TITLE: <u>WiSE Mentoring: Encouraging Women to Pursue Graduate Education in STEM</u>
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ABSTRACT

Recent research has shown that participation in undergraduate research programs enhances the likelihood of STEM students pursuing graduate education or professional degrees (Eagan et al., 2013). Students who express aspirations towards graduate school at the conclusion of their undergraduate studies are significantly more likely to pursue further education and have greater access to faculty networks that facilitate successful admission. Recognizing that these early years in scientists' and engineers' education are critical to later career trajectories and post baccalaureate achievement, the USC Women in Science and Engineering (WISE) Program implemented a newly revised Undergraduate Research Program in 2013 aimed at addressing the so-called "leaky pipeline" and encouraging more women to pursue graduate education. Mentoring is a critical component of this new program. The WiSE Undergraduate Research Experience promotes three crucial forms of mentoring. The program (1) facilitates faculty-student mentoring relationships by helping underclassmen identify potential mentors and sources of funding and by providing competitive grants to upperclassmen to conduct semester long research projects under the guidance faculty mentors, (2) provides an additional faculty mentor (currently Professor Jessica Parr) who works in tandem with the students' research mentors to provide professional development opportunities that complement their applied work, and (3) creates a supportive environment that enhances academic socialization and community involvement for women -- where students mentor each other. Students develop relationships that strengthen their own identities as scientists and engineers and provide important moral support, motivation, and encouragement.

CONTENT

In 2013 the USC Women in Science Engineering implemented a newly revised Undergraduate Research Program aimed at addressing the so-called "leaky pipeline" and encouraging more women to pursue graduate education. Founded in 2000, the WiSE Program is an endowed initiative housed in USC's Office of the Provost whose stated mission is to increase the representation of women in tenured and tenure-track faculty positions in the sciences, mathematics and engineering. In addition to supporting faculty recruitment and retention, the program administers a suite of grant programs aimed at supporting women undergraduates, PhD students, and postdoctoral scholars.

As one of the WiSE Program's original grant opportunities, the WiSE Undergraduate Research Program provided substantial grants ($4,500 per semester) to upperclassmen to support research under a tenured or tenure-track faculty mentor. Thirteen years later, the program conducted a review of past awardees (2006-2013) to examine career and education trajectories upon graduation. Of the 89 student recipients reviewed, 23 (26%) pursued PhDs, while 11 (12%) pursued degrees in healthcare (MDs, DDs, PharmD, and MAs and MSs in health fields), 32 (36%) pursued Masters degrees in the physical sciences and engineering, and 23 (26%) pursued professional positions. Bearing in mind recent research on the importance of mentoring, culture, scientific identity, and community support in successfully placing women in science and engineering PhD programs, the WiSE Program implemented a more comprehensive program that

provides students two paths to participation in scientific research and involves all students in organized professional development workshops.

The first path introduces students early in their academic career to research within the University. "WiSE Fellows" submit an application describing their interests and objectives in participating in the program. Once accepted, they receive a small stipend and commit to attending a variety of programming opportunities aimed at demystifying the research process, assisting students in locating appropriate mentors given their research interests, highlighting undergraduate research funding opportunities at USC, and locating appropriate Research Experiences for Undergraduates (REUs). The second path supports upperclassmen, "WiSE Researchers," in their research under a faculty mentor. Grants are typically awarded for projects undertaken during the summer semester, when students benefit from full-time participation in the lab without the added demands of coursework. Alternative arrangements can, however, be made, particularly for students in disciplines in which the summer is needed for fieldwork. If selected, students commit to participating in WiSE programming efforts throughout the academic year in parallel with their research. Students are competitively selected based on proposed research projects, prior classroom success, and faculty recommendations. Both sets of applications are reviewed by a committee of faculty members drawn from across the departments of engineering and physical sciences, which provides students with a unique opportunity to gain feedback from external faculty members on strengthening their project proposals and making themselves more competitive for other awards.

The program was renamed the WiSE Undergraduate Research Experience in order to accentuate the emphasis it places on personal growth and development and the creation of community rather than solely academic achievement and the acquisition of laboratory and investigative skills. Prior research has shown the advantages of Undergraduate Research Programs in terms of student retention, skill development, preparation for graduate school, and long term achievement (Bauer and Bennett, 2003; Craney, 2011; Eagan, Harkness, Hurtado, Mosqueda, and Chang, 2011; Eagan et al., 2013; Hunter, Laursen, and Seymour, 2006; Kardash, 2000; Kinkead, 2003; Lopatto, 2004; Seymour, Hunter, Laursen, and DeAntoni, 2004). Research also suggests that similar programs are particularly significant to the success of underrepresented students (Hurtado, Cabrera, Lin, Arellano, and Espinosa, 2009). Traditional Undergraduate Research Programs provide funding to enable students to participate in research and to facilitate faculty-student mentoring. The WiSE Undergraduate Research Experience is unique in that it involves students in an interdisciplinary and intergenerational (students at all levels of their academic careers) science and engineering community. Students are mentored by a tenured or tenure-track faculty member, are exposed to a series of professional development opportunities, learn to discuss their research with people performing research outside of their areas, and are mentored by an additional faculty member outside their own field of research. Unlike students in traditional research programs, who can easily become isolated in discipline specific labs with few women colleagues and mentors, WiSE Undergraduates are part of a larger and more extended community.

The objective of the new WiSE Undergraduate Research Experience is to address factors outside of the research environment that influence students' interests and involvement in the sciences and engineering. For example, women confront a culture in which science and engineering continues to be perceived as male disciplines; many people erroneously believe that men are innately better at math and science than women; and science continues to be a highly competitive environment in which many women are uncomfortable and intimidated (Hurtado,

Cabrera, Lin, Arellano, and Espinosa, 2009; Armstrong, 2013). Tendencies for women to be much harder on themselves in terms of achievement than men, to view a low exam or course grade as indicative of overall ability, also contribute significantly to women abandoning the research path (Rampell, 2014).

Of particular concern is research that suggests that the media's use of images of engineers as antisocial, immature, geeky, and awkward plays a significant role in deterring women from careers in engineering. TV shows such as *The Big Bang Theory, CSI,* and *NCIS* and movies such as *Revenge of the Nerds, Weird Science,* and the most recent James Bond film, *Skyfall,* imply that engineers are made up of a very narrow subset of the population -- one that consists almost exclusively of "nerdy" men. According to a team at the University of Washington (Armstrong, 2013), women believe that a computer scientist is "a genius male computer hacker who spends a great deal of time alone on the computer, has an inadequate social life, and enjoys hobbies involving science fiction" (p. 60) "Such media depictions," they conclude, "may cause students to believe that these characteristics are not only typical but even required of people in the field. As a result, students who do not fit the current stereotypes may be discouraged from developing an interest in these fields" (p. 61) Moreover, contemporary culture today values personality characteristics in women, such as sociability, grace, and poise, which are in direct opposition to stereotypes associated with computer science and engineering.

Fortunately, the UW team found that preconceived stereotypes about individuals in computer science and engineering can be altered through education and increased awareness. They divided students into two groups, providing the first with short essays that argued that computer scientists continued to embody "geek stereotypes" and the second group with short essays that argued the opposite – that these stereotypes are no longer accurate. The researchers found that women who read the latter article were far more likely to agree with a statement acknowledging that they had considered majoring in computer science. In other words, women reconsidered stereotypes and imagined themselves in roles they had previously associated exclusively with men -- as engineers.

To address these concerns and stereotypes, the WiSE Undergraduate Research Experience emphasizes peer support and the creation of a "learning community" that involves women in "shared learning and the discovery and generation of knowledge" (Pfund et al., 2012, p. 66). Students commit to participating in a series of WiSE-organized discussions, panels, and workshops, which are overseen by a member of the faculty and target potential deterrents to careers in research.

The WiSE Undergraduate Research Experience recognizes that students succeed within the context of a broader culture. By creating a small and intimate cohort of students, the program seeks to develop a strong student community that fosters mutual support and a sense of belonging. For students who are often one of only a few women in a class, this community has the potential to become an important source of support and to positively influence student achievement (Hurtado, Cabrera, Lin, Arellano, and Espinosa, 2009). Underclassmen also benefit from learning about the experiences of upperclassmen. By providing students with the opportunity to talk about their research, interact with other scientists and engineers, and engage with the faculty, the program seeks to strengthen scientific identity, which has been shown to be particularly important for women and minorities (Carolone and Johnson, 2007). The program recognizes that identity is a social construction and aims to engage students in "social processes" that foster their personal sense of themselves as scientists and engineers (Hurtado, Cabrera, Lin, Arellano, and Espinosa, 2009). Faculty mentors, PhD students, postdoctoral students, and

distinguished speakers also assist in deconstructing many of the stereotypes about women engineers and scientists and demonstrate the ability to balance careers in these disciplines with commitments to family and personal life.

Past programs have included workshops such as: how to create scientific posters, writing personal statements and CVs, applying to graduate school, talking about and presenting research, graduate student life, and work-life balance. Faculty members are invited to participate in a series of programs, referred to as "Myths vs. Me," in which they describe their personal as well as professional interests. These conversations directly challenge the stereotypes applied to women engineers and scientists that continue to be perpetuated by contemporary culture.

Mentoring is paramount to the success of the program.   First and foremost, the program emphasizes the importance of the faculty–student relationship, sometimes referred to as "mentor-protégé relationship." Research has shown that close interaction with faculty members is a strong predictor of student success and academic achievement. (Astin, 2007; Cole, 2007; Crisp and Cruz, 2009; Jacobi, 1991; Lundeberg and Schreiner, 2004). Students involved in close faculty mentoring relationships also have greater access to professional networks that facilitate entrance to graduate school. The culture of universities does not always, however, encourage faculty members to engage in these relationships, which though rewarding can also be time intensive (Eagan, Harkness, Hurtado, Mosqueda, and Chang, 2011). To address the fact that faculty members may be deterred from undergrad mentoring due to a lack of financial incentives, the WiSE program provides a small stipend of $500 to faculty members to cover lab or research-related expenses related to mentoring the students. These funds are often used to print posters and support student travel to conferences, which is invaluable in terms of the student's personal and professional development. The compensation is both financial, as well as cultural, indicating the value USC administration places on student-faculty engagement.

In addition to the primary faculty member under whom a student conducts research, the WiSE Undergraduate Research Experience provides students with a second faculty mentor. The program coordinator, currently Assistant Professor Jessica Parr, gets to know all of the students personally and, as an external faculty member with whom the students are not directly involved in research, provides an alternative source of information and feedback. Finally, the WiSE Undergraduate Research Experience promotes peer mentorship. We maintain that a sense of belonging to a social group, acknowledged support by faculty, students, and staff, and a comfortable and collegial environment in which to experiment with a developing scientific identity is crucial to women's success. WiSE fellows are asked to give back to the WiSE community by sharing their experiences with their peers and by being available for occasional volunteer activities. Students have worked with non-profit organizations such as the Boys and Girls Club of Santa Monica, the science education research group, Iridescent Learning, and USC outreach activities to encourage middle school girls from underprivileged areas in South Los Angeles to pursue their interests in STEM disciplines. Individual students have taken prospective students on tours of campus and have organized and presented science demonstrations (with the consent of their mentor) in the labs in which they work.

WiSE Researchers conclude the academic year by presenting a scientific poster highlighting their research results at the USC Undergraduate Symposium for Scholarly and Creative Work in late Spring. The symposium is a unique opportunity for students to exhibit their work and gain feedback from faculty and students. Programming throughout the year is aimed at preparing the Researchers to present clear and compelling presentations and to interact with faculty and students outside their research area. In addition to the skills they gain preparing

for the symposium, students also have the opportunity to be recognized for their work. At the 2014 Symposium, 4 WiSE students received awards for their work, including a first place award from the USC Schwarzenegger Institute for State and Global Policy, a second prize award in the physical sciences and engineering division, an interdisciplinary award in the physical sciences and engineering division, and an honorable mention in the Life Sciences Division. These awards provide important encouragement to students early in their academic careers.

The WiSE Program on the whole is conscious of the ways in which sex segregation can contribute to perceptions of men and women as essentially different. At the same time, it also recognizes the value of concentrating on the unique challenges of individual groups (Frieze, Quesenberry, Kemp, and Velazquez, 2013). Research has shown than men and women participating in the same undergraduate programs valued different sets of skills and experiences. Women, for example, valued the improvement of their communication skills more so than men (Craney, 2011). By involving students in a single-sex environment, the WiSE Undergraduate Research Experience is able to target concerns that are particularly relevant to women – social stigma, gender stereotypes, work-family concerns, etc. The program supports mentorship by both male and female faculty members and most of the undergraduate researchers work closely with male postdocs and PhD students, ensuring that their research experience does not promote unilateral assumptions about male or female skills.

The program has only been in operation for two years, making conclusions about its success in increasing the number of women to enter PhD program difficult to gage. However, the personal statements provided by applicants, as well as their end of year reports, indicate that the program's goals and objectives align well with the needs of the students. Students emphasize the importance of community support, skill acquisition, and interactions with faculty members and distinguished speakers. They also frequently reference potential plans to attend graduate school. A few telling comments provided by the women include:

> "I want to participate in WiSE events because I hope that they will serve as a gateway for me to pursue research by offering incredible resources, such as connections with possible mentors. WiSE offers many opportunities, from meeting graduate students to professors to mentors, all potentially incredibly influential people in my college experience. Having such esteemed professors and students offer their advice and perspectives is invaluable at a time when they are most needed. I also look forward to meeting other WiSE Fellows as well as WiSE Researchers, and build friendships with other passionate and motivational female scientists."
> - Freshmen, WiSE Fellow

> "Having had the opportunity to participate in the WiSE Undergraduate Research Experience as a fellow for the last two semesters, I have been able to interact with the brightest young women who seek involvement in the sciences as a way of making a positive impact on society. I have not only been able to exercise curiosity with my own research in the lab but also have been able to have intriguing conversations with other student researcher who I have met through the WiSE Program."
> - Junior, WiSE Researcher

"For the past year, I have participated in various WiSE events, especially those about applying for graduate school. From these panels and discussions, I have learnt a lot and finally determined to apply for graduate school to further my studies in Biomechanics field. Therefore, I definitely want to be part of WiSE community next semester to expand my interest in other fields as I know WiSE invites faculty from Electrical Engineering Department and Computer Science Department. Besides, I want to meet with new friends who may share similar inspiration with me. It is possible that I can come up with some new ideas and discuss with professionals to obtain advice."
- Junior, WiSE Researcher

"Female friends and mentors in the field of science and engineering is so crucial to a student's personal and professional development and I feel so fortunate to have the support of such a kind and intelligent community."
- Junior, WiSE Researcher

"As a WiSE researcher, I would particularly love to meet and hear from USC WiSE faculty and guest speakers in order to develop a better sense of how to successfully conduct research, pursue my interests in graduate school and be a proper research model for other young women aspiring to become engineers, thereby encouraging the growth of women in the STEM research fields and work force."
- Junior, WiSE Researcher

"The WiSE grant would provide me with not only the financial means to participate in research, but also the opportunity to hear from various speakers, network with different researchers and students, and gain a better understanding of professional research as a whole. Through this funding, I would be able to learn the basic techniques and fundamental procedures that comprise research, which would inevitably translate to and prepare me for research I may conduct in the future."
- Sophomore, WiSE Fellow

"While I have not been able to do so thus far in my education at USC, I hope that being in WiSE will open up opportunities for research and learning. Also, the designation of women would mean that I would be able to discuss ideas and acquaint myself with people that have been in similar situations, as well as interact within a community of research-minded females."
- Freshmen, WiSE Fellow

In summary, the WiSE Undergraduate Research Experience expands upon the models established by traditional Undergraduate Research Programs. By emphasizing faculty-student mentoring, both in the context of research and in the context of a larger women in science and engineering community, and by fostering a student community in which the participants support

and mentor each other, the WiSE Undergraduate Research Experience attempts to address the isolation many women feel in school and the social stigma associated with pursuing science and engineering as a career. By involving women in a thriving interdisciplinary student community that engages faculty, PhD students, postdoctoral scholars, and staff, the WiSE Undergraduate Research Experience seeks to encourage women to pursue their interest in graduate school in the sciences and engineering.

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