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Championing Institutional Goals: Academic Libraries Supporting Graduate Women in STEM

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Abstract:

Academic libraries are well-positioned within their scientific research communities to assist with the retention of women in STEM fields. Librarians have an opportunity to find new ways to match collections and services to student needs and institutional goals by providing resources and programming in support of women in STEM. This paper will focus on the ways in which academic librarians can help support female graduate students in STEM, beginning with a review of the literature to determine the causes for the under-representation of women graduate students in some STEM fields. Next, it will review interventions conducted by institutions to address the uneven distribution, including a scan for resources or services provided by the library. Finally, it will use the findings presented in the literature to propose services and resources that libraries and librarians can provide to help address the issues that contribute to the low number of women in STEM fields.

Introduction:

In "The Value of Academic Libraries", Megan Oakleaf exhorts librarians to align their goals with those of their institution, and to seek ways to demonstrate impact via library services (Association of College and Research Libraries, 2010, p. 11). This is necessary, Oakleaf contends, as the government increasingly focuses on the economics of higher education (ACRL, 2010, p. 27). As a result, administrators will view academic libraries as cost centers rather than "value centers", unless they reflect the business model of the institution (Basefsky, 2006). By adopting institutional goals as their own, and by adjusting services to meet changing needs, libraries and librarians will function in ways that are not only meaningful to their educational communities, but which are also highly visible and impactful (ACRL, 2010, p. 13).

One such highly visible issue facing academic institutions, and one with much national focus, is the ongoing lack of female representation in Science, Technology, Engineering, and Math (STEM) fields. The National Science Foundation (NSF) has long sponsored grants to academic institutions for the creation of programs aimed at the promotion of women in STEM, with efforts dating back to at least 1982 (Kirkpatrick, 2014). However, according to recent data by the NSF, only 20.0% of doctoral degrees in physics are awarded to females, 22.6% of engineering doctorates are earned by women, 21.4% of computer science doctorates, and 28.2% of mathematics doctorates. The disparity inherent in these numbers is further highlighted when compared with the 60.8% of total doctoral degrees awarded to women in fields outside of science and engineering (National Science Foundation, 2013, Table 7-2). Among the recent efforts to contribute to gender equity is a five-year Federal Science, Technology, Engineering, and Mathematics Education Strategic Plan outlining proposals to address under-representation by women through a variety of avenues, including additional funding to NSF to assist in "…designing graduate education for tomorrow's STEM workforce" (US Department of Education, 2015, p.1).

Some would argue that these efforts to retain women in STEM are not appropriate, and have certainly not been effective. While the latter part of this assertion is undeniably true, one reason for the resistance to programming in support of STEM women is a belief that such efforts give an unfair advantage to women, based on gender rather than merit (Van den Brink & Stobbe, 2014, p. 187). Van den Brink and Stobbe contend that this misconception is due to the more public nature of the support for women. "The support that men receive during their academic careers tends to be taken for granted, while women are expected to advance on their own to prove they are sufficiently qualified. In contrast, women's programs were noticed, leading to the perception that women cannot succeed on their own merits." (2014, p. 199). Such perceptions reinforce biases, which are discussed below. Possibly as a result of the negative attention to this kind of support, some faculty are reluctant to take on the implementation of the necessary outreach, programming, and education to retain women graduate students (University of Wisconsin-Madison, 2000, p. 15). Programs and resources provided by libraries may counter these hesitations, and can be a way to engage both men and women in a dialogue about these issues. Libraries offer sources of trusted information, and are safe spaces that provide a neutral platform of discourse for academics of differing viewpoints. Librarians, who already support STEM departments through collections, instruction, and liaison and outreach activities, can take up this challenge as part of their ongoing workflow.

Academic diversity officers, departments, and residential services have already integrated efforts at a variety of institutional levels to aid in the retention of women in STEM fields. Although multiple resources support women in STEM within single institutions, often these programs operate as separate silos, unaware of others concurrently addressing the same concerns. The Committee on Institutional Cooperation Women in Science and Engineering Initiative (CIC WISE) Evaluation of Outcomes found that efforts aimed at female STEM retention are better accomplished when centrally organized within an institution (University of Wisconsin-Madison, 2000, p. 46). Academic librarians, as departmental liaisons, can span boundaries across these divides by joining these efforts and acting as communication bridges between offices and departments. A review of NSF-funded programs confirms that "widespread and synergistic participation across campus and the existence of visible actions and outcomes" were among the factors that contribute to the success of efforts to support women in STEM (Bilimoria and Liang, 2012, as cited in Society of Women Engineers, 2015, p. 228). Libraries have an opportunity to contribute to their campus-wide initiatives by partnering across units to improve female STEM retention, and by using their liaison relationships to engage with faculty to meet this common goal. Diaz speaks of this kind of relationship in his thoughtful commentary on the new roles of librarian engagement, noting that "Because the librarian knows his institution's story and its new directions, he can commit, in partnership with his constituency, to build a different future cemented by new initiatives, programs, and resources his library or university support." (Diaz, 2014, p. 230).

Academic libraries must embrace institutional and national goals and demonstrate positive impacts on these goals in measurable ways. Given the nationwide urgency to retain women in all

STEM fields, academic libraries are well situated to seize opportunities to join this pressing need. The time has come for academic librarians to champion this national and institutional goal and to lend their support to women in STEM fields. First, though, it is essential to investigate the nature of the problem of under-representation.

Literature Review

The long history of under-representation of women in STEM fields has generated plentiful literature around this topic. A review of this literature primarily from the past fifteen years reveals some common themes. The issues identified that seem to most affect female graduate students are the persistence of bias about women in STEM fields within academia; the lack of self-efficacy among females in STEM fields; and the difficulty in achieving work-life balance for some female STEM academics. There was also significant evidence found for the acceptance of the stereotype of STEM fields as being inherently masculine; however, as this seems to contribute mostly to the enrollment of undergraduate women (Society of Women Engineers, 2015), this topic will not be addressed.

Bias

We would like to believe that institutions of higher learning have all but eradicated bias, but ongoing research does not confirm this. While outright discrimination and harassment are infrequent, more subtle or covert biases have taken their place (McCullough, 2011, p. 2). To counteract this often unrecognized form of bias, Sevo and Chubin (2008) have reviewed the literature concerning bias literacy, and offer definitions of conscious and unconscious discrimination, implicit bias, and overt versus covert discrimination. Unconscious discrimination can occur when biases against a particular group are unknown to the person who holds them (Sevo and Chubin, 2008, p. 7). This can be the result of implicit bias, which is the product of traditionally held views that are assimilated beginning at a very young age; for example, the belief that boys are naturally better at math than girls (Sevo and Chubin, 2008, pp. 2-3, 10). Overt bias is blatant, whereas covert bias is carried out in an unobservable way. People may recognize their covert biases or they may hold them unconsciously (Sevo and Chubin, 2008, p. 8).

The National Academy of Science published a report documenting gender bias in science disciplines entitled *Beyond Bias and Barriers: Fulfilling the Potential of Women in Academic Science and Engineering* (2007). It found that "women are very likely to face discrimination in every field of science and engineering" and "a substantial body of evidence establishes that most people—men and women—hold implicit biases." (National Academy of Science, US, National Academy of Engineering, US, and Institute of Medicine, US, 2007) In 2012, Lincoln, Pincus, Koster, and Leboy found that female scientists' work does not get as much recognition as that of men and designate this the "Matilda effect". This is opposed to the "Matthew effect", wherein a male scientist's good reputation enhances his ability to garner more awards and prestige. In an analysis of data over a nine-year period from thirteen disciplinary societies, the authors found that women were frequent winners for teaching and service, but not for research. The "findings suggest that the 'Matilda Effect' persists – men receive an outsized share of scholarly awards and prizes compared with their representation in the nomination pool, despite efforts to increase nominations of women." (Lincoln, et al, 2012, p. 316).

Not all studies corroborate these findings. A controversial article by Ceci and Williams in the Proceedings of the National Academy of Science (PNAS) found that "Women's current underrepresentation in math-intensive fields is not caused by discrimination in these domains, but rather to sex differences in resources, abilities, and choices (whether free or constrained)." (2010, p. 1) The authors attribute the current imbalance of women in these fields in part to a lack of accommodation of family demands, and the possibility that women therefore choose to opt out of these positions (p. 1). The article was criticized, and subsequent work favored the existence of subtle biases rather than outright discrimination. Moss-Racusin, Dovidio, Brescoll, Graham, and Handelsman (2012) refute the Ceci and Williams findings in a *PNAS* article titled, "Science faculty's subtle gender biases favor male students". In a double-blind study, participants were asked to rate applications for a lab manager position, who had been randomly assigned to either a male or female name. "Faculty participants rated the male applicant as significantly more competent and hireable than the (identical) female applicant. These participants also selected a higher starting salary and offered more career mentoring to the male applicant." (p. 1). Gender of the faculty member had no influence on the results, leading the authors to conclude that both female and male faculty show bias against female graduate students.

Recently follow up articles were written by Williams and Ceci, as well as by Handley, Brown, Moss-Racusin, and Smith in *PNAS.* Williams and Ceci conducted randomized experiments involving nearly 900 tenure-track male and female faculty from across the US, to determine if there was a hiring preference for male or female applicants for a tenure-track position in the fields of biology, economics, engineering, and psychology (2015, p. 5360). They concluded that both male and female tenure-track faculty gave preference to female identified applicants. However, they do admit that "faculty members may be eager to hire women, but they and their institutions may be inhospitable to women once hired." (Williams and Ceci, 2015, p. 5365). In their follow up on gender bias, Handley et al. come to the disturbing conclusion that not only does gender bias exist against women in STEM, but also that there is a bias against research which confirms the existence of gender bias. This study, using three randomized, double-blind experiments found that men, and particularly male STEM faculty, tend to devalue research which demonstrates a gender bias in STEM fields (Handley, Brown, Moss-Racusin, & Smith, 2015, p. 13201).

Additional research focuses on minority women in STEM. In a thorough literature review, Ong, Wright, Espinosa, and Orfield studied women of color in STEM, and revisited the 1976 seminal work by Malcom, Hall, and Brown, "The Double Bind: The Price of Being a Minority Woman in Science." Ong, et al., conclude that despite progress to eliminate the outright discrimination of that earlier time, both overt bias and covert bias are the biggest obstacles to minority graduate women's success (2011). A recent study by Glass, Sassler, Levitte, and Michelmore analyzed twenty-nine years of data from the US Bureau of Labor Statistics, comparing the retention of women in STEM professions to other professions, during the first five years of work. They concluded that the higher the degree held by the woman STEM worker, the more likely they are to leave, "…suggesting that the STEM jobs held by advanced-degree holders are either more noxious or more isolating than those held by bachelor's degree recipients." (2013, p. 744). It should be noted, though, that this study does not separate the results from women employed in academia; therefore the conclusions may not apply to academic women in STEM fields.

Self-efficacy

Rittmayer and Beier (2009) define self-efficacy as the belief in one's ability to perform a specific task. They found that beginning at an early age, girls believe that they are not good in math; they correlated girls' low self-efficacy in math with the lack of women in STEM fields.

> "Boys and girls interpret their grades and performance in STEM differently. For example, in a science class, a girl might view a B on an exam as a poor grade, indicative of her lack of science ability. A boy receiving a C on this same exam might view the grade as passing and therefore indicative of his strong science ability" (Seymour, 1995, as cited in Rittmayer and Beier, 2009, p.1).

One of the conclusions reached by the authors, which is also relevant to the problem of bias, was that providing information about gender bias in science helped increase girls' self-efficacy "because it led them to reinterpret past negative feedback about their own and females' performance in science to discrimination rather than lack of ability." (Rittmayer and Beier, 2009, p. 7).

This difference in male and female self-efficacy in math was demonstrated in an earlier large-scale longitudinal study using data from the National Educational Longitudinal Study of 1988 (NELS-88), by Correll in 2001. Findings show that when males received positive feedback about their abilities in math, they tended to accept them as correct, but that females receiving the same positive feedback did not perceive themselves as being good in math (Correll, p. 1700). Although the study observed gendered self-efficacy in high school students, the findings are relevant in that they demonstrate beliefs that can create an implicit bias that will carry through various stages of life.

Another longitudinal study followed female undergraduate engineering students through their four years of study at four different institutions, and examined self-confidence and persistence in the engineering major. Chachra and Kilgore (2009) state,

> Research has repeatedly shown that there is a confidence gap that exists along gender lines. Our study shows that this gap persists throughout the college years even among high-performing students, that cultural and organizational factors contribute to the gap, and that this self-confidence is integral to the identity development of students and how they present themselves to others. (p. 13).

Although the study is about undergraduate women engineering students and the results cannot be extrapolated to female graduate engineering students, the implications are that these women graduate with a lessened sense of confidence in their abilities, which may discourage them from pursuing graduate studies or careers in academia. A survey by Heilbronner (2012) of high STEM achievers in high school at ten to twelve years post-graduation, and another sample at twenty to twenty-two years post-graduation, confirms that women's self-efficacy in STEM abilities contributes to their attrition from these fields (p. 50). Studies of female graduate students in STEM found that factors contributing to a lack of self-efficacy also included isolation (Robnett, 2013) and a need for greater numbers of female mentors (Potvin, Bauknight, Cellucci, & Tai, 2010).

Work-Life Balance

O'Callaghan and Jerger surveyed the literature regarding the enrollment in and attrition from STEM fields by women, and examined them for undergraduates, graduate students, and faculty. The authors found that one of the biggest challenges facing women graduate students in STEM is a lack of accommodation for family issues, in addition to bias, an unwelcoming environment, and a lack of role models and mentors (2006). Rosser surveyed recipients of the NSF Professional Opportunities for Women in Research and Education awards (POWRE, replaced by ADVANCE in 2001) from the years 1997 through 2000, and found that lack of accommodation of work-life balance is the most often cited challenge facing women in STEM fields (2003, p. 26). Although the participants in this study were in faculty or research positions, a workshop by the American Physical Society in 2007 titled "Gender Equity: Strengthening the Physics Enterprise in Universities and National Laboratories" suggested that female doctoral students in physics leave due to their observation of the lack of work-life balance in academia. The report concluded that

> Physics as a career will be more attractive to all participants—women, men, and under-represented minorities—if students perceive that being a successfully funded researcher does not preclude having a life that includes family, friends, and time for pursuing personal interests. Changes in the present culture are a must. (p. 21)

In 2011, the NSF began a ten year Career-Life Balance Initiative, recognizing that the lack of accommodation for family issues negatively affects the enrollment and retention of women in STEM fields (NSF.gov, 2011). However, not all agree that this program will properly address the work-life struggle facing females in STEM. Bonnekessen suggests that although the initiative is a welcome change, it also serves to reinforce the notion that women are responsible for family care; efforts should be made to make work-life balance attainable for both sexes so that the norm is not perceived as one being free of family responsibilities (2011, pp. 306-307).

Bonnekessen echoes an older study in *Science* by Etzkowitz, Kemelgor, Neuschatz, Uzzi, and Alonzo, of thirty academic departments in five disciplines that found that women were successful only if they adopted a work style that did not include accommodations for family (1994, p. 51). The study explored retention of female graduate students with respect to the idea of "critical mass," that is, the notion that once science faculty reach parity between the sexes, this will serve to attract and retain more female graduate students. Their findings discounted this notion, concluding, "In the face of exclusionary practices, both explicit and implicit, built into the research university system, many women PhD's, seeing the handwriting on the wall and seeking to balance work and professional life, sought employment in industry and teaching colleges." (p. 53). A more recent study by Wyss and Tai sought to identify relationships between gender and issues of work-life balance among graduate students in chemistry and physics. They analyze data from over one hundred interviews and surveys from participants in Project

Crossover, which questioned graduate students, postdocs, faculty, and scientists employed in industry about their experiences as graduate students. Wyss and Tai conclude, "…scientists experience a definite conflict between science-life and family-life, and female scientists experience this to a greater extent than males" (2010).

Environmental Scan

Many government-sponsored grants have supported institutional initiatives to retain women in STEM fields, some of which focus on the issues described above. In order to document the impact of these programs, the author conducted an environmental scan of the websites of the current fifteen institutional members of the Committee for Institutional Cooperation (CIC), as well as those of an additional thirty randomly selected Association of Research Library (ARL) institutions, for evidence of programming and support for women in STEM (n = 45). The institutions included in this sample are provided in Table 1. The scan, conducted in July and August of 2014, used the search boxes available on the institutions' websites in most cases, or searched Google using the institution name and keywords. Search terms used were "women," "women in science," "women in engineering," and "women in STEM." In addition, the author also searched the library websites of these institutions, supplemented by browsing these sites via navigation tabs, and also by searching the terms in the libraries' catalogs. No doubt, the availability of information provided in this manner limits the effectiveness of such scans, and the ease of finding results. Programs very well may exist that were not readily discoverable, or their URLs were no longer available.

Table 1. Scanned Institutions

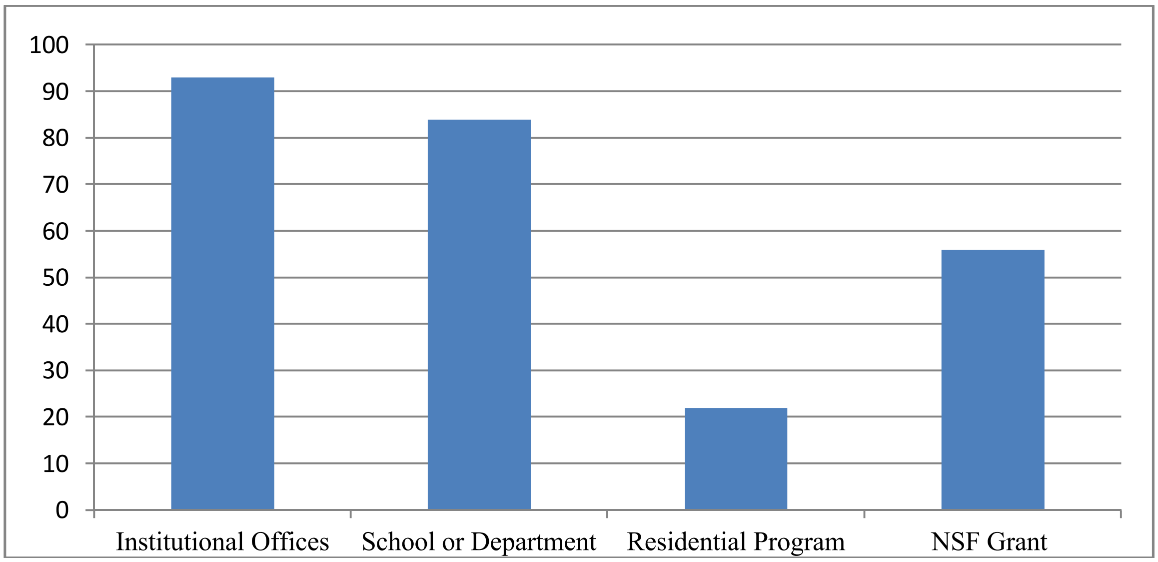
	Scanned Institutions: 30 Randomly Selected ARL, in addition to the CIC, Total n= 45*
1.	University at Albany, SUNY
2.	Boston University
3.	Brown University
4.	University at Buffalo, SUNY
5.	University of California at Davis
6.	University of California at Los Angeles
7.	Case Western University
8.	**University of Chicago**
9.	Cornell University
10.	University of Delaware
11.	Florida State University
12.	George Washington University
13.	Georgetown University
14.	University of Georgia
15.	University of Hawaii at Manoa
16.	**University of Illinois at Urbana-Champaign**

17.	**Indiana University**
18.	**University of Iowa**
19.	Iowa State University
20.	Johns Hopkins
21.	Kent State
22.	**University of Maryland, College Park**
23.	University of Massachusetts Amherst
24.	Massachusetts Institute of Technology
25.	University of Miami (FL)
26.	**University of Michigan**
27.	**Michigan State**
28.	**University of Minnesota**
29.	University of Missouri- Columbia
30.	**University of Nebraska-Lincoln**
31.	**Northwestern University**
32.	**Ohio State University**
33.	Ohio University
34.	**Penn State University**
35.	University of Oregon
36.	University of Pittsburgh
37.	**Purdue University**
38.	University of Rochester
39.	**Rutgers University**
40.	Southern Illinois University Carbondale
41.	Temple University
42.	University of Tennessee- Knoxville
43.	University of Virginia
44.	Wayne State University
45.	**University of Wisconsin-Madison**

*Institutions in bold type are members of the Committee on Institutional Cooperation, as of 2014-2015. CIC Wise participants 1996-2000 are not necessarily the same.

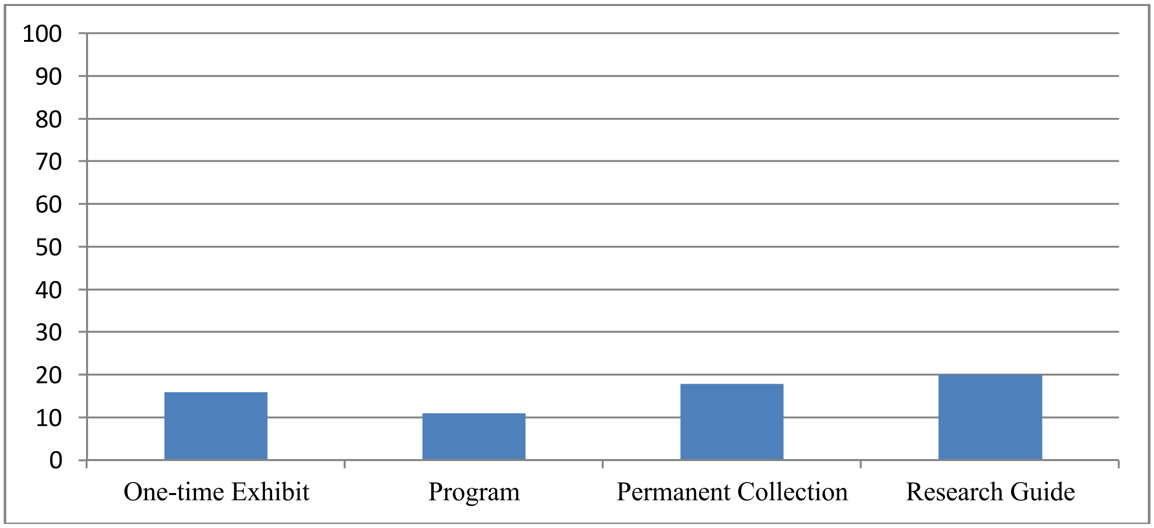
The scan was conducted so as to determine the existence or lack (1 or 0) of any institutional programming, past or present, and to identify its sponsor. Not surprisingly, given the long-term concerns about the retention of women in STEM, all of the websites reviewed contained evidence of institutional support for them. Institutions demonstrated support in some or all of the following: cross-campus programming, programming by schools or departments, residential services, and/or NSF funded programs. Without accounting for overlap, and identifying programs only as present or not, 93% (n = 42) of the institutions scanned identified cross-campus programs supporting women in STEM. Eighty-four percent (n = 38) listed programs sponsored by schools, such as the School of Arts and Sciences, or by individual departments. Ten of the institutions (22%) offered residential programs for women in STEM, although these were primarily for undergraduate students. Of the forty-five institutions, twenty-five or about fifty-six percent (56%) received National Science Foundation (NSF) sponsorship for their programs through ADVANCE (Increasing the Participation and Advancement of Women in Academic Science and Engineering Careers) awards, or participated in the NSF CIC WISE (Women in Science and Engineering) initiative from 1996 to 2000. (Fig. 1).

Fig. 1. Institutional Support for Women in STEM, Percentage of Scanned Institutions (n = 45)



The numbers are not so robust, however, when scanning for evidence of support for women in STEM on the websites for these institutions' libraries. Evidence was sought for the existence or lack (1 or 0) of programming and/or informational resources. Without accounting for overlap, and identifying programs or resources only as present or not, seven of the forty-five institutions' libraries (16%) provided a one-time exhibit concerning women in STEM; five (11%) provided some form of one-shot programming (although it is unclear if any have repeated them); eight libraries (18%) listed materials housed in permanent collections, either digital or print, related to a woman or women in STEM; and nine libraries (20%) posted research guides containing, but not exclusive to, information about women in STEM. (Fig. 2).

Fig. 2. Library Programming and Resources for Women in STEM, Percentage of Scanned Institutions (n = 45).



Notable Library Resources to Support Women in STEM: Collections

Although few in number, some notable resources were found in the scanned libraries. Of the libraries with print or digital resources about women in STEM, three provided resources that document and complement women in science programs on campus, or which resulted from collaborations with departments on campus. These resources have the potential to create additional impact by sharing ownership with a campus group outside of the library. The author found a good example of this type of collaborative programming at Southern Illinois University at Carbondale where the library held a Women in Science and Engineering Symposium, featuring a digital exhibit, "Petticoats and Slide Rules: The Life of Mary Hegeler Carus" using the library's special collections holdings of the Hegeler-Carus family papers (Morris Library Southern Illinois University Carbondale, 2013). Mary Hegeler Carus was the first woman to earn a BS in Engineering from the University of Michigan, and was actively involved in the operation of the Illinois-based Matthiessen & Hegeler Zinc Company (Hegeler Carus Foundation, 2013).

Another example of a collection that has complemented its institutional Women in Science and Engineering (WISE) program is at Ohio State University, in the Archives of Women in Science and Engineering. According to its website, "The Archives solicits, collects, arranges, and describes the personal papers of women scientists and engineers, as well as the records of national and regional women's organizations in these fields" and also contains an oral history project (Iowa State University Special Collections and University Archives, 2015). A similar collections-based project at Michigan State University involved collaboration with the History department and provided full-text access to the works of women scientists, along with biographies. While not related to a STEM event or organization on campus, the creation of the biographies involved both students and faculty in a department outside of the library (Michigan State University, 2015).

Other notable "collections-based" efforts supporting STEM women included reading groups or campus-wide book discussions at a few of the scanned institutions, but these only peripherally involved the library, if at all. One, involving the library, and launched in response to the terrorist attacks of September 11th, was the Campus Community Book Project at the University of California at Davis, co-sponsored with the Office of Campus Community Relations, the Office of the Chancellor, and the Office of the Provost (University of California Davis, 2014). Although one of the selected books for discussion touched on gender issues and women in STEM, this was not a group devoted specifically to women in STEM. A smaller scale book discussion group was noted at the University of Minnesota. This group was for undergraduate women in STEM, and was run by the College of Science and Engineering without library participation (University of Minnesota College of Science and Engineering, 2015). A similar book group for graduate women in STEM was run by the Graduate Women in Engineering Network at the University of Pittsburgh, again without library involvement (University of Pittsburgh Swanson School of Engineering, 2014). While these examples appeared to include little or no library involvement, book groups like these seem a natural fit for an activity that libraries can use to inform and support graduate women in STEM.

Notable Library Resources to Support Women in STEM: Spaces

Among the scanned institutions, the Science Library at Brown University boasts an impressive Science Center, a learning space set up for faculty and student collaboration. From the library's website:

> Brown's Science Center is a state-of-the-art facility that supports teaching and learning in the sciences. The Center houses academic mentoring and support programs and serves as the campus clearinghouse for information about research and fellowship opportunities at Brown and around the world. Students come to the Center to find a tutor, to join or to organize a study group, and to learn about research opportunities in their field…The Center also sponsors community education programs that extend Brown's science-related resources to the broader community. By bringing together faculty and students from across the science disciplines, the Science Center promotes curricular innovation, helps students achieve their academic goals, and fosters a community of science at Brown. (Brown University Science Center, 2015)

This enviable library space, while for the benefit of everyone, held events specifically for women in STEM. The Center hosted a dinner and discussion of issues faced by women and minorities in STEM fields, following a performance by a theatrical group that was designed to promote diversity on campus (Brown University Science Center, 2014). Libraries, even without a dedicated area for scientific collaboration, are a centrally located, neutral space that can host programs in support of women in STEM in collaboration with departments, schools, or offices.

Notable Institutional and Library Programming in Support of Women in STEM

The author found very few library-sponsored programs in support of women in STEM in the targeted institutions, perhaps due to the limitations noted previously, namely the impermanence of URLs describing these events, and the inability to find events by searching library sites using the chosen keywords. But the author did find many events at an institutional level, likely due to the existence of long-established NSF grants in support of these programs; many similar, presumably because they originated from the same NSF grants.

Many institutions specifically mention graduate women in science or engineering groups on campus. The University of Pittsburgh's Graduate Women in Engineering Network lists "book clubs, speed networking, and guest lectures" as some of the activities they provide (University of Pittsburgh Swanson School of Engineering, 2014). Likewise, Purdue University sponsors an active program for women graduate students in science-- a part of their Women in Science Program (WISP) where graduate students participate in a mentoring program that includes regular dinners with faculty. The program is led by paid, supervised student teams, who are responsible for organizing the activities (Purdue University College of Science, 2014). A similar program exists at Case Western University, which hosts Women In Science and Engineering Roundtables (WISER) at their Flora Stone Mather Center. The Center has as its mission to provide "a safe space that honors the diverse experiences and aspirations of all women." (Case Western Reserve University, 2014).

Some universities provide websites addressing the needs of graduate students. One at Brown University includes links to resources for families, such as day care, family activities, health and wellness resources, and other local information (Brown University Graduate Center, 2015). Although this site is not intended just for women in STEM, with a few additions it could also meet some of the specific needs of this group. Libraries have long created websites and research guides about informational resources, although only a few were found in the environmental scan pertaining to women in STEM. One example is the University of Michigan Library's research guide for the Women in Science and Engineering (WISE) Research Seminar (University of Michigan Library Research Guides, 2015); this one credit seminar is a requirement of their WISE residential program for undergraduates (University of Michigan College of Literature, Science, and the Arts, 2015). Collaborations in programs such as these are an opportunity for librarians to expand something they already do very well to the needs of this group, and also to work more closely with any existing programs and offices at their institutions.

Another for-credit course about women in STEM was found at Temple University, which lists a course titled "Gender Issues in Science and Technology" offered through the Computer and Information Science Department that satisfies general education requirements. It discusses contributions of women to STEM and explores "the impact on gender relations" (Temple University General Education Program, 2015). A similar course, led by librarians and entitled "Closing the Gap: Women in Science, Technology, Engineering, and Math" (Rutgers University Undergraduate Academic Affairs, 2015), was recently taught by this author and a colleague at Rutgers University. This was a one credit, pass/fail seminar open to all freshmen. Although not available to graduate students, we could readily adapt the literature assigned around the gender gap, discussion of career choices, and interviews with guest speakers from industry and academia to a graduate-level class.

Indiana University hosted a Women in STEM research conference, including poster sessions by both graduates and undergraduates (Indiana University, 2009). This was billed as an annual conference, but evidence of activities past 2009 was not found. Several of the scanned institutions have held similar research symposia for women in STEM, mostly for undergraduate research. Rutgers University Libraries recently held a successful session of lightning talks from STEM graduate student researchers, which was part of a graduate student research lunch series, hosted in collaboration with the Centers for Global Advancement and International Affairs (Rutgers Centers for Global Advancement and International Affairs, 2015). While the focus for this session was on STEM research with global applications, it could easily be adapted to highlight research by or about women in STEM, with collaborators from the science departments, history department, or other institutional offices.

Many more examples of institutional level programs were found in the environmental scan; however, very few of these included libraries, even when appropriate or desirable to do so. It is likely that the offices and departments involved in the programs viewed the libraries simply as the 'place with the books', and have not imagined other ways they might integrate libraries and librarians into their work. Going forward, it will be up to academic librarians to demonstrate how research-based programming and collections can be used to further the goal of retention of women in STEM.

Programming and Collections to Address Bias, Self-Efficacy, and Work-Life Balance

In focusing their efforts on the retention of graduate women in STEM, academic libraries will do well to curate collections and create programming within their spaces that address obstacles to their retention, including subtle biases, a lack of self-efficacy, and the difficulty of attaining work-life balance. Academic libraries are well positioned to address one or more of these issues through their programs, services and collections. The following represent possibilities for consideration.

1. *Libraries can highlight collections of the work of past women in STEM fields* to address all three of the previously identified issues contributing to graduate women's attrition from STEM. By acknowledging the significant accomplishments of women during a time when biases against women were overt and even accepted, it reminds us that biases did and still exist, even if they are not as prevalent or apparent today. By revealing bias, libraries can help women reframe their perceptions of their own abilities, thereby contributing to self-efficacy, as noted in the study by Rittmayer and Beier (2009, p. 7). And by bringing to public attention the women who have worked in STEM fields while also maintaining personal lives, it demonstrates how they achieved a work-life balance. Librarians can create bibliographies and research guides around these resources, and can partner with faculty to create them, as was done at Michigan State University Libraries (Michigan State University, 2015). They can amplify their impact by combining them with exhibits, symposia, and in use for course work, also in collaboration with faculty.

2. *Libraries can host reading groups* that address the themes of bias, self-efficacy, and work-life balance and provide reading lists of books or articles that deal with these issues. Library sponsored reading groups can be a safe environment for both sexes to discuss the issues contributing to the lack of women in STEM. Once initiated by librarians, a volunteer can lead the group as a way to share ownership and encourage participation. Library spaces and service hours are well-suited to scheduling flexible and convenient meeting times and places.

3. *Libraries can sponsor science cafés* and other collaborative gatherings focused on women and others in STEM. Growing in popularity, these cafes introduce scientific research to non-specialists, and encourage broad discussion of current scientific findings. NOVA, NSF and others have sponsored such sites as sciencecafes.org that offer guidance for launching similar initiatives (WGBH Educational Foundation, 2015). Librarians can leverage their liaison relationships with faculty by hosting cafés that feature female researchers within the institution, highlight the work of graduate students, or bring in speakers who can address issues such as work-life balance. Another approach librarians can take is to sponsor dinners or lunches that allow students to interact with and receive encouragement from faculty, helping them feel a greater sense of self-efficacy (Berg and Ferber, 1983, p. 644-645).

4. *Libraries can add lightning talks by graduate students* to their research methods workshops and presentations in collaboration with existing women in science groups, in order to give students the chance to gain feedback and practice their skills in a welcoming atmosphere. This will contribute to their sense of self-efficacy in conducting, presenting and discussing their research, which could result in more recognition, counteracting the bias of the 'Matilda effect' (Lincoln, et al., 2012).

5. *Libraries can contribute to or even co-sponsor courses about women in STEM.* Discussing the recent literature about women in STEM allows students, both male and female, to examine their own beliefs about their abilities, and makes them aware of bias, which may no longer be obvious but nonetheless continues to exist. It also allows a conversation about work-life balance, which may be a concern about which women are reluctant to speak within their departments.

6. *Libraries can expand work-life balance offerings.* Many already address these concerns through programming to reduce stress, such as visits by therapy dogs, meditation, and even massage therapy during finals (Rutgers University Libraries, 2014). Although these events are typically for undergraduates, libraries can easily adapt these programs to benefit existing graduate women in science groups on campus. Other offerings could include time management workshops, writing groups, support groups, and a web-based collection of resources available on campus and elsewhere. Libraries can bring in speakers to discuss various aspects of work-life balance, in an informal coffee-house setting, which will benefit both men and women.

7. *Libraries can offer "safe spaces" that "bring together faculty, staff, students, and community."* Just as the Flora Stone Mather Center at Case Western promotes their role as place, academic libraries help people "achieve their goals and transform society" through learning, and provide "resources and educational programming to enrich the academic, professional, and personal lives" of users (Case Western Reserve University, 2014). In short, library spaces are well suited to expand their programs, services, and collections to advance participation by women in STEM.

Conclusion

The lack of women graduating with advanced degrees in STEM fields is a problem that has not significantly improved for more than thirty years, despite national attention and funding.

Research continues to identify some of the factors that contribute to the attrition of women from these fields, and clearly more research and increased efforts based on this research are needed.

The issues of bias, self-efficacy, and work-life balance are influenced by and affect everyone. Programs aimed at retaining women in STEM should not be seen as initiatives to “fix the women”. As pointed out by Bonnekessen, systematic change is needed which also includes men. “When all participants in research and scholarship emphasize that both women and men must be included, women’s presence in the STEM fields moves from being a desired state to being a necessary state, while it becomes possible for men in the STEM disciplines to add a successful family life to their career.” (2011, p. 310). We will therefore gain nothing by ignoring the problems contributing to the lack of women in STEM fields. Rather, as with all possibly controversial topics, it is necessary to continue to bring the issues to light by collecting and sharing impartial research around this subject, by pursuing additional research into the causes of the lack of women in STEM, and by implementing programming based on that research. Libraries and librarians, situated within the hearts of their research communities, and with existing relationships with faculty, are ideally positioned to accomplish these tasks.

Librarians can build upon their liaison relationships with faculty to implement new programming, and can use their skills in creating websites, research guides, bibliographies, and digital collections, and in teaching critical thinking skills to address the attrition of women from science. As academic librarians are being asked to tie library outcomes to student engagement, retention, and graduation (ACRL, p. 12), they are also called upon to do so in non-traditional ways, driven by a “a more active paradigm [which] now calls for librarians to make conscious efforts to increase their contact with students” (Dow 1998, 280, as cited by ACRL, p. 34). By engaging with graduate women in STEM, and sponsoring and assessing the above described activities in collaboration with faculty and other campus partners, “Academic librarians at universities, colleges, and community colleges all can take part in the quest to document the existing value of libraries and maximize their value in future years.” (ACRL, 2010, p. 18).

We still have much to learn to further the progress of graduate women in STEM via academic libraries. We need to understand the factors contributing to retention of graduate women in STEM, assess existing and new efforts to increase the enrollment and retention of graduate women in STEM fields, and identify any institutional gaps in the support of graduate women in STEM. Unless we commit to joining the initiative to retain women in STEM, we will lose this opportunity to increase our institutional impact, and to engage more deeply with this user community.

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