Development of a K-12 Summer Program to Promote Women in Engineering and Technology

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Abstract

As recruitment and retention of women in engineering and technology programs at the university level is a concern, K-12 programs are being developed to address this issue. Although many reasons exist for the low enrollment numbers of females in engineering and technology (ET) programs, several are related to the limited pre-college exposure levels in math, science, and applied technology areas and guidance of these students into more traditionally female-populated disciplines. By developing extra-curricular ET programs for K-12 females, it may be possible to overcome some of the hurdles of the past and increase enrollments in the future.

The Purdue School of Engineering and Technology at Indiana University-Purdue University Indianapolis (IUPUI) offered a K-12 program for females in collaboration with the Indiana University School of Education summer program "Young Scholars." The course entitled "Technology for Girls" is a program developed for young females entering grades 6-8. "Technology for Girls" is a one-week, all-day course emphasizing a broad range of concepts in science, engineering, and technology presented in an informal, supportive, and educational setting. From this starting point, several possibilities exist for expansion of the program, breakout into subject matter concentration, and reformatting for different grade levels.

The objectives of the course are to encourage hands-on science, engineering, and technology activities by females, increase interest and awareness of the potential careers for women in engineering and technology, and create a sense of acceptance, and increased self-esteem for young females entering these typically male-dominated academic and professional fields. These objectives were approached in a unique way throughout the course and the efforts were well received. The development, sample course material, instructional approach, general results, and the overall experience from this past summer's course will be presented.

Introduction

Similar to the report published by the National Science Foundation (NSF) in 1982 on Women, Minorities, and Persons With Disabilities in Science and Engineering, the 2000 report found that at all levels of education and in employment, women are less likely than men to choose science and engineering fields[1]. On a positive note, the report also shows that in 1996, women received 55.2% of all bachelors' degrees, 55.9% of all masters' degrees, and 40.9% of all doctoral degrees conferred. However, the percentage of engineering degrees conferred at each level are 17.9%, 17.1% and 12.3% respectively. In 1996, women represented 53.4% of the total enrollment at 4-year institutions, but only 19.2% of the undergraduate enrollment in Engineering programs. And

finally, in 1997, of the 1,397,100 engineers reported to be in the US workforce, only 126,800 were women[2].

Reported in 1998 by the American Association of University Women, "With caseloads of up to 300 students, school counselors-who are best positioned to help students make informed career decisions- are often hard-pressed to carry on meaningful interaction with students[3]." Having resources to distribute for career counseling is very important in K-12, but the "Technology for Girls" program can only approach the issue from the aspect of educating students, not career counselors, presently.

Considerable effort is being placed toward raising the number of females in the engineering and technology professions, and much of the work is focused at the K-12 level. "Technology for Girls" was developed to address a need within Indianapolis, in hopes of closing the area's gender gap within the ET academic and industrial community in the future.

Development

The Young Scholars program is a summer program developed by the Indiana University School of Education at IUPUI. Traditionally, the courses offered revolve around liberal arts, and more traditional K-12 areas. A couple of years ago, the Purdue School of Engineering and Technology at IUPUI, was approached to develop a course for the program. The course, "Electronics", was a huge success and continues to thrive and grow as an "Advanced Electronics" course has been added for returning students. Original discussions that some of the female students in the class were quiet and possibly intimidated led to the idea of developing a class for females.

The development of the "Technology for Girls" class was possibly the most difficult part. There are so many areas that can be covered but not enough time to cover them properly in one week. The main question was whether or not the class should focus on only one area of ET or sample several areas. Since a focused class was currently being offered, the sampling method was chosen. This decision also allowed for an open-ended and potentially less intimidating course title, "Technology for Girls." Another very strong reason for offering multiple subject areas was to showcase as many of the school's degree programs as possible.

The brief course description published in the registration materials mailed out to the families asked the question: "Do you think that engineering and technology is just for boys? Well, it's not. Come join us to see the things we can do using everything from flubber to hairdryers." The intent for the course was not to keep the females out of the "Electronics" course, or to make the males jealous by offering a course only for females, but to see what the demand would be for an ET class designated for females.

One of the most important features in the class, was the development of the hands-on activities. Short attention spans and the need to schedule around restroom breaks, lunch, and dismissal times meant that activities needed to be interesting and enlightening, but relatively brief. This was not the setting for lecture material, either. Whatever lesson was to be learned, the material needed to be presented experientially[4]. Therefore, the day was broken down into morning and

afternoon segments in which all activities for the segment could be completed in 1.5 – 2.0 hours, including setup and cleanup.

Course Material

The challenge of identifying course material was twofold. Even though the class is about engineering and technology it cannot be too complex because the students have not had the science and math background. Similarly, even though the class is hands-on, tasks that are too difficult to perform without assistance may be discouraging. These difficulties are present in most elementary and middle school programs regardless of gender. So the approach is to present material as difficult as desired as long as there is no real necessity to comprehend the mathematics and physics behind it. This means explaining it in terms that they can understand and with examples they can relate to. As contradictory as this may seem, children are often very receptive to abstract ideas and thoughts and have a level of understanding based on association.

Although engineering and technology material is very technical and mathematically complex, the applications are also very abundant in our daily lives. The children that are growing up now have had computers in their households since they were born, believe the Internet has always been in existence, think cell phones and pagers are essential, and televisions have always had remote control and more than one hundred channels. It is more of a question of do they realize there is science, engineering and technology behind these commodities?

The course was designed to offer a wide variety of technological disciplines from the available programs and laboratories at our school rather than focusing on one area. Each day, a new topic was presented and various activities were employed. Day one, we introduced some basic physics principles and performed related experiments. Marshmallow Towers challenged the students to create a skyscraper from marshmallows and tooth picks, and the team with the tallest tower won a prize. After the adventure, the discussion revolved around statics, strength of materials, moments of inertia, gravity, and of course eating marshmallows.

Day two consisted of Computer Programming Technology and the students learned about search engines, created web pages, and other activities. Day three had silly science and Electrical Engineering Technology when the students made flubber, learned about electronics, and soldered their own circuit board together. Day four was Biomedical Engineering Technology and the students were introduced to, among other things, a defibrillator dummy. Finally, the last day was related to all things mechanical as the students, used hand tools to create their own catapult, cast key chains in the foundry lab, and constructed Egg Drop Vehicles.

As we are learning, technical expertise is not the only quality necessary for success in the ET professions. Other desired “soft skills” include teamwork, critical thinking, creativity, problem solving, and communication skills. Although these concepts were not introduced formally, some of the activities were constructed with these principles in mind. As an example, for the Egg Drop Vehicles, students were given one sheet of paper, scissors, straws, and tape and given the objective of creating a vehicle able to protect a raw egg from breaking when dropped from more than twenty feet in the air.

Instructional Approach

The desire was to have the class filled with females and taught by females. Although this may not be representative of the true setting in the university or industry, it would show the students that females really become engineers and technologists, and there are no gender limitations to what people can do, only psychological limitations. Having no males to "compete" with or be intimidated by, the environment was hopefully one of self-realization, confidence building, and support within the context of learning about engineering and technology.

Very importantly, there was no pressure to perform. Everyone was expected to do their best, and that was enough. It is not a crime to ask for help, no one knows all of the answers, and there really are no bad ideas – just physical limitations to implementing some of them. These issues were discussed primarily to create a sense of acceptance and reduce the fears of rejection. Although there was some competition in a few of the activities, the majority of the course was non-competitive in nature. Also, the setting was informal and this was beneficial as well. The casual nature fit perfectly into the auspices of a summer program.

In addition to the instructor and students, we had a counselor present in the classroom also, and everyone was on a first name basis. The counselor was generally a college-age student, most likely attending Indiana University School of Education either in Bloomington or at IUPUI. The counselor was responsible for transferring the students from the main gathering area to the classroom in the mornings, restroom breaks, transferring students to the lunch area and back, attendance, and helping the instructor with the activities. The counselor was a great resource and also removed some of the organizational stress from the instructor.

Results

For the premiere offering of "Technology for Girls," the enrollment was eleven with the majority entering sixth grade. This was perfect for a new course. There were just enough students to keep things exciting and not too many that individuals were being neglected. Considering that more instructor-attention is necessary with this age group, the maximum suggested group size is about fifteen students, even with the assistance of a counselor.

The students had many positive comments, the parents were pleased with the activities of their children, and so the first attempt at the class was well received. Each student was able to bring their creations home with them after it was completed, and they were asked to discuss the project and concepts with their family. On the last day of each session, an open house was held so that the parents and other family members could see what the children had been doing during the week. It was an opportunity for the parents to speak with the instructor and relate their thoughts. Most of the parents felt the class was an excellent idea and were encouraged to know that an initiative was being taken to promote science, engineering, and technology to females at this point in their schooling.

The major difficulty with this program, and other K-12 programs, is measuring the true success. As stated in the abstract, the desire is to have more females entering engineering and technology programs at the university level and eventually flowing into industry. It is strongly believed that exposing females to these disciplines at an early age may increase their penetration into the ET

areas in the future, but it is very difficult to track the progress of these programs when the students are four to six years away from entering college.

Overall Experience

As with any new course development, there is always room for improvement and this course is no exception. The course was challenging to develop and decide upon course material, fun and stressful to implement, and rewarding at its completion. The general idea behind the course is very versatile and can be adapted to a multitude of environments, formats and age groups. The sixth through eighth grade age group is good because they are able to work well on their own and in a group, they are quite creative, not set in their ways, and able to understand much of the scientific information they receive.

Passing along some sage advise, always have more planned that can be accomplished, and always have a backup plan. Patience is not one of children's best characteristics, and much of their impression on how well the course is executed is based on the success of the activities and whether or not they were "bored."

This program is also an exercise for the instructor. Unlike the traditional lecture hall setting, this environment requires the instructor to be very dynamic and flexible, use multiple modes to convey ideas, be able to "think on their toes," as well as be patient, supportive, and creative. This experience for the students can be the one that sparks their interest in the ET fields, or potentially the one that turns them off the subject forever. Probably the results are not that severe or distinct, but the outcome is primarily dependent upon the instructor.

"Technology for Girls" was successful at engaging middle school females in hands-on scientific and technological activities, increasing awareness for the ET fields and professions, as well as creating a supportive learning environment for ET focused only on young female students. The future remains to be seen, but actions are being taken now to promote females in engineering and technology for tomorrow.

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