Engineering a Difference: Outreach Component

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Abstract

Preparing students for STEM careers is the thrust of our campaign. We hope to arm the future workforce with the tools needed to fill the high-tech and healthcare needs for the world's future technology.

The Pre-Engineering Instructional and Outreach Program (PrE-IOP), a collaboration of the New Jersey Institute of Technology's (NJIT) Center for Pre-College Programs and Newark College of Engineering, was created in 2001 to increase the future pool of qualified high-tech workers and professionals, especially underrepresented groups like minorities and women. This program is comprehensive in that it has two major components: outreach efforts and instructional methodologies.

1. The "Engineering the Future" outreach component consists of a comprehensive information campaign about the rewards of engineering and technology professions.
2. The "Education and Training Institute" instructional component implements pre-engineering curriculum in middle and high school classes.

This paper will focus on the programs of the "Engineering the Future" outreach component.

Introduction

An ASEE report says, "Engineering education programs must attract an ethnic and social diversity of students that better reflects the diversity of the U.S. and takes full advantage of the nation's talent." This is especially important since, according to the U.S. Department of Education, most of the 25 fastest growing careers over the next ten years will be in high-tech and healthcare industries. This growth means, the 21st century economy demands an educated and diverse workforce. Engineering, science, and technology jobs will have increased by 51% between 1998 and 2008. Despite the current soft economy, many high-tech industries have jobs that are going unfilled. The U.S. needs over 1.3 million new engineers, scientists, and computer experts by 2006. To fill these positions the US needs to attract more young men and women to the engineering profession.

The goal of many pre-engineering programs has been to enlarge the future pool of qualified high-tech workers by implemented various curriculum or curriculum changes. This approach has been utilized based on the belief that students do not enter Science Technology Engineering and Mathematics (STEM) careers due to a lack of interest in material from classes relating to those fields. Changing curriculum alone has not worked! A campaign to promote the engineering field and to demonstrate their contributions to society is of major importance.

Engineering is invisible in our society! Many people are unaware that most everything they use is dependent on some form of engineering. Thus, they do not know the benefits that engineering provides people in their daily lives. All around us, from developing consumer goods, building a network of highways, air and rail travel, to creating artificial devices such as knees or hearts, the merger of science, mathematics and technology, better known as engineering, benefits people and creates the world we live in.

Many factors have been cited that affect students' interest in engineering. Some of those include the streaming out of math and science in school curriculums, students' perception of it being difficult, lack of exposure to role models in engineering, lack of knowledge about engineering, the social status of the profession, and lack of hand-on activities to capture their interest.

Students are unlikely to encounter positive images of engineers or detailed information on engineering careers unless they actively seek it or have family or friends who are engineers. [1] While the perception that medicine and other health related fields help people, students do not perceive engineering, and related science and mathematical education, with providing them a basis to enhance society. This is especially true in underrepresented groups such as women. Fields such as medicine, dentistry and law have seen a significant increase in women entering their profession. [2] Almost half the law students are women. [3] These students are attracted to fields that are more oriented to care-giving, and with the exception of biomedical engineering, other engineering disciplines have failed to demonstrate how they also can benefit people.

Many people are not aware of what the engineering profession does causing low participation rates of woman and minorities in this field. [4] We feel that if students, parents, educators and counselors have a better understanding of engineering this will lead to an increased interest in the engineering field. This understanding can even help with the retention of future engineering students, since students' attitudes to engineering upon arrival in college are an important predictor of persistence in the major. [5] Therefore, to attract students to STEM careers, an outreach program, dedicated to inform not only the students but all the stakeholders in their career decision, is equally as important to the student's career decision as modifying course content.

PrE-IOP

To this end the Pre-Engineering Instructional and Outreach Program (PrE-IOP) was established. This program, funded by the New Jersey Commission on Higher Education, is a joint program of NJIT's Newark College of Engineering and NJIT's Center for Pre-College Programs. Our goal is to enlarge the future pool of qualified high-tech workers in New Jersey, including those who have been historically underrepresented (such as minorities and women).

PrE-IOP is based on the assumption that effective science/pre-engineering secondary school curricula (and effective teacher training), coupled with better understanding of the profession would eventually lead to significant increases in engineering enrollment. Hence, this comprehensive program has two major components: the Instructional component and the Outreach component.

The Instructional component, under the auspices of an Education and Training Institute, includes the adaptation and/or development of pre-engineering curricula for use in middle and high school science and mathematics classrooms and the provision of institutes for teacher professional development. The Outreach component involves the implementation of an "Engineering the Future" outreach program and the formation of alliances with three groups of stakeholders: educators, counselors and parents. This paper will focus on the programs of the "Engineering the Future" outreach component.

Outreach Programs

The "Engineering the Future" Outreach component promotes STEM careers through programs for students, parents, and educators with an emphasis on urban areas. Almost 90% of the parents, students, and educators that participate in our outreach programs come from these under-represented groups. Some of our outreach programs are briefly explained below:

Engineering Outreach Visitation

Our Engineering Outreach Visitations take place at the school or on the NJIT campus. Each visit is geared towards the students' grade level and topics that are being studied in class. Most outreach visitations included a presentation on engineering, engineering education, and a hand-on activities related to scientific and engineering topics. 35 high school and middle schools throughout the state of New Jersey have already participated in our visitations.

National Engineers' Week

National Engineers' Week takes place each year in the month of February. The Engineering the Future: Outreach program helps to organize engineering workshops and activities for students, educators, and parents in the local area. One activity that was done in conjunction with the American Society of Civil Engineers was two fun-filled days at the Liberty Science Center. Liberty Science Center is a science museum that is located in Jersey City, NJ. At the Center booths were set up where engineers worked with students on projects that explore simple engineering concepts.

Another Engineers' week activity was to a trip for high school girls to the L'Oreal Company. This event was part of "Introduce a Girl to Engineering Day." The students toured the facilities, explored how certain L'Oreal products are made and talked to female engineers who work at the plant.

Summer Engineering Career Exploration Program

Our first year implementing the Summer Engineering Career Exploration Program was the summer of 2002. During this summer we had female sophomore and juniors in high school participate in an overnight engineering experience. This program was so successful that in the summer of 2003 we extended the program to include male sophomore and juniors. 30 students participated in each overnight.

The two day career exploration included a breakfast meeting between parents, students, NJIT faculty and administration, participation in an engineering design project on the building of bridges, a site visit to a local civil engineering firm, and a tour of the New Jersey Performing Arts Center to look at the architecture, structure, and design of the building.

Counselor Conference

School Counselors play a key role in answering students and parents' questions and in counseling students as they consider pre-engineering or engineering technology as a career. We held a guidance counselor conference to increase their knowledge of engineering and show them the benefits to students and the future technology workforce. The counselors walked away with valuable information that they could take back to their schools. About 75 counselors registered for the conference and the feedback we received from the event was outstanding.

Annual Parent Conference

Parents also have a great role to play in the decisions their children make about careers. This year outreach conducted workshops for parents on choosing science, technology and engineering as a career. Over 250 parents attended the event and were exposed to what engineering can do for their children. Even parents whose children we not interested said they learned something new and would encourage their child to view it as a possibility. The workshop provided them with handouts and other resources such as activities, games, and websites.

JETS Competition

Each February Outreach participates in the JETS competition at NJIT by conducting workshops for teachers while their students participate in the competition. Topics for these workshops include the different types of engineering, where they can find more information on engineering careers, and how they can promote STEM careers in their classroom. This past year the Engineering the Future: Outreach Program also helped to fund a team from Hillside high school to participate in the competition.

Graduate Assistant Program

NJIT Graduate engineering and science students from NJIT go into middle and high schools classrooms once a week to provide teachers with in-class support in integrating engineering into their current curriculums. This past year we have had a total of 4 middle schools and one high school participate in the program. Next year the number of schools will increase to 2 more

middle schools and 3 high schools. The goal of the program is to enhance the teaching of hands-on science, math, and engineering in 6-12 classrooms and to improve teachers' engineering knowledge.

Teleconference

The Engineering a Difference: Outreach Program developed and implemented a teleconference series titled "Building an Engineer". These teleconferences were used for educator's professional development. The purpose was to have a simple, organized structure for a diverse group of experts to discuss information concerning engineering and engineering education.

Two teleconferences were run, one in the fall and one in the spring, and our third teleconference is scheduled for February 24, 2004. The first teleconference focused on preparing for engineering college, how students can have fun with engineering, entering and graduating from engineering colleges, identifying issues of women and minorities in engineering, and how to succeed in the industry. The second teleconference focused on women in engineering. How to get female students interested in engineering as a career, and what they should expect as a female engineering student and as a female engineer working in the field. Our third teleconference will focus on the Project Lead the Way (PLTW), a national program designed to increase the quantity and quality of engineers and engineering technologists graduating from our educational system. Through this teleconference we will show PLTW's services, how to get involved in these projects, examples of courses and students work, and introduce teachers and administrators who are involved in PLTW.

Dissemination Materials

The primary focus of Outreach is to inform our stakeholders of the many benefits of an Engineering Career. In order to reach out the most people we use a variety of methods to disseminate our materials. Here are some of the ways that we have tried to promote engineering:

Website

Since the web is the place that most people go for answers to everyday questions. It was very important that we developed a website that was esthetically pleasing, easy to follow, and filled with useful information. In designing the layout we took into consideration the people who the website would serve, what information would be the most useful to these people, and how to provide the information in the best way so that the user could quickly access what they were looking for. Some of the items included in our website are a listing of upcoming events for parents, teachers, counselors, and students, Engineering activities page of hands on engineering activities, definitions and examples of "What is Engineering?", and useful engineering links.

PowerPoint Presentations

We have also been using PowerPoint software to create informational and educational presentations. These presentations are used to advertise for PrE-IOP, for conference presentations, for educational sessions in schools with students, and for teacher and counselor workshops at NJIT.

DVD

We have also been using DVDs to distribute our materials. We took our first teleconference and put it on DVD. The DVD is separated into segments and chapters so that the viewers can view the teleconference all at once or view individual sections. We also created additional segments on "what is engineering," and "different types of engineering," The DVD package will also include an engineering resource booklet. In this booklet you will find a summary of each section of the DVD and additional information on each topic. A DVD of the second teleconference will be released in the spring.

Brochures

We have also created a variety of brochures. Some of the brochures are to advertise our program and others are to inform our stakeholders on the benefits of an engineering career. These brochures are distributed at conferences and sent out as enclosures in mass mailings.

Bookmarks

We have made bookmarks to promote engineering and to also promote our website.

Feedback and Evaluation

In order to evaluate the effectiveness of our programs we conducted summative evaluations using a modified pre and post-test design. The goal of the summative evaluation is to measure all programs' impact on participants' attitude to, interest in and knowledge about engineering careers.

Our evaluations are in the form of an "Attitudes to Engineering" survey. The surveys were developed as part of PrE-IOP. Information from this survey is being used to shape program interventions and provides data to determine whether our programs are influencing attitudes to engineers and knowledge about engineering as a career. There are five forms of this survey now developed including a survey for parents, for teachers, for counselors, for middle school students and for high school students. Participants are given these evaluations either before or after participating in our Outreach programs and in events that are ongoing, participants are given the same survey once before and once after participating.

Questions are rated on a six point scale including "I don't know," "strongly disagree," "disagree," "No Opinion," "Agree" and "strongly agree." "Some questions include, "I think that engineering could be an interesting career," "Engineers are creative," and "Engineers are highly respected by others." Questions vary by survey audience, for instance, the high school survey includes "I am considering studying engineering in college," and "I would like to study engineering because it could provide me with more money." The teacher survey includes questions such as "I would not like any of my students to be engineers," and "At least one of my students is planning on studying engineering in college." [6]

These evaluations are on going and the data is still being compiled at this time. We are planning to write a paper in the future about the results of these surveys and the effectiveness of our programs.

Conclusion

Educators, parents, and students enthusiastically receive all the programs. It is difficult to pick out which one of the programs has been the most effective. In the opinion of the authors, it is the hands-on experiences. Providing hands-on experiences in the classroom and at home are very important to students' growth as they begin to think about their career options. Our advice to other universities and schools are to start some of these programs as early as elementary school. Since the creation of outreach within PrE-IOP at NJIT, there have been over fifty school visits. Every school visited has asked the outreach component back for repeat visits in future years.

While there still exists an initial gender and ethic bias against pursing engineering as a career, female and minority role models and outreach programs can significantly increase interest in engineering among students. Our institution and program will continue to help reduce social and educational barriers and encourage students to pursue and persist in science, technology, engineering and mathematical careers. [1]

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Biographies

Aisha K. Lawrey is the Project Manager for the Outreach component of PrE-IOP. She has a B.E. in Electrical Engineering from Stevens Institute of Technology. Previously she worked as a math and science instructor of the Consortium for Pre-College Education in Greater Newark at the University for Medicine and Dentistry of New Jersey (UMDNJ). She gives back to her community as the Technology Instructor at the Boys & Girls Clubs of Newark Central Ward Clubhouse. Over the last seven years she has worked with the National Society of Black

Engineers (NSBE) Pre-College Initiative Program. Ms. Lawrey's activities include conference and workshop planning, curriculum development, and many other outreach programs.

Suzanne B. Heyman is the Educational Technology Specialist for PrE-IOP. She has a B.S. in Education and an M.A. in Educational Communication, and Technology. She holds a New Jersey Teaching Certificate and has taught in New Jersey schools. Previously she worked as the coordinator of the Elementary Science Outreach Program. Ms. Heyman's activities include professional development workshops, in-class support, curriculum development, development of evaluation tools, and educational technology support for teachers.

Dr. Ronald H. Rockland is a Co-Principal Investigator for PrE-IOP. He is an Associate Professor of Electrical and Computer Engineering Technology and Biomedical Engineering at NJIT and the recipient of the 2000 Excellence in Teaching award, upper division. He is also the co-PI of the New Jersey - DoE "Tech-Prep Program in Engineering, Science and Technology", Project Director of a Whitaker Foundation "Industrial Internship for Biomedical Engineering Students" grant, an investigator for the NJIT/Gateway Professional Development Project and an active member of NJIT's Teaching, Learning and Technology Committee.