Attracting Girls to Technology: Reach Them Before High School

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Abstract

Today, a technology company may “feel good” if 30% of their employees are women but most will not be engineers. This reflects the facts provided by the National Science Foundation showing 35% of the undergraduates in science and math majors are women, while only 10% are in engineering. It’s no wonder that many girls and young women perceive these fields as “for men”. Recent research shows attitudes and perceptions being developed early in the secondary education process.

During this discussion, current statistics and research with a focus upon the factors that educators can impact will be reviewed. Community colleges, in particular, are uniquely positioned close to their communities, to be able to make a significant difference in the way girls and young women view technology and related fields.

Lessons learned during five summer technology camps for girls are related. Growing from humble beginnings, these camps are now fully-subscribed, and expanding to accommodate annual growth. 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.
A. 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. The research of Margolis and Fisher [1] 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 in general. 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.

The American Association of University Women (AAUW) has been influential through their straight-forward texts [2, 3]. These make the point that often a teacher’s behavior or actions have the effect of weakening girls’ self-confidence. By paying more attention to boys, providing different instructions, and giving the impression of different learning capabilities, girls recognize the negative pattern. Following up on this initial awakening shock, 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 three years thus far.

B. High School Experiences

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 [4] 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 targeted effort was made to improve this situation during the last two years. Informative presentations were made to all eighth grade students at the feeder middle school to describe the high school technology programs and highlight the opportunities to gain new and interesting skills. Uses of technology that may be attractive to girls were specifically addressed by one of the high school girls currently in that program. 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.

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In contrast, the enrollment in more traditional business office-type courses (information systems, word processing, business presentations) was majority female. 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) [5].

C. The First Technology Camp for Girls

During the summer of the author’s final year teaching 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. One mother requested to stay and learn as well. The camp ran Monday through Friday, 9 am through Noon.

The camp was based primarily upon the recommendations made by Margolis and Fisher [1] and by the AAUW [2]. 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.

Table 1. Camp Activities

<table>
<thead>
<tr>
<th>Women in Tech Fields</th>
<th>Digital Photography and Editing</th>
<th>Visual Basic Programming</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of the Internet</td>
<td>Webpage Design</td>
<td>Computer Hardware</td>
</tr>
</tbody>
</table>

With an emphasis upon motivating girls to consider technical fields, the author was the only male instructor. Two female teachers donated their time and effort for this first camp. Knowing that students often consider teachers as biased sources of information, a female consultant was recruited to bolster the presentation. She has a Bachelors’ in Computer Science and was working for a fast-paced Internet-based technology company; thus was an excellent role model. During girls-only discussions with her, the girls were allowed to ask any question they wanted.

Lessons learned from the first camp:

1. In the rural setting of this school, public transportation is not available and it was often a challenge for parents to pick-up campers at mid-day. If public transportation is available, consider chartering a bus to pick up and drop off campers each day. A modest fee for this service can most likely be charged.

2. Provide food (snacks, if not lunch), drinks and a suitable location away from
computers. The girls enjoyed the “down time” and were able to learn more about each other.

3. Make a more personal approach to groups of girls who may be interested. The one presentation to all is still needed, but guidance counselors, math and science teachers should have more specific recommendations that should result in increase enrollment.

4. This camp was free. However future summer activities should charge tuition, find sponsors or obtain grants to provide fair compensation for camp faculty and staff.

5. Conduct a full-day camp. Three hours a day is not the optimum use of either the facility or the staff. Short days make it difficult to spend adequate time on more than one activity per day and limits the number of possible activities.

D. The Community College Reaches Out to Girls and Women

Anne Arundel Community College positions itself as a learning college; an educational organization [6] committed to student learning. Professional development for new faculty begins prior to the start date for returning faculty, with an orientation and growth program known simply as “learning college”. The brainchild of Associate Vice President Trish Casey-Whiteman, learning college is much more than a new employee orientation. During these 45 hours, faculty members explore all aspects of the community college and are challenged to make an early and positive contribution to the learning community. It was during this experience that the author met Brandi Shepard, instructor of architecture and construction management. Together they formulated one community college response to low enrollment of women in the technology fields (engineering, electronic engineering technology, computer science and information systems, architecture and construction management).

The summer technology camp for girls became associated with a larger movement to increase participation of women in fields and courses where they are underrepresented; Science, Technology, Engineering and Mathematics (STEM) were of particular concern to the author. Barriers (perceived or real) were discussed. Under the guidance and direction of Dean Kathi Happ, computer and technology courses were examined relative to content, presentation style conducive to women and examples illustrating women in professional roles.

There have been two community college programs that have had broad and lasting effects. The Bridge Project, which helps African-American students to succeed in college and the Tech Camp for Girls, which encourages girls to continue engagement in math and science courses. A grant was used to fund the staff for the planning and conduct of the first tech camp for girls. This allowed the college to charge a minimum tuition of only $75.

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With such a low fee, the staff envisioned a maximized enrollment of forty girls. This proved overly optimistic. Publicity and access to the target population was more difficult than anticipated. Design and production of college-approved fliers were time-consuming and expensive. This caused distribution to be at least a month behind schedule. It is not known if most of the fliers ever reached their desired destinations, middle school girls, through their guidance counselors. Without an established college program to shepherd the advertising, the staff personally stocked the community college displays in many public libraries, hoping for more visibility. Five days prior to the start of the camp the enrollment stood at only eight. That number was doubled over the weekend, in response to an email announcement to the entire college community. When the camp opened on Monday morning, there were sixteen excited middle school girls waiting to learn new technologies.

Lessons learned relative to publicity:

1. Develop a relatively-solid plan early in the fall semester for summer camps. Preparations will always take longer than anticipated.

2. Public relations (PR) personnel have high expectations and strict standards, often driven by the college strategic plan, community environment, recruitment and legal requirements. Allow ample time to work a flier through PR and it will be good when it is complete.

3. Distribution to public schools via a central mail room may not be effective. The volume of paper going to each school is tremendous and the fifty fliers you send may well be lost or deemed not sufficiently important. A more direct approach to specific school system’s program directors, school chairpersons and departments would be better. Distribute materials early in the spring semester and call each school to see if they have any questions.

4. Do not overlook the public libraries, but don’t rely on them exclusively. A colorful, attractive and informative brochure will catch the attention of a few students or their parents.

5. Locate an established organization at the college with which to partner and advertise.

E. Three More Years, Four More Camps

Each year enrollment increased from that initial sixteen. By the second year, it was at capacity, forty girls. To handle this number, two teams were formed for some activities. This allowed more participation by each girl but also doubled the instructors that were required. While Lanzer and Shepard comprised the entire staff in the inaugural year, this was not possible in latter years. Adding adjunct instructors required coordination of logistics (classrooms, breaks, lunch, switching classes, etc.) and instruction (materials,
topics, resources, and techniques). 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.

Increased staff also consumed a more significant portion of the tuition that was being charged. The subsidizing grant expired at the end of the first year. From then on, each camp was required to be self-sufficient. Fees were raised to over $200, which were still significantly less than comparable private camps. Some parents of previous campers expressed concern about the increase and some could not pay this amount. However, enrollment was been sufficient each year to cover all expenses and have some funds to invest in the next year’s activities.

Other than increasing enrollment and the actions to handle more girls, the most significant event that occurred was joining the college’s Kids in College (KIC) program. Part of Lifelong Learning, KIC provides a uniform standard for enrollment, medical and PR permissions, and for accountability. They provide a before- and after-camp program which allows more girls to attend, and they train counselors to assist the camp staff. Most importantly, Kids in College provides a “home” for camps, a director experienced with youth programs, and a wealth of knowledge.

F. The Tech Camp Program, Rationale and Results

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

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 the central theme and standard by which we selected activities and by which they were assessed.

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. If software was used it is also listed.

1. Digital photography – Analog vs. digital, sensing color/brightness, A-to-D conversion, storage, color depth and resolution related to bytes stored
   Software: Serif PhotoPlus 6

2. Webpage design – Networks, WWW, size vs. time to retrieve, hierarchy of data
   Software: Notepad w/HTML (first year only), Microsoft FrontPage (past two years)

3. Visual Programming – Sequence of execution, objects, physics of motion
   Software: Visual Basic 6 (first year only), Alice (past two years)
4. Cryptography – probability, statistics, frequency tables, patterns, cryptograms

5. Construction – strength of materials, structures that support
   Software: West Point Bridge Design Project (first year only), Google SketchUp (past two years)

6. Field trip – At least one half day was dedicated for a field trip to a technology-related site for every camp. The National Cryptologic Museum is a vast, interesting resource operated by the National Security Agency at Forty Meade, Maryland. The staff presentation on cryptography used *The Gold Bug,* by Edgar Allen Poe, to illustrate the importance of mathematics to codes and ciphers. This trip was made twice. For the third year, the Electrical and Computer Engineering Department at the U.S. Naval Academy hosted the camp with presentations on solar power and the Academy’s entry in *SOLAR SPLASH®* - The World Championship of Intercollegiate Solar Boating (4th place finish). However, the most enjoyed activity of the field trip was the hands-on demonstrations in the Biometrics Lab.

These following activities were attempted and discontinued for the reason provided:

1. PC Hardware – Most of the girls were not interested in how PCs worked. They mechanically disassembled/reassembled the machines without significant learning

2. Concrete garden pads – Risk of reaction to concrete dust and latex gloves. The girls enjoyed the activity; however the theory of the chemical reaction was too advanced

3. Survivor Challenge (competition using all of the skills learned) – While this was of interest to a few of the girls, most did not like competition and working under pressure. The two hours allowed is now better used for a new skill

F. Highest Rated Activity – Solar Cars

This year the newest activity received the most acclaim from the girls. Realizing that we needed an interesting, yet fun challenge, an entire day was spent with each girl to build their own solar-powered 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 risk. Over $1,600 was spent to purchase a Ray Catcher Sprint® solar racecar kit from Pitsco [7], for each girl. There was concern about the math and drafting skills required, about the youngest girls using X-Acto knives, 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 electrical potential (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 two instructors 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.

It was a 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. Tables 2 and 3 provide the rankings of activities by average rating.

Table 2. Student Rating of Tech Camp Activities (June 26-30, 2006)

<table>
<thead>
<tr>
<th>Activity Ratings (4= highest, 1=lowest)</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Solar Cars</td>
<td>3.71</td>
</tr>
<tr>
<td>2 Sketchup!® 3D Modeling</td>
<td>3.71</td>
</tr>
<tr>
<td>3 Lunch</td>
<td>3.67</td>
</tr>
</tbody>
</table>
### Activity Ratings (4= highest, 1=lowest) Average

<table>
<thead>
<tr>
<th>Activity</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual Programming in Alice®</td>
<td>3.48</td>
</tr>
<tr>
<td>Webpage Design with FrontPage®</td>
<td>3.43</td>
</tr>
<tr>
<td>Graphics Arts</td>
<td>3.29</td>
</tr>
<tr>
<td>Length of Camp</td>
<td>3.24</td>
</tr>
<tr>
<td>Codes and Ciphers</td>
<td>3.24</td>
</tr>
<tr>
<td>Thinking about the Future Time capsules with the Institute for the Future</td>
<td>2.71</td>
</tr>
<tr>
<td>Presentation by Johns Hopkins Applied Physics Lab Engineers</td>
<td>2.67</td>
</tr>
<tr>
<td>Field Trip to the United States Naval Academy</td>
<td>2.57</td>
</tr>
</tbody>
</table>

Table 3. Student Rating of Tech Camp Activities (July 31-August 4, 2006)

<table>
<thead>
<tr>
<th>Activity Ratings(4= highest, 1=lowest)</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar Cars</td>
<td>3.83</td>
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<tr>
<td>Lunch</td>
<td>3.69</td>
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<tr>
<td>Sketchup!® 3D Modeling</td>
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<tr>
<td>Length of Camp</td>
<td>3.47</td>
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<tr>
<td>Webpage Design with FrontPage®</td>
<td>3.45</td>
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<tr>
<td>Graphics Arts</td>
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<td>Codes and Ciphers</td>
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<tr>
<td>Visual Programming in Alice®</td>
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<tr>
<td>Field Trip to the United States Naval Academy</td>
<td>2.98</td>
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<tr>
<td>Thinking about the Future Time capsules with the Institute for the Future</td>
<td>2.55</td>
</tr>
</tbody>
</table>
G. Conclusion

These summer camps are a demonstration of reaching girls before they reach a critical time of their lives, when peer pressure drives so many to lose self-confidence and “swallow their voices”. This 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 girls to learn new technical skills, experience aspects of engineering, architecture and computer science, observe professional women who love what they do, and work with other girls who have similar aspirations, they appear to be more motivated to pursue their goals. The importance of advanced studies in 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. Activities that demonstrate designing or building constructs that serve useful purposes will probably be the most effective.

H. References


[7] [http://www.pitsco.com](http://www.pitsco.com)
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 the 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 school girls each summer. 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.

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