Expanding Engineering through an S-STEM Program

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Dr. Ricky Castles is an assistant professor in the Department of Engineering at East Carolina University. He is primarily affiliated with the ECU Electrical Engineering concentration. His research work focuses on the use of wireless sensor networks, microcontrollers, and physiological data collection for a variety of applications. His primary interest is in the area of adaptive tutorial systems, but he has ongoing projects in the area of hospital patient health monitoring. He is actively engaged in K-12 outreach through several venues including Summer Ventures, high school STEM day, the N.C. Science Olympiad, a Math Science Partnership grant, volunteer work with a local literacy camp, Boy Scouts Robotics Merit Badge counseling, and teaching the science portion of VBS and children's Sunday School at his local church.

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Dr. Brown is a professor in the Department of Engineering at East Carolina University. Most of her research is in the area of applying industrial engineering techniques to health care process improvement. However, she also does research in the area of STEM education. Dr. Brown has published education-related research in INFORMS Transactions on Education, Proceedings of the 2009 ASEE National Meeting, and Proceedings of the 2008 ASEE Southeast Section Meeting. She is PI on an active NSF S-STEM grant in the amount of $599,894.

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The engineering program at East Carolina University was only six and a half years old when it was awarded an S-STEM grant for $599,894 in the spring of 2011. Most of the funds were used to provide scholarships to small cohorts of academically talented, FAFSA-eligible students in the incoming classes of 2011-2014. Participants in the S-STEM scholarship program also benefitted from numerous internal and external engagement and professional development opportunities.

This poster examines one specific external engagement opportunity of our S-STEM program - job shadowing with a local engineer. As Bandura and Walters [1] indicate, observing can be a very effective way to learn. One goal of the shadowing experience is for student participants to have a better understanding of what engineers do and what skills are needed in order to be successful. We included the shadowing activity in our S-STEM program in an effort to improve participants' confidence and self-efficacy. As noted by Ponton et al [2], "vicarious experiences", such as shadowing and observing, can serve as significant contributors in the enhancement of self-efficacy.

Perhaps one of the best features of the shadowing experience is that it requires minimal funds, making it easily replicable at other institutions. Most of the locations that students visit are within 10 miles of campus, so students do not seek reimbursement for mileage. The short travel distance also allows students to maximize their time spent on-site with the company while minimizing the disruption to their academic course schedules. It is our hope to expand the shadowing program so that other students in the department may apply to participate. We believe that an application process is necessary in order to ensure that the student is serious about participating and understands his/her responsibilities associated with this activity.

Included in the poster are survey results from S-STEM scholars indicating their perceptions of the shadowing experience and how this experience impacted them. Survey results from the participating employer-partners are included to indicate how shadowing partners felt about the experience, and how the department could improve the shadowing experience in the future.

Outline of Use of Grant Funding

The S-STEM grant was primarily used to support student scholarships for those with a strong academic record and demonstrated financial need. The scholarship amounts ranged from $5,000 to $10,000 depending upon each student's high school record and FAFSA eligibility. Specifically, the three levels of awards were $5,000, $7,500, or $10,000. It was expected that the funding would support approximately six students in each incoming cohort. Over the course of four graduating class cohorts, it was expected that the award would benefit 24 total students.

In addition to providing scholarship funding for engineering students with outstanding potential and demonstrated financial need, this program also encouraged the development of a support network for these students. Many of the students receiving the award were first generation college students, and ensuring that they felt welcomed and supported was important to retain them at the university.

One of the main components of the students' network of support was connecting them with local industrial partners to showcase the types of careers the students could aspire to upon graduation. Since many of the students at East Carolina Unviersity were raised in towns near the university and have a desire to live near their families upon graduation, it was important to showcase local engineering opportunities through a shadowing experience. This experience involved visiting a local company and shadowing an engineer for half a day to see what types of engineering jobs are available in <local region>. Students were encouraged to participate in shadowing each of their years in the program.

Organizing Shadowing Experience

In order to find shadowing partners for our students, the grant team leveraged existing relationships with our advisory board. During the first year, the students were asked to identify which type of engineering they were interested in and an appropriate shadowing partner was found through the advisory board. Based upon discussions with students after their shadowing experience, it was determined that advisory board members are often senior personnel and involved in managerial positions at companies rather than engaged directly in engineering work. The PI then reached out to young engineering alumni in the early stages of their career to seek shadowing opportunities where students would better be able to see the opportunities that exist for entry-level engineers and to experience the engineering field more directly.

Shadowing Participants

Over the course of this S-STEM program, approximately 80% of the S-STEM scholarship students have shadowed engineering professionals. Some students have been able to shadow several times over their years in the S-STEM program. Our students have been able to shadow engineers from several local companies including:

- ARK consulting - A civil engineering consulting company
- Carver Machine Works - A machining and mechanical fabrication specialist
- CMI Plastics - A custom plastics manufacturer specializing in thermoforming.
- Cox Marine - A manufacturer of diesel marine engines
- The East Group - An engineering, architecture, and surveying business that focuses on health care, industrial, and infrastructure planning.
- Keihin Carolina System Technology - A manufacturer of motor vehicle engine control units and electronically actuated devices
- Hyster-Yale (formerly Nacco Materials Handling Group) - A manufacturer of fork lifts and pallet moving walkie trucks
- RTI Surgical (formerly Pioneer Surgical) - A manufacturer and researcher of synthetic and biologically-based medical implants
- Roberts Company - A mechanical fabrication company specializing in pressure vessels, heat exchangers, and tanks
- SPX Transformer Solutions (formerly Waukesha Electric Systems, Inc.) - A manufacturer of power transformers and a parts supplier for replacement components

Students were paired with a company based upon their chosen concentration and the mutual availability of the student and a shadowing partner. In nearly all cases, the students were able to provide their own transportation to attend the shadowing experience, so the only expense to the department was for insurance to cover students while they were on site, which was less than $2.00 per site visit. In one instance a student without her own car was driven to the industrial partner site by a faculty member. Since partners are all located within an approximately 25-mile radius of campus, it was logistically feasible to take students to their tour without significant interruption to the workday.

Student survey

In the first year of the grant, a survey was given to all scholarship recipients. All of them indicated that they enjoyed the shadowing program and thought it should be continued. One major change that needed to be addressed was identified through these student surveys. In the grant proposal, we indicated that the S-STEM scholars would shadow engineers who serve on our department's advisory board. Not only was it difficult to schedule time with advisory board members, many of them hold positions that required them to take part in confidential meetings throughout their work day, which would preclude students from attending. In addition, since many of the advisory board members held senior-level positions, the shadowing experience did not give a realistic portrayal of the work done by entry-level engineers.

One of the co-PIs suggested that we utilize our alumni who work within a 25-mile radius of our campus. Fortunately, that area includes many alumni, several of whom were willing to host our students. Their companies are industrial partners of our engineering program, and they welcomed the opportunity to partner with us on this endeavor. Our alumni are also all early in their careers (graduating 2008 or later), which allows the shadowing students to get a more realistic picture of what is entailed in an entry-level engineering job. This model has persisted throughout the remainder of the grant timeline.

Employer survey

Shadowing partners were surveyed about their experience hosting students at their worksite. When asked why they agreed to allow students to shadow some responded that they enjoyed sharing their work with future engineers. Some said they hoped the experience would encourage students to continue in the engineering program. Some alumni of the engineering program said they had a strong interest in the program being successful and wanted to help in whatever way they could.

Shadowing partners were asked if they would consider allowing a student to shadow them in the future and all respondents indicated that they would. The responses from shadowing partners also helped to determine how much time to allow for shadowing students to visit the company. Since sites vary in size, respondents indicated that some shadowing experiences could last as little as 3 hours, but others may take as much as 5 hours to provide a full experience.

Over the last few years, some of the shadowing partners have established internship programs that have hired our students. Many of our shadowing partners have also hired our alumni into

fulltime positions so our network has expanded and there are more potential shadowing partners to work with at several companies in the region.

Future Expansion Plans

In the future, the engineering department is considering allowing more students to engage in a shadowing experience. In the employer survey, each shadowing partner was asked how many students they could accommodate during the academic year and how many they could handle during each site visit. One shadowing partner indicated they could host 10-12 students in an academic year, with no more than 2-3 in each visiting group. Another shadowing partner indicated they could host 16-18 students in an academic year and would like the students to attend in pairs. A third respondent indicated they could host 2-4 students each semester with 1-2 per visit.

Based upon this feedback, we believe it is feasible to expand the shadowing experience to allow other students to participate. The department is currently considering establishing a shadowing program where upperclassmen could submit an application indicating their field of interest and GPA, and a shadowing coordinator will pair qualified students with appropriate shadowing partners. Over time the department hopes to open up the opportunity to shadow to all of our upperclassmen with at least a 3.0 GPA.

References

[1] Bandura, A., and Walters, R. (1963) Social learning and personality development. Holt, Rinehart, and Winston, New York.

[2] Ponton, M.K., Edmister, J.H., Ukeiley, L.S., Seiner, J.M. (2001) "Understanding the role of self-efficacy in engineering education". *Journal of Engineering Education* 90(2), 247-251.