GIRLS EMBRACE TECHNOLOGY: A SUMMER INTERNSHIP FOR HIGH SCHOOL GIRLS

Jacquelyn F. Sullivan¹, Derek Reamon² and Beverly Louie³

Abstract - High school girls explore their potential for a career in engineering and technology through developing educational interactive multimedia software during a six-week summer internship. “Techno-neutral” girls — those who do not envision themselves pursuing a career in high-tech, yet have the academic preparedness, curiosity and commitment to complete the internship and produce a successful multimedia product — are recruited. The internship experience makes information technology accessible and attractive to the girls via developing creative, hands-on educational software for younger children. The girls develop technical skills in graphic design, user interface development, visual programming, digital image manipulation, multimedia authoring and user testing. The girls were as impacted by the environmental and cultural conditions of the internship — including working in teams — as they were by the opportunity to learn new technological tools. The internship helped the girls become aware that a technology-based career can be creative and fun while serving the needs of society.

Index Terms - Gender Equity in Computing, Girls and Technology, Information Technology, K-12 Education, Teenagers and Technology.

INTRODUCTION

Concurrent to society becoming increasingly more technology-driven — with new technologies pervading and shaping our economy and way of life — the representation of women prepared to contribute to the technological revolution is shrinking. In 2002, girls made up only 14% of the high school students who took AP computer science exams, down from 17% in 1999, and by far the lowest percentage of girls’ participation in all AP tests given. By comparison, girls made up 46% of calculus, 45% of chemistry and 30% of physics exam takers [1].

A profound and growing gender distinction pervades the information technology (IT) world: “boys invent things and girls use things boys invent,” [2] with girls shunning being the creators of the very technologies that are shaping everyone’s lives. This void of women’s voices as technology creators is disconcerting. Girls begin to lose interest in computers during middle school, just as boys are getting deeply involved in computer games. Research has found that the basic premise and rules of engagement for most games are not interesting to girls, prompting them to relate to the computer more as a tool for word processing and homework than as a puzzle that may be a source of creative enjoyment itself [3]. This drop in girls’ interest in computers as they reach their teens is thought to be an accumulation of recurring biases and subtle patterns, both at home and school, ranging from brothers and fathers dominating computer use at home to teachers preferentially asking boys technical questions [4].

The strength of the U.S. economy and military both depend greatly on technology [5], and it is predicted that the high tech industry will have grown by more than five million jobs by 2008 [6]. The outlook for younger women engaging in these industries and this growth is discouraging, creating a paradoxical situation. Aside from the obvious issues of access, fairness and equity, all citizens should be equipped with knowledge and experience to make informed choices on issues involving technology [5]. Clearly a cyberspace culture increasingly dominated and designed by men, by nature alienating the desires and sensibilities of the female half of our population, represents substantial lost opportunity and diminishes our nation’s capacity to perform.

K-12 OUTREACH PROGRAM OVERVIEW

The Integrated Teaching and Learning (ITL) Program is a College of Engineering and Applied Science K-16 initiative focused on integrating engineering theory with practice through hands-on, inquiry-based learning. Using engineering as a vehicle to integrate math and science, our commitment to learning by doing extends into the K-12 community.

During summers, the ITL Program offers numerous engineering-based professional development teacher workshops, hands-on children’s classes, and design/build engineering resident camps for under-represented teenagers [7]. The primary emphasis of our outreach program is the preparation of students — especially those with backgrounds under-represented in engineering (girls, students of color and...
first generation college-bound youth) — for the engineering and technology pipeline. Applying engineering and design principles in hands-on, inquiry-based ways underscores that *engineering is about creating things for the benefit of society*, motivating youngsters to consider engineering or technological futures at critical points in their K-12 career when they can still make pivotal academic and life choices.

**GIRLS EMBRACE TECHNOLOGY PROGRAM**

The *Girls Embrace Technology* (GET) summer internship was developed to more fully explore barriers to the engagement of high school girls in technology, and promote the exploration of a technological future by success-oriented girls. The internship target audience is high school girls from all ethnicities who are well prepared in math and science, but not inclined to pursue a technological career path.

The objective of the GET internship is to actively engage high school girls in a “job-like” experience (for which they are paid a modest weekly stipend) to explore their potential for a career in engineering and technology as they collaboratively develop educational interactive multimedia software.

**Program Logistics**

Girls were recruited who likely do not envision themselves pursuing a career in technology, yet who have the academic preparedness and curiosity to complete the internship and produce a successful multimedia product. They might be called “techno-neutral” — girls who are neither technophobic nor particularly attracted to technology.

Through our partnerships with regional schools, Mathematics Engineering Science Achievement (MESA) programs, and many community-based programs, we successfully recruited 70+ girls from 27 different middle and high schools in nine communities. Working in teams and paid $80 for a 16-hour workweek, 36 interns created interactive educational multimedia software to teach science phenomena to elementary age children. They learned to integrate digital graphics, digital audio and other media, as they became computer and technology savvy while working on a fun group project (see Figure 1).

Working in mixed-age teams of four, the high school girls explored and acquired technical skills by integrating various software and technical tools, as they incrementally developed the multimedia software product for which they were held accountable. Along the way, as we had hoped, they began to imagine themselves pursuing technological careers, correcting misconceptions about the IT field by experiencing that a technology-based career can be collaborative, creative and rewarding.

**Instructional Design**

The instructional design for the GET program was methodically derived from the program goals. Using the general goals, 23 learning objectives were defined, each falling into a category of knowledge gained, skills acquired or values reinforced. High-quality learning objectives also
included defining the conditions of performance and the criteria for evaluating performance [8]. Example GET learning objectives include:

- **User Testing** — Interns will conduct user testing with testers that they find, using video cameras if needed. The user testing will reveal software components that mislead the user, or components that should be added to aid the understanding of the user.

- **Creativity** — By developing the media used in their multimedia curriculum modules, interns will understand that creativity is an essential part of the engineering process, and that art and technology are equally important to successful design.

From the defined learning objectives, the instruction plan was developed. It details the daily activities that support the learning objectives, the time span and the materials needed [8]. The GET activities were designed to appeal to a diversity of learning styles by addressing the four modes of the Kolb Learning Cycle [9]. The learning objectives were shared with the interns and their parents during the orientation.

**Creating a Context in Which to Explore Technology**

Understanding that girls more readily engage with software that is "girl-friendly" — defined as being fun for girls, technically sophisticated and challenging of stereotypes that limit girls’ notions of what they can accomplish [10] — the nature of the software product they would develop was deemed important. Toward that end, during the pilot summer, the interns created a stand-alone multimedia software product that teaches youngsters about physics phenomena as observed in a kinetic Rube Goldberg exhibit.

In the second summer, interns will create multimedia software to teach elementary-level students about the interaction between biology and physics, variously explored through the fate and transport of contaminants introduced into river systems and the air, biochemical processes and statics in muscle systems, or biological influences on the optics of the human eye. These projects illustrate the cross-disciplinary nature of work undertaken by engineers and technologists.

After researching the scientific principles underlying their challenge, the interns develop creative, interactive educational multimedia software, typically in the form of an interactive game or demo, suitable for younger students.

**Technological Challenges**

The interns rotated through five specialty areas, experiencing a wide range of information technology (IT) tasks and responsibilities, and mastering technical skills in:

- **Graphic design** through creation of digital graphics;
- **User interface design** including needs graphics, conceptual design and user testing;
- **Product creation** using a visual programming authoring tool and basic programming for software development;
- Ensuring their multimedia product **met curriculum goals**, including state educational content standards; and
- **Project management** through taking responsibility for their team schedule, coordination and project deadlines.

A primary goal was to make IT accessible and attractive to the girls. Through the development process, interns:

- Produced a real world, interactive educational product;
- Developed positive attitudes towards creating and using technology;
- Developed technical skills (see list above);
- Increased their awareness of technological career opportunities; and
- Were exposed to professional technological female role models.

The internship also increased parents’ awareness of technological career opportunities for their daughters and allowed the university engineering and computer science faculty to explore and better understand the barriers for entry of girls into the male-dominated IT world.

**Why Multimedia?**

Two reasons underline our decision to define the final deliverable as an interactive educational multimedia product. First, designing educational interactive multimedia software allowed the girls to experience the complete design/build process while engaging IT tools and developing IT skills. Second, the products interns produced are of benefit to the educational community by teaching the users more about a specific area of science or engineering. Hence the entire GET experience became a service-learning project — one that imparts real benefits to the end-user community — as the interns learned how to create curriculum modules that addressed particular math and science standards, and evolved the modules into multimedia products.

**Design Process**

The software design process used by the interns was patterned after that used in the software industry [11] — an iterative process of improving upon ideas until a product is created that meets the design requirements. The relative rapidity with which prototypes could be created and modifications made allowed the interns many opportunities to experience the design/build/test/redesign cycle.

A typical software design process begins with a concept, or cognitive model, which defines the idea of the
product and how it will be conceptualized and interacted with by the user [11]. From this point, the designers create storyboards, detailing how specific users will use the product (see Figure 2). The storyboard illuminates the conceptual model while also developing specifics of program sections, modes, etc. From the storyboard, the designers develop a project plan that details the required media and algorithms, and assigns team members’ responsibilities and deadlines for each task. The plan is implemented to create a product prototype.

At this point, the interns found user-testers in their product’s target age range to test their prototypes. User testing was an eye opening experience for the interns, as is common for software designers. Ideas, modes, buttons and other affordances that were obvious to the designers were ignored by, or often unclear or confusing to the user-testers. The interns completed three cycles of design, user testing, and refinement prior to completing their final product.

**Software Tools**

The interns learned and used three primary software tools. The multimedia products were authored with *Macromedia Director<sup>®</sup>*, a full-featured, professional multimedia development tool that provides the capabilities to gather the multimedia elements, and organize, coordinate and animate them, or perform whatever other operations are required. *Director* also features a complete authoring language called *Lingo<sup>®</sup>*, which can be accessed via commonly used functions in libraries, or by algorithms written from scratch by the interns. *Director* also includes tools for exporting multimedia products to the web.

The graphical elements for the multimedia products were edited or created using *Adobe Photoshop<sup>®</sup>*. Music and sound elements were edited or created using *Sonic Foundry Sound Forge<sup>®</sup>*.

**Collaboration Partners**

The GET internship collaborators include the ITL Program, Computer Science Department (CS), Women in Engineering Program (WIEP), and the CU-Boulder Alliance for Technology, Arts and Media (TAM) program.

The internship was led by a mechanical engineering professor, an expert in the development of educational interactive multimedia software, assisted by four women undergraduate student mentors (two from TAM, two from CS). The women “coaches” served as role models and provided individual and team mentoring to ensure that each team functioned well and that every girl was engaged, as well as providing technical expertise on multimedia creation.

Women engineers and IT professionals participated in weekly lunch-hour presentations, sharing their educational and career experiences.

**THE PROOF IS IN THE OUTCOMES**

We have found that offering carefully designed, resource-intensive pilot programs, accompanied by extensive assessment and evaluation activities, is a successful model for developing effective, sustainable programs that can be replicated and scaled to larger audiences [12].

Through numerous forms of assessment, the pilot internship was closely monitored, evaluated and improved during the course of the six-week program. Each girl’s knowledge and comfort level in using technological tools as well as each intern’s attitudes towards IT were evaluated. Assessment methods included:

- An in-class weekly snapshot of student opinions to help the instructor and mentors to immediately adjust their teaching to better meet student needs was accomplished through *formative assessment*.
- A mid-internship *individual performance evaluation* provided guidance to each girl on her accomplishments and suggested where each should focus their energy for the remainder of the internship.
- *Outcomes assessment* was obtained by the use of pre / post self-rated skills and attitude inventory surveys, and pre / post content testing on technical concepts. Content testing helps to objectively assess student learning, providing a complement to student impressions.
- *Participant feedback* was obtained via a student group interview feedback session held at the end of the internship to interactively solicit feedback on the strengths and suggested improvements of the initiative. Team mentor feedback was also solicited.
This in-depth assessment provided data and information to measure program impact and allowed us to continuously evaluate and evolve the program.

Assessment Results and Evaluation

During the weekly feedback, students provided comments on what they liked, “I think the storyboards were really fun and they helped get good ideas for our big project,” and suggestions for improvement, “There should have been more interactive teaching instead of just reading a web page.” Findings were discussed among the mentors and the instructor, and led to immediate adjustments.

Assessment results from the pilot internship indicated highly significant gains in skills and content. Interns rated five of six skill categories significantly higher on the post-test with strongest gains in user interface design (+166%) and formatting images and sounds (+105%). Content gains (see Figure 3), were significant overall (+153%) with large increases in understanding of types of programming structures (+521%), formatting of digital images (+238%) and user interface design (+142%). Evaluations of the workshop format revealed that 97% of girls found the six-week length appropriate.

Attitudinal assessment revealed that 53% of participants reported that their attitude toward women in technology careers had been changed because of the internship. One girl commented, “Technology is not just for men!”

During a structured end-of-program group interview session, interns brainstormed on strengths of the GET experience and suggestions for program improvement. Their top rated strength of the course (100% agreement among the interns) was the mentoring aspect of the program. Their top suggestion for improvement (100% agreement) was a request for more hardware including tools, microphones and digital cameras.

Mentor feedback was also solicited via an open-ended questionnaire. Mentors agreed that team functioning was aided by the early team dynamics exercises and attention to team selection. They also reported that content lectures and lunch speakers should be more interesting, suggesting that speakers should be recent college graduates with whom the interns could best relate. When reporting on outcomes of participating as a mentor, the women students were very positive about the experience. One mentor commented, “I have actually discovered an interest in teaching. I thoroughly enjoyed working with the girls and hope to be involved in upcoming events similar to this one. I learned patience and developed a sense for simply being a mentor and not a boss.” All mentors agreed that they would participate in the program again and recommend it to friends, “I would absolutely be a GET mentor again and only recommend the program to those worthy enough to work with such amazing girls.”

![Figure 3: Pre/Post Pilot Internship Content Assessment Results](image-url)

The 65+ parents and family members who attended the final team presentations were highly complimentary of their daughters’ accomplishments and experiences. Based on feedback received, we are confident that the goals of the

0-7803-7961-6/03/$17.00 © 2003 IEEE

November 5-8, 2003, Boulder, CO

33rd ASEE/IEEE Frontiers in Education Conference

T4D-10
Continuous Improvement: Future Plans

With the success of the pilot GET internship, we repeated the six-week structure the next summer (2003). The feedback suggestions from the girls and mentors helped refine the internship design, including reducing the weekly stipend from $80 to $50. This change reduced program costs and selected out those few participants who were unduly motivated by the higher stipend. The remaining $300 stipend for six weeks of “work” is still enough to maintain the sense among participants that this was a job for which they are accountable. The content focus of the multimedia product the interns develop changes each year to maintain interest for returning interns.

In 2003, we will again structure the internship for nine teams, limiting team size to four. Interns from the pilot program will be invited to return, creating mixed teams of “veteran” interns and new 9th grade girls. To increase socioeconomic and ethnic diversity among our participants, second-year recruitment efforts will focus more on low-income, first-generation college-bound or girls of color, through already-established partnerships with local schools.

CONCLUSION

Quality engineering and technology outreach is vital to the future of the engineering profession and our country’s technological future. Each summer, the Girls Embrace Technology internship benefits not only 36 high school girls, but our College as well. Knowledge gained from this internship allows us to help girls overcome barriers for the university’s entering first-year women students. We are deeply focused on evolving a sustainable outreach model in which engineering colleges form meaningful and impacting partnerships with K-12 students, teachers and schools, with girls considering, early on, engineering or technology as stimulating, rewarding and viable career paths. Technology is transforming our economy and our way of life: how we do business, how we communicate, and how we support and sustain ourselves. Women must be more than end users of technology as it increasingly shapes the future of all humankind [3].

ACKNOWLEDGMENT

The program described in this paper was developed under a patchwork of grants from the Colorado Commission on Higher Education, the CU-Boulder Outreach Committee, and the Xcel Energy Foundation. Opinions, findings, conclusions and recommendations expressed in this paper are solely those of the authors.

REFERENCES