2006-1688: EDUCATIONAL PARTNERSHIPS WITH SECONDARY SCHOOLS TO PROMOTE MINORITY ENTRY INTO THE ENGINEERING AND TECHNOLOGY DISCIPLINES – THE INITIATIVES AND ACHIEVEMENTS OF PROJECT SMILE

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Educational Partnerships with Secondary Schools to Promote Minority Entry into the Engineering and Technology Disciplines – The Initiatives and Achievements of Project SMILE

Abstract

The strong need to educate the next generation of technically oriented students within minority communities and women has continuously been a focus of many K-12 coalitions. Available data shows a very low representation of minorities and women in the Science and Engineering fields. Through early introduction to engineering and technology, and dissemination of information related to careers and education in these fields, minority and women student representation is being expanded. This paper reports on a collaborative project between a university and middle and high schools to address this low representation. A coalition involving faculty in the university, and science and math teachers in various school districts resulted in the development of a unique educational model that was first piloted in the summer 2005. The model comprises of a series of short educational modules emphasizing hands-on applications within various technical areas. Four modules were developed and offered to the middle and high school students. They involved electronics, manufacturing, structural modeling by bridge building, and plastics processing. Except for bridge building, each module was developed as a stand alone component to be completed within a two to three hour time frame, and culminated into a tangible product that the students took home. Through the application of hands-on experiments, the students were able to feel the connection to the engineering and technology areas as they developed a sense of skill, workmanship, and accomplishment by making a complete part. The bridge building was team-based and the individual student teams competed amongst each other to build a bridge that held the largest load. The winning team and runner-up were awarded prizes. This paper reports the development, initiatives and accomplishments of the project, which has been funded by Verizon Foundation. The effect of the learning modules on increasing the students' knowledge about engineering and technology, and the related careers is also discussed.

Introduction

This project was developed through a joint effort between the Department of Technology at Northern Illinois University and selected school districts in the region (Dekalb, Sycamore and Belvidere). The project was conceived based upon the following facts. The metropolitan areas of Chicago and Rockford have the highest concentration of manufacturing and electrical industries in the state of Illinois[1], and thus, there is a constant demand of skilled workers. The demographics of these two important localities show large populations of minorities and families with low incomes, and their representation in the skilled workforce is very low[2]. In many cases, this can be attributed to the fact that technical education in the underrepresented areas is not adequately stressed early enough in the educational system. The general trend in minority enrollment in engineering and technology at universities, both nationally and statewide, have seen a decline over the last 10 years. Their representation in fields of science and engineering is also still very low. For instance, data from National Science Foundation's Division of Science Resource Statistics[3,4] shows the percentage of minorities (African American, Hispanics and

American Indians) in the science and engineering workforce as of 2000 was 17.4% although they represent 24% of the US population. Women represented 46% of the workforce in science and engineering with bachelors degrees (ibid). Minority full-time first-year undergraduate enrollment in engineering related field has seen several patterns. The percentage of minority African Americans decreased 15% from 1990 to 1996 (peaked to 25,920 in 1993), then increased by about 2% from 1996 to 1999 to 24, 419. The enrolment for Hispanics on the other hand has seen a steady increase from 18,873 in 1990 to 29,111 in 1999 (35% increase). At state level, the enrolments have followed similar patterns. In the fiscal year 2001-2002, the number of B.S. degrees granted in Engineering and related fields in Illinois shows that only 12.3% (6.8% African Americans and 5.5% Hispanics) were minorities[5]. Recognizing the fact that Northern Illinois University (NIU) is strategically located between these two important metropolitan areas, the authors conceived a novel collaborative educational program that would increase the awareness of engineering and technology to this important underrepresented student group.

The Department of Technology at NIU offers highly competitive programs in the areas of Manufacturing Engineering Technology, Electrical Engineering Technology, and Industrial Technology. The Departmental laboratories are outfitted with modern experimental equipment in the areas of Manufacturing and Electronics. Through collaboration with high schools and local industry the Department constantly seeks to provide avenues for future workforce development. These collaborative efforts culminated into the development of a novel educational program with secondary schools to promote entry into engineering and technology programs, especially amongst girls and minorities. Available literature[6-11] shows that if students can be engaged in the tools of the trades and provided with information, then they will have a greater desire to apply themselves in the respective technical areas. Based upon the model which the authors developed for this project, students were invited to attend 2-hour workshops which were presented in several different areas of technology. Emphasis was placed on inviting more minorities and females to the program. Through the attendance at these sessions students designed and produce simple products like a pop-sickle stick bridge, a blinking light circuit, plastic products, and a name plate. As a result of this interaction, the attendees had a greater understanding of the technology areas. The initial target audience was minority student population in 7th -10th grade within the Elgin, DeKalb, and Sycamore, school districts. However the final student population came from DeKalb, Sycamore and Belvidere school districts in the region. A description of the project is the focus of the next section of this paper.

The project SMILE

Overview of Project

The project was titled SMILE as it involved ***s***cience and ***m***athematics ***i***nitiatives through ***l***inkages in ***e***ngineering. The authors, working with faculty within Technology and Engineering Departments, as well as teachers and administrators in the DeKalb, Sycamore, and Belvidere school districts developed a series of short educational modules emphasizing hands-on applications in various technical areas. Through these interactions, the students gained an understanding of the educational tracks in Engineering and Technology that are available. The educational program comprised of four core areas; electronics, manufacturing, structural design and plastics. Each module was developed as a stand-alone component. Students could complete

as many modules as they wanted. Each module was designed to be completed in two hours, with groups of no more than twenty students. In all the modules, there was an introductory short lecture and videos, lasting about 20 minutes. This was followed by hands-on activities. In the manufacturing and electronics modules, each student worked on his/her own part. For structural design, they worked in small teams of three to four. This was intended to enable students interact with group-mates, thus learning teaming skills; interacting with faculty; and also engaging in discussions on the various needs within the technology areas, as well as the benefits of an education is these areas.

Promotion of Project.

To advertise and promote the project, the authors developed a number of promotional tools. First, fliers were printed and circulated at various schools within the participating school districts, and other schools within the area as well. These were given to science and math teachers to distribute to the students to take home to their parents so they could sign up for the program. The fliers showed the various modules, locations and dates the program was going to be offered. The second way of promoting the program was through local media. The authors contacted the local newspapers who then reported on this upcoming event, giving program highlights, dates and location. A website was created for the project[12]. The website had information about the project, dates and locations for programs. It also had links to other websites that would provide interesting information particularly to the K-12 student group.

The modules

1. Fundamentals of Electronics

The electronics module features fundamentals of electricity and electronics. These principles were used to run simple exercises involving implementation of basic electronic circuits. In this module, the learning objectives included principles of electricity and basic electronics, and an introduction to knowledge of electronic circuits and how they can be used in real-life applications. Scientific principles covered included electricity, basic electronics, and experimental design. It essentially covered introduction to electricity and electronic circuits. With guidance from faculty and graduate students, the participants built a simple circuit to control blinking lights. At the end of the exercise, they took the completed project home. A sample project is shown in figure 1.

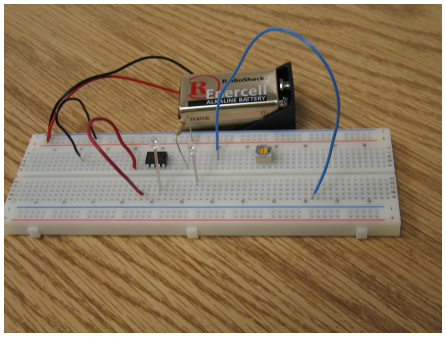

Figure 1. Circuit board for blinking lights

2. Manufacturing

This module covered basic principles of design and machining with the use of computer technology. A short video on the design and manufacture of a commercial airliner was shown to the students at the beginning of the session. The students were then provided with graph paper on which they plotted their initials. They calculated the overall length of their initials and using given machining parameters, they also calculated how long it would take to machine their initials. The students were then taken through a simple computer aided design process using CAM software tools, followed by a brief introduction of how the software is used in numerical control machining (CNC). The students then interacted with the CNC machine and produced simple name tags on 3-inch square plastics which they took home. The learning objectives here included knowledge and understanding of graphics, measurement, design and machining processes. The math principles covered geometry, trigonometry and algebraic manipulations. The scientific principles on the other hand included principles of measurement, critical design of experiments and materials processing. Figure 2 shows the table top CNC engraving machine that was used. Figure 3 is a close up of a sample name tag.

Figure 2. CNC machine set up

Figure 3. Sample name tag

3. Plastics Processing

The plastics module was developed to introduce students to the different applications of plastic materials such as medical, computers, plumbing, clothing, building materials and transport industry. They were then introduced to the different plastic manufacturing processes available in the plastics laboratory at NIU. These were; thermoforming, injection molding, compression molding and blow molding. With the assistance of faculty and graduate students, the participants utilized several different plastic molding machines to produce key chains, signs, name plates, small bottles and other objects. Samples of the parts produced are shown in figure 4.

Figure 4. Sample plastic products

4. Structural Design

An important aspect of engineering is to ensure structural integrity through correct choice of materials and structural design. In this module, students were given insights into the different types of engineering materials, their properties and applications. After a brief introduction into structural design, the attendees worked in groups to build a basic truss bridge out of small pieces of wood and a tube of superglue. They designed and built the bridge according to the dimensional guidelines provided. Each bridge was tested for load bearing capacity using a simple portable tensile testing machine. The winners and runners up were given prizes. This approach has popularly been used by other educators[9]. Figure 5 shows a group of participants working on the project while figure 6 shows testing of the bridge structures.

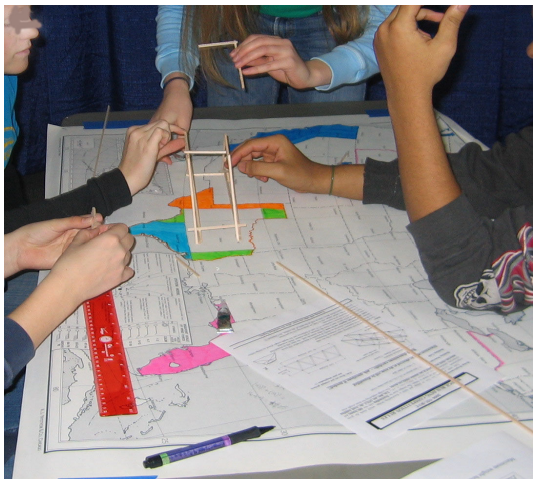

Figure 5. Students working on bridge

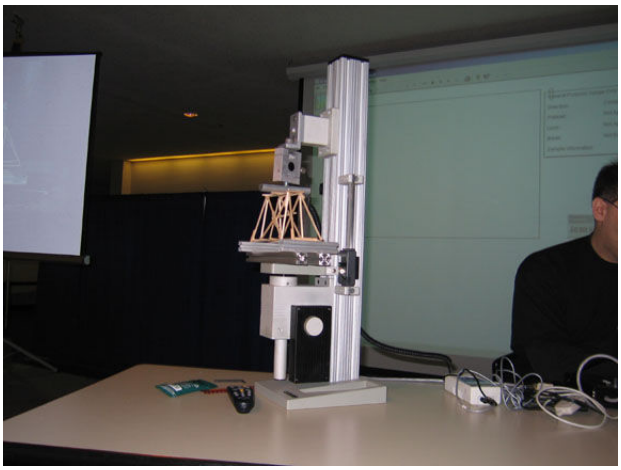

Figure 6. Bridge testing

Outcomes of Project SMILE

It can be seen from the four areas that there is a common thread of instruction and construction. Within the technical areas, it is known that if students are introduced to simple engineering concepts and tools early in the education process, then they will have more interest in the subject. Students at the 7th - 10th grade level have a need for hands-on application activities, and through these introductory projects, they can work with engineering faculty develop further interests in the technical areas[10,11]. In project SMILE, over 200 students registered to participate

either through the website or email or by making phone calls. A total of 136 participated. Out the 136, five were minorities and there were 19 females. Those who participated had a chance to work directly with faculty in the Department and also with graduate students in the labs. All of the modules offered (except for plastics) were portable in the sense that they could be offered in any location. In total, the modules were offered over 8 days in two major locations In the first two days in (June 27-28, 2005), all four modules were offered at NIU. The next two (June 29 – 30), electronics, manufacturing and structural design were offered in Belvidere. The next four days were in July 25 – 28, 2005, with the same pattern repeated except for a change to another school in the case of Belvidere. It should be noted that although the priority of the project was to target minorities, the school districts that participated had very low enrollments of minority students (27.7% in Dekalb, 9.8% in Sycamore and 27.6% in Belvidere). In phase two of the project (Summer 2006) the plan is to expand into Rockford and Aurora East school districts. These two districts have the highest populations of minorities the state, after the Chicago school district.

Because the students developed products that they will took home and showed friends and family with pride, their levels of enthusiasm and excitement were very high. Many students were asked whether they would consider engineering as a career before and after attending the modules. The majority of those who had either replied "no", or were undecided changed their minds after seeing what they could achieve in 2 hours. Of special interest was the bridge building session as most students enjoyed an environment of competition while learning how to build a strong truss structure. This unique interaction involving design, production and structural construction was seen to develop the student's interest in the technical fields, and the interaction with faculty provided them with further understanding of the needs in this important area. As a result of this interaction, program attendees are given the opportunity to develop an understanding of the goals and needs within the technical professions of engineering and technology.

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