

Girl Power 21st Century: An Early Intervention Approach To Enhancing Gender Diversity in Technology Education

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Abstract-- *Girl Power 21st Century: Growing Strong, Moving On* is an ongoing five-year project. Recently expanded through a three-year grant from the National Science Foundation, the project addresses the need for early education intervention to increase the number of women CS/IT professionals. Predicated on psychosocial theories of self-concept and identity development and attitude acquisition and change, the project addresses the hypothesis that high school and even middle school interventions may come too late in the developmental process to have an impact on girls' relationship with technology. The project extends the education intervention backwards to elementary school, offering girls in grades 2-8 a series of three modules comprising a continuum of experiences within a unique "culture of women" built around technology, to substantially increase the likelihood that young women will consider CS/IT as an education and career option. Presenting elementary school age girls with a normative environment in which girls, women, and technology intersect through a series of integrated experiences may help to offset implicit and explicit negative cultural messages regarding women and technology.

The project is designed around three main goals: (1) to challenge girls' perceptions of technology as "geeky" while encouraging a change in how girls relate to technology; (2) to encourage girls' perceptions of technology as an education and career option; and (3) to increase the probability that minority and low income girls will consider technology-related educational and career paths. The four primary objectives that extend across all program modules are to increase or enhance: (1) Basic technology skills; (2) Perceptions of technology-centered activities as social, not solitary; (3) Global and technical (tech-savvy) self-confidence; and (4) Perceptions of technology-based activities as gender-normative for girls.

The project serves approximately 60-75 girls per year. Assessment, including oral interviews, games-format skills assessment, and parent surveys, reveals that (1) girls in all modules demonstrate appropriate technology knowledge and skills and retention between modules; (2) most girls exhibit comfort with problem-solving through experimentation, indicating a positive shift in relationship with technology; (3) more than 90% of girls agree that a computer lab is a place where: they feel comfortable, people work together, one can get work done and still interact with others, and it is okay to make mistakes or do things differently; (4) girls in the advanced module express awareness of opportunities in technology for women, and indicate that they are at least a little interested in pursuing such careers; (5) at home, girls in the program frequently talk about and demonstrate what they are learning.

An unexpected finding is that teaching in the program may have positive effects on their own learning experiences for female undergraduate and graduate students in CS and IT programs.

Introduction

We know that one reason for our continuing shortage of CS/IT professionals (Jackson, 2004; “Women Yield High-Tech Field,” 1998) may be a historic gender imbalance in the technology education pathways and resulting CS/IT applicant pool (Kennelly, Misra, & Karides, 1999). Psychosocial theory and research support the presence of culturally-derived and reinforced perceptions of gender-specific roles, abilities and occupations as a crucial factor in the development of the current predominantly male technology workforce.

Cultural frameworks include pervasive schemas, including gender-specific schemas, which make it possible for human beings to process the large amount of social information to which they are exposed (Shaffer, 1996). Without cognitive schemas we would be literally unable to process information that enables us to function as thinking social beings. However, schemas are cognitive “shortcuts”, forcing us to unconsciously ignore complexities in incoming data so that we can categorize more efficiently. This means there are a lot of data that bypass awareness partially or completely, making the impact of schema-based intellectual processing enormous, but also reflexive and generally invisible.

From a developmental perspective, the gendered social schemas or scripts woven throughout cultural frameworks influence the formation of individual beliefs regarding the self (Shaffer, 1996). Over time, individuals develop core identities based on these beliefs, including global self-concept (encompassing gender identity), academic self-concept and self-esteem (Smith, 2000; Aronson, 1999). These core identities have been shown to become quite stable and may be difficult to alter beyond a certain point in human development.

Cultural frameworks also include negative and positive attitudinal cues linked to various schemas. In general, this means that from a cultural perspective individual behaviors in the context of gender elicit positive attitude if they fit the corresponding role schema and negative attitude if they do not. Cultural attitudes such as those relating to pursuit of gender-appropriate educational and vocational goals are internalized over the course of individuals’ social development (Aronson, 1999; Smith, 2000; Steele, 1995, 1997; “Threats Within,” 2004). In our western culture, the abilities perceived as necessary to enter a pathway to technology careers are not only identified as part of the male schema, the male schema itself drives the identification of the skills and qualities necessary to become a CS/IT professional (AAUW, 2000; Colley, Gale, & Harris, 1994; Cooper & Weaver, 2003). Not only are males and females constrained by their own internalization of these gendered social attitudes toward their potentials, during their formative years their behaviors and activities are highly influenced by the culturally-derived internalized attitudes of important adult authority figures (e.g., parents and educators) who guide them as they make their education and career choices.

Culturally-derived gender role schemas begin to be acquired early and are reinforced over time, so that by the time girls have entered high school it may be much too late for them to ever feel deeply comfortable with technology, as technology-related gender role expectations and attitudes may have become internalized and intractable. Lack of deep comfort with technology means that high school girls are likely to spend less time with computers, are unlikely to enroll in high school technology courses, and therefore will be unlikely to develop the foundational skills that would enable them to perceive CS/IT as a viable or attractive post-secondary education pathway (Trusty & Ng, 2000). While many interventions have focused on this older cohort of high school girls (National Science Foundation, 2003, 2004), *Girl Power 21st Century: Growing Strong, Moving On* is a project predicated on a developmental approach and a psychosocial framework. In short, the program directs its efforts toward helping very young girls resist cultural gender schemas related to technology, at a period in their development when these schemas are not yet completely internalized (Kohlberg, 1966). Early introduction of positive technology experiences in a female-centered environment may create cognitive dissonance around gender schemas, enabling girls to resist cultural expectations, internalize more positive attitudes toward technology education and careers and, most importantly, incorporate technology into their perceptions of career options available to females.

Funded by the National Science Foundation, *Girl Power 21st Century: Growing Strong, Moving On* (<http://www.celt.sunysb.edu/gp21/>), is a project that addresses the need for research on early education intervention to increase the number of women CS/IT professionals. The parent project was funded for four years through small grants from a local women's fund. National Science Foundation funding supports the expanded project for three full years, permitting development of an integrated research component. Predicated on psychosocial and developmental theories of self-concept and attitude acquisition and change, the *Girl Power 21st Century* project addresses the hypothesis that high school and even middle school interventions may come too late in the developmental process to have an impact on girls' relationship with technology. The project extends the education intervention backwards to elementary school to substantially increase the likelihood that young women will consider CS/IT as an education and career option.

Once acquired, attitudes are notoriously persistent and difficult to change. Presenting elementary school age girls with a normative environment in which girls, women, and technology intersect naturalistically in a long term continuum of integrated experiences can help to offset the implicit and explicit negative cultural messages regarding women and technology. Blunting the effectiveness of these cultural messages may influence young girls' attitudes (and those of their families and teachers), resulting in the incorporation of technology affinity and competence into girls' academic and global self-concepts. In addition, presenting girls with a positive social-academic environment peopled almost exclusively with female models and mentors, in which social interaction is encouraged and rewarded in the context of learning technical skills, may help them to internalize a more positive set of expectations around CS/IT education and careers, countering "computer geek" stereotypes that appear to make computer science an unattractive education or career option for girls and young women.

Method

Girl Power 21st Century serves a target population residing in a large suburban school district with a high concentration of racially and ethnically diverse (African American, Latino/Hispanic, American Indian) and low income families. Approximately twenty new second-graders enter the program each spring. Returning girls advancing through the program bring the total number of current program participants to about seventy. Of the current participants, approximately forty percent are members of underrepresented minority groups.

Procedures

Project structure. All technology activities occur on the university campus. The project is comprised of a continuum of three modules, each serving a specific age group, through which girls advance over a period of several years. **Module 1**, “Girl Power,” is the original parent program. It is a two-year module that includes Beginner (second-grade) and Advanced (third-grade) classes. Beginner and Advanced classes in Module 1 meet for two hours twice each month during the spring semester. Beginner class activities focus on basic computer skills, technology vocabulary, and the creation of a basic web page from a template. Advanced class activities include an expanded program of computer skills and technical vocabulary acquisition, Internet exploration, fundamental information literacy skills, technical and academic skill-building games, and web development skills.

Module 2 is the one-week “Summer Technology Camp” for fourth grade girls who have successfully completed both of the Module 1 classes. Girls attend five half-day sessions, during which they practice and expand their skills to include a basic understanding of HTML and DreamWeaver, as well as the use of an online course environment for posting ideas and participating in threaded discussions. Technology camp participants choose a topic, learn online research skills to collect information, and create a web page about their topic.

The technology camp experience provides a bridge into **Module 3**, “Project Options,” for girls in grades four through eight. This module meets once per month during fall and spring semesters, with participants completing “homework” assignments on their own between classes. Girls in Project Options are developing a technology-related careers website for other girls. The girls choose a career that interests them and work individually and in groups to conduct online research about the career and the ways in which it uses technology. Module 3 is in its second year and so it currently includes two cohorts of girls who have completed the first two modules; girls in the older cohort have completed a first year of Project Options as well, and so can serve as mentors for the new cohort.

Project goals and outcomes. Each *Girl Power 21st Century* module expands and builds upon girls’ experiences of the previous module, and activities of each module address the project’s overarching goals. These are to

- Challenge girls’ perceptions of technology as “geeky” and to encourage a change in how girls relate to technology.
- Encourage girls’ perceptions of technology as an education and career option.
- Increase the probability that minority and lower income girls will consider technology-related educational and career paths.

Within the framework of these goals, each module's activities are set in a structured but distinctly socially interactive environment and focus on outcomes associated with the project goals. These outcomes include acquisition of knowledge and skills related to technology, development of positive self-concept (global and academic/technical), and development of positive attitudes consistent with a revised gender schema that includes technical interest, knowledge and skills as gender normative for girls and women.

Sample

The young age group targeted by this project requires that we work with relatively small numbers of girls in each module. The project modules are part of a continuum of experiences, so attrition between modules will necessarily impact numbers of girls participating in successive modules. During the first full year of the NSF-funded project, 20 second-graders were recruited for the Girl Power (Module 1) Beginner class and approximately 15 third-graders continued from the previous year of the parent project into the Girl Power (Module 1) Advanced class. The Summer Technology Camp (Module 2) recruited 16 girls, and for the first time included those who had not only completed the Girl Power module, but also those who had completed their first year in Project Options. (Experimental inclusion of girls who had completed only the Beginner class of Module 1 confirmed that the minimum level of experience necessary to ensure a worthwhile camp experience is completion of both Module 1 classes.) Module 3 (Project Options) recruited 16 girls, all of whom had completed both Module 1 classes and many of whom had attended Summer Technology Camp in the preceding summer under the parent program.

Measures

The assessment detailed here represents the data obtained during the NSF-funded Year 1 of the *Girl Power 21st Century* project. Given the very small total sample of approximately fifty girls and even smaller sub-samples when divided by module, a pure quantitative assessment approach is not appropriate or meaningful. Therefore, qualitative observations were used heavily to supplement quantitative data. There were four outcomes addressed by the assessment:

1. Basic technology skills
2. Perceptions of technology-centered activities as social, not solitary
3. Global and technical (tech-savvy) self-confidence
4. Perceptions of technology-based activities as gender-normative for girls

Instruments were developed to assess these four outcomes in ways that were non-threatening and would be unlikely to trigger performance anxiety in the girls.

Basic skills and confidence. To assess basic skills, as well as global and technical self-confidence, a game format was developed that required girls to answer questions and perform assigned tasks. Questions and tasks were specific to each module, with girls acting as teams in the Module 1 Beginner class and individually in the Module 1 Advanced class and in Module 2 (Technology Camp) and Module 3 (Project Options). Questions included simple fill-ins, more difficult "challenge" questions, and problem-solving or skills challenges that required demonstration.

Behaviors, attitudes and beliefs. Exit interviews were administered to girls individually at the last meeting of each module. Exit interviews included questions about technology-related behaviors and attitudes. All interviews included a set of seven basic questions; the Project Options interview also included additional questions designed to assess the older girls' computer usage as well as their opinions about and interest in technology-related careers.

Parent surveys. Parent surveys were distributed at the project "graduation ceremony". These were designed to address parents'/guardians' perceptions about the project, as well as general attitudes relating to girls and technology.

Results

Module Assessments

Regarding the basic skills outcome, all girls in each of the three modules were able to demonstrate appropriate levels of knowledge and skills learned during their *Girl Power 21st Century* experiences. In addition, girls who had participated for multiple years demonstrated retention of knowledge and skills between modules.

Though clearly challenged, girls in all modules evidenced remarkable self-confidence and lack of performance anxiety, demonstrating little self-consciousness or concern about answering incorrectly. Regardless of module, girls who had difficulty immediately answering a question or performing a skill were invariably able (sometimes with prompting from instructors or other participants) to discover the solution by experimenting with the software and/or active problem-solving. This behavior was completely unselfconscious, demonstrating global and technical (tech-savvy) self-confidence that suggests the girls are shifting toward a relationship with the technology that includes a reflexive experimental mindset.

Exit interviews with girls in all modules suggest that most of the girls ($\geq 90\%$) believe that a computer lab is a place where people work together, a place where one can get work done and still interact with others, a place where they feel comfortable, and a place where it is okay to make mistakes or to do things a different way. In addition, older (Project Options) girls expressed the belief that there are opportunities in technology for women, and they indicated that they are at least a little interested (and some are very interested) in pursuing such careers. Girls' responses to exit surveys indicated that nearly all participants endorsed statements that indicated perceptions of technology-centered activities as social, not solitary, and of technology environments as comfortable. Such endorsements offer support for the conclusion that the *Girl Power 21st Century* experience is facilitating an attitudinal shift toward perceptions of technology-based activities as gender-normative for girls.

Parent surveys indicate that girls in the program frequently talk to their families about what they are learning, and often demonstrate what they have learned by showing and teaching family members. Anecdotally, families evidence attitude shift toward perceiving IT education and careers as gender normative and desirable for their daughters.

Module Instructors

Though not presently included in the project assessment plan, informal discussions occur during regular meetings with female undergraduate and graduate CS/IT students acting as module instructors. In the course of these discussions, it has become apparent that teaching in the *Girl Power 21st Century* project may contribute to a positive education experience for our student instructors, especially the undergraduates, in their academic programs. Instructors very clearly express their great satisfaction with providing young girls with these technology experiences, and that satisfaction translates into a strong commitment to the project, its participants and staff. Beyond this, the student instructors have developed extraordinarily close relationships with the project coordinator and director and among themselves. These relationships appear to be an important component in each instructor's social support system, providing not only emotional support but also instrumental support in the form of academic resources. This has been especially true for the undergraduate instructors, who have been able to support their learning through access to the knowledge and skills of the project's graduate instructors.

Such informal support resources are very important for women in CS/IT, and they are often difficult to come by. According to our student staff, the few women in the CS/IT majors often work together, but are less comfortable working with males in their programs. Other sources of "woman-centered" CS/IT academic and social support are few, and those that exist are endangered in the current ant-affirmative action climate. Indeed, one of our undergraduate instructors informed us that the campus chapter of the Society of Women Engineers (SWE) is now required to accept male members, eliminating that group as a "safe" place for women in CS/IT majors to find personal and academic support. Therefore, it appears that the community of women created within the *Girl Power 21st Century* project has become a rare and valuable resource for the undergraduate and graduate CS/IT majors who act as module instructors.

Discussion

Results thus far appear to indicate that participation in *Girl Power 21st Century* is impacting girls in ways that support the stated goals of the project. However, as with any project of this nature, data collection is a constant challenge. Data collection has been somewhat hampered by small sample sizes, compounded by some inconsistencies of individual girls' participation from one session to the next within a module. For example, attempting to collect baseline and follow-up interview data from girls participating in Project Options, we were able to collect each set of data from about half of the girls participating, but not from the same half at both timepoints. This makes longitudinal within-subject analysis impossible, and illustrates how difficult it is to collect quantitative data in programs of this size.

Having settled on a mixed method assessment design, it is becoming clear that in practice it is the qualitative elements that may offer the best approach, supplemented by small amounts of supporting quantitative data. Qualitative data, no less than quantitative data, requires a planned framework for collection and interpretation. With this in mind, the project is currently developing better instruments for recording observational data in a structured, consistent format.

We have also identified another factor, a possible "ceiling effect," to be considered as an obstacle to measuring project effects. This project was in place in a smaller form for several years before its current National Science Foundation funding was obtained. Over the earlier

implementation, *Girl Power 21st Century* has become institutionalized in the school district, especially the elementary schools, from which we draw our participants. The community has developed a sense of ownership of the program, and considers it an established part of the spectrum of enrichment activities provided through the schools. So true is this that on several occasions, parents of incoming kindergarten girls have asked the building principal when their daughters can apply to participate in *Girl Power 21st Century*. This is certainly not a negative result, but it implies that the project may be impacting the attitudes of girls and their families even before girls begin participating. With such a small sample of participants, effects prior to participation may create a ceiling effect that will make it extremely difficult to establish positive effects once participation begins.

Future Research

In addition to enhanced technology-specific knowledge and skills, classroom teachers have reported their belief, based on classroom observation, that girls' overall classroom performance is enhanced through their participation in *Girl Power 21st Century*. This suggests an interesting area for future research, as evidence demonstrating such a globally positive academic effect would be an additional argument for early education programs such as this that target ethnically, racially and economically diverse populations. There is a great deal of research to be done in this area, using data obtained through interventions at all age levels. In the coming year, the *Girl Power 21st Century* project will be accessing school data on participants' district- and statewide Math, Science and English Language Arts performance. The project assessment plan includes plans for longitudinal comparisons between *Girl Power 21st Century* participants and girls of the same school cohorts who have not participated in the project.

Another area for continued research is in the assessment of attitudes and attitude change. It is well-known that attitude change is difficult to measure quantitatively, and the task is even more difficult given the young age of our participants. This makes collecting evidence of attitude change the most difficult component of our assessment. In the coming year we plan to continue development of a consistent, structured system for collecting observational data of the behavioral outcomes that indicate shifts in attitudes. Our struggle to develop a solid methodology for this purpose is not unique, and our continued efforts in this regard have potential to make positive contributions to the assessment of attitude change.

The potential for positive outcomes accruing to undergraduate and graduate students teaching in the project is another area to be pursued in future research. We generally think of role models and mentors having a positive effect on those for whom they serve these functions, but beyond the good feelings and satisfaction that these activities generate we don't often think about the positive effects that move in the other direction. Our project assessment plan is being revised to collect some preliminary data regarding the impact of project participation by student staff on their own educational experience, with an eye toward obtaining funding for a more extensive research project to explore this phenomenon.

Conclusions

We began this paper with a discussion of the psychosocial concepts underlying this project. The translation of cultural assumptions and expectations into personal schemas, and the concurrent formation of attitudes are part of a powerful social development process. These concepts are the foundation not only for the project, but for the interpretation of data as well.

As mentioned above, attitude change is difficult to measure. Measuring the development or alteration of cognitive schemas is a related and even more difficult task, and the process must often be inferred from behavior. For example, if project participants go on to choose CS/IT education in numbers greater than would be predicted by current national data, it may be cautiously inferred that girls who participate in *Girl Power 21st Century* are able to resist the prevailing culturally-derived schemas and form schemas of their own within which technology is gender normative for girls.

While most certainly preliminary, results of the first year project assessment are heartening and appear to support the premise that earlier intervention may be an important avenue toward increasing the presence of women in CS/IT. However, we are ever mindful of asserting causal relationships, especially when using qualitative methods. In the absence of a true experimental framework, impossible for a program of this type, alternative explanations for apparent results can always be generated. With that caveat in mind, years of longitudinal data collection will be required before we can assert that participation in early intervention programs such as *Girl Power 21st Century* leads to increased participation of women in postsecondary CS/IT education. Even then, it may be difficult to unequivocally demonstrate that such an outcome is caused by participation in the program rather than by some other variable or cluster of variables, or that the mechanism for the outcome is the development of cognitive schemas consistent with CS/IT as gender normative for women. In fact, it is always possible that if there is increased participation in postsecondary CS/IT education, the *Girl Power 21st Century* program may not be the direct causative agent, but rather some or all of that increase may be attributed to what is known as the “Hawthorne Effect,” resulting from the mere presence of observers.

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