

NSF RET Program to Incorporate Bioengineering Education in the 4th and 5th Grades

Lewis EM*, Blair, L**, Friis EA*

*University of Kansas, Mechanical Engineering, Lawrence, KS; **Southeast Kansas Education Service Center, Girard, KS

Statement of Purpose: A survey of 4th grade students showed that 66% of girls and 68% of boys reported liking science. By middle school, girls self-report lower interest in science than boys – the damage has already occurred. “BET 4 Teachers” is an NSF funded RET (Research Experience for Teachers) program that is a collaborative effort between the University of Kansas (KU) Bioengineering (BioE) program and the Southeast Kansas Education Service Center-Greenbush, a K-12 science education resource. The program pairs 4th and 5th grade science teachers with university faculty members and graduate students to work on existing BioE research projects and translate the fundamental BioE concepts into interactive toolkits, while still meeting state education standards. Bioengineering does not suffer from lack of participation of females and minorities. The hypothesis of this study is that this exposure to BioE at the 4th and 5th grade levels will positively impact students’ self-perception before they have had time to adopt the negative stereotypic descriptions of scientists and engineers. The program is designed to encourage girls and minority students to see themselves in the role of a scientist or engineer and thus help to retain their interest in science and engineering through these formative years. We believe that this influence at the critical age will carry through the students’ academic career and make both female and male students more likely to pursue careers in engineering or science, regardless of the discipline.

Methods: Researchers at KU worked with Greenbush staff to recruit 6 high potential 4th and 5th grade science teachers from a range of socioeconomic level schools in KS. Teachers represented schools with percent averages of students with free and reduced lunches ranging from 2.1 to 59.1 % (average and standard deviation 34.6 +/- 21.8%). Three schools were above the state average of 42.8%. For the first 4 weeks of the summer program, the teachers worked with 6 KU BioE faculty and 10 engineering students in faculty laboratories on existing research projects. 40% of the teachers’ time was spent in research activities, 40% on toolkit development, and 20% on didactic training, networking, and industry tours. RET teachers collaborated with the faculty, students and Greenbush staff to develop toolkits to translate the research concepts to the 4th and 5th grade levels while addressing state curriculum requirements. At the end of the 4 week session, RET teachers participated in 2 weeks of educational development at Greenbush. Graduate students, faculty, and Greenbush staff worked with the teachers for one week to refine and develop their toolkits. The next week included sessions with 3rd to 6th grade students to provide teachers the opportunity to field-test lesson plans prior to classroom implementation. Pre- and post-surveys were given to teachers and graduate students to gauge increase in knowledge and comfort with research and education. RET teachers are implementing the toolkit lessons in their school classrooms in the 2009-2010

school year. Surveys are being given to students before and after toolkit presentation.

Results: The following BioE toolkits were developed:

- **Spine Biomechanics:** students explore material properties of spinal components, learn about scoliosis treatment options, and become “brace engineers” by designing braces to correct a scoliosis spine model.
- **Tissue Engineering:** students examine cheek cell components, learn about the effects of diabetes on the pancreas, and explore the best scaffold biomaterial on which cells (modeled as hydrobeads) will grow.
- **Vibration Biomechanics:** vibration and waves are introduced to students using music and hearing; students discover the concept of center of gravity by participating in controlled balance experiments.
- **Hydrogels for Drug Delivery:** students engage in experiments focused on material properties and useful bioengineering applications of a variety of hydrogels.
- **Biomechanics of Falling:** students participate in activities including balance activities, levers in the human body, and gait cycle analysis using playdough molds of their own feet.
- **Biomechanics of Fluids:** material properties and applications of a variety of fluids are introduced; students are charged with developing their own cough medicine based on appropriate fluid properties.

Ten toolkits were disseminated to regional teachers. One of each toolkit was kept at Greenbush to allow the lessons to be taught onsite and through internet distance learning. Teacher feedback showed satisfaction of the program and toolkits, increased levels of understanding of engineering principles and laboratory research protocol, and an increased comfort in communicating bioengineering ideas to elementary students. Graduate students reported an increased comfort level in scientific communication with the public, an understanding of the organization of elementary education, and an increased appreciation for the education profession. The project team learned of elementary educational needs and requirements, especially the importance of meeting state standards for learning. It was also noted that in the application, the term “engineering” was daunting, whereas the term “science” is much more accessible to elementary educators. Students who participated in the lessons at Greenbush were enthusiastic about bioengineering. Parents reported a positive influence on their childrens’ perceptions of engineering and experimentation. Results from the classroom teachers’ students are pending.

Conclusions: The 4th/5th grade RET program will run for two more years. Several changes will be implemented based on the first year experience. The long-term goal of the program is to continue the partnership with Greenbush to develop 7th/8th grade toolkits and translate to SFB members/student chapters for national distribution.

Acknowledgements: NSF Project 0808749