Attracting Girls to Engineering & Technology: Reach them before they're turned off

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Abstract

The low percentage of woman and minorities in engineering, and other technical fields, is well-documented. While one cannot force persons into a given field, we ought to ensure that students are exposed to these disciplines and provided with both basic skills and a vision of what they can become. Research generally shows attitudes and perceptions of what individuals want to become being developed early in the secondary education process. Community colleges, in particular, are uniquely positioned close to their communities, to be able to make a significant difference in the way that all youth, female and minority students in particular, view technology and related fields. Lessons learned during nine summer technology camps specifically for girls are related. The newest camp addition, TechnoSleuth, for both boys and girls is then presented. Each camp has been unique, building upon previous experiences, and tailored to impress middle school girls with the importance of math and science in their futures.

Introduction

Although the situation had been so for too many years, by 2002 the lack of girls in technology and computer science was being noticed and investigated. A presentation was made to the 2006 Mid-Atlantic Conference of the prior research, conclusions, initial plans and activities to improve this situation[1].

At that time the research of Margolis and Fisher[2] was being widely read. Although the Carnegie Mellon University study centered on computer science, many of the premises and conclusions are just as applicable to engineering and technology. Educators at both secondary and post-secondary institutions seeking methods to increase enrollment and retention of girls and women, explored programs that directly affected their own students and those that sought to influence much younger populations. Also influential were the straight-forward publications of The American Association of University Women (AAUW) [3,4]. These make the point that often a teacher's behavior or actions have the effect of weakening girls' self-confidence. The AAUW proposes sound, effective methods and programs that enable girls to retain or gain confidence to pursue fields for which they have the desire or the skills.

These two sources were the motivation behind the author's initial efforts to recruit and retain girls in high school classes in information technology and in computer science. After two years, the effort was expanded to the local community college, where it has grown every summer for the past six years.

High School Experiences

A brief synopsis: In the first four years of the Advanced Placement (AP) Computer Science program at Chesapeake High School in Pasadena, Maryland there were a total of five female students compared to sixty males. During the same period of time, the school's Academy of Information Technology[5] enrolled ten girls and one hundred boys. Girls comprised roughly ten percent of the total students enrolled in the only information technology specific programs in the school. The exact numbers varied from year to year with no detectable trend. A concerted effort was made to improve this situation through informative presentations to all eight grade students highlighting the opportunities to gain new and interesting skills. Result: Although overall enrollment went up for the Academy of Information Technology, the presentation had no apparent effect upon computer science. The percentage of girls remained hovering around ten percent.

In contrast, the enrollment in more traditional business office-type courses remained majority female, which is also the case at the community college. This conforms to the

national situation of more girls in the office/clerical skills course and fewer in the more technical courses. The College Board statistics show a testing rate of roughly 30% females for computer science (both exams) and physics (all 3 exams)[6].

The First Technology Camp for Girls

During the summer of the author's final last year at the high school, a new approach was initiated. Instead of telling girls about technology and trying to convince them that it was not "just for geeks", the invitation went out to all rising ninth grade girls for a free technology camp hosted by the high school. Despite a major recruiting effort, only seven girls enrolled. The camp was based primarily upon the recommendations made by Margolis and Fisher[2] and by the AAUW[3]. The aim was very specific, to increase enrollment in computer science and information technology. This forced the activities into a narrower range of computer-based experiences instead of general technology. Activities included: digital photography and editing, programming, networks, web design and hardware. Because the emphasis was motivating girls to consider technical fields, the author was the only male instructor. All others were female to present positive, identifiable role models. Specific lessons learned are included in the initial paper[1].

The Community College Reaches Out to Girls and Women

Anne Arundel Community College positions itself as a learning college; an educational organization[7] committed to student learning. The college is attuned to and supports opportunities to improve teaching effectiveness. This is the major criteria for both promotion and for tenure. Partnering with a female construction management professor, the author, they formulated an initial community college response to low enrollment of women and minorities in the technology fields (engineering, electronic engineering technology, computer science and information systems, architecture and construction management). The first summer technology camp (for girls only) became associated with the larger movement of the Women's Institute Taskforce to increase participation of women in fields and courses where they are underrepresented.

The "First Tech Camp for Girls" was subsidized by grant funds which allowed the greatly reduced camp tuition of $75. With such a low fee, the staff envisioned a maximized enrollment of forty girls. This proved overly optimistic for a number of reasons[1]. This first effort provided the foundation for the following six years of expansion and refinement.

Four More Years

Each year enrollment increased. The second year, we were at capacity, forty girls. By the third year, two separate camps were run with a combined enrollment of fifty-six girls. Four

different adjunct instructors were hired for these camps. The increased staff consumed a more significant portion of the tuition that was being charged. The tuition was raised to the college norm of $200, gradually increasing each year, which is significantly less than comparable private camps. The most significant event that occurred was joining the college's Kids in College (KIC) program.

The Tech Camp Program, Rationale and Results

Instead of assessing each camp, year by year, the issues will be present as aggregated.

From the beginning, the primary purpose of the camps was to convince girls of the importance of continuing math and science courses throughout high school. Not to do so would limit their choices in college. This message was presented often to the girls and to their parents during the camp. It was and still is the central theme and standard by which activities were selected.

The following activities were conducted each year because of their interest and for the requirements of math and science. Some of the applicable math and science aspects or concepts are listed. To the core topics of hardware, digital media, web design and programming, we added cryptography, engineering, architecture and networks. The field trip to a technology-related site became the highlight of every camp. The National Cryptologic Museum, operated by the National Security Agency at Fort Meade, Maryland is the primary destination.

Highest Rated Activity – Solar Cars

Realizing that we needed an interesting, yet fun challenge, an entire day was spent with each girl to build their own solar-power car. This took two days and each team had fourteen girls, all of whom were to construct and race their own car.

Undertaking this activity was a financial risk that paid off. Over $1,600 was spent to purchase a Ray Catcher Sprint® solar racecar kit[8], for each student. There was concern about the initial math and drafting skills required, about the youngest girls using sharp tools, doubt about their fine motor skills to assemble the car chassis, and whether they could appreciate the electrical theory and apply what they receive.

A lesson on the basics of electricity and safety preceded working on the cars. Using low-voltage DC power supplies, 6 volt lamps, and a digital multimeter (DMM), the fundamental quantities of voltage, current and resistance were demonstrated. One requirement was to be able to set the power supply to 2 volts in order to test their solar car motors, gears and wheels for proper operation in the correct direction. The girls wanted to

be sure that their cars went forward and not in reverse when it was race time. Following the electrical exercise, we prepared to build the chassis of the car.

The younger girls (generally ages 10-11) also had some reservations about using sharp tools, so a safer and more suitable method to cut the balsa parts was found. Most had never seen a T-square and some faced challenges using a ruler to measure and mark the cuts to be made. Detailed cutting diagrams were drawn on the chalkboard, and the older girls helped the younger ones, and all had boards marked for cutting. Fortunately the lab had coping saws in addition to the X-Acto knives. With modest care, all girls succeeded in making the required cuts, which was the first time that many had used a saw.

The assembly went without major problems. The instructors and older girls used hot glue to attach the chassis pieces of each car, the axels and the DC motor, while the girls carefully observed what was happening, listening to the explanation. While waiting for all the cars to be glued, the girls made colorful graphics on the top (side and bottom in some cases) of their own cars.

A functional check was performed by powering the DC drive motor with 2 volts and observing the gear drive and wheels for proper rotation. After all discrepancies were fixed the solar cells were checked for output voltage, and were attached to the top of each car.

We have been blessed with often clear sunny summer day, hot and very few clouds. The solar cells produced over 3.5 volts powering the cars faster than most of the campers could run. A few parents came to observe the races and shared in the excitement of their daughters. This was an excellent event to end the day and the camp with. It was a practical application of engineering, that each and every camper was a part of, and took home the fruit of their labor. It is no wonder that this was the most highly rated activity, even higher rated than the free lunch!

The campers rated their experiences at the end of camp. Over these three years the data has been consistent. Following the solar cars, in order of preference, were architecture, programming, web design, digital photography and cryptography. Over the years there have been activities that were not as successful as we had hoped and anticipated. This relatively short (thankfully) list includes working with concrete and survivor-type competitions.

A Bold Opportunity in 2008

The initial plans for 2008 were to continue the Tech Camp for Girls but to also offer an Imaginary Worlds Camp (IWC) based upon the work of Joel Adams at Calvin College[9]. In a discussion with Adams, he emphasized the need to keep the boys and girls separate. This

is primarily due to the conflicting nature of the projects developed by these boys as opposed to girls. We had planned to follow this plan, i.e. two separate camps that cover the same material. We were interrupted during this cycle with a state grant of nearly $10k, which we accepted but necessitated dropping the IWC. Proceeding with a more-inclusive STEM camp that included aspects of information security, we were also able to offer six scholarships to students who would normally not be able to attend financially. Coinciding with the camp dates was the opening of the movie Get Smart®. Thus, the name was changed to TechnoSleuth Camp.

It was decided that one week was insufficient to accomplish all that we wanted to do with up to forty students. With ten instructional days additional topics were added along with an underlying theme of security. The stalwarts of the Tech Camp for Girls were retained: digital imagery, programming, web design, engineering and architecture. With the additional days we added: cyber forensics, geocaching, audio & video editing. The field trip to the National Cryptologic Museum was more meaningful with a focus on security than in the past. Not only was the technology explained or demonstrated but the history as well. All this brought the issues of security to life. It was placed in perspective with world and national history/event as well as the persons involved. This was one of the highlights of the two week experience.

Certain activities within the above topics were especially effective and worthy of additional details.

1. Alice was used for programming along with the model developed by Adams for the Imaginary Worlds Camp. It was encouraging that many girls favored this activity.
2. The West Point Bridge Design Contest was central to engineering design. All students enjoyed the contest after a discussion of why structures support loads and the effect upon materials chosen. Environmental aspects are considered as to designs that require excavation.

3. Another product for construction of structures was a surprise sensation, Armadillo Run. Students proceed through a sequence of statics and dynamics challenges to achieve the goal within a given budget. We were especially pleased when the author of this program donated it for our use.

4. LEGO Mindstorm NXT robotics always seem be well received. Followed a discussion of problem solving methods and autonomous machines, students again experienced the basics of programming and especially learned from seeing the results in action.

5. Cyber forensics covered several days with varied activities. These included

stegonometry, encryption, network intrusion and detection, file recovery. The highlight was a crime scene investigation where teams attempted to solve a crime using physical and electronic clues.

Conclusion

These summer camps are a demonstration of reaching girls and minority students before they reach a critical time of their lives, when peer pressure drives so many to lose self-confidence and "swallow their voices". This commonly happens during high school. Despite their own desires, they may at that time decide that belonging to a group, now, is more important than keeping future options open. By encouraging middle school students to learn new technical skills, experience aspects of engineering, architecture and computer science, observe professionals who love what they do, and work with others who have similar aspirations, they appear to be more motivated to pursue their goals. The importance of advanced studies mathematics and science is consistently emphasized and is reinforced through interesting activities which require these.

The structure of these programs must fit the faculty available and the perceived interest in the local community, however one should always keep in mind that most girls view technology as tools and not the goal. In a camp with both boys and girls, some activities must be kept separate. Those that demonstrate designing or building constructs that serve useful purposes will probably be the most effective.

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Author's Biography

Frank Lanzer is an Associate Professor of Engineering and Engineering Technology at Anne Arundel Community College in Arnold, Maryland. A graduate of the United States Naval Academy (BSEE '73), he served in the U.S. Marine Corps as a Naval Flight Officer and a Data Systems Specialist, earning two Masters' degrees (MSBA '83 and MSEE '84) and Profession Engineer license, before retiring to become a public high school teacher. During those eight years Lanzer taught business and AP computer science, while founding the first Academy of Information Technology in the state. Since moving to his current position he has continued to plan and conduct technology camps for middle and high school students each summer. He was presented the NISOD Award for Teaching Excellence in 2008. Lanzer's website is http://ola3.aacc.edu/fplanzer where more detailed information on the Tech Camp for Girls and Kids in College may be found.