Reaching 6th through 8th Grade Students through the National Science Foundation Research Experiences for Teachers Program

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Abstract: The National Science Foundation instituted a novel program recently called Research Experiences for Teachers (RET) which allows principal investigators to request a funding supplement to existing grants to enable interaction with K-12 teachers. At Auburn University in Auburn, Alabama, the Department of Industrial and Systems Engineering received funding for two teachers for the summers of 2002 and 2003. A science teacher of 6th and 7th graders and a math teacher of 8th graders joined the research team on the project "Relating Field Data to Accelerated Life Testing". The project aimed to correlate wear and degradation of solder connections on under the hood electronic components with that expected through accelerated testing using temperature cycling. Besides conducting research, the other primary goal of the RET was for the teachers to develop classroom modules based on their research experiences. This experience has been enriching, not just for the teachers and their young students, but for the Auburn University industrial engineering faculty and students. This paper will describe how the RET program works and the possibilities for benefits to both K-12 and higher education in math, science and engineering.

1. Overview

Through the National Science Foundation's Research Experiences for Teachers (RET) program, at Auburn University in Auburn, Alabama, Alice Smith of the Department of Industrial and Systems Engineering received funding for two teachers for the summers of 2002 and 2003. Mark Jones, a science teacher at Drake Middle School (6th and 7th grades), and Cynda Fickert, a math teacher at Auburn Junior High School (8th grade), joined the research team on the project "Relating Field Data to Accelerated Life Testing (EEC-0002669)". Both schools are part of the Auburn City Schools. This school system serves a diverse student body which includes approximately 30% low income students. This project was conducted jointly with the interdisciplinary NSF sponsored University / Industry Center for Advanced Vehicle Electronics (CAVE) and DaimlerChrysler Electronics in Huntsville, Alabama. The project aimed to correlate wear and degradation of solder connections on under the hood electronic components with that expected through accelerated testing using temperature cycling. The test subject was the transmission controller on Jeep light trucks.

Jones, with his background in the natural sciences, worked primarily on the examination of the solder joint material through mechanical testing and scanning electron microscope photos. Fickert concentrated on the data analysis and statistical modeling for the correlation between mileage of the field units and solder joint degradation as measured through joint shear strength.

Figure 1. Teachers Mark Jones (left) and Cynda Fickert (right) work in the CAVE labs.

Besides conducting research, the other primary goal of the RET was for the teachers to develop classroom modules based on their research experiences. These modules were to be used in their classes as both hands on learning experiences for their students, and as stimulators for students to consider career opportunities in engineering. During the RET time, Fickert and Jones designed two inquiry-based units to use in each of their classrooms.

Jones says of his RET experience, "I use a great deal of discussion in my classroom to promote inquiry in my classroom culture. One aspect of that culture is the students' perception of the teacher as an expert on certain topics. The experience with CAVE allows me to put myself in a professional setting if I find the opportunity to use that experience within the context of the classroom. I expect that I will be able to use CAVE within my own testimony when my class begins a unit on properties of matter." Fickert states, "The interaction with the entire CAVE project challenged me in many ways, and I enjoyed learning how the project relates industry to education, at both the graduate and junior high school levels. The interaction with professionals, the financial opportunity, working with graduate students, operating the machines in the lab, and helping with the CAVE project all helped to make this a very meaningful opportunity for me personally and professionally. I believe this summer's work will help me in various ways throughout this school year and the years to come. I use many activities in my classroom to incorporate problem solving skills and number sense. In addition, the experience added to my knowledge of real-world applications for the skills in my pre-algebra curriculum. I will be able to help my students better understand the need for a solid understanding of statistics, graphs, ratios and proportions, and I will be able to help them connect this information with everyday electronics such as cell phones and video games... This

was the one of the most dynamic summer experiences I have had, and my students will reap the benefits."

2. Mathematics Students

The math-oriented unit involves the use of different cross-section sizes and different types of wood to test them for strength. This was inspired by the use of shear-strength testing of the solder joints from the project. The students' objective is to test different woods for strength by placing samples of wood on a loading block and hanging a bucket in the middle of the wood by a force sensor. Part of the materials money supplied by the RET grant was used to buy digital interfaces that included force sensors, so that the experiment would integrate computers. The students pour sand into the bucket until they break the wood. The computers log the data automatically and allow for faster data gathering, enabling the students to complete this activity in one class period. The inquiry part involves the groups' interpretation of the results on the next day. Eighth graders performed this module during fall term with the side result of a sand-laden computer lab.

Figure 2. Math students performing shear strength activity at Auburn Junior High School.

3. Science Students

The science-oriented unit is about soldering copper pipes. This is connected to the CAVE project since it is about solder, lead's effects on the environment, but also to the common student, since all of them have running water and some of them may have experience with soldering or one of their parents soldering. The RET grant funded soldering kits and propane blowtorches. The students first learned how to solder a joint using a soldering iron in order to introduce them to the technique and allow them to become more comfortable and mature when working with something that is extremely hot. After that, the students soldered four pieces of

copper pipe (one for each person in the group) with a blowtorch. The competition was for the students to create solder joints by using the least amount of solder, while also keeping the joints watertight. This correlated with CAVE's work with industry in which research is done to make the cheapest product that is still safe and functionally dependable. The student groups were ranked according to their product. First, students' pipes were attached to a faucet and if they leaked, they were ranked behind all others that did not leak. All of the pipes that did not leak were then ranked according to the amount of solder used. Students had to integrate some math into this set of labs as well as getting a good understanding of how business and research work together by experiencing the challenge of production.

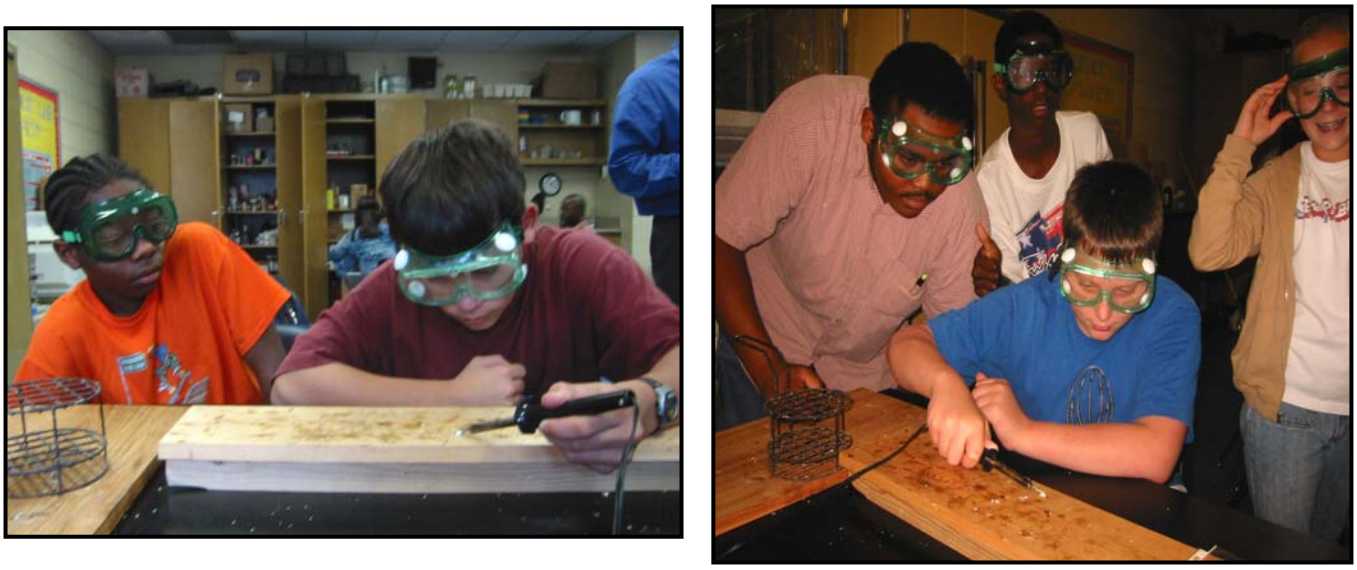

Figure 3. Science students solder on wood to get used to working with the soldering equipment.

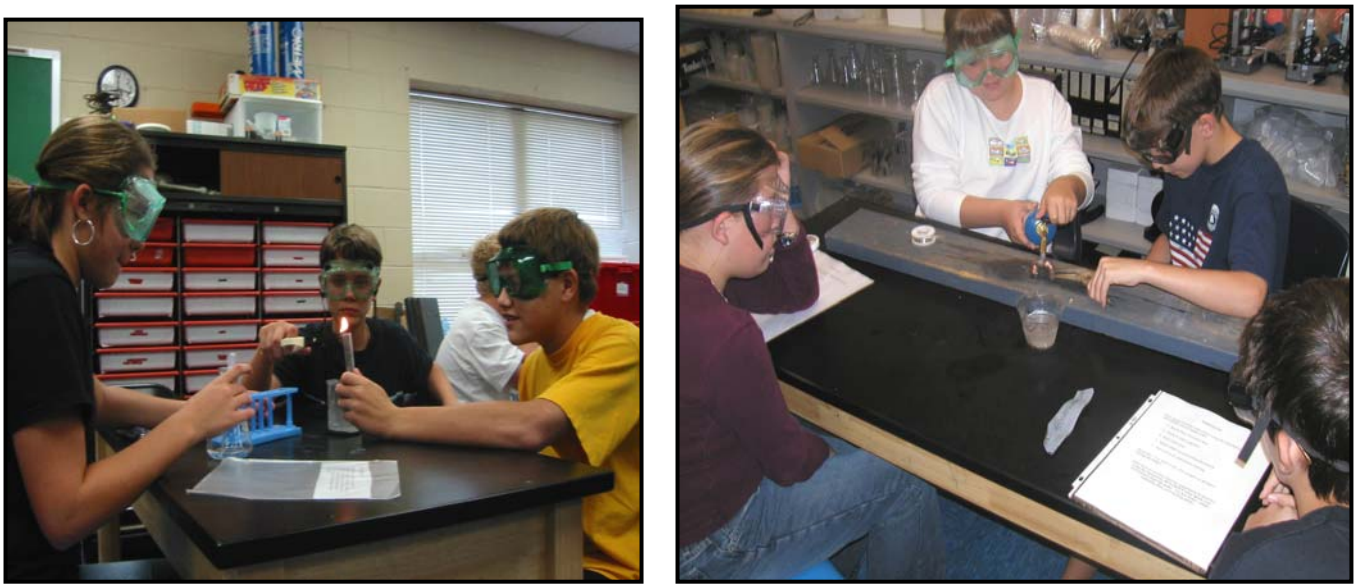

Figure 4. Science student blowtorch copper pipes (left) and get used to working with heat (right).

4. Field Trips

As an extra activity, the University invited both schools on a field trip to the CAVE labs. Over 100 students from four math classes at Auburn Junior High and over 100 students from four science classes at Drake Middle School visited on two different days. The students were rotated through stations at the CAVE labs (clean room and screen printing room) and student designed and built race cars (mini Baja and formula racer). At each station, they were hosted by undergraduate and graduate engineering students who described what was going on. Each student took home a screen-printed coaster from the CAVE lab with the Auburn University logo on it.

Figure 5. Field trip to the CAVE labs to see how circuit cards are manufactured.

5. Training at NASA Goddard Flight Center

NSF, in conjunction with NASA, sponsored the teachers to attend a one-week intense training session at Goddard Flight Center in Maryland in June. The training was customized from five of the NASA courses on soldering, ESD, fiber optics, crimping, surface mount and polymeric coverings. The teachers learned many techniques and had a chance to tour the Flight Center. NASA also donated 120 soldering kits for their students, which are being used in this year's activities.

6. Concluding Remarks

This experience has been enriching, not just for the teachers and their young students, but for the Auburn University industrial engineering faculty and students. We have learned more about how 11 to 14 year olds learn and their views on engineering. It is been a joy to interact with these youngsters – their sense of wonder and enthusiasm are infectious.

Figure 6. Teachers Cynda Fickert and Mark Jones with their NASA instructor.

This year's activities are even more exciting. Cynda will be working with her students on soldering stained glass ornaments, then using the ornaments to measure angles, areas, etc. This combines science with geometry and art. Mark has added the subject of conductivity to his units and has started an Electronics Club for students especially interested in that area. This after school club will provide more in-depth activities that tie science and engineering together and create devices for the regular classroom to use like an ultrasonic translator. We also anticipate some more technical field trips to the CAVE labs for this group of students.

Reference

"Are you experienced?", *Industrial Engineer Magazine*, vol. 35, no. 9, September 2003, 36-39. Article on the RET (Research Experiences for Teachers) project.

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