Empowering Women in STEM through Research and Mentorship in a Multi-Tiered Program

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Dr. Butler joined the faculty at WPI after completing a postdoctoral fellowship in biomedical engineering at Worcester Polytechnic Institute in 2016. Dr. Butler received her masters and doctoral degrees in Kinesiology (Athletic Training, Integrative Exercise Physiology) with her research interests focused on skeletal and bone biomechanics. She combines her love for education, exercise science, and her passion for diversity, and inclusion in her current position as a Teaching Professor in BME and the Director of the Office of Multicultural Affairs at WPI. Dr. Butler fosters a student community at WPI that respects and celebrates diversity in all its dimensions, including but not limited the many intersectional identities of race, ethnicity, religion, gender, sexual orientation, age, socioeconomic status, and physical ability.

Mrs. Ryan Meadows, Worcester Polytechnic Institute

Ryan Meadows holds a B.S. in Mathematics and Business from Fitchburg State University and an M.A. in Teaching from Sacred Heart University. She is currently the Associate Director of Pre-collegiate Outreach Programs at Worcester Polytechnic Institute. Meadows works with K-12 S STEM outreach programs during the summer and academic year.

Dr. Katherine C. Chen, Worcester Polytechnic Institute

Dr. Katherine C. Chen is the Executive Director of the STEM Education Center at Worcester Polytechnic Institute (WPI). Her degrees in Materials Science and Engineering are from Michigan State University and MIT. Her research interests include pre-college engineering education, teacher education, and equity in education.

Ms. Suzanne Sontgerath, Worcester Polytechnic Institute

Sontgerath holds a B.S. in Mechanical Engineering from Worcester Polytechnic Institute and an M.Ed. from Worcester State University. She is currently the Director of Pre-collegiate Outreach Programs at Worcester Polytechnic Institute. Sontgerath supervises K-12 STEM outreach programs at WPI including Camp Reach and several other summer and academic year programs for students and parents.
Good Afternoon, Thank you so much for attending this talk entitled, “Empowering Women in STEM through Research and Mentorship (WRAMP) in a multi-tiered program”. My name is Professor Tiffiny Butler and I am a Teaching Professor in the Department of Biomedical Engineering and Director of the Office of Multicultural Affairs at Worcester Polytechnic Institute. I am the eldest daughter of African American parents, first generation, cis-female, middle class, able bodied, devout evangelical Christian and a PhD. In my experience in STEM, I have constantly been underestimated and mislabeled in the areas of which I found interest. This constant misclassification and lack of representation created a strong sense of not belonging which drove me to me the representation in my field and create the support structures that I did not have that would have made a difference for me walking my path. On this project I worked in conjunction with two stellar colleagues Kathy Chen, situated to my left in the picture, the Executive Director of the STEM Education Center at WPI, who is the daughter of immigrant parents from Taiwan, cis-female, middle-class, able-bodied, PhD. Kathy is someone who always felt as an outsider or not belonging in STEM, she used her position as an engineering faculty member to support others to feel included and bringing in something special to their field based on their own live experiences and perspectives. Sue Sontgerath, the Director of Pre-Collegiate Outreach pictured in the red polo shirt on the far left. Sue describes herself as a white, cisgender, able-bodied female who is also an alumna and a parent of an alumna of the institution at which the research was conducted. Her undergraduate experience shaped her identity as minority in STEM. However, she acknowledges that she has been afforded privileges associated with being a member of a majority racial group. Sue’s career consists of two significant periods; one in STEM industry and one in higher education. During her career in
industry, she never had a female mentor or a female supervisor. Her career in higher education has focused primarily on increasing the number of underserved individuals in STEM. Because of her industry experience, her research interest focuses on the importance of role models and mentors in informal educational settings. She recognizes that she has had a strong focus on women in STEM in her research and look forward to further investigation of the intersectionality of race, gender, first generation, or socioeconomic status. The approach to the origins of this program begins in understanding our unique positionality in STEM in higher education and adds context to how we approach this work. The WRAMP program was funded by a grant through the Women’s Impact Network whose goal is to fund projects to bolster the efforts of women for women pursuing professions in the STEM fields.
Let me first begin by giving a brief overview of the background, goals and objectives, and the unique skeletal framework of the program to establish context for how we started and progressed through our program iterations.
Worcester Polytechnic Institute (WPI) is a moderately sized private institution of higher education located in Worcester Massachusetts serving approximately 5,000 undergraduate students and 1500 graduate students. Our university is situated 40 miles west of Boston and is considered the second largest city in New England. As the second largest city, the Worcester public school district is made up of 42 schools with 7 high schools in our local area. The Worcester public high school student population is made up of 58% of students being categorized as economically disadvantaged. Economically disadvantaged is calculated based on a student's participation in one or more of the following state-administered programs: the Supplemental Nutrition Assistance Program (SNAP); the Transitional Assistance for Families with Dependent Children (TAFDC); the Department of Children and Families' (DCF) foster care program; and MassHealth (Medicaid). 79% of students categorized as high needs which is defined if they are designated as either low income (prior to School Year 2015), economically disadvantaged (starting in School Year 2015), or English Language Learner (ELL), or former ELL, or a student with disabilities. A former ELL student is a student not currently an ELL, but had been at some point in the two previous academic years. 74 languages are spoken in our Worcester public schools indicating a tremendously diverse population with 41.9% of the student population being Hispanic, 28.5% White, 18.8% African American, 6.4% Asian, and 4.2% multi – race, non – Hispanic.
Worcester Polytechnic Institute, although situated in a very diverse city the demographic representation of the undergraduate and graduate student populations are starkly different with WPI having far less diversity than the Worcester public school. The large majority of students at WPI are white making up 61% of the total undergraduate student population, 11.9% students of unknown ethnicity, 11% Non-resident alien, 8.9% Hispanic/Latinx and roughly a combined 8% Asian and Black or African American. Our graduate student population is far less with only 8.5% of our total graduate student population as underrepresented students in STEM. However in the last three years our undergraduate women population has grown to 42% as of Fall 2019.
In response to our own stories in STEM and the changing demographics of our institution while being situated in a community that reflects the diversity represented throughout the country Sue and Kathy set out to start a pilot program called the Women’s Research and Mentoring program (WRAMP) to introduce STEM to women, specifically women of color, pursuing a career in a STEM field. To address representation and engage our diverse community of students a multitiered mentorship program was created. The program had three levels of women in engaged in education, high school women from the local community, undergraduate women at WPI serving as mentor and mentee and graduate women at WPI engaged in research at WPI. All students were engaged in research at WPI with high school women from the community participating in laboratory work 24 hours per week over the course of 1 semester with Saturday session for professional development of all women students. Primary outcomes for the program was to increase interest in STEM careers, confidence in lab skills and engineering design process, learned persistence, particularly in research. Additional objective were for mentors to gain mentoring skills, and the formation of community to foster belonging.
In the first iteration of the WRAMP program, affectionately call WRAMP 1.0, 1 graduate student was paired with 1 high school student. Research was designated for 2-4 hours for each high school student to get hands on research experience in the lab. Graduate students were afforded training session for professional development, with Saturday sessions for professional development of high school students. Upon reflection of the completion of the first cohort and reviewing the specific outcomes for the program, two primary issues became apparent that needed to be overcome: increasing the number of women of color and decreasing the age gap between mentors and mentees. I was added to the team for WRAMP 2.0, to help with these apparent issues in the cohort. I am the PI on the Louis Stoke’s Alliance for Minority Participation at WPI which is a National Science Foundation program that aims to provide support for underrepresented groups earning degrees in STEM to go on for degrees in higher education in STEM to diversify the STEM workforce. This position gave me access to a subset of students from diverse backgrounds interested in pursuing STEM professions. WRAMP 2.0 was the integration that transitioned from a 2-tiered program to a 3-tiered program, adding an undergraduate woman to bridge the gap in age and introduce a diverse representation of mentors. In addition, Saturday professional development sessions were then created for each cohort of the student groups. Also, in this iteration, college readiness was emphasized. In the most recent iteration, all high school women were from local public high schools. Saturday session were limited to two per semester to allow for increased opportunities for social
engagement within each group to foster better sense of community.
Here is a graphical representation of WRAMP 3.0 multiteried program where there were 2 high school women from our local public high schools, 1 undergraduate woman mentor/mentee, and 1 graduate woman mentor at WPI. Here you can see our students working together in their respective lab on their semester long projects. Each group had the goal of 2-4 hours per week to do research in the lab. If you notice, we have kept the total number of hours students are doing research in the lab due to the carriable schedules of all students involved, feedback from the students have indicated that this amount per week is the appropriate range of time students can commit to during the week in combination with their other scheduled responsibilities. The graduate student is responsible for scoping out an appropriate research project and training their mentees, which is a tremendous experience for those considering becoming a professor.
Saturday sessions throughout the program have changed in each iteration. Even though they initially started with programming just for high school students, the second and third iteration has increased programing for professional development for each student cohort group related to combatting imposter syndrome, strategic planning for a career (who and what do want to be when you grow up), recognizing and managing micro and macro aggressions in the workplace and laboratory setting, and training in an asset-based approach to mentoring emphasizing growth versus fixed mindset in our training. Students also focused on team building, communication training particularly in regard to “bragging” about one’s accomplishments, time management, how to give presentations utilizing techniques in improvisation, college readiness related to applying for college and the transition from high school to college, as well as building self esteem through effective self promotion.
The activities for WRAMP was to not only provide opportunities for growth in STEM of all the participants (i.e., high school, undergraduate, and graduate student), but to also improve their confidence (self-efficacy) and identity as someone who belonged in STEM. In addition to the professional development activities, the structure of WRAMP culminates in a team poster and presentation of the research work. With only a semester (~10-14 weeks) timeframe, much of the presentation is centered on what the HS and UG learned and the lab skills they developed (e.g., taking data, using special microscopes). They present to their peers and parents during the WRAMP closing ceremonies. Here, the mentees shine by sharing their newly gained knowledge and skills to others. They realize how far they’ve come from the very beginning of the program.

Theories about the formation of identity involve:
1) Interest and value
2) Seeing themselves in the role (e.g., scientist or engineer)
3) Having others see them with that identity

Thus, by the end of the WRAMP program, the mentees are presenting their research work just like “real” scientists/engineers and their families/peers see them in that role.

One of the things we’ve been thinking about with our K-12 outreach efforts in general, is how do we engage with families and champions more to support students interested in STEM? Based on the literature, can we be strategic in sending messages to the parents, teachers, and champions to encourage them to connect the student’s interests to STEM in everyday life?
Furthermore, does the mentoring experience support the graduate students in their confidence in considering academic faculty positions? Despite the underrepresentation of women faculty in most STEM fields, can this experience empower them to be a faculty member who purposefully engages and supports students from underrepresented groups in STEM?

And for the undergraduate students, WRAMP offers a research experience during the school year with a female graduate student. Some outcomes for the UG students have been 2 of them are now in graduate programs! (Most of the UGs have yet to graduate.)
In line with the overall program’s primary objectives, we have been able to increase the number of women of color in the program with each iteration. With increases in our high-school women being most compelling starting at underrepresented women making up 34% of the high school women at the start of the program in Spring 2018, to 70% in our latest completed cohort in Spring 2019.
WRAMP 2.0 and 2.5 (Spring term of the second year) mentors met 4 Saturdays per semester. While there were specific topics planned for the training sessions, the Saturday sessions were also a time for the mentors to share their experiences as undergraduate and graduate students at WPI and elsewhere. They formed a "Community of Practice" to help brainstorm solutions to challenges in communications with their high school students and the expectations for research within a semester. They offered lab tours for the other research groups so that the mentees could have more exposure to other research labs, as well as helping one another with their research (e.g., access to a scanning electron microscope). The women also bonded through shared experiences outside of the lab, such as family and cultural expectations of women.

The mentors also came up with suggestions to improve the program and we had an impromptu design session for future iterations of WRAMP. They had suggestions for their mentor trainings to be during the week vs. on Saturdays and for them to facilitate some of the sessions with TedTalks or articles/books that they hoped the group to discuss together. They also wanted to lead some of the Saturday sessions for the high school students themselves. (The structure of the Saturday meetings had the women break up for part of the morning for HS students for a presentation by a WPI representative such as Admissions or the Library, while the UG and grads had their mentor training.)
One of our primary outcomes was to increase the number of underrepresented groups interested in pursuing professions in STEM. 39 high school women have been served to date through our last complete session in Spring 2019. In regard to the high school women who have participated in our program, two students applied and were admitted to WPI but did not enroll. One stated it was due to financial reasons. Three women have attended summer programs sponsored by the pre collegiate outreach department at WPI with approximately 50% of participants engaged with other WPI outreach programs. Even though students have not enrolled at WPI, we believe that we can make the assumption that if they were applying to WPI, they at least intended to enter a STEM field.
Here are some of the outcomes for the undergraduate and graduate women. A two-tailed T-Test was run on the data from Fall 2018 and Spring 2019. Quantitatively, we don’t have any statistically significant differences on any of the quantitative measures with analysis on qualitative measures. Across 42 measures, we have more positive changes post program than negative changes, but there are some negatives. Results for spring 2019 are overall more positive than fall 2018 so changes to the program may have resulted in more positive outcomes but we can not show a correlation with a low n and the qualitative analysis incomplete and data from WRAMP 3.0 in Fall 2019 yet to be collected and analyzed. What can be reported is that girls indicate moderately increased confidence in science, in learning science and studying science in college after the program. Both undergraduate and graduate women felt that they empowered other women to understand lab – based research and explore their goals/possibilities in STEM. Mentors also were able to utilize their strengths and share those experiences and were able to foster...
community. An impact that is particularly interesting and gives rise to the importance of the focus on increasing the number of women of color in the cohort was that they were able to know more about the goals of another person who is different from them as well as seeking out similar experience in the future. I am particularly encouraged by the 3rd response, in that there is a lot of value in women graduate students having access to a community and other mentors.
An unexpected outcome and unplanned activity was for the WRAMP mentors to present at the regional Zone 1 ASEE (American Society for Engineering Education) conference. 4 grads and 1 UG WRAMP mentor decided to go above and beyond their WRAMP commitment to jump on the opportunity to present about WRAMP at the conference. Extra time was required from them to meet and decide what to present. They wanted to share how the program for them was about empowering other women. They decided to do both the student poster session and lightening talk session and ended up winning both competitions! In addition, two undergraduate mentors that have completed our program in the second cohort have now matriculated into PhD programs in STEM directly from their undergraduate studies, one at Cornell and the other at UMASS Amherst.
WRAMP 1.0 to WRAMP 3.0 has been an iterative process of developing a multitiered mentor program for women to bolster interest for women and underrepresented groups to increase their interest in pursuing STEM careers. Primary outcomes for the program were to increase interest in STEM careers, confidence in lab skills and engineering design process, learned persistence, particularly in research, mentors to gain mentoring skills, and the formation of community to foster belonging. We have piloted a program in WRAMP 1.0 and then reflected and looked at feedback from past and current student participants to learn anecdotally and quantitively what students are determining as the gaps and creating support structures to address those gaps in the next round of programming in rapid iterations. The opportunity to create a brave space where women students in STEM feel that they are not alone, they are empowered and are looking for more opportunities to participate in programs like this in the future tells of the impact of the program on the way they will approach a laboratory experience in the future.