

Is the Academic Climate Chilly? The Views of Women Academic Chemists

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Recent government statistics indicate that although women comprised 46% of the total labor force in 2006, they made up only 34% of those employed as chemists and material scientists (1). This underrepresentation parallels the percentage of women obtaining doctoral degrees in these fields. For example, even though women received almost 50% of all doctoral degrees awarded in 2005–2006, they earned only 30% of those awarded in the physical sciences and technology (2).

The situation becomes even more extreme in the academic workforce, especially in some scientific areas, where the representation of women does not parallel the receipt of advanced degrees. For instance, although the proportion of doctoral degrees in chemistry that have gone to women has increased markedly over the past few decades, the representation of women among higher education faculty has not increased at the same rate. At the 50 schools with the highest chemistry-research expenditures, 31% of all doctorate degrees in chemistry awarded between 1993 and 2002 were given to women. Yet, women remain underrepresented on chemistry faculties, especially among the highest-ranked departments that have the highest levels of spending and receive the most research funds. In 2007, women comprised less than 15% of the faculties at these top-ranked schools and only 22% of those at the assistant rank, far below the representation of women among newly minted doctorate degrees (3–6). The National Academy's recent "Beyond Bias and Barriers" report concluded that when women reach a "critical mass" in their individual departments, a level that is near 20%, a transition occurs and women "start to perceive their common interests and join together to press for improvements in policies relevant to their needs" (7). Most chemistry departments have not yet met that threshold.

Numerous authors have suggested that women's underrepresentation in academe reflects a negative gender-related climate. Studies of the climate within academic departments including, but not limited to, chemistry indicate that, when gender differences occur, women faculty are significantly more likely than men to report negative experiences and unfair treatment and to be less satisfied with their positions. Women's lower levels of satisfaction and negative experiences, such as exclusion from networks and support, are related to a greater

tendency to leave academe and to lower productivity. Several authors suggest that continuing experiences with this negative gender climate cumulate through a "weathering" or "cascading" process, which can exacerbate issues associated with women's underrepresentation (8–10). A study of graduate students suggests that women in mathematics and sciences are more likely than men to have concerns about the academic lifestyle and to alter their aspirations away from academic research careers (11).

To date, analyses of the gender-related climate within the sciences have focused mostly on representatives of several disciplines. This no doubt results from the relatively small numbers of women within specific areas. Yet, the various science disciplines vary, often substantially, from each other, especially in the extent to which they have incorporated women. For instance, women have been more integrated into the biological sciences than the physical sciences. In 2006, over 60% of all bachelors degrees and almost 50% of all doctoral degrees in the biological sciences were awarded to women. In contrast, in the physical sciences, only 42% of the bachelor degrees and 30% of the doctoral degrees went to women. In addition, the sciences vary in the extent to which women with doctoral degrees opt out of academe for other employment opportunities. In general, women have been underrepresented as academic new hires relative to their representation in the pool of possible candidates in areas where doctoral recipients have employment opportunities in a variety of sectors, such as economics, engineering, medicine, and chemistry (3, 5, 12–15). Thus, relative to most other scientific fields, women chemists have more employment alternatives and appear to choose areas other than academe. One reason that women do not enter academe may involve the negative gender-related climate that has been documented in studies of broader groupings of academic areas.

This article focuses on women's perceptions of the gender-related climate within academic chemistry. This focus is important because most previous studies have generally aggregated data across disciplines, thus potentially obscuring the true picture within the field. The focus is also important because women in academic chemistry represent only a subset of those with advanced degrees in chemistry. Understanding more about the views of women who have entered academe can be important

for developing ways to help more women to pursue academic careers.

Data and Methodology

The data for this analysis come from women chemistry faculty who attended workshops designed to develop negotiation and leadership skills and provide a venue for them to network with other successful women chemists. The workshops were sponsored by the Committee on the Advancement of Women Chemists (COACH), which is composed of senior women faculty members in chemistry from around the country, and are described in the companion article to this piece (16). Since 2001, with the financial support of the National Science Foundation, National Institutes of Health, and Department of Energy, COACH (17) has sponsored workshops at national professional meetings. Over one-third of the women faculty who hold tenure track positions at the top 100 chemistry departments along with over 200 additional women faculty from other chemistry departments around the country have undergone training at COACH workshops at the national American Chemical Society (ACS) and American Institute of Chemical Engineers meetings. Dozens more (not surveyed) have attended COACH workshops held at their home institutions. Before attending the COACH-sponsored workshops all participants filled out a questionnaire that asked about their career experiences and views regarding their departments. The questionnaire was distributed and completed using a Web-based format. Information was available from over 250 attendees.

Even though the respondents to this survey comprise a substantial proportion of women in academic chemistry departments, the fact that all had chosen to attend a workshop for women on negotiation and leadership certainly introduces a possibility of bias. This bias could occur in at least two ways. First, the respondents may be more aware than others of gender-related issues and thus more likely to report such problems. Second, anticipation of the upcoming workshop content could have prompted the respondents to be more forthright and open about the gender-related issues that they faced in their work life. If so, the responses may be more accurate and revealing than might otherwise be obtained. While we cannot determine the nature or extent of this bias, examining the views that were expressed is still important. We have no reason to believe that the responses were not firmly held and sincere.

Our analysis is descriptive and exploratory and focuses on four general areas: First, we examine the extent to which women report that they have received mentoring and support throughout the various stages of their careers, for numerous studies have cited the importance of mentoring and interpersonal support in encouraging women to pursue academic careers and to stay within the profession (9, 18, 19). Second, we examine women's perceptions of the relative resources and privileges that women and men receive within their academic departments. No matter how much individual encouragement someone receives, actually having resources, material support, and privileges is crucial for ultimate career success. Third, we examine perceptions of issues that affect recruitment, hiring, and career progress. Finally, we describe the faculty members' general satisfaction with their work life and their overall view of the ways in which women and minorities are treated. These questions parallel those that have been used in national surveys, allowing us to directly compare the views of the women chemists to others within academe.

In our data, we examine the views and experiences of all the women in our sample regardless of rank. The views of women with greater job security through higher rank and academic tenure are compared with the views of those at the beginning stages of their careers. It is possible that, as women have become more common within graduate programs, a chilly climate may have diminished and those at the early career stages will have had fewer negative experiences. Alternatively, those at the early stages may be more vulnerable and aware of negative environments. Our data were gathered over a seven-year time span, from 2001 through 2008, and we compare, when possible, the views and experiences described in the more recent part of that time span with the earlier views. This allows us to examine the possibility that there have been changes in the academic climate and that negative experiences may be less common in recent periods. In the text and supporting material we refer to those who attended in more recent years as the "later attendees" and those who attended before that time as the "earlier attendees". The quantitative data, summary tables, and statistical results are included in the supporting material.

Demographic and Career Characteristics

The women in the sample ranged in age from their late twenties to mid-sixties and from those who were newly hired in their positions to those who had been in rank for over twenty years. A third of the attendees were untenured assistant professors, and another 14% held other untenured ranks. Among the tenured attendees slightly more women were at the associate rank than at the rank of full. As would be expected, the tenured faculty members were significantly older than the untenured, had been hired in earlier years, and had been at rank and in their positions for longer periods of time. The attendees' fields of study include all the major areas of chemistry, and the majority was employed at research 1 or 2 universities. There was also diversity in the extent to which attendees were married and had children. About two-thirds of the attendees were married and slightly fewer had at least one child. The vast majority (three-fourths) were non-Hispanic white, with relatively even representation of other race or ethnic groups. Members of minority groups were slightly more likely than non-Hispanic whites to be untenured.

In short, while the sample was not selected in a manner designed to represent the entire population of women chemists in academe, the diverse nature of the respondents indicates that their views may reflect those of a wide spectrum of women in the field.

Mentoring and Support

To examine how much support and guidance the women had received throughout their careers, the women were asked whether they had someone they regarded as a mentor during their education and training, in the first ten years of their career, and in later career stages (Table 1 of the supporting material). They were also asked whether they had mentored others. Overall, 37% of the attendees reported that they had someone they considered a mentor during their education and early professional training. This figure rose to 43% regarding the early years of their career and to even higher levels (57%) for those who had been in their careers for more than ten years. Only one-third reported that they had served as a mentor to others.

There were rather striking differences between tenured and untenured faculty and also between those who attended the

earlier workshops and more recent attendees, suggesting that mentoring may have become more common in recent years. Although there were no significant differences between tenured and untenured faculty in their reports of mentoring during their education and early training, the untenured faculty members were significantly more likely than tenured faculty to report that they had a mentor after launching into their career and to have served as a mentor to others. In addition, the more recent attendees to the workshops were significantly more likely than the early attendees to report having been mentored both during their education and early training and the early stages of their careers and to have served as a mentor to others. Among the later attendees who had a mentor, almost half reported that the mentor was a woman. This could suggest that at least part of the recent increase in mentoring may result from women providing increased career support for each other.

Participants in the early workshops were also asked a series of questions regarding the extent to which various groups with which they interacted were "supportive of women" (Table 2 of the supporting material). While a majority reported that others were generally supportive of women, a substantial minority did not feel that there was support for women and responses differed depending upon the nature of the group. For instance, slightly less than one-third of the participants felt that undergraduate students, staff, and administration and faculty were not supportive of women. Somewhat more felt that the community in which their institution was located or the graduate students in their department were not supportive. The least support was perceived as coming from students across campus. There were no differences in views of tenured and nontenured women.

Perceived Resources and Privileges

All of the women were asked a series of questions regarding relative resources and privileges given to males and females within their departments (Table 3 of the supporting material). A clear pattern of perceiving that privilege accrued to men faculty more than women was apparent. More than half of the respondents reported that men had higher salaries and almost that many reported that men got more recognition within the university for their research. Well over a third reported that men were taken more seriously by graduate students and undergraduate majors in their departments and had better promotion rates. Close to a third of the respondents reported that men had more or better space and found it easier to receive secretarial assistance. The only experience that was perceived as more likely for women than for men was having heavier teaching loads (reported by 20% of the attendees) and having heavier departmental and university responsibilities (reported by 36% of the attendees). Notably, neither of these experiences promotes research agendas or the traditional pathways to career success.

With only two exceptions, these perceptions were held equally by the tenured and untenured faculty and by those who attended more recent or earlier workshops. The two exceptions indicate that the pattern of perceived male privilege has not declined over time: The women who attended the recent workshops more often perceived that male faculty were taken more seriously by undergraduates (55% of the later attendees versus 37% for the earlier attendees) and that men had better promotion rates (45% of the later attendees versus 38% of the earlier attendees).

Issues That Affect Recruitment, Hiring, and Career Progress

In addition to asking about their mentoring experiences and their perceptions of their own treatment, those women who attended more recent workshops were asked a series of questions regarding the degree to which a variety of issues had limited their department's ability to recruit and hire women faculty as well as factors that they believed slow women's career progress relative to men's in academic chemistry (Tables 4A–C of the supporting material). The issues reflect three major areas: combining family and a career, women's own actions, and most importantly, characteristics and practices of the department or chemistry as a whole. Tenured and untenured women had similar views. For instance, ninety percent of the women said that concerns about combining family responsibilities and an academic career had presented either a moderate or major difficulty in their departments' efforts to recruit women, and almost as many gave a similar score to uncertainty about obtaining employment for a spouse. Similarly, over ninety percent said that balancing professional and family obligations was a moderate or major factor in slowing women's career progress relative to men.

There were three areas regarding women's own actions that respondents felt affected their careers: the extent to which women self-promote and market themselves, their success in obtaining funding, and their ability to compete for the best graduate students. Over half of the respondents felt that women's lack of self-promotion was a major factor in slowing their progress, while slightly fewer, but still a majority, saw the other factors as at least somewhat important.

Concerns regarding general treatment of women were reflected in four different ways. The first involves career support and mentoring. More than three-fourths of the women cited lack of mentoring of potential women faculty as presenting at least a moderate difficulty in recruiting new faculty and almost that many believed that lack of mentoring was at least moderately important in slowing women's career progress. The second area involves departmental practices that impede women's career progress. Approximately three-quarters of the women cited heavier teaching and service loads and exclusion from important department and institutional decisions as at least somewhat important in slowing women's career progress. Third, the respondents reported that department environments and faculty views regarding women in chemistry were important factors. Almost two-thirds of the respondents reported that an unwelcoming department environment produced at least a moderate difficulty in recruiting women, and substantial minorities (close to one-third) reported that opposition to the hiring of women affected hiring. Finally, the majority of respondents reported that gender biases in the peer-review process of articles and grants slows women's career progress relative to men's, with just under half believing that this was at least moderately important and three-quarters believing that it was at least somewhat important.

It is important to note that these various factors are probably interrelated. For instance, a lack of mentoring may be related to women's patterns of self-promotion and success in grant competitions. Concerns regarding the combination of family and career may be related to colleagues' hostility toward women and the general environment of a department. Even more important, the various disadvantages do not occur in isolation but probably accumulate over time, in the weathering

process that has been noted in the literature and was mentioned above. Eighty percent of the respondents reported that the subtle biases against women faculty that accrue over the years are at least moderately important in slowing their career progress relative to men.

Work Satisfaction and General Treatment

The participants in the later workshops were asked about their general satisfaction with their work lives and their views of the ways in which women and minorities were treated in their departments. Because these questions were modeled on those asked of a national sample we were able to compare the responses of the women chemistry faculty to other men and women in academe, both throughout the university and within the physical sciences (20). In general, the results indicated that the women chemists in this study were less satisfied and more likely to perceive that discrimination existed than were respondents in the national sample (Tables 5 and 6 of the supporting material).

The women in our sample were much less likely than the faculty in the national sample to report high levels of satisfaction. For instance, almost one-third of the women in our sample reported they were somewhat or very satisfied with their workload and salaries, and slightly more (almost one-half) give these ratings to their overall work situation, while this response was significantly more common (given by over half) among both men and women in the national sample. At the other end of the scale, the chemistry women were significantly more dissatisfied with workload than other faculty, although there were no significant differences in dissatisfaction with salary or overall conditions. Differences between the views of tenured and nontenured women were relatively minor with the tenured women significantly more satisfied with their salaries than the nontenured women.

The comparisons of views regarding the fair treatment of women and minorities resulted in similar conclusions. More than half of the chemistry women agreed that women faculty and newer faculty are treated fairly, and indicated, on average, that women were treated more fairly than minorities. Again, however, the chemistry women were significantly less likely than the faculty in the national sample to believe that women and minorities were treated fairly.

Discussion

The data suggest that women chemists perceive a work climate that is problematic and less than welcoming. First, a large proportion of the women received little professional support through mentoring, especially while in school or in their early careers, and perceive that their campus environment is not always supportive of women. Second, the women believe that there are substantial differences in the resources and privileges awarded to men and women faculty, especially in the areas that are most likely to be related to career advancement such as salaries, recognition for research, space, and workload. Third, substantial proportions of the women report that gender-related issues affect their department's ability to recruit and hire or have a negative impact on the progress of women's careers. Finally, the chemistry women were significantly less likely than those in a national sample of academics to report being satisfied with their jobs and were significantly less likely than those in the national sample to agree that women and minorities are treated fairly. There was no

indication that more recent cohorts of women, as indicated by their tenure status, were less likely to report negative gender climates.

The results underscore the need for additional research on gender-related climates of specific academic areas. The tendency in earlier studies to combine results across several academic disciplines may obscure important and serious differences. Future work should be careful to examine variations across individual disciplines and also include both men and women. This could allow researchers to explore the ways in which varying academic cultures influence gender climates and the extent to which men and women perceive such climates in similar or dissimilar ways. It would also be important to replicate this study with a sample selected in a representative manner.

Our results may have important implications for those who wish to promote gender equity within departments and develop procedures and policies that can help attract and retain women in academic chemistry. The data suggest that special attention should be given to mentoring, equitable career support, fair distribution of resources, and combating hostile departmental and discipline-wide climates. Increasing women's representation in academic departments of chemistry will require that decision makers attend to these issues.

These problems are not unique to chemistry, and models exist for promoting change. For instance, support and resources for those interested in mentoring and coaching others are well developed in the business world and public sector, as well as in academe, and are easily accessible. Similarly, negative departmental climates can change, and views regarding women can become more supportive. A recent workshop with department heads in chemistry illustrates ways in which strong changes in gender-related attitudes can occur (21). Finally, disciplinary practices that are believed to be discriminatory and to impede women's careers can be examined and altered.

Recall that three-quarters of the respondents believed that gender bias in the peer-review process was at least somewhat important in slowing women's career progress. In other research we have found that over half of a sample of chemistry department heads share this belief (21). In other words, our data indicate that a majority of both department heads and women faculty believe that the chemistry peer-review process may be discriminatory and hinder women's career progress relative to men's. The experiences of other disciplines can provide insight and guidance into how such perceived bias can be addressed. For many years journals in other disciplines, such as medicine and economics, used a nonblinded system of reviewing articles, similar to that which is currently used in chemistry. Faced with concerns that the practice was discriminatory and could also result in the exclusion of less-traditional, but high-quality work, medicine and economics conducted extensive experimental evaluations of the practice. This involved procedures in which the same work was reviewed in a blinded and nonblinded fashion and, in the nonblinded condition, with authorship reflecting variation in gender, race or ethnicity, and affiliation. The results indicated that using blind reviewing practices almost always resulted in both higher-quality work being accepted and less discrimination against racial or ethnic minorities and women (21–24). Based on this evidence, most journals in both of these fields have altered their review practices to blind reviewers from the names and affiliations of authors, believing that this practice would produce both better science and a more equitable discipline.

Summary

Although our data indicate that many women chemists perceive their work climate to be quite chilly, it is possible that this situation can change. The data presented in this article suggest that the field could be well served by addressing issues related to mentoring, career supports, allocation of resources and privilege, and attending to issues within individual departments and within the field as a whole that impede women's career advancement.

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Supporting Information Available

Quantitative data, summary tables, and statistical results. This material is available via the Internet at <http://pubs.acs.org>.