineer as male [44,45,66], when it comes to giving credit to members of a science team in the absence of complete information, these implicit gender stereotypes subtly push evaluators to assume men on the team must have made more unique contributions than the women, absent clear markers of leadership. For similar reasons, expectation states theory would also predict that in masculine professions like STEM, evaluators often assume that men (more than women) are the intellectual leaders in the team whose contribution is critical to the team's discovery.

## 2.3. Collaboration in Career Development

Past research suggests that collaboration in career development, including mentoring, is key to retaining women faculty in STEM [67–69]. As Kemelgor and Etzkowitz argue, “Mentors provide an indispensable relationship necessary for every young scientist, to learn the craft, the unwritten rules, and give entrée into social networks crucial to professional growth” ([70], p. 240). Through mentoring, faculty learn important insights such as how work is structured and valued in their discipline or workplace, how to access resources necessary to conduct their research, connect with potential collaborators, teach and advise students, and engage in meaningful and recognized service. Faculty mutually mentoring each other to advance their careers is a form of collaborative career development that is important to both women and men in STEM.

While traditional faculty mentoring relationships involve senior faculty members informally advising junior colleagues, research suggests peer and mutual mentoring networks are more effective than traditional top-down dyads [5–7]. Peer relationships also last longer than traditional mentoring

pairs [5]. In addition, the more mentoring relationships professionals have, the greater their professional satisfaction [71]. Institutionalizing mentoring activities helps ensure that women receive professional development and career coaching that may be overlooked by more informal models [72,73]. Increasingly, institutions are developing peer mentoring networks or mentoring committees for faculty members [7,72,74].

Expectation states theory would suggest that in the STEM context, men faculty may have access to a wider network of informal faculty mentors than their women colleagues because of their higher status in science and engineering professions. Women, particularly women of color in STEM, may be excluded from collegial interactions, isolated not only socially but also professionally [68,75,76]. Being mentored by a variety of peers can mitigate isolation that is endemic for many STEM women, and may help them develop relationships with other women both within and outside their home department even when numbers are small [68,70,75]. Moreover, finding mentors, including peers, who have had similar gendered experiences is likely to be important to ensuring women's success [68,70,72].

Situated in the context of prior research, the present study uses focus groups to examine faculty experiences of collaboration in the context of their research, and professional development. The next section describes the institutional context within which these focus groups were conducted and the methodology used in the study. Following that, we detail main findings that emerged from the focus groups.

### 3. The Present Study: Institutional Context and Methods

We conducted research at a large research-intensive, doctoral-granting public university in the US enrolling almost 30,000 students. This university is comparable to many other land grant universities—with women composing approximately 40% of all Department Chairs and Deans. However, among STEM departments (which includes all of the NSF funded sciences) women comprise a smaller proportion of leadership positions: approximately 35% of Department Chairs, 20% of Distinguished Professors, and 25% of full professors are women. Larger proportions of women are in mid-career and pre-tenure faculty positions: 40% of associate and assistant professors are women. While men and women appear to have similar chances of attaining tenure and promotion to associate, women achieve promotion to full professor more slowly than men. Efforts toward increasing equity and inclusion for all faculty have primarily been in the arenas of work-life policies and recruitment policies, although the university also has invested in a peer-mentoring model [7] that has been particularly effective for women and members of underrepresented minorities.

Our aim was to understand the challenges that STEM faculty identified in how they were supported and credited in their work. We invited all tenure-line STEM faculty (defined as faculty in NSF-supported fields) to attend a focus group set at a specific date and time, and organized by rank and gender. Altogether, sixteen focus groups were conducted with 72 STEM faculty participants in Spring 2015. Written feedback was gathered from 13 additional participants who could not attend. The 85 faculty who provided input along with the seven faculty facilitators make up about 15% of all full-time faculty in the NSF funded science and engineering colleges at the university. Among the full professors, department heads/chairs and other former leaders were well-represented. The majority of faculty who participated in these focus groups came from natural science departments who do experimental research in laboratories (e.g., physics, chemistry, biology, neuroscience, physical anthropology) or theoretical research (e.g., mathematics, theoretical physics); others came from engineering, and computer science. A smaller minority of faculty came from non-lab oriented social sciences (e.g., economics, sociology). Table 1 shows the comprehensive list of departments for each group of faculty interviewed by rank and gender.



**Table 1.** STEM Fields Represented in Focus Groups.

Rank & Gender of Focus Group	Field
Assistant Men	Biochemistry and Molecular Biology, Chemistry, Chemical Engineering, Computer Science, Electrical and Computer Engineering, Mechanical and Industrial Engineering, Political Science, Psychological and Brain Sciences
Assistant Women	Astronomy, Biology, Chemistry, Chemical Engineering, Civil and Environmental Engineering, Economics, Environmental Conservation, Geosciences, Linguistics, Mechanical and Industrial Engineering, Microbiology, Physics, Psychological and Brain Sciences, Resource Economics, Sociology
Associate Men	Biochemistry and Molecular Biology, Biology, Chemistry, Civil and Environmental Engineering, Computer Science, Economics, Electrical and Computer Engineering, Landscape Architecture and Regional Planning, Sociology
Associate Women	Anthropology, Biology, Chemistry, Ecological Conservation, Math and Statistics, Physics, Psychological and Brain Sciences, Sociology
Full Men	Astronomy, Biochemistry and Molecular Biology, Biology, Chemistry, Computer Science, Linguistics, Management, Math and Statistics, Political Science, Physics, Psychological and Brain Sciences, Sociology
Full Women	Anthropology, Biology, Chemistry, Economics, Electrical and Computer Engineering, Geosciences, Mechanical and Industrial Engineering, Landscape Architecture and Regional Planning, Physics, Political Science, Psychological and Brain Sciences, Sociology

These focus groups should not be seen as representative of all STEM faculty nor should this one university be seen as representative of all research-intensive universities. In using a qualitative method like focus groups our goal was to generate new insights about the nature of professional collaborations and not necessarily to generalize to a larger population. Focus groups provide a rich hypothesis-generating mechanism by using inductive methods to identify and develop emergent themes. As compared to surveys, focus groups allow researchers to ask more nuanced questions, and receive considerably more complex answers than are possible to include in survey measures. As compared with individual interviews, focus groups benefit from the interplay between different respondents. At times, respondents disagree with one another; at other times, they chime in with similar experiences. The conversations thus capture how people make sense of their experiences; highlight convergences and divergences in their encounters at the university; and give us important insights into our respondents' understandings of their positions as faculty members. Although focus group data are not necessarily generalizable to a larger population, quantitative research that builds on focus group findings may later test the insights developed through these qualitative methods on larger, more generalizable samples.

We attempted to avoid the potential 'groupthink' outcome of focus groups where minority voices may be silenced by organizing focus groups by rank and gender. In this way, the homogenous gender/rank groups could identify concerns faced by women and men at different ranks, including attaining tenure, time to promotion, and leadership roles [77]. Department heads and chairs were informed about the focus groups and asked to encourage their faculty to attend, but the research was faculty-based (and not institutionally required). Among the six sessions divided by gender and rank, there were at least two or three tables of 4–5 people from different departments, composing sixteen groups in all. This helped avoid faculty members feeling concerned that their comments might be heard by senior colleagues, or reported back to department leaders. Given the fairly critical comments made in the focus groups (as presented in the findings), we do not expect that the faculty who attended our focus groups were reluctant to speak.

Two members of the research team, one serving as facilitator and another as note-taker, also sat at each table. Each group started with an initial conversation aimed at understanding challenges faced by faculty within that group. A structured protocol (see Appendix A) was used in which specific questions were posed to the group and responses solicited. The structured protocol included questions about mentoring, departmental decision-making, transparency in personnel decisions, support for collaborative and interdisciplinary research, job satisfaction, and barriers to faculty work. We focused on these topics based on our reading of the existing literature on collaboration and interdisciplinarity.

The final 15 minutes brought all focus groups together when a moderator asked faculty to identify some of the key interventions that the university could design to address challenges they had identified. Detailed notes of the sessions, flipcharts where intervention ideas were recorded, and the informal conversations with faculty after the session were used for data analysis.

The larger research team was composed of three social scientists, three natural scientists and one engineer. While all members of the team did not attend every focus group session, a majority of the team was at each focus group session, which led to useful insights as we compared similarities and differences across groups. The research team members wrote up summaries of their impressions immediately after each focus group, which were discussed by the entire research team to identify main themes that emerged from all-men and all-women focus groups within each rank. For example, after holding focus groups with assistant professors who were men vs. women, our research team identified key themes that emerged from these two types of groups. The team was also attentive to whether the same themes, or the same gender differences or similarities emerged from focus groups of associate and full professors. We considered whether women and men spoke of experiencing different challenges or had different interpretations of the same challenges. We found more evidence of the latter: women and men often reported the same experiences, but interpreted the same experiences through different lenses. We identified three themes in focus group responses regarding collaborations: comments about professional resources, recognition, and relationships. These themes are used to organize the results section below.

## 4. Findings

### 4.1. Resources for Collaboration

Resources always matter to research productivity; yet in STEM fields, where collaboration is critical, challenges in accessing resources to foster collaboration can be particularly problematic. This included inadequacies in staff support to get labs started and connected and facilitate collaborative grant-writing, limited collaborative research space, lack of opportunities to meet potential collaboration partners due to physical and disciplinary boundaries, and lack of seed funding to get new collaborative research off the ground. Both men and women identified these issues to collaboration, suggesting that they have similar experiences, but women seemed particularly disadvantaged in locating resources to facilitate collaboration.

A major concern voiced by faculty members was difficulty finding basic resources such as access to staff. However, there were differences in how men and women of different ranks interpreted the problem of too little staff support for collaboration. Men of all ranks and some senior women expressed frustration about the *lack of staff* to provide logistical support for collaboration. In contrast, assistant professor women talked about the *lack of time* to do the work themselves or lack of time to identify appropriate resources to support collaborations. In keeping with expectation states theory, it appears that men and senior women, holding more privileged status, feel more entitled to resources than junior women.

Staffing was a key theme in all of our focus groups, even though we did not explicitly ask about staffing (see Appendix A). Focus group members noted how much more productive they would be, and how many more research collaborations they could develop, if they had adequate staff support, given the particularly time-consuming nature of organizing teams of collaborators. In one group of associate professor men, a faculty member argued that, while colleagues at other universities receive 20 h a week of administrative support, he receives “much closer to zero administrative support, which affects my productivity.” Another associate man responded that inadequacies in staffing particularly affect interdisciplinary research collaboration: “Support makes a big difference. I recently put in [a grant] proposal with someone who had administrative help and that was great. You could focus on stuff you’re good at.” Faculty members also discussed the high level of administrative demands

beyond research work, and how this work takes faculty time away from collaborative research and teaching activities.

With a shrinking tenure-line faculty, and increased administrative demands, faculty described frustration with doing clerical and administrative work that could be carried out by staff, rather than what they viewed to be the key elements of their jobs. This clerical work gets in the way of developing relationships with new collaborators, while also slowing progress on existing collaborations. Both men and women identify a problem in how much clerical work they do to support collaborations, but junior women tended to be more apologetic, suggesting that they understood staffing constraints meant that they had to take on more administrative work. However, senior women faculty opinions tended to align with men. For example, one woman who is an associate professor responded to our focus group questions in writing took a tone more similar to the men's comments, noting: "There is *so much* that could be done 10–20 h/week by an administrative assistant, if I had one. My life would be *dramatically* improved if I had a 10–15 h/week secretary (emphasis hers)." One group of associate women faculty members agreed that men talked about and shared resources that facilitate collaboration more, in part because they were more integrated with their colleagues. As one associate professor argued "some department members got grant prep[aration] assistance, [there should be] transparency that everyone gets the same access to staff support." Applying for funding to support collaborative research is hampered when women faculty members cannot access grant preparation support.

Assistant professor men conveyed frustration in words, tone, and body language with the lack of staff support for research collaborations. One man who is a full professor noted the challenge for new faculty, arguing that they "get the run around when trying to set up their research programs—very opaque processes." Assistant professor men described relying on seasoned colleagues (usually senior men) to advise them about the resources they needed. In contrast, assistant professor women were more likely to blame themselves for their inability to find existing resources to support collaboration. Assistant professor women described needing more information about where and how to access institutional resources. One described the time-consuming nature of getting important and necessary information—"it's not that the info doesn't exist or people aren't helpful, [but] you spend two days [looking for it]." Assistant women seemed to lack mentoring to find resources, something their men took for granted in our focus group discussions. Yet the junior women suggested that, if they were less busy, they would learn to navigate the system and develop collaborations with colleagues. Most did not consider that what was lacking was not time, so much as appropriate staffing and mentoring to identify research-related resources on-campus.

In addition, faculty voiced substantial challenges around buildings and lab space, some of which was not adequate for their work. Both men and women were concerned about space that would permit collaborative research to thrive. One woman full professor argued, "Space is not transparent; I got . . . an un-renovated lab that was supposed to be torn down. I'm the only one in the department in that building—me and retirees." An associate man similarly noted that he was "isolated" with a few other senior faculty in a different building, which limits his ability to build collaborations. As he explains, "All the new faculty go to the new building. When people visit, they say and think—'you weren't good enough to move to the new building?'" In a university where some departments are located across buildings, some faculty feel geographically isolated and this limits opportunities to collaborate with their colleagues. Space was therefore a barrier to collaborative research, especially potential collaborators were located in distant buildings.

Another concern involved scarce opportunities to meet and engage with potential collaborators. Faculty in our focus groups described how they often experienced roadblocks from units that were supposed to support collaboration. Assistant professor men noted a "huge wall" between colleges within the same university, such as the college of natural sciences and the college of engineering that made it almost impossible to engage in interdisciplinary collaboration between two colleges. Assistant women also described roadblocks to finding collaborators. One assistant woman noted that, because her department's faculty has been changing, "I don't have anyone senior that I can say 'hey, do you



want to collaborate?” She further noted that, because her research requires large computing power, she lost two years of research time because her Dean would not provide her with an adequate computer. Yet, she characterized herself as “very happy with [her] department, just issues I had to work through.” While she and other assistant women had experienced obstacles that had seriously impacted their collaborative work, they downplayed these concerns. Untenured women may recognize that being assertive could lead to negative repercussions in fields dominated by men as such behavior goes against status expectations for women. This awareness may lead them to soften complaints.

Related to the concerns about finding collaborators was the need for internal seed funding to pay for research assistants, supplies, and initial pilot data to stimulate a new collaborative project and set the stage for a future collaborative grant proposal seeking external funding. For example, one assistant man argued, “[my previous university] would give small seed grants to fund interdisciplinary collaboration among faculty in different departments.” At another table of assistant professor men, one argued,

My work is very interdisciplinary. There’s not much chance to interact with other departments. The exception is [interdisciplinary program with] cross-college faculty members. Faculty share what they are doing, but beyond that, is there other support? There are no seed grants for working together. This is discouraging.

STEM faculty men looked for additional resources that would allow them to develop more robust interdisciplinary collaborations. Assistant men also noted that the lack of university-supported research assistants made it difficult for them to get their collaborative research programs off the ground: “the absence of RA-ships for graduate students makes it difficult to attract graduate students without [my] already having grants.” Assistant men suggested that support for interdisciplinary RAs and postdocs would be a major resource that would help facilitate collaboration across units or faculty at the university. While many of the assistant women in our focus groups came from engineering and lab science fields that emphasize collaboration, they did not make the same claims for internal funding for RAs and postdocs.

Overall, we found that faculty were concerned about the lack of resources for collaboration available at the university, despite the importance of collaboration to their careers. Assistant women tended to blame a lack of accessible information or themselves for not being able to identify resources, while assistant men were more critical of the lack of staff and resources to support their collaborative research. We also found that men were somewhat more likely to have colleagues helping them learn about how to access resources for collaboration, while women were less integrated. As a result, women seem disadvantaged in gaining access to resources needed for collaboration, even as both men and women identify this as an issue they face.

#### 4.2. Recognition

Recognition was a second theme that emerged from our focus groups. The key recognition narrative focused on how collaboration was perceived during tenure and promotion at the university. Faculty spoke about the difficulty getting institutional recognition for collaborative and interdisciplinary research when it came time for tenure and also for promotion to full. Expectation states theory and implicit bias research suggests that in male-dominated contexts where gender stereotypes favor men, women may get less credit for collaborative research than men in personnel actions like tenure and promotion—if the independent contributions of individual team members is not self-evident in co-authored publications and grants.

The challenges of evaluating collaborative and interdisciplinary research in personnel actions was a topic that came up among both men and women faculty. Because funding agencies tend to prioritize collaborative work, many STEM faculty carry out collaborative and interdisciplinary projects. Yet, they noted personnel evaluation gave primacy to independent research without collaborators. Both men and women saw a need for personnel committees to have greater training in evaluating

collaborative research during personnel actions. Funding and personnel evaluation seemed at odds to many of our respondents. In one interchange, assistant professor men described the challenges of doing collaborative research in the current funding environment, where funding is harder to get, and there is a greater support for collaborative research than for individual principal investigators (PIs):

Assistant Man 1: The old standard used to be that you have to get a grant and be the PI on it. Now it's more common to be a co-PI (instead of PI) or get a collaborative grant.

Assistant Man 2: Collaborative work often raises questions in people's mind about who the "real" leader is in a collaborative project.

Assistant Man 1: In my department, collaborative work would not count as my work. This is made very explicit in my department.

A woman assistant professor made a similar argument in another focus group:

It's not olden days for funding. Everyone is trying to be in a silo to write grants, and [they are] not going to get funded. Interdisciplinary efforts get funded . . . saying you won't get promoted if [you are] co-investigator or co-PI on the grant . . . is throwing the baby out with bathwater.

Another assistant woman similarly noted, "I feel like [the university] is shooting itself in the foot with that. If collaborative grants were valued and you could still show your independent contributions, it would cost the university a lot less money in terms of start-ups and having to hire people." Devaluing collaborative grants left these faculty feeling uncertain about how to carry out their research programs, given tensions between collaborative funding opportunities but emphasis on individual grant-getting at the university.

These issues are also challenges for interdisciplinary scholars. One assistant professor man argued regarding his department, "People have had shaky tenure cases before because they've been doing interdisciplinary research." A woman assistant professor noted that she had received "mixed messages" about interdisciplinary research: "There is a difference between valued and useful for your tenure package. Interdisciplinary is awesome and cool, but you will have plenty of time to do this later." As one full man noted, comments from interdisciplinary program directors are "never used" in personnel decisions, even though they should be according to personnel procedures. Another full man noted that "the places where it has failed is where [a] junior faculty does interdisciplinary research that the department doesn't buy into."

One woman assistant said that even with interdisciplinary hires, "the department wants them to work on one discipline especially when comes to evaluation of performance. If you brought [a] grant as a co-PI, and if you are on many, many papers, but you are not the first author, it is discounted." A woman associate professor argued,

It would almost be politically incorrect to say we do not support interdisciplinary research. I think we are open verbally . . . the [research] literature they are bringing in [to their paper] is [interdisciplinary], but the co-authorships are not. Again, coming back to the cultural impediments, high impact journals are the ones that are very field and disciplinary specific, no matter how interdisciplinary, that is where you are going to get published and read, not in interdisciplinary venues. There is a conflict there.

A full professor who is a woman similarly argued that "disciplinary flagship journals are valued more than interdisciplinary journals," leading to a conversation about how external letter writers might review interdisciplinary faculty poorly who are up for tenure and promotion if judging simply by the standards of their field. We also heard from a woman associate professor who felt that since external reviewers are usually within the field, "if someone has a big interdisciplinary focus," it would be challenging to find external reviewers who do not judge them primarily on "what they are doing

for the field.” This suggests that doing interdisciplinary research is not entirely recognized in tenure and promotion decision.

Both men and women noted that there are increased pressures to collaborate, particularly for external funding, but that recognition for collaborative work is more problematic, including difficulty in proving leadership in collaborations. One major concern for those evaluating personnel cases is determining how central a faculty member’s work is to a particular collaboration. In one conversation among full professor men, one faculty member noted that evaluation depends on whether the research is “thematically related or are they just doing a task for six different labs—how involved are they in the collaborative work?” Another full professor who is a man noted that judging credit for “collaborative projects requires significant contribution—work with people who are different enough so that your contribution is clear.” Many faculty similarly called for identifying exactly what the faculty member’s contribution is in a collaboration. In a conversation with full women, one noted “academia emphasizes what *you* did in evaluations. The PI for example is rewarded; the co-PI is not” on collaborative projects. Yet a full professor man noted that, in the best collaborations, clear delineations of contributions “are hard to define because there has been so much interaction.”

Although both men and women raised the issue of how to credit collaborative work, women faculty were more likely to report substantial concerns about lack of recognition for their collaborative work. One full professor woman suggested that, although it is “sold as a positive in recruiting . . . [tenure and promotion] discussions are very negative about collaborations, with even first authorship downgraded.” An associate woman professor similarly noted, “If you collaborate, it’s not independent work, so it’s basically ignored.” One assistant woman professor argued regarding her collaborative work, “I don’t know what I need to do to demonstrate that I’ve been part of the team, bringing something to the table, rather than riding on others’ coattails.” Another woman assistant professor argued that

the advice I got was to work on my own work. They don’t really count much of these collaborative papers unless it’s your students, your name. If you’re the co-PI on a collaborative grant, the money is kind of discounted, especially related to tenure and promotion.

This is very challenging for faculty members trying to ensure both research funding and promotion.

One conversation provides a glimpse into how full professor women understood collaborative research, and how they assessed their colleagues, as well as themselves. One woman who is a full professor noted, “Without collaboration, I would not have lots of NIH money, but I would not have dared before full promotion. It’s not so valued in my department, crossing the line so far as [discipline] goes, and [it] would not have been seen as a good thing before full professorship.” Another full woman argued, regarding engaging in collaborative research, “not before tenure, I tell juniors to stay within line” while another said “even then, not until they are a full professor.” Women at this table further noted that engaging in interdisciplinary research was perceived as “crossing into uncharted territory,” and that while it could bring “notoriety for junior faculty,” they “want people to take a safer path.” While both men and women reflected that receiving recognition for collaborative work was challenging, women were much more likely to bring up this topic, and spent much more time discussing these problems.

Men appeared less likely to recount problems in how their own collaborative research was considered in their evaluations. For example, one associate man noted, “I had several research projects and worked with people outside the department. That was important for my work. I never thought of how this was viewed by my department.” In answer to a question as to whether he did this collaborative research pre-tenure, he further noted “Not an issue. It worked well in terms of work and publications. Equal work from all PIs.” However, another associate man suggested, “If you don’t have publications by yourself it is bad/viewed negatively. If you have your own publications and some

with others—it is good. If all of your research is collaborative—you are not capable of doing your own research.” This man suggests that collaborative research is read within the context of a broader research agenda, and at least some solo publications are necessary (although this norm likely varies by field). Overall, it is interesting that women at all ranks were more likely to emphasize the challenge of assigning credit for collaborative research, while fewer men emphasized it as a central problem.

To summarize, we found that faculty raised a number of issues around recognition, including of their collaborative research. Both men and women identified challenges in receiving recognition for collaborative and interdisciplinary research, but women seem to express more concern about receiving recognition for collaborative research than men faculty. This finding fits with expectation states theory, which suggests that women may, in fact, get less credit than men peers if they are in fields where women as a group are stereotyped as being less competent relative to men. Given the importance of collaboration to STEM research, experiences of engaging in collaborative research without receiving adequate credit further limits women’s advancement.

#### 4.3. Relationships

Career development through peer mentoring collaborations was another critical point of conversation. One of the key themes that emerged was the type of mentoring structures that were effective or ineffective for faculty, such as formal versus informal mentoring, or top-down versus peer mentoring. Faculty also discussed mentoring support on papers and grant applications, and concerns around how to receive effective mentoring about getting grants given the current scarcity of funding. A final theme focused on concerns about burdening mentors or feeling burdened by mentoring. Men and women both discussed these issues, though men were more likely to report sustained mentoring from a range of colleagues, while women were more likely to report concerns about burdening mentors. Expectation states theory helps explain why men may be more likely to be mentored in male-dominated fields, as their colleagues may be more likely to see them as competent, and thus worthy of mentoring. Women’s concerns about burdening their mentors may reflect their attempts to live up to status expectations of women to care for others and think communally.

Many of the faculty were aware of the importance of professional development and faculty mentoring. This awareness meant that more departments assigned mentors to faculty when they joined the university. Yet, these assigned mentoring relationships were not altogether successful. Most men and women noted that assigned mentors were seldom activated. One assistant woman professor said her assigned mentors “rarely met with me and were not particularly helpful.” An associate woman described her department as “dominated by older white men,” and said “I don’t know if I was assigned a mentor, but my mentoring came from my graduate student friends and colleagues.” One associate man noted that assigned mentoring worked only “so-so,” arguing that it “depended on whether personalities matched up.” As one assistant woman, 18 months into her time at the university reflected, “I have my mentoring committee, but I haven’t really talked with them . . . but I’m going to do it soon.” Here again, we noted that women tended to blame themselves for the challenges that they face. Rather than wondering why her “mentoring team” had not contacted her, she expressed guilt for not contacting them.

While hierarchically assigned mentoring was not altogether successful, peer mentors were more helpful. The most successful formal mentoring programs involved peer mentoring networks that operated at department or college level, rather than a hierarchical relationship between a senior mentor with a junior mentee. For example, an assistant woman described a mentoring group in her college:

We felt a little frustrated in our department, and we had no senior women faculty at the time, so we did a College . . . mentoring group for women that focused on issues of research, teaching, work-life balance. Women of all ranks were included.

Here, junior women have created a peer mentoring program to provide each other with support that had been missing within their department. Another group of associate women discussed a

previous mentoring program funded by an external grant that was no longer active because the funding had ended:

we all shared a love of the mentoring program we had pre-tenure and . . . that is lacking, post-tenure . . . it was so productive, we would all like to see an effort, built in structurally. It needs to be institutionalized, can't be just depending on funding, gone away the next year.

One full professor who is a man also argued for this sort of mentoring system, adding that multiple types of mentoring are important—not just one (powerful) mentor. One larger department runs faculty mentoring sessions every other year for new faculty. These sessions count as departmental service for the senior faculty member running the sessions. An assistant man described the sessions: “[We have] monthly mentoring session for junior faculty around special topics (applying for NSF CAREER awards, balancing teaching and research, etc.) . . . We discuss teaching, balancing research, getting tenure, like 5–6 sessions a year.” Other faculty around the table thought this was an excellent idea, given that the advice is tailored to the needs of junior faculty members in that department. In all of these examples, cross-rank mutual mentoring networks institutionalized within departments or colleges, as opposed to individual assigned mentors, seemed to receive enthusiastic support.

One of the issues raised by faculty was whether there was a culture of mentoring in departments. For example, one associate man noted that he had lunch with his assigned mentor once a month, who served as his “official point person,” while those in his research area “are fairly close, so [they provide] lots of mentoring for things—grant writing to teaching.” Yet, he further noted “That’s the culture of my group. It’s not true for all groups in the department.” An associate woman also noted, “I’ve not experienced any mentoring as an associate prof. There is no structure [for it]. There are people who would be willing, they’re not hostile. It’s just not part of the culture.” An assistant woman conveyed that her assigned mentor did not work out and there is “no culture of mentoring” in her department. Interestingly, this missing “culture” of mentoring seemed most evident to women. However, one associate man expressed similar sentiments about mid-career faculty: while “mentoring for junior [faculty] is good. Once you get tenure, that system collapses.”

In addition to formal mentoring programs, faculty respondents also discussed informal mentoring. Men argued that they received a great deal of informal mentoring, making the formal mentoring less important. Comments among the assistant and associate men in different sessions and tables were fairly consistent:

Assistant man: The lunch bunch [including faculty of all ranks] discusses what is “valued” within the department. Learning this is important and one can only learn it by talking to people. You have to get some sense of what’s valued and not, what should you focus on with limited time. I got this in the informal discussions, because no one will actually tell you: How many students? How many papers? No one will tell you in the formal conversations.

Assistant man: There are five or six people giving me comments so I get as much as I want or more. There are monthly lunches with mentors, and I stop by [their offices] when I have questions.

Associate man: Informal mentoring may focus on grant writing, teaching, and identifying collaborators. Where mentoring does not exist formally, faculty still form collegial relationships and aim to help junior faculty succeed.

Associate man: There were many [faculty] interested in my success when I arrived. People read my grants, helped me formulate lectures, get matched up with people.

All in all, most assistant and associate men expressed that they were collaborating with their colleagues to enhance career development very effectively.

Women tended to feel less engaged with informal mentoring, particularly when they were in departments made up mostly of men. An assistant woman argued, “Networking depends on being



part of the boys' club, and women can't do that," noting that much socializing occurs after 5 pm, which is difficult for mothers, even though many men are also fathers. An associate woman similarly referred to informal mentoring as "the men chumming around [after] work." One woman who is a full professor argued, "Male mentoring happens organically, on the golf course, but women keep busy, but don't hang out outside of getting things done." For many of the women, this sort of informal collaborative work toward professional development seemed out of reach.

Men full professors, many of whom noted that they had not experienced formal mentoring themselves, were less certain about the need for institutionalized mentoring. Women full professors were somewhat more divided about mentoring. A number of full professor women noted that there was "no mentoring after tenure" or that "mentoring is only for junior faculty," calling for more peer mentoring efforts aimed at senior faculty. Yet in one group of women full professors, one referred to peer mentoring as "fabulous," while another suggested that formal and institutionalized mentoring was "intrusive and infantilizing." Similarly, in one discussion of why faculty were slow to advance to full in one department, full professor men suggested that those faculty were "too cautious," while one noted that "we found our own way, there is too much spoon feeding [now]."

Some men who are full professors suggested that processes such as departmental seminars, where faculty might present their work, or regular pre-tenure personnel evaluations, provided the necessary mentoring, and were skeptical about the need for additional mentoring efforts. One full professor who is a man said, "[We] have an informal system and talk about making it more formal, but it seems to work well. When it breaks down, the department head steps in. We also have—with one gap [one case where the junior faculty did not get mentored]—the department head and head of the personnel committee meet with junior faculty early in fall and talk about generalities—expectations, and meet informally." In this discussion, there appeared to be a disconnect between the mentoring that associate and assistant professors wished for and the mentoring that some full professor men thought was appropriate.

Respondents also discussed the mentoring that they received on papers and grants, suggesting that it was easier to ask for specific feedback. One assistant professor woman noted about her formal mentors:

I do get [feedback], if I bug them, like [on] a grant, I ask them to read my grant . . . but they are both senior people. I don't feel that connection, maybe [I have questions about] very stupid things about student, [they'll say] 'learn to deal with it,' no real suggestions. There is no real understanding between my situation and their situation."

Some assistant and associate women suggested that men mentors were more likely to collaborate with men mentees, and read their proposals and paper drafts, but were less focused on mentoring women. As one assistant woman noted, "overall, I'd characterize the mentoring environment in the department as one of benign neglect." One associate woman argued that men were more likely to mentor other men, "It's the case that men will talk to junior women, but won't read a paper . . . That's the male style of mentoring and it's rare to do any at all." From her standpoint, men were less likely to read and provide feedback to women. This may be because their senior colleagues are implicitly less likely to view women as worthy of this mentoring help. Men did not report these types of experiences.

Women respondents were particularly likely to point to mentoring as a burden. Women expressed concern about taking time from their mentor's busy schedules, but we did not hear this theme among men. One assistant woman wistfully described that she did not take full advantage of her mentors in her first year: "I had wonderful mentors, and they have advanced to other positions . . . and have new mentees in their first year, but you didn't know all the questions to ask yet." Assistant women in different focus groups tended to make the same points about not wanting to burden their mentors:

Assistant woman: I find that often it's the stuff I don't know to ask about that ends up being an issue...[but] I really don't want to take up more of my mentor's time than I already do.

Assistant woman: As a junior faculty, you don't want to bother people.

Assistant woman: You feel like everyone is so busy, you don't feel like always going to someone's office, would be nice to have senior faculty to initiate it."

Assistant woman: You do sometimes feel like you do not know if your issue is big enough to bug them.

However, one woman in her first year as an assistant professor noted that she was "always asking questions," and felt that being proactive was working well for her.

Our respondents suggest mentoring tended to go unrecognized and unrewarded. One assistant woman suggested, "Mentoring should be initiated by senior faculty and include [mentoring regarding] amount and types of service to undertake and grant writing. Maybe senior faculty should get service credit for mentoring—[the university should] incentivize it." From her standpoint, by creating incentives to mentor, faculty would be more likely to engage in needed mentoring. Another assistant woman argued, "[mentoring is] almost out of the goodness of the faculty hearts. The people that genuinely care, but if mentoring is that critical, then mentors should get credit somehow at some level." One associate woman noted that though she is now a mentor, she has no time, suggesting that course releases would facilitate tenured faculty serving as mentors. While many women full professors valued interactions with other women at the same level, they also felt overwhelmed by work demands, including mentoring. Some full professor women called for more information resources to be put online, so that they could direct junior faculty to the resources they need to do their jobs well to make mentoring less time-consuming. Women untenured faculty further mentioned the lack of incentives to mentor, despite their need for mentoring. Faculty suggested personnel committees need to do more to value the mentoring and service work that facilitates a collaborative climate.

The key concern assistant professor men mentioned was about the changing funding environment, especially with respect to both the increasing scarcity of federal grants and greater emphasis on collaborative research. As one assistant man argued:

Funding is tight these days. It's sometimes hard to get mentoring around grants because senior faculty without funding may not have gotten a grant in this climate. Now people are scrambling to find a way to sustain funding in a new environment, people who before had these massive labs, just don't.

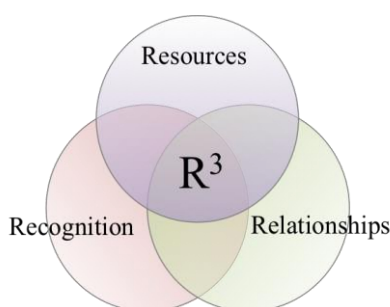
Women also expressed these concerns, such as the assistant woman who said, "I have to say it's harder with the funding situation. Before juniors could get funding in first or second round, money to solve research questions, but now the funding is a problem and still on top of that, we're junior faculty." Both men and women reflected that they may not receive effective grants mentoring if older colleagues have not had similar experiences.

Overall, when it comes to collaboration in career development, we heard more differences in the experiences of men and women, although they both agree about the need for mentoring, especially around grant proposals. While assistant and associate men could recount substantial mentoring engagement, much of it informal, assistant and associate women reported less mentoring. Women provided examples of the difficulty of connecting with colleagues, and receiving feedback on their work more than men. Women also were concerned about the time-consuming nature of mentoring, and the lack of incentives to mentor faculty colleagues—making them more cautious about requesting time and attention from their mentors.

## 5. Conclusions

For most STEM faculty, research collaboration is crucial for research productivity and career advancement. Yet, there may be gender differences in the resources available for research collaboration and how contributions to collaborations are evaluated. At the same time, while collaboration in career development is also important to developing social networks and teach faculty members the informal norms that lead to career success, women in STEM fields dominated by men may be less likely to

be engaged in these collaborations. Based on focus group data from STEM faculty at one research university, we find that faculty primarily identified three major issues around collaboration: *resources* for research collaboration, *recognition* for collaborative work, and collaborative *relationships* that support professional development, as illustrated in Figure 1. These three themes reflect many of the issues raised in the literature we reviewed on research collaboration and collaborative professional development, but also may serve as a broader framework to address gender equity in the academy [68,73,78–80].



**Figure 1.** Interactive Model of Resources, Recognition, and Relationships.

By holding our focus groups separately by gender and rank, we were able to identify both similarities and differences in how men and women, at different ranks, perceive the climate for collaboration at their university. While all faculty noted the need for greater resources for collaboration, men expressed greater outward frustration about the lack of resources, and women were more likely to identify their own inability to access resources needed for collaboration. Women were also much more concerned about how their collaborative research was viewed. Indeed, even senior women thought that they would not be credited as making contributions to their collaborative research. While both men and women expressed that formal assigned mentoring was not particularly effective, men were much more likely to describe informal mentoring that they received that was invaluable to their career development. In comparison, women were less likely to report these types of supports, and worried about asking for their mentors' time, which led them to feel less certain about whether they were making good career decisions.

Despite being located at a university that has developed supports for STEM women, it appears that men and women continue to experience their work quite differently. In keeping with expectation states theory women's and men's different statuses in STEM fields may have affected their experiences. If a particular field is framed as masculine, status beliefs about women may be based on the implicit stereotypes that women have less expertise in that field. Those who hold more privileged statuses—such as men and, in some cases, senior women, feel more entitled to resources and mentoring than junior women. In comparison, those who hold less privileged statuses, such as assistant and associate women, express substantial concern that they are less likely to be credited in their collaborative research. Men also appear to benefit from more consistent mentorship from colleagues whereas women express concerns about burdening mentors, which may reflect their attempts to live up to communal status expectations for women.

Expectation states theory does not suggest that these statuses are fixed. Even if women are viewed as less competent, other statuses, such as being a full professor, can counteract the status effects of gender. Indeed, senior women were more likely to make strong claims about needing resources for collaboration that mimicked men's. In other words, gender differences in faculty responses were more apparent among untenured men and women than full professors. It is important to recognize the gendered experiences and understandings of untenured faculty because it may lead to differential rates of tenure, promotion, and professional success. If untenured women make fewer claims for resources, are less likely to be recognized for their contributions for collaborations, and are less likely to be engaged in collaborative career development—they may also be less likely to attain tenure

and promotion. This pattern then reinforces assumptions that women may be less competent in particular fields.

These findings also provide insights into the factors that could lead to greater gender equity. Although our framing was around collaboration, our findings suggest that women's professional outcomes may be better in units where they have access to the same resources, recognition, and professional relationships as men. Substantial research has pointed to how women may not be able to access the same resources as men [43,68,73,78,81–87]; for example women may receive less investment through research funds, which limits their research productivity. The existing literature also points to the crucial role that relationships play in academic workplaces [6,7,67,74,88–94]. If men are more readily integrated into faculty networks, they may find it easier to learn the informal workplace norms and access information that helps them succeed. Research also suggests that recognition via transparent evaluation processes and communication matters, particularly regarding women's advancement [15,80,86,95–99].

We suggest that each of these factors—resources, recognition, and relationships—matter to academic success for STEM faculty. Moreover, our data suggests that when resources, relationships, and recognition intersect—as when a faculty member knows how to access essential resources (staff, space), whom to ask for help (a mentor or a staff member), and how his or her activities will be evaluated (as in the departmental personnel committee)—the effects are multiplicative rather than additive (see Figure 1). In other words, where access to all three “R”s exists (the central portion of Figure 1), the professional conditions are optimal, and we expect to see greater gender equity in retention, job satisfaction, and advancement of women STEM faculty. The area where two Rs intersect will lead to better outcomes than in the areas where only resources or recognition or relationships support collaboration. These factors influence each other in a bi-directional manner. Resources catalyze relationships and recognition. Recognition creates opportunities to attract more resources and build new relationships. Relationships help connect faculty to resources and receive greater recognition. All three factors matter, and indeed, the accounts from our focus group suggest that relationships are truly crucial for faculty to learn how to access resources and gain recognition or their collaborative work. We suggest that this model may be useful to universities as they address the challenges of gender equity. By examining and ensuring gender equity in resources, relationships, and recognition, in a variety of domains, it should be possible to develop strong and effective supports for women in STEM fields.

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## Appendix A.

The interviews began with an introduction that provided broad context for the discussion, and our goals, followed by focus group discussions at separate tables regarding the following questions.

- Q1. What support for peer mentoring exists (if any) in your department?
- Q2. How are decisions made in your department—do you think decisions are made hierarchically, or more collectively? (for example, do chairs consult and make decisions, do committees decide/how are committees selected)
  - Q2B. Relatedly, how much transparency would you say exists around personnel decisions in your department? (promotion, tenure, merit, distinguished, teaching awards)

Q3. In your own work, do you engage in interdisciplinary research?

Q3A. Do you see interdisciplinary research as supported by your department? (i.e., How do you think interdisciplinary research will come into play when it comes time for tenure review?)

Q4. What do you think the general level of satisfaction is among faculty in your department? (why?)

Q5. What barriers do you perceive to faculty work?

After these small group discussion were completed (after about 40 minutes), we shifted to a large group discussion, for all of the participants in the room. We first provided data on the race, gender, and rank breakdown of faculty in STEM fields. We also presented results of a survey that indicated that men perceive more equal treatment than women in personnel decisions, and asked the participants to discuss the data.

Q6. Are these data surprising? Why do you think there is a gender gap?

Q7. What recommendations do you have for interventions to address perceived barriers to faculty work?

Q7A. Are there ways that decision-making could be improved?

Q7B. Would you recommend additional support for interdisciplinary research, and if so how?

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