Work In Progress – Integration of Sensors into High School Classrooms

Adam Crowley¹, Stephen Godsoe², Constance Holden³, John Vetelino⁴

Abstract - The GK-12 Sensors! program is a collaborative effort between the University of Maine (UM) and Maine high schools. The program is focused on sensor technology, which is a high profile research area at UM. Sensors, which cover many engineering and science disciplines, have been integrated into high school courses such as chemistry, physics, mathematics, computer science and also civics. It is anticipated that students’ exposure to sensors will encourage them to follow career paths in science and engineering. The program, which is completing year two, has had a significant impact on a number of Maine high schools, high school teachers and students, and UM graduate students. The program operation, accomplishments and activities are presented with plans for the program’s future.

Index Terms - GK-12, High School, K-12, Sensors.

BACKGROUND

The idea for the GK-12 Sensors! program was spawned when Stephen Godsoe, head of the Bangor High School (BHS) Math Department, Dr. Vetelino, professor of Electrical and Computer Engineering at UM, and Dr. Constance Holden, a former high school teacher and currently an instructor at UM, began to discuss methods to encourage Maine high school students to follow career paths in science and/or engineering. Since sensors are a UM research strength, it was decided that sensors would be the vehicle of choice to try to convince high school students to follow a science and/or engineering career path. Students are surrounded by sensors in their homes, schools and other places they frequent. Students, however, do not know the science or engineering that underlies sensors and sensor systems. This underlying science and engineering and how it relates to sensors can easily be integrated into high school classes such as chemistry, physics, mathematics, computer science and also social sciences such as civics. A proposal was developed and submitted to NSF to integrate sensors into the high school curriculum. This proposal was funded and the program began in the spring of 2002.

PROGRAM ORGANIZATION

The Principle Investigator (PI) of GK-12 Sensors! is Dr. John Vetelino, and the two Co-Principal Investigators (Co-PI’s) are Stephen Godsoe and Dr. Constance Holden. The program manager is Adam Crowley. In 2002, the PI and Co-PI’s selected fellows for the GK-12 Sensors! program. The fellows came from a number of different science and/or engineering related backgrounds and all were involved in MS or PhD theses in the sensor area at UM. The PI and Co-PI’s also selected a number of regional secondary school educators to participate in a summer Research Experiences for Teachers (RET) program. As part of their RET experience, these teachers became GK-12 Sensors! program participants.

2002 OPERATIONS AND ACTIVITIES

In the Spring of 2002, UM graduate students working in sensor research in science and engineering were made aware of the opportunity to become GK-12 fellows through the GK-12 Sensors! program. Each applicant had to submit a written statement expressing his or her career objectives, two references and a grade transcript. Selection was based on a personal interview, references, academic promise, performance in sensor research, and interest in participating in the project.

The first targeted high school was Bangor High School (BHS). There were three reasons. Co-PI, Steve Godsoe, provided a direct link to BHS. BHS was reasonably close to UM, therefore minimizing travel time for the GK-12 fellows. BHS is the largest public high school in Maine and offers a diversity of high quality programs to students. 15 BHS teachers were selected to participate in a one week workshop that occurred near the end of the 2002 summer. The teacher selection was based on their interest in the program and the high school courses that they taught. In addition to the 15 BHS teachers, a teacher, Scott Burgess, from John Bapst Memorial High School (JBMHS) was chosen to participate in the RET program. In the summer of 2002, fellows and Scott Burgess began IDL 465. IDL 465 covered sensor technology from the perspectives of the various science and engineering disciplines. The application of the sensors in fields such as medicine, homeland security, agriculture, and the environment were also discussed.

A summer workshop was held in August. In this workshop teachers presented material covered in their respective high school courses. Individual topics such as fluid sensors, air quality sensors, medical sensors, biological sensors, automotive sensors, agriculture sensors and use of sensors in everyday life were targeted for module development. Teacher and fellow teams were formed and the
team was asked to create a module for an individual topic. Teams worked together in the schools and created model curricula based on the application of sensors that can be disseminated state-wide and nationally.

**2003-2004 ACCOMPLISHMENTS**

In the spring of 2003, two program supplements funded by NSF were added to the GK-12 Sensors! program. A social science component was added, enabling the addition of Dr. Kevin Boyle, a UM professor of Economics, as our program evaluator. Also, funds were obtained to support a social science fellow, Brad Neumann. An RET supplement to our existing grant allowed the expansion of our program into selected rural Maine high schools: Dexter High School (DHS), Lee Academy (LA), Jonesport-Beals High School (JBHS), and Sumner High School (SHS). After a statewide search, one teacher from each of these schools was selected to participate in the RET program. The second program supplement involved international interaction with European sensor researchers. One fellow and one BHS teacher spent two weeks at the Otto-von-Guericke University in Magdeburg, Germany. They interacted with graduate students and researchers and developed several different modules. Another BHS teacher and fellow spent two weeks at the University of Brescia in Italy. As a result of these interactions, a number of modules involving the determination of the quality of coffee, olive oil, and wine, gases emitted from landfills in Bangor, Maine and ozone monitoring in the atmosphere have been developed.

The RET program was continued with teachers from the four previously mentioned rural high schools. These teachers came to UM and took part in research projects with research scientists. As was the case during the summer of 2002, the RET participants established bonds with the GK-12 fellows while at UM. These bonds served as links when the 2003-2004 academic year began, and made it easy for the fellows to become established in these schools in the fall.

In August, GK-12 Fellows, all program participants met at UM to formalize GK-12 Sensors! activities for 2003-2004 academic year. Dr. Vetelino suggested that teams begin to think of portable modules that would be appropriate for ninth grade students. At that meeting, fellows and teachers were divided into a number of interest groups focused on subjects like air quality, water quality, sound and light, and transportation. Each group developed at least one portable module that would be appropriate for ninth grade students. During the 2003-2004 academic year, 25 portable modules have been developed. Their creation ensures that our program is capable of demonstrating similar technologies at schools with vastly different resources. The fellows have been organizing community outreach programs in Bangor, Maine, such as the GIS Emergency Response Mapping Project, which enable students to produce valuable maps for local police and fire departments.

During our second academic year, the high schools involved in GK-12 Sensors! increased from two schools to six.

These schools have vastly different resources, resulting in the development of 25 portable modules. The fellows also wrote and submitted a number of journal articles. These articles were written with the assistance of various high school teachers. Each article focuses on the description and implementation of the fellow’s portable modules in the classroom.

**SUMMARY**

The fellows have honed their interpersonal and pedagogical skills. Furthermore, they have gained invaluable knowledge about how the aspirations of students can be fostered in the secondary schools. The high school teachers have benefited from interacting with the fellows in a number of ways. The curriculum has been enlarged and aligned with state standards using cutting-edge sensor technology. The greatest beneficiaries of GK-12 Sensors are the high school students. Comments by the students to the fellows demonstrate that these students are more interested in science and engineering now than they were prior to the arrival of the fellows. The students are learning not only about science and engineering, but also about the role science and engineering plays in their everyday lives.

**PROGRAM’S FUTURE**

In the spring of 2004, GK-12 Sensors! received a three year RET grant from the National Science Foundation. As a result, during the summer of 2004 and for the next three summers, ten teachers will be brought to UM by the RET program each summer. By bringing these teachers to UM, we hope to significantly increase the number of schools we can influence in Central and Northern Maine. During the summer of 2004, program participants, including high school students, will identify “best practices” from GK-12 Sensors! for dissemination across Maine and the nation. GK-12 teams will identify the best modules and develop a “lending library” of materials and curricula to be sent to teachers at local high schools. The work will culminate with the implementation of a hands-on, inquiry-based honors class founded on the theme of sensors at Bangor High School. GK-12 Sensors! is now in the second of three years of funding. We have applied to NSF to continue our project into the next funding cycle, which would last until 2010. To ensure that the financial means will exist to support the GK-12 Sensors! program into the future, a proposal has been developed and submitted to the Chancellor of the UM System. If the state funds this proposal, GK-12 Sensors! will become a permanent and major UM initiative to improve the aspirations of Maine youth with a positive effect on economic development in the state of Maine.

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