

Incorporating Polymer Engineering in the Classroom

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Abstract

The Research Experience for Teachers in Engineering and Computer Science Site for Sustainable Polymer Engineering Research (RET) at the School of Polymers and High Performance Materials (SPHPM) at the University of Southern Mississippi (USM) provides meaningful summer research experiences for teachers in the laboratories of faculty and provides year-long activities to support implementation of research-based curriculum in the classroom. High school teachers and community college faculty are engaged in a six-week summer research and training program in cutting edge research in sustainable polymer engineering. Integrated with the research experience are education and professional development programs, including team-building workshops, short courses in polymer science, field trips to industry, presentation skills development, and workshops in developing activities for laboratory experiments based on their research. Teachers partner with graduate students, who serve as research mentors during the summer and visiting “scientists in the classroom” during the school year. School year activities include field trips to USM, visits of faculty and graduate students to teacher classrooms, graduate student mentoring of high school science and engineering fair projects, presentation by teachers of workshops at the Mississippi Science Teachers Association (MSTA), and participation by teachers in American Chemical Society (ACS) symposia. The research-based classroom activities are disseminated through the RET website and publication in Teach Engineering.

Activities and Impact

The goal of the RET in Engineering and Computer Science Site for Sustainable Polymer Engineering Research (RET) at the School of Polymers and High Performance Materials (SPHPM) at the University of Southern Mississippi (USM) is to develop long-term professional relationships between faculty researchers and local teachers by providing meaningful research experiences in relevant polymer engineering research efforts and establishing follow-up activities to extend the impact of the program throughout the school year. In 2016, twelve teachers (ten supported by the RET Site, one supported by the RET Supplement for Veterans and one supported by the NSF Experimental Program to Stimulate Competitive Research (EPSCoR) from six local high schools and a community college participated in the summer program. Teachers participate in a six-week summer research experience with polymer science and engineering faculty members to perform research in the area of sustainable materials. Teachers work in pairs with faculty and student researchers in efforts focused on addressing 21st century grand challenges in engineering in three areas: (1) improved efficiency polymer solar cells, (2) high performance polymers and composites from renewable feedstocks, and (3) environmental impact of synthetic materials in sea water.

RET participants receive a stipend of \$5000 for their summer research and receive an additional \$1500 stipend during the school year for participation in planned activities. Additional funds were made available for materials & supplies for implementation of the school activities and for travel to the MS Science Teachers Association, American Chemical Society meeting and other technical/educational conferences.

The goal of the RET program recruitment is to focus on the qualifications and diversity of teacher applicants. We have built on the successful recruiting practices used in past RET and GK12 programs to identify qualified RET candidates and to advance our diversity initiatives. Over the last few years, approximately 80% of the applicants were women and 30% came from minority groups. RET participants are teachers and community college faculty from local schools with minority populations that are generally representative of or higher than that of the state population (At 37%, MS has the highest population of African Americans as a percentage of total population), from schools with high levels of free and reduced lunch, and from both high needs and high performing schools. From the junior colleges, chemistry and engineering faculty are targeted for recruitment. Chemistry, polymer science, physics, and math teachers are recruited from participating high schools.

In preparation for their summer experience, teachers attend a one-day orientation session in May. The orientation session is designed to prepare the teachers to participate fully on the first day of research, and includes an explanation of expectations for the program, contracts, detailed calendar, introduction of faculty and graduate student mentors, a tour of the facilities, and a two-hour safety training class implemented by the Safety Officer for the College of Science and Technology. During the summer program, Polymer Science & Engineering faculty members provide lectures in polymer chemistry, polymer physics, polymer processing, and polymer analysis. Teachers are provided with the instructional materials used in the lectures and made available for the teachers to use in their own classrooms. The teachers also participate in team building exercises and training in how to work in a high performance team. A professional development workshop in communication is held during the first few weeks of the program to address basic presentation development, effective delivery techniques, and PowerPoint do's and don'ts. The workshop includes elements from the successful "Sharing Science" workshop developed by Wingo in collaboration with the USM Speaking Center. Weekly team meetings, led by program leaders, provide help and resources in developing research-based activities for the classroom. A department-wide poster session is held the last week of the program to showcase research projects of the teachers. Teachers participated in field trips to the Western Container Corporation (Coca-Cola bottling company) and Algix Bioplastics manufacturing facility in Meridian, MS, to gain understanding of commercial advances in sustainable polymeric materials.

The RET program broadens teachers' exposure to cutting edge research and allows them to translate the research to the classroom and to their students. Teachers are required to visit the university with their students for hands-on activities, demonstrations, lectures and laboratory tours (Fig 1). This visit allows the students to gain a better understanding of their teacher's summer research experience. Over the school year, graduate student and faculty mentors visit teachers' classrooms to aid in implementation of research-based lessons.

Three of the RET participants' classroom activities were accepted for publication in *Teach Engineering*: 1) "Selectively Permeable Membranes" by Jamie Sorrell, Sumrall High School, and Eric Shows, Jones Country Junior College, https://www.teachengineering.org/activities/view/usm_membranes_activity1; 2) "Soap vs Shampoo Surfactant Lab" by Mark Holcomb, Oak Grove High School, https://www.teachengineering.org/activities/view/usm_surfactant_activity1; and 3) "Laser Engraver Activity" by James Brownlow and Turkesa Bullock of Hattiesburg High School

(accepted). Other teachers have submitted activities or are in the process of developing them for submission. Two workshops were presented at the MS Science Teachers Association in Biloxi, MS, October 24-25, 2016, which resulted in expanded interest in the program and increased applications for this year's program. Three presentations were accepted at the upcoming Incorporating Polymer Science into the Classroom session at the American Chemical Society Meeting, April 2 – 5, 2017 in San Francisco, CA.¹⁻³ A website was created to provide information about the program and links to the classroom activities developed by the teachers.⁴



Figure 1: Hattiesburg high school students visiting with graduate student Levi Moore in the Polymer Science Research Center at USM to learn about fabricating solar cells.

Conclusion

By providing teachers with relevant research experiences, the RET program impacts high school and community college curricula and classrooms. Teachers develop laboratory experiments and advanced curricula related to their research in materials sustainability. Teachers and their classes visit the university for tours, demonstrations, and lectures. Faculty and graduate students visit the schools to help implement research-based curricula. This program contributes to building the educated workforce needed to address sustainability challenges of the 21st century. It also provides teachers tools to engage students in the engineering enterprise and encourage them to pursue science and engineering careers.

References

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