Factoring Family Considerations into Female Faculty Choices for International Engagement in Engineering, IT, and Computer Science

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Renetta Garrison Tull is Associate Vice Provost for Graduate Student Professional Development & Postdoctoral Affairs at the University of Maryland, Baltimore County (UMBC: An Honors University in Maryland), where she is the Co-PI and Founding Director for the National Science Foundation’s PROMISE: Maryland’s Alliance for Graduate Education and the Professoriate (AGEP) for the 12 institutions in the University System of Maryland, and Co-PI Louis Stokes Alliance for Minority Participation (LSAMP) Bridge to the Doctorate at UMBC. Dr. Tull has worked with thousands of students from Alaska to Puerto Rico, and in Latin America through graduate school preparation workshops that have been sponsored by The National GEM Consortium, National Society of Black Engineers, Society for Hispanic Professional Engineers, Society for the Advancement of Chicano, and Native American Scientists, American Indian Science and Engineering Society, and the Alliance/Merck Ciencia Hispanic Scholars Program. She has presented workshops on graduate school admissions, “The Success Equation,” STEM initiatives, and PhD Completion in Panama, Mexico, Ecuador, Colombia, Puerto Rico, and schools across the United States. Tull is on the board of advisors for the PNW-COSMOS Alliance to increase the number of American Indian/Alaska Native (AI/AN) students who complete STEM graduate programs, and is a speaker on “GRADLab” tour with the National GEM Consortium, giving talks across the US each Saturday morning during the Fall. Tull researched speech technology as former member of the faculty at the University of Wisconsin-Madison. She has co-authored several publications on achievement in STEM fields, and is a mentoring consultant for Purdue, Carnegie Mellon, Cornell, and MIT. She co-leads the "ADVANCE Hispanic Women in STEM" project in Puerto Rico, and the Latin and Caribbean Consortium of Engineering Institutions’ (LACCEI) "Women in STEM" forum. Tull is a Tau Beta Pi "Eminent Engineer.”

Dr. Lourdes A. Medina, University of Puerto Rico at Mayaguez

Dr. Lourdes A. Medina earned her B.S. in Industrial Engineering in 2006 from the University of Puerto Rico at Mayagüez, where she graduated Summa Cum Laude and obtained the highest recognitions in the graduation commencements: Luis Stefani Rafucci Award, College of Engineering Award and Frederick M. Taylor Industrial Engineering Award. In 2007, she was admitted at The Harold and Inge Marcus Department of Industrial and Manufacturing Engineering at The Pennsylvania State University, where she received her M.S. degree in Industrial Engineering in 2009 and Ph.D. degree in Industrial Engineering in 2012. While at The Pennsylvania State University. Dr. Medina is currently an Assistant Professor at the University of Puerto Rico at Mayagüez in the Department of Industrial Engineering. She teaches courses in Automation Processes, Project Management and Linear Programming; and is conducting research in the areas of Systems and Product Design Methods, Medical Devices, Regulations, Complexity Assessment, Decision Support Systems, Manufacturing, Automation, Real-Time Process Control and Engineering Education. Dr. Medina is the IDEAS (Improving Design Decisions in Engineering and Applied Systems) Research Group Leader. This group is dedicated to innovating the development process of products and
processes. Dr. Medina has been the recipient of several fellowships such as the GEM Ph.D. Engineering Fellowship, NASA Harriet Jenkins Pre-doctoral Fellowship, Alfred P. Sloan Dissertation Fellowship, Graham Endowed Fellowship, Marie Underhill Noll Graduate Fellowship, and General Electric Fellowship, while also becoming a scholar of the Center for Integrated Health Delivery Systems at Penn State. She is member of Alpha Pi Mu Industrial Engineering honor society, Tau Beta Pi Engineering honor society, and Institute of Industrial Engineers (IIE). Currently, she holds the position of Media Director of the Manufacturing and Design Division of IIE and track co-chair of the education track for 2015 Industrial and Systems Engineering Research Conference (ISERC).

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Factoring Family Considerations into Female Faculty Choices for International Engagement in Engineering, IT, and Computer Science

Introduction

Advances in cyberinfrastructure and telecommunication have enhanced the ability of faculty and students to engage in transnational scholarship. In “New Developments in International Research Collaboration,” Hatakenaka notes that twenty percent of the world's scientific papers are coauthored internationally due to globalized communication channels. Hatakenaka’s work implies that engaging in international collaboration is a necessity if one wants to fully participate in the competitive environment of science, research and innovation.

As international collaborations in research continue to increase, it is important to consider how such changes may affect the gender, ethnic, and economic diversity of the Science, Technology, Engineering and Math (STEM) workforce. Furthermore, the globalization of research activity, coupled with the understanding of the importance of a diverse STEM workforce, promotes the need to support diverse groups of researchers who will engage in international collaborations. This paper considers the inclusion of U.S. citizen women STEM faculty from underrepresented minority groups and the barriers or challenges that might prohibit their participation in global activities, which can threaten acceptance, respect, and achievement within the broader international community.

This paper is organized in five sections. In the first section, we provide a brief review of the literature pertaining to women faculty in STEM and issues related to leadership. In the second section, we present an overview of the literature related to the significance of building a critical mass of female faculty in STEM. The third section includes a description of the methodology that utilizes a constructivist, hybrid approach that paired responses gathered during group discussions with recollected responses generated in an online community of U.S. graduate students, faculty and staff of color during the 2014 Latin and Caribbean Consortium of Engineering Institutions (LACCEI) Conference. In the fourth and fifth sections, we include the results from our analysis, discussion and recommendations for supporting female faculty’s engagement in international collaborations. The results provide insights about the factors that both limit and facilitate the engagement of women of color in STEM international collaboration.

Female Faculty in STEM and Issues of Leadership

Workforce diversification is a fundamental component for the successful development of any organization. Leadership development of underrepresented groups who pursue careers in STEM is an important step for an organization. Yet the issue may prove to be cyclical: the limited number of role models and mentors from underrepresented groups also inhibits this progress. For women in particular, this dilemma is what Sandberg calls the “ultimate chicken-and-egg situation” . While we need women in leadership positions to drive change, there are many factors that do not allow women to advance into these positions. For example, research suggests that women and minorities switch out of science as a result of the strength of their career. 
orientation. This orientation is in part initially influenced by parents, and then compounded by teachers.\textsuperscript{17} Despite the lack of career orientation toward the STEM fields, reports from the National Center for Education Statistics\textsuperscript{13} show an increase in the number of females pursuing doctoral degrees in general. Even with this increase in female PhDs, there is still a significant disparity between the number of females who obtain doctoral degrees, and those who have faculty careers and transition to becoming assistant professors.\textsuperscript{20} Consequently, these studies reinforce the need to recruit, retain and develop female faculty in STEM.

The Importance of Building a Critical Mass of Women Faculty in STEM

Studies have identified three issues that are significant to the building of a critical mass of women faculty in STEM. The first includes concerns related to recruitment. A second includes the issue of retention. Finally, studies have examined the factors that may impede or support the advancement of women faculty in STEM. These three factors are important to consider in international collaboration, research and engagement in the field.

Recruitment

The recruitment of females in STEM has been investigated so that we can understand the factors that influence career choices and career awareness. If we start with the selection of an undergraduate education in a STEM field, studies show that females are influenced by family, mentors and role models.\textsuperscript{2, 18} Family’s influence becomes a decisive factor, as the level of their approval and support can either encourage or discourage a young woman’s selection of a particular career path. As an example, awareness about particular professional career paths often stems from family members who are already involved in higher education, or from close relatives who work in a given field. In addition to family influence, the opinions of extended community members can exert pressure or power on a woman’s choice to pursue a career in STEM.\textsuperscript{2} For example, in a large scale quantitative and qualitative examination of women in engineering in Turkey with over 800 participants, Smith and Dengiz\textsuperscript{18} found that a significant number of females were discouraged from pursuing a career in engineering by their high school teachers.

If one examines the influence of role models and mentors, research suggests that the gender composition of institutions contributes to the number of females who enter the field.\textsuperscript{20} However, Canes and Rosen\textsuperscript{4} found no statistical evidence to support the view that an increase in the number of female faculty in sciences and engineering leads to an increase in the number of females pursuing those majors. Conversely, Harris et al.\textsuperscript{7} note that the number of females students majoring in Industrial Engineering at the University of Oklahoma could be in part explained by the high proportion of female faculty, the level of faculty-student interactions, and advising/mentoring practices.

The road to the professoriate isn’t always easy. Female faculty in particular find that having few women colleagues, unwelcoming search processes, and lack of development opportunities, to be inhibiting factors that influence the desire to pursue and enter tenure-track positions. Addressing these issues calls for institutional transformation which requires senior administrative support, collaborative leadership, flexible vision, and visible action.\textsuperscript{3} External agencies, such as the
National Science Foundation (NSF), and a network of peer institutions can also influence institutional transformation. Research suggests that females make career choices based upon their internal particular circumstances, the expected benefits, and personal perceptions. The internal particular circumstances or “internal factors” refer to circumstances that remain within the control of the individuals. These factors include geographic mobility, self-perceptions, and self-confidence. Women also evaluate the expected benefits through the lens of their gender role, income, credibility and perceived levels of prestige. This evaluation is coupled with the effort that women need to put forth to gain credibility and respect. Finally, personal perceptions impact career choices based upon the female's perception of the tasks involved, and the perception that there are fewer opportunities for females in comparison to males.

Retention & Advancement

Recruitment of women into faculty positions is difficult. Likewise, the retention of women faculty poses a unique set of challenges. Investigations in issues related to retention reveal that female faculty in STEM either take career breaks or change career paths voluntarily or involuntarily. The investigation of career breaks reveals that family matters. Results from empirical studies reveal that family considerations affect female faculty retention rates in STEM. While this revelation would seem to be common sense, females take career breaks as a result of their fatigue from managing “two full-time jobs” - work and family. On one side of the equation, we have the career which requires “maximum time investment”. While on the other side is the "biological clock" that imposes genuine constraints when women bear children. As an example, Assimaki et al.’s study of issues that affect the retention and professional development of female faculty in Electrical and Computer Engineering in universities in Greece noted that there are difficulties related to “the demands of an academic career due to the parallel demands of the role of the woman as wife and mother.” Similarly, women’s perceptions and professional issues in Civil Engineering include concerns with the level of commitment that an academic career requires in comparison to their family obligations. Females also take career breaks due to their partner’s relocation or to take care of an elder family member. Research suggests that some females who take career breaks report feeling satisfied with their decision while others report feelings of disappointment especially if they felt the break was their only alternative. Moreover, feelings of disappointment may persist if upon return to work women experience isolation and a disconnect from their careers, and face issues of self-confidence and fear when returning to the workplace.

Gendered divisions of labor also play a role in female faculty members’ career decisions and corresponding levels of satisfaction. Female faculty dedicate a greater portion of their time to undergraduate education in comparison to their male counterparts who invest more time in graduate education, research, and other activities. Female faculty are more likely to be assigned to do “the more caring and less valued duties of the faculty job.” Moreover, female faculty members’ experience higher dissatisfaction due to lower research support, advancement opportunities, and free expression of ideas. Research reveals that while the average number of yearly publications and presentations has increased for males faculty in STEM, the number has decreased for females. Valian concludes that women are slow in their advancement in academic science and engineering careers, due to lack of collegiality, discriminatory practices, less money, slower promotions and lower tenure rates as compared to men.
As we investigate career breaks and impediments to career advancement, we theorize that opportunities for advancement can also be developed via international activities. However, women of color in particular may not be participants in such endeavors. The paper presented here suggests that international engagement can be a medium for advancement and that women of color must be active participants in order to reap the benefits of collaboration, recognition, and opportunities for leadership.

Traditionally, international engagement involves collaboration between researchers from different countries working in sectors such as academia, industry or public institutions. We broaden the definition and consider collaboration to include consultation, advice, research lab or site visits, conferences, and exchange of information and research results. Such collaboration often facilitates student mobility and curriculum improvement. It is well documented that international collaboration is important for the development of knowledge, exchange of ideas, and solution for complex problems for both, students and faculty. While the benefits of international engagement seem evident, family considerations should be factored in the planning of these activities, otherwise, career breaks will continue.

Using the experiences of female faculty in engineering and computer science, and a combination of male and female STEM graduate students who attended an international conference, we seek to uncover answers to questions such as: How do we expose female faculty to these opportunities and help them balance work with the responsibilities at home? and How do we make these collaborations sustainable? We present data collected from participants who blogged during an international conference and draw conclusions using qualitative analysis methods.

Methodology

To learn more about female faculty members’ choices and thought processes regarding international engagement, we accompanied a group of 12 participants to an international conference. We asked them to participate in an online daily blog to record their perceptions of their ability to engage in international collaborations using the experiences during the conference, past experiences, and their perceptions of how the experience can facilitate opportunities to engage globally in the future. The group of 12 consisted of four female faculty of color, five male and female graduate students of color who were in training to become professors, a university administrator who served as the program’s leader, and two staff members. The participants were individuals from three programs sponsored by the National Science Foundation (NSF): ADVANCE: Increasing the Participation and Advancement of Women in Academic Science and Engineering Careers, AGEP: Alliances for Graduate Education and the Professoriate, and LSAMP BD: Louis Stokes Alliance for Minority Participation Bridge to the Doctorate Fellows Program.

The analysis utilizes a constructivist, hybrid approach that examined responses that were generated during group conversations, and recorded in an online community format during the 2014 Latin and Caribbean Consortium of Engineering Institutions (LACCEI) Conference. LACCEI is an international non-profit organization that provides academic and professional development programs in Engineering and Technology to universities, colleges, industry and
private organizations. In 2010, LACCEI and the Organization of American States (OAS) started a Women in Engineering initiative in response to the OAS Ministers of Science and Technology’s Vision 20/25, which seeks to increase graduates in STEM. LACCEI’s 2014 conference was held in Guayaquil, Ecuador, with attendees from countries in Latin America, the Caribbean, and the United States. The participants in the study were asked to attend sessions during the LACCEI conference, blog about their experiences and observations during the conference, and answer a series of guiding questions that were developed during the course of the trip in response to observed phenomena within the context of the international experience. Participants were also asked to give particular attention to the “Mujeres en STEM y Diversidad” (Women in STEM and Diversity) session which featured topics that could stimulate discussion on the blog. Table 1 showcases sessions and topics that were used as guide points for the blog conversation.

Table 1: Topics presented during the “Mujeres en STEM y Diversidad” (Women in STEM and Diversity) session at LACCEI 2014, Guayaquil, Ecuador, and resulting themes from which bloggers could develop online conversations.

<table>
<thead>
<tr>
<th>General Topic</th>
<th>Themes</th>
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| Women in STEM: Conversations in the Caribbean and Latin America | “Male Champions” in positions of power  
Work-Life balance (maternity leave, health, understanding from male counterparts, and job security)  
Opportunities to be considered for prestigious prizes (nominations, networks, and collaborations)  
Visibility and role models, opportunities for women in positions of power to be recognized (universities and corporations) |
| Transforming Climates for the Academic Women of Color: Facilitating Greater Understanding in the Workplace Climate and in Social Structures | Writing workshops for women faculty (proposals, articles)  
Women faculty perceptions of feeling overwhelmed by their university responsibilities because of multiple roles and expectations  
Women faculty’s family members’ perceptions of the women’s world load, e.g., family members who don’t understand faculty time requirements, leaving family events to return to the lab, staying at work late at work even though there aren’t class sessions  
Factors that impede the academic success of women faculty in engineering  
Historical positioning of majority men as academics and the perception of impacts on present-day biases against women faculty, e.g., academic community dominated by men in positions of power, perceptions of lack of support for women, and biases  
People of color are discouraged from pursuing a PhD, or a graduate degree  
Solutions: Workshops and support structures for family members of the women to explain what is expected from
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<th>Title</th>
<th>Summary</th>
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<td>their family member, the female academic; discussions with single women group about the relationship between the marital status and their career choice</td>
<td>Results: The study showed that the groups who participated were able to create strategies with family, such as understanding the academic calendar, plans for help with work at home, and recognition from partners for all of the hard work. Desires: More opportunities to mentor and progress toward improving isolation felt due to the perceived need to separate personal life from work life.</td>
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<td>Promotion and Prizes: Pursuit of Excellence and Recognition in Honorific Organizations (Christine Grant, North Carolina State University, Speaker)</td>
<td>Pursuit of prizes enables women to feel empowered, and celebrate success. Awards beget other awards; awards are morale boosters. Awards provide avenues for networking within the field. Strategies: Let your colleagues know who you are and what you do, connect with previous awardees, identify specific awards for which you would like to be considered and that are relevant to your career path, cultivate relationships with professionals in that area or group, join professional organizations, develop a portfolio of current promotions and prizes, learn from award evaluators, be actively engaged in your career trajectory, and request consideration for awards or promotions. Be resilient, solicit feedback, develop professional friendships, promote your work, and take an active stance.</td>
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<tr>
<td>Assistive Technology Research as a Mechanism to Broaden the Participation of Women, Underrepresented Minorities, and Persons with Disabilities (Patricia Ordóñez, University of Puerto Rico, Río Piedras, Speaker)</td>
<td>A female computer science (CS) professor at a university in Puerto Rico worked with a female CS graduate student in the continental U.S. who had disabilities to develop a program that expanded research for disability solutions. The Assistive Technology Research area was developed at a university to specifically broaden the STEM participation of people from underrepresented backgrounds, especially persons with disabilities. Using the premise of sharing knowledge, the projects include providing open source assistive technology research. Technologies focused on researchers with disabilities such as spinal muscular atrophy, and hearing impairments. International collaborations have been formed as a result of the project.</td>
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<td>Opportunities for Students (A. James Hicks, National Science Foundation, Speaker)</td>
<td>The Louis Stokes Alliance for Minority Participation Bridge to the Doctorate (LSAMP-BD) is a key program that provides full fellowships so that fellows can be full-</td>
</tr>
<tr>
<td>Opportunities for International Partnership (Clare Muhoro, US Agency for International Development, Speaker)</td>
<td>International partnerships enhance careers Be involved with international projects that include networking, writing proposals, and academic activities Go to international meetings and network Collaborate with a lab in another country</td>
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<td>The Prometeo Program of Ecuador and opportunities in Latin America (Nohelia Zambrano - Prometeo, and Julia Nieto Wigby - Escuela Superior Politécnica del Litoral (ESPOL), Speakers)</td>
<td>It is a challenge to keep women in STEM programs Mentors and role models for women are needed Prometeo provides partnerships: academic and researcher The international experience allows for academic activities, e.g., teaching, workshops, and curricular design</td>
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There were 15 project participants, but only 12 participated traveled to Ecuador for the international experience. Two participants were not able to travel to the conference, but contributed to the blog. One participant did not contribute to the blog, but participated in oral conversations during the conference, and those responses were captured and posted to the blog by other participants. These conference attendees and participants are summarized in Table 2.

There was purposeful variety in the backgrounds of the participants, because the researchers wanted to create an interdisciplinary environment with people from different ranks to stimulate conversation. There was also a purposeful plan to include a few participants outside of traditional engineering fields so that they could be fully immersed into an engineering context. The blog, titled: the “International Engagement and Broadening Participation in STEM from a Family-Friendly Perspective for Women of Color” project, invited graduate students and faculty from the ADVANCE, AGEP, and LSAMP BD communities from two regions in Maryland and Puerto Rico to contribute to an online discussions about international engagement and work-life balance. Participants were informed that their responses would be used for research on international collaborations and that we were interested in challenges and strategies that either affect or facilitate career-life-balance. All who visited the blog were invited to participate in the discussion and they were free to use any format for the blog name or avatar. Responses from anonymous users were valued equally among those who use identifiable blogger names or those who use pseudonyms. We welcomed and encouraged participation from the general public and from an international audience.

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<th>Subject</th>
<th>Position</th>
<th>Discipline</th>
<th>Participant Status</th>
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<tbody>
<tr>
<td>F-NC1</td>
<td>Postdoc/Staff</td>
<td>Biology</td>
<td>Blogger + Conference Participant</td>
</tr>
<tr>
<td>F-QB2</td>
<td>Faculty</td>
<td>Computer Science</td>
<td>Blogger + Conference Participant</td>
</tr>
<tr>
<td>F-RT3</td>
<td>Administrator</td>
<td>Electrical Engineering</td>
<td>Blogger + Conference Participant</td>
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This research project included a total of 6 questions and sub-questions which asked the delegates to blog about their experiences at the conference. Participants from the online community provided 188 qualitative responses. The blog questions included topics related to international collaboration, preparation for travel, and work/family/life balance (see Table 3).

Table 3: Guiding Questions Provided to the Participants to Stimulate Online Blog Conversation

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<tr>
<th>Topics</th>
<th>Questions</th>
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<tr>
<td>Question 1: General Experience</td>
<td>a. For those participants, who are preparing for the LACCEI conference in Guayaquil, please share your general thoughts over the next few days regarding your experiences with international collaborations, preparing for an international conference, observations as you travel, challenges, and expectations.</td>
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<td>(preparation, observation,</td>
<td></td>
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<tr>
<td>expectations etc.)</td>
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<td>Question 2:</td>
<td>a. What did you learn from the Wednesday plenary and the</td>
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Women & STEM

b. Is there a research benefit to meeting someone in person versus using technology to connect?

Questions 3 & 4: Demographic composition of group; Impact of trip on career goals & work life balance

a. Please describe the impact of having a mixed group of faculty (external to your university) and graduate students.
b. Has this trip facilitated any collaborations or research ideas that move you closer to your academic goals?
c. How can an excursion like this one contribute to career-life balance?

Question 5 Career building strategies

a. How did this international engagement experience influence your career strategies? (Please be specific.)
b. How will you encourage and model career-life balance for your current and future female mentees.

Question 6 Barriers & Recommendations

a. Name 5 things that impede underrepresented graduate students and faculty in STEM from taking advantage of international research or collaboration opportunities.
b. Provide 5 suggestions for increasing the numbers of underrepresented graduate students and faculty who will develop international collaborations.
c. Name 5 ways that international research and collaboration travel threatens or challenges the concept of career-life balance.
d. Suggest 5 ways that international research and collaboration travel can facilitate career-life balance.

Results and Recommendations

The results below are divided into five parts and each section includes recommendations for consideration as women faculty of color plan their careers. The sections are:

- International Collaboration: Barriers & Recommendations
- Financial Barriers & Recommendations
- Work Demands and Family/Life Balance
- Travel and Work/Family Balance
- Work Life Balance Advice to Future Female Mentees

Responses included concerns that are common to women: missing family, finding the time to travel, and balancing family concerns during the travel (e.g., child-care), course loads, research responsibilities, and financial barriers. However, the responses also included additional challenges such as acceptance in an environment where their skin color is completely different from that of the people in the region, and concerns about language or overall communication barriers. Responses from the participants suggest that inspiring a culture of international engagement among women faculty of color should start early, as undergraduate or graduate students. Early training can tackle potential fears of the unknown, increase language skills, and address other intercultural competencies.
Results - Part 1: International Collaboration: Barriers & Recommendations

As part of their blogging reflections, delegates were asked to list five factors they consider to be barriers to international collaboration for underrepresented minorities, particularly related to work/life balance. They were also asked to provide recommendations for dealing with such barriers. The following sections provide an overview of common factors discussed among the group both from the general perspective of being underrepresented minorities as well as related to the issues specific to women.

Both male and female delegates listed lack of knowledge as one barrier to participation in international collaboration. As one male Latino graduate student explained, “Lack of access to information: if you do not know about it, you can’t take advantage of it.” Delegates also noted that there may be a lack of knowledge about the benefits that participation in international collaboration could have on their careers, or when to pursue those opportunities in their careers. For example, while an African American female assistant professor was aware of the benefits of international collaborative research, she noted, “Prior to attending this conference, my thought was that international activity wasn’t needed to be promoted from assistant to associate professor. Though the thought was intriguing, it seemed as if this was something I needed to focus on later.” Limited access to information is considered to be an important barrier to international collaboration. The delegates provided recommendations to improve information flow about international collaboration. These recommendations included: using peer networks and creating educational opportunities through mechanisms such as conferences and university programs. Table 4 lists these suggestions.

For graduate students who will be future members of the faculty, there was concern of not having the support of professors and advisors. An African American male graduate student wrote that [there is a problem with], “Not being encouraged enough by their advisor to take advantage of these opportunities. Not every advisor is supportive. I have been lucky, but I know many underrepresented students in with advisors who do not support them.” Another blogger noted that there may be fear that an international collaboration could extend the time that one takes earn their graduate degree.

Table 4: Recommendations to Increased Awareness & Support

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<th>Themes</th>
<th>Sample Quotes</th>
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<tr>
<td>Utilize Peer Network; Conferences; University</td>
<td>“Word of mouth [...] it is more likely for anyone to pursue something if you hear from it from someone that went through that experience.”</td>
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<td>“Allow previous participants to engage potential participants through a webinar or personal contact.”</td>
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<td>“Increase awareness. At conferences it might be helpful to share information from those who have traveled abroad for research, mechanisms for funding, and benefits of international collaborations on career development. I also think that emphasizing the importance of such activities on one’s career rather than on the research is important. It is possible to have a research career without international activity; however knowing the career benefits that extend beyond research puts this in a different light.”</td>
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Educate Advisors  “Inform the advisors of students about the benefits of international travel and partnership. If they emphasize the significance of this type of work and are themselves given opportunity to take students, it may help to remove some of the barriers.”

“Yes, maybe some advisers didn’t have to make international collaborations to have their current position at the university, but in this global world of knowledge, that is not possible anymore.”

Results - Part 2: Financial Barriers & Recommendations

Funding was identified as a main barrier for participating in international collaboration. One delegate explained that the cost for international travel relative to domestic travel may lead some people to select the later over the former. “Travel is more expensive than national travel thus since there is a limited travel budget, often people rather prefer to make two trips to U.S. than one international trip.” With respect to gender and financial barriers, another delegate noted unequal pay for women could hinder women from participating international collaboration. “Economic limitations may be a barrier for women because fruitful international collaboration may require some traveling. Note that statistics also show that women earn less money than men.” Several delegates identified opportunities that they have used or know of to address financial barriers such as grants for travel that are available in some universities for students and faculty (see Table 5).

Table 5: Recommendations for Funding

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<tr>
<th>Themes</th>
<th>Sample Quotes</th>
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<td>Graduate student fellowships</td>
<td>“Some societies offer grants for graduate students to cover part of the travel, the academic department has some funding for students […]. Personally I have taken advantage of those and have reduced the money I have spent when traveling.”</td>
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<td>Mini-grants for faculty</td>
<td>“Provide funding. If it had not been for the funding that Dr. Tull received I would not have visited Ecuador or begun to think about international collaborations. Though I have grant funding, none of it would have supported my travel for this trip. Perhaps seed funding or mini-grants for faculty would be enable us to start collaborations and develop them enough so that they are mature enough to be written into a proposal.”</td>
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<tr>
<td>Greater funding agency support</td>
<td>“More funding agencies should promote international collaborations by providing funding for these collaborations.”</td>
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Results - Part 3: Work Demands and Career-Life Balance

The decision to pursue or take advantage of opportunities for international collaboration may be hindered by work demands and lack of support from their academic advisors, mentors, or job. One female assistant professor discussed the potential impact that the demands of achieving tenure may have on hindering participation in international collaboration. “As an assistant
professor, there are certain things that I have to do to get tenure and promotion. In addition to the basic milestones, adding an international collaboration to that list does honestly seem a bit daunting.” Another female assistant professor noted that time itself is an issue. “Since national collaborations take less paperwork, then it takes less time to do them and since there is a lack of time to do all that is required of an Assistant Professor, then less is done on an international level.” With concerns related to the time of the tenure clock, faculty in the beginning stages of their careers may not be motivated to pursue an international collaboration opportunity.

Results - Part 4: Travel and Career-Life Balance

The process of preparing for international travel and engagement presented concerns related to career-life balance. For example, delegates with children mentioned issues related to child care. An assistant professor with two children explained, “As a graduate student with children, I doubt that I would have been able to leave home for more than a week. Now that my girls are older, 2, 3 [days] at the most, might be the longest that I feel comfortable leaving them.” Another blogger noted pressures from family members to give up travel due to parenting responsibilities. “From personal experience, my mom has always encouraged me to stop traveling. In fact, she did not think I should work during the summer because I should take care of my baby. I must also say that I do not have day care in the summer, and she has been helping me since I gave birth.”

Delegates however, noted some ways that travel required for international collaboration could beneficial for the entire family. They also discussed how the use of technology could offer families who cannot travel together the ability to communicate and maintain contact. Table 6 shares these responses.

<table>
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<th>Themes</th>
<th>Sample Quote</th>
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| Travel with children                | “When deciding to attend the conference I was faced with a common work/life balance issue, childcare. The opportunity [was] not one that I wanted to pass up. However, arranging childcare was proving to be a challenge. I reflected on the times when I’d left my girls to attend conferences and wasn’t comfortable while away. During these times I know, in hindsight, that I wasn’t fully able to (mentally) participate in the conference because of this unease. So this time I decided to bring them along.”  
“Can bring family along to conferences and combine career and life so that children can experience international travel that they may not have experienced otherwise.”  
“Exposes us and family to more cultures to make us more globally aware”                                                                                                                                 |
| Communicate with family though technology | “[Technology] has worked out pretty well for me from a work/life balance standpoint. I left my baby (1 year old) for the first time. So, I have been able to see him through face-time, and receive text updates – with pictures.”  
“Maybe not having my family here can be a challenge, but I take advantage of new technologies such as Facetime or Whatsapp and I keep in touch with them daily. Sometimes I call my parents during dinner and |
Results - Part 5: Career-Life Balance Advice to Future Female Mentees

The U.S. delegates included female professors, and male and female graduate students. As such, the male delegates had the chance to reflect upon and participate in discussions on ways that career-life balance impacts women in STEM. In response to the question, “How will you encourage and model career-life balance for your current and future female mentees?,” male delegates provided a range of answers that included: encouraging mentees to be aware of the double standards held for women and men as they pursue their careers and not internalize it; seeking out female mentors; seeking out positive interpersonal and institutional support systems that might be available for women; being persistent and not quitting too early; and maintaining clear work and family boundaries by keeping work at work. As a result of the topics that were discussed in the “Women in STEM” session (see Table 1), the male participants became very aware of their roles as potential “male champions.” Their positions and recognition of their roles in society are reflected in their responses.

Results - Summary: Personal, Institutional, External, and Sociocultural Factors

To summarize the results, we use Medina et al.’s conceptual model of critical factors for women in STEM to analyze the concerns, challenges, and barriers for female faculty engaging in international collaborations.23 The model presents the factors that impact recruitment, retention and development of females in STEM fields in the context of four categories of factors: personal, institutional, external, and sociocultural. As a result of this analysis we identify personal, institutional, and sociocultural factors as barriers or challenges to female faculty members’ international engagement. Personal issues are mostly related to career-life balance, i.e., females are juggling between the work commitments and the family responsibilities. In the case of graduate students, there is the additional fear of extending the date of their graduation. Further, financial barriers impact both graduate students and faculty who wish to engage in, and pursue international travel. Regarding the institutional factors, some primary barriers to entry were related to the lack of institutional support, lack of role models, and the lack of knowledge/awareness about these opportunities and their importance to career advancement. Sociocultural issues also have an impact based on issues of acceptance due to differences in skin color and language of the country that is being visited. Finally, external factors do not show to be a challenge but a solution to enhance international engagement. Table 7 includes a summary of recommendations, based on participants’ blog responses that relate to the Medina et al.23 model factors.

Table: 7: Summary of Recommendations for Female Faculty to Pursue International Engagement

<table>
<thead>
<tr>
<th>Factor</th>
<th>Recommendations</th>
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<tbody>
<tr>
<td>Financial Barriers</td>
<td>Graduate student fellowships</td>
</tr>
<tr>
<td></td>
<td>Mini-grants for faculty</td>
</tr>
</tbody>
</table>
Greater funding agency support

Support from mentors to pursue opportunities
Educate advisors
Encouraging mentees to be aware of the double standards held for women and men as they pursue their careers and not internalize it
Seek female mentors

Increase knowledge and awareness of opportunities
Promote awareness through peer networks, conferences and the university

Personal and Institutional
Seeking out positive interpersonal and institutional support systems that might be available for women

Discussion of Results: Observing a Transtheoretical Model of Change

To examine issues of recruitment, retention, and advancement of women of color in engineering, information technology, and computer science, we identified “international engagement” as an intervention that could stimulate collaborations, improve productivity, and facilitate both retention and advancement. The decision to engage in international activities was not automatic for our sample of participants, despite clear evidence that development of an international reputation for scholarly activity is needed for advancement. Therefore, we look to social science to inform our findings and future actions as we seek to encourage more women of color to find and take advantage of global opportunities that can enhance their careers.

This study can draw upon the Transtheoretical Model of Change developed by James O. Prochaska. Prochaska’s model is based on the premise that change is comprised of six different stages: precontemplation, contemplation, preparation, action, maintenance and termination. We use this model because women may not know enough information about the benefits of global collaboration (e.g. the needs for increased awareness and support listed in Table 4), and they need to be convinced that international engagement is worth the time and effort. In the model, precontemplation is the stage where individuals are not ready to take the necessary steps to alter their behavior in the foreseeable future. There are factors that might impede the level of readiness, for example an individual or group may be uninformed or unaware about the benefits of change. Others may be aware but may be unmotivated or resistant to take the necessary steps to change. The contemplation stage occurs when individuals begin to weigh the pros and cons of altering their behavior. The preparation stage is when individuals begin to plan to make changes in the future typically within the next month. Change processes at the preparation stage can include acts such as doing research about the issue or consulting an expert for help. During the action stage, people begin to make a conscious effort to change their behavior. The maintenance stage occurs when individuals continue to perform the new learned behavior or action. Termination occurs when the individual adopts the desired behavior change typically over a period of five years or more.

Our project was able to take participants through the first four stages fairly quickly. The participants were informed about ideas regarding an international opportunity in March 2014, reminded of the opportunity in May 2014, invited to participate in the blogging project and travel
excursion in June 2014, and travel commenced in July 2014. The period of introducing the opportunity near 5 months in advance of the excursion may have provided the participants with enough time to experience the precontemplation, contemplation, and preparation stages prior to participating in the action stage.

The instability and juggle of career-life balance feeds the notion that the women may not be ready to make permanent decisions about their ability or freedom to engage in international activities. The process of change is not linear. An individual may move from the stage of precontemplation to action and then back to contemplation. In addition to the six stages of change, the transtheoretical model has deeper levels that describe ten processes of change. These processes include: consciousness raising, self-evaluation, self-liberation, counter-conditioning, stimuli control, reinforcement management, helping relationships, dramatic relief, environmental reevaluation, and social liberation. We did not conduct additional analyses to examine all of these processes in the context of our project. However, we did note that the process of consciousness raising was employed, as our project provided opportunities for individuals to become aware of the issues of international engagement and career-life balance through literature, informational lectures and by receiving feedback from others. The delegates participating in the study regarded consciousness as an essential first step to increasing the number of underrepresented minorities and women in international collaboration. In our project, consciousness raising began before the trip, and continued during the trip through exposure to the lectures during the conference and the conversations between the participants. Consciousness raising continued after the trip as the blogging process and reflections continued once the participants returned to the U.S. and were back in their respective home environments. Even without evaluating the other 9 processes, we believe that continuous consciousness raising is a key factor that can lead to the final two stages of the Transtheoretical Model of Change: maintenance and termination. In our case, maintenance means that the participants continue to seek opportunities for international engagement, and termination means that they have made the change completely and continually engage in global activities over the course of their careers.

An increase in awareness might not be enough to bring about the desired change for international collaboration. As the literature on women in STEM suggests, there are multiple factors that impede the recruitment, retention and advancement of female faculty in the field. Such factors include having a family, academic and work environment that is supportive the unique needs and interests of women as the struggle to balance the demands of work and family. We found such issues to be pertinent in this study.

Conclusion

Providing a funded and guided opportunity for global research and collaboration was important for women of color, and for men who are “in training” to be champions of change for women. The participants agreed that the cohort-based experience was a good introduction to, as well as preparation for, international collaborations, and that this kind of organized entry point can lead to academic advancement. We believe that developing organized international engagement cohorts of underrepresented women in fields like engineering, IT, and computer science, can increase retention and advancement through the faculty ranks if there is attention to consciousness raising about issues of importance to the women. These issues include, but are not
limited to attention to family responsibilities, capacity to complete career-related tasks, strategies for dealing with the potential manifestations of racial and gender inequity, and financial obligations. When deliberate attention is given to these career-life balance and cultural issues, and when information about such issues are coupled with explanations regarding the benefits of international activities, we believe that participants can experience positive change as they take action and maintain levels of global engagement.

We propose our organized cohort-based model as a potential, replicable intervention to address the current limited participation of women of color in STEM international activities. Administrators in offices of faculty affairs and Principal Investigators for projects such as the National Science Foundation’s ADVANCE program for women faculty, or the AGEP program for graduate students, can consider cohort models as structures that can be offered to their faculty. Conversations with participants revealed that many had not participated in an international experience prior to this project. We learned that active (not passive) “invitations” to engage must also be employed as part of the consciousness raising process to increase the participation of women and people from underrepresented groups in international collaboration and research. Along with an “invitation to engage,” other areas of concern must be addressed to assist women faculty of color with opportunities for advancement. As administrators seek to recruit women of color into faculty positions, they should invest in building new, or deploying existing structures that facilitate women’s retention and promotion in STEM in ways that incentivize international collaboration and research as part of the tenure process. As such, they are invited to consider the results and recommendations in this paper. These recommendations include addressing issues such as: financial barriers, work demands, demands of travel and career-life balance. Our next steps include replicating the model and organizing deeper levels of engagement within other international settings. This includes focusing on maintaining women’s global engagement for the long-term and moving them from precontemplation to the termination phase, which could theoretically manifest in the expansion and increase of international networks, collaborations, publications, and recognition.

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