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Promising Practices in Informal Information Technology (IT) Education for Girls

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Informal Information Technology (IT) education programs serving girls between grades 6 – 12 were surveyed to identify practices effective in engaging girls in IT. Women are significantly underrepresented in IT education paths and careers and many programs aim to increase girls' interest to address this disparity. A set of similar promising practices were identified by a variety of programs. Another survey reaching 937 women working in IT found the women had experienced many of the identified practices in their youth. Informal IT education program respondents and the women working in IT selected a similar set of program practices they thought to be critical to a program's success. The high level of agreement among programs and women in IT shows that findings should be widely applicable to many types of informal education programs. These findings were used to create a booklet of promising practices, published by the National Center for Women and Information Technology (NCWIT).

Project Description

Evaluation and Research Associates (ERA), funded by the Girl Scouts of the USA, conducted a study to identify effective practices for engaging girls in information technology (IT) in informal education programs. The study collected data from two sources: informal IT education programs and women working in IT careers. The informal IT education programs were asked what practices were most important to their success and the survey reaching women in IT investigated what types of experiences were important in influencing their career path. These data were compared to provide strong evidence of factors affecting the involvement of females in IT, where they are significantly underrepresented.

The theory of change underlying this project is that informal education programs can influence the career choices of girls and there are specific practices that are effective when used with girls in informal education programs in grades 6 – 12. Informal education programs that adopt these practices will be more successful in influencing girls' career choices. A guide to promising practices was created and disseminated to informal education programs based on the findings.

Methodology

The project was comprised of three components: a survey and site visit to informal IT education programs, and a survey to women working in IT-related jobs.

Informal IT Education Programs Survey and Site Visit

Quantitative and qualitative data were collected from informal IT education programs, including scale questions on the survey rating practices identified in the literature as effective, survey questions requiring an open-ended explanation of ratings, and site visits to a smaller number of programs to gather more in depth information on program practices.

The online survey to informal education IT programs serving girls in grades 6 – 12 (in single-sex or co-educational programs) was targeted to representatives who were most familiar with their program's structure and goals. Program representatives were asked to identify the

level to which a number of practices contributed to the success of their program in engaging girls and to describe their evidence.

For survey purposes, practices were divided into the following categories: Staff Practices; Curriculum Practices, Learning Experience Practices, Career Information Practices, Other Practices (not categorized into the above categories), and Additional Practices (survey respondents wrote in practices). Each practice was rated on a scale of 1 to 5 as part of each category and then respondents were asked to select the five practices overall they felt were most important in determining success of a program.

Site visit observations and interviews were conducted with a selection of informal IT programs to provide further evidence of effective practices being utilized by successful programs. Site visits gathered qualitative data in interviews with program directors, instructors, group interviews with participants and observations at four program sites. The site visits gave voice to the data, elucidated the survey responses, and provided an in-depth look at what practices are being used successfully. At each site visit, two research team members were present for a session of the program where they took detailed notes on the setting, resources, curriculum, learning activities, participants, interactions (between participants and between the instructor and participants), and instructor actions. The observation experience and notes provided an overall sense of each program's atmosphere and components as well as concrete examples of practices referenced in the interviews.

Three researchers independently conducted a content analysis of the interview and group interview transcripts, using iterative codes to mark each discrete idea not previously raised. The codes were grouped into more broad categories or themes: activities, learning experiences, program director practices, instructor practices, learning environment and career information.

Women Working in IT Survey

A background literature review was conducted at the beginning of the project to gain an understanding of the number of women working in IT, become familiar with the existing knowledge on what encourages girls to pursue IT careers, and to learn common methodologies and tools used to investigate similar research questions.

Survey questions asked respondents to reflect on IT-related education experiences and influences that led them to an IT career. They were also asked to indicate, from the same list of practices developed for the survey to informal IT programs, which practices they had experienced.

The invitation to take the survey for women professionals in IT was spread to multiple networks via listservs, newsletters, professional organizations, and word of mouth. The survey was completed by 937 women. Of the respondents, 80% were Caucasian and the average age was 40. All but 10% of the respondents had earned at least an undergraduate college degree, most in an IT-related field. Nearly 30% have worked at their current positions for more than 21 years, and many work for large organizations with over 500 employees. Slightly over 80% of the respondents agreed or strongly agreed that, overall, they are satisfied with their job and almost all planned to remain working in IT.

A limitation of the survey was the sample. Women working in IT who chose to submit a survey may differ from the population of women working in IT as a whole. Additionally, older

women may not have had the same experiences or knowledge of IT when they were younger as it is a fairly new field.

Background Literature

This project was borne out of concern from the partners regarding the low percentage of women working in IT careers and the underrepresentation of girls in the pipeline for those careers. The pipeline refers to those who are "on-track" to qualify for positions in IT. Candidates are likely to have positive experiences with technology in middle school, take relevant courses in high school, and earn undergraduate or graduate degrees such as computer science.

Research shows women to be significantly underrepresented in the world of information technology (Commission on Professionals in Science and Technology, 2006). Melymuka (2001) showed that although teenage girls use computers and the Internet at rates similar to male peers, they are five times less likely to consider a technology-related career or plan to attend post-secondary technology classes. High school girls are less likely than boys to participate in computer labs, computer clubs and computer science courses (AAUW, 2000) and only 15% of students taking the Advanced Placement exam in CS-A and CS-AB were female in 2005 (The College Board, 2006). While the number of computer science undergraduate degrees decreased in the nineties for both males and females, numbers increased since 1997 at a much higher rate for men. Women earned 33% of the master's degrees in computer sciences in 2002 and 20% of the doctoral degrees in 2003 (National Science Foundation, 2006).

Factors such as negative perceptions of careers, low confidence, and a lack of role models and career advice have been noted in the literature as contributing to the lack of females in IT (Bartol & Aspray, 2006). In computer science, the number of bachelor degrees awarded to women between 1985 and 2004 dropped from 37 percent to 25 percent (National Science Foundation, 2006). Slightly over 70% of computer and mathematical occupations are occupied by men (U.S. Census Bureau, 2000). Ten percent of executives in Fortune 500 computer companies are women (Xie & Shauman, 2003). Women's earnings in professions such as computer systems analysts, systems researchers, and computer programmers average 81% of men's earnings (U.S. Department of Labor, 2005).

The demand for qualified professionals is growing as they are a vital part of the global economy. U.S. Department of Labor statistics predict that women will account for more than half the increase in total labor force growth between 2004 and 2014, and that three of the ten fastest-growing occupations by 2014 are computing-related (U.S. Department of Labor, 2005*).* If the participation rate of women in the IT workforce during the last IT job boom had been as high as the rate for men, the U.S. would not have had a labor shortage and would have not had to rely on foreign workers (Freeman & Aspray, 1999).

There are a large number of programs in the United States that aim to increase middle school and high school girls' interest in IT, providing them with positive experiences and exposing them to career possibilities in the hope that more girls will continue through the pipeline. Females' perception of IT and computer science are mediated by their experience in the fields and influenced by parents, teachers, and mainstream media images. Ideas of what

careers are appropriate for women and men are formed early (Philips & Imhoff, 1997) and negative consequences are expected for deviance. In a longitudinal study, attitudes toward computers, including positive schemas such as IT helps the world and uses problem solving and negative schemas such as geeky, socially isolating, are more important for women's than males' career decisions (Zarrett & Malanchuk, 2005).

A growing amount of literature on what type of experiences and attitudes affect females' decisions regarding IT jobs exists. One's perception of how well they can perform IT-related tasks has a strong influence on whether they will pursue education or work in the field, especially for women. In a longitudinal study, Zarrett & Malanchuk (2005) surveyed almost 1500 participants and found that, in 11th grade, the students' perception of their ability to do math and the value of math determined whether they would aspire to work in IT. To investigate the low numbers of women earning Computer Science degrees, Moorman & Johnson (2003) found that in high school, males rated their abilities higher and were more likely to indicate interest in majoring in Computer Science compared to females. Both male and female students perceived Computer Science as a "male" field.

Zeldin & Pajares (2000) conducted in-depth interviews with women working in STEM to better understand their academic and career choices. They concluded that academic and relational self-efficacy was very important in their career paths, motivating them to pursue IT, and helping them overcome obstacles. The importance of the women's perception of competence led the researchers to conclude *that "educational programs should be geared to helping girls develop stronger self-efficacy beliefs during critical periods in their lives"* (p. 240). Zarrett & Malanchuk (2005) conclude that since early factors either directly influence or are indirectly related to later IT-related occupational decisions, then *"interventions early in youths' development that address such factors may play a key role for getting young adolescents on track for the pursuit of an IT career"* (p. 76).

Fadigan & Hammrich's (2004) longitudinal study of urban, low-income students participating in a year-long high school informal education science program found increased rates of enrollment in college STEM programs. They found that having staff to talk to, learning job skills, and socialization with like-minded peers influenced their career and educational decisions. Additionally, the most frequently mentioned influential experiences in a survey of professional women in IT were taking a programming course and enjoying it, or having IT initial on-the-job experiences (Turner, Bernt & Pecora, 2002).

A number of researchers and reports recommend increasing girls' exposure in IT. In order to get more females involved, Gurer & Camp (1998) suggest providing more experiences for girls, such as computing programs, exposure to computer games, and access to computers in the school and at home. Crombie (1999) discusses the strategy of increasing positive learning experiences for girls in order to increase female interest and enrollment in academic courses related to IT. She highlights a successful program which diminishes stereotypes and provides learning experiences to promote positive attitudes. A recent report by the National Research Council (Bell, Lewenstein, Shouse & Feder, 2009) shows that informal learning experiences in science can significantly improve outcomes for individuals from groups that are historically underrepresented in the field. The type of learning in informal settings, such as understanding and use of concepts and facts, how scientists actually conduct their work, and the development of an identify as someone who knows about, uses, and sometimes

contributes to the subject. AAUW (2003) proposes promoting the benefits of education in computer science, engineering, mathematics, and technology to women and girls, and creating opportunities and incentives for women and girls to pursue these fields.

A goal of this project is to add to the research data on what practices and structures are effective in informal education for increasing girls' interest and engagement in IT and identifying factors leading them to careers in IT. The project also aims to bridge the gap between researchers and practitioners by sharing the findings through dissemination of a guide to promising practices in informal IT programs for girls.

Findings

The sections under "Findings" summarize major findings from the surveys and site visits. The discussion section looks at the relationship between the data from the different research methods.

Informal IT Education Program Survey

One hundred-seven of 363 identified IT programs (51.5%) responded to the survey, representing 35 U.S. states. Fifty-eight percent served girls-only while the remaining 42% were co-educational. Almost all (97%) of the programs were run by not-for-profit organizations. According to the program representatives, many programs aimed to change participants' perceptions of IT and increase their confidence, interest, and competence levels.

The six most highly rated practices from the survey, or those that most contributed to a program's success (on a scale from 1 to 5), were:

- Hands-on experiences (mean = 4.90)
- Opportunities to work together with other people (mean = 4.73)
- Opportunities to use technology to be creative and explore (mean = 4.67)
- Project-based learning opportunities (mean = 4.61)
- Making curriculum relevant, tying it to real-life issues (mean = 4.49)
- Experienced program director (mean = 4.49)

Hands-on learning opportunities were also most frequently marked as being within the top five most important practices, along with project based learning activities, curriculum that is relevant/tied to real-life issues, and opportunities to be creative and explore. These type of activities allowed girls to see the real-life uses for work in IT and made them feel successful. One respondent stated, "*Our curriculum is primarily hands-on and lab-based, with students building projects and actively solving problems in teams. Our surveys (intake to program exit) show a dramatic increase in the students' confidence and self-rated ability to tackle engineering, computer science, and applied math subjects."*

Survey respondents indicated that girls appreciated opportunities to work together with others. Making collaborative decisions and being social was very important to the success of

many programs surveyed, and an element also identified in other research (Penuel & Kim, 2000; Birmingham, Pechman, Russell & Mielke, 2005).

Informal education programs benefited from the relaxed environment that showed how IT could be "fun." Staffing was an important variable in determining the success of a program. Program director qualities were deemed as more important to the success of the program, compared to other staffing practices. A program director with strong leadership and experience has a strong influence on the long-term direction, goals and practices of a program. Instructors were important for setting the tone of the program and making the lessons fun and interesting. One respondent stated, "*If staff are fun and relate well to girls, girls like the program regardless of the topics. So staffing is even more important than fun or meaningful activities to connect the girls to our science goals."*

Informal IT Education Program Site Visit Findings

The most frequently noted practice was incorporating a hands-on component to the learning activity. Being active and physically doing something rather than observing, reading or writing about it was observed at every program site and mentioned in many interviews. Program directors, instructors, and girls agree that providing girls with the opportunity to design and create their own project keeps girls engaged. Research has shown that girls do well when they are allowed to make decisions and have a level of control over the activities (Hanor, 1998; Berenson, Droujkova, Cavey, Smith & Barnes, 2000).

Instructors have many personal interactions with participants and therefore play a large role in setting the tone of the program and activities. There were many practices associated with instructors; the one most often mentioned by girls was that instructors need to be fun. To make girls feel more comfortable, instructors also aim to build their self-esteem by setting the girls up to accomplish certain tasks and offering frequent praise of their work. During observations, the research team noted an informal atmosphere, which included girls talking and joking with one another and with the instructor. One participant noted, "*It's not like school. You are doing something really fun, but you are also learning something at the same time."* There were three other instructor practices noted that also made the girls feel comfortable—being outgoing, developing a rapport, and making the participants feel successful. When participants were at ease, they were more likely to ask questions without feeling embarrassed and take risks in trying new things.

The most frequently mentioned factor for the learning environment, mentioned by girls and by program directors, is that the physical environment should simulate where real work in this field is done as much as possible. Working with another person was also seen as an effective practice, especially by program directors, but also by participants. Program directors mentioned the support of the community and the importance of working together with other organizations that have different strengths. The site visit programs also featured a career exposure aspect: Girls learned about a variety of different jobs, from programmers to managers, seeing a variety of opportunities. One camp included a job-shadowing experience and a networking sheet to encourage the girls to talk to the organization's employees.

Six of the most highly rated practices from the survey to informal IT programs were visible during site visit observations by the research team and were also mentioned in interviews with program directors, instructors and participants.

Summary: Informal IT Education Programs Survey

There was not much variation between different types of programs and the different data sets on what constitutes an effective practice for engaging girls in IT, signifying that a common set of practices can be effective for a diverse set of programs. Practices rated highly by informal IT education program representatives are summarized here in three areas: learning activities, learning environment, and career information.

Learning Activities

A number of the practices that were identified as highly contributing to a program's success were related to teaching or exposing participants to the nature of information technology as a discipline. While work in school traditionally includes reading and writing about content, the informal education programs take the opportunity to involve participants in interactive lessons where they learn by doing. Including hands-on activities were noted as effective in getting girls' interested and engaged in IT. Using hands-on activities received the highest scale rating of practices that contribute to a program's success, and was most commonly selected as a critical practice. Similarly valued were project-based curriculum and other lessons that related content to real-world experiences or let girls use technology to be creative and explore.

Learning Environment

It is important for informal education programs to let the participants relax and enjoy themselves. This was not believed to interfere with learning, but rather to make content more interesting and learning more enjoyable. Program instructors are responsible for setting the tone of the program and getting girls to feel comfortable.

The program location can contribute to a program's success. Holding events on a college campus or large corporation can spark girls' imaginations of what it would be like to work or study there. Many programs appreciated higher-end or cutting-edge technology resources, but these were not necessary to make a program successful. Girls-only programs were significantly more likely to agree that a girls-only environment, female staff, gender neutral materials, and mentors strongly contributed to the success of their program.

Career Information

Representatives from the informal education programs envisioned a series of career-related steps that would hopefully result from participation in their program. First, programs aimed to increase interest in IT by engaging participants in fun, hands-on activities. Secondly, through these activities and contact with mentors working in the field, participants should gain an understanding of the nature of IT and realize that it allows for creativity, collaboration, and that there is a place for them in the field. Mentors were used by many programs to provide girls with personal contact with female professionals.

Women Working in IT: Survey Findings

As IT is a relatively new field, many survey respondents did not have similar opportunities to engage in computers or IT-related activities as youth today, which is one limitation of the findings in this portion of the study. Overall, the most common IT-related youth experiences of 937 women currently working in IT were access to a computer at school, playing computer games or video games, support or encouragement from parents, and friends interested in the subject. The first experience with computers for the majority of respondents was between ages 14 and 25. Respondents mentioned attending technology-related summer camps, especially during middle and high school years, learning and experimenting with computers at home, such as programming, and being exposed to a family member's work in IT.

IT Education Experiences

Forty percent of respondents were involved in an informal IT-related education program, and they rated their experiences positively (mean = 5.01 on a six-point scale). Additionally, they indicated that their experiences in informal IT-related education impacted my decision to pursue a career in IT (mean = 4.40).

Respondents commented about the opportunity to work with other women, peers, or with friends in networking or social groups as part of informal IT programs. They enjoyed summer camps at college campuses and hands-on experiences. The women who participated in an IT-related education program were significantly more likely to have positive attitudes toward the field during middle school and high school, including feeling more competent in IT skills and more comfortable in IT environments.

When asked about their best experiences in informal IT-related education, 41 women wrote about the opportunity to work with other women, peers, or friends. They appreciated the information they received from others with similar interests, working in a team, and networking opportunities. Hands-on activities provided in informal IT programs were also mentioned as one of the "best" aspects. They enjoyed manipulating technology, and especially programming, designing, or creating in projects. The women liked to explore and play as a way to learn, even if it was not in an organized group, *"My informal IT-related education was mostly independent studying and experimentation. I didn't always have success, but it's a huge confidence-builder to experiment and explore on one's own and learn something new that other kids didn't know, so I could feel proud of myself."* The feelings of excitement due to successes were also frequently described. Projects that involved a real-life application or problem-solving were appreciated, especially those that allowed them to help other people, *"Seeing a project through from start to completion, and working on a project that had a positive impact on a community."*

The women who participated in an IT-related education program were more likely to have positive attitudes toward IT during middle school and high school. There was a significant difference between those who participated in an IT-related education program and those who did not, with the respondents who did participate feeling more competent in their IT-related skills, having a positive image of those involved in IT, feeling comfortable in IT environments, having a good understanding of the nature of work in IT, and believing it could solve social problems. However, just 2% of survey respondents stated that an informal education instructor was one of the top three most influential people in their decision. Eight percent marked that

positive experiences in IT, including non-formal programs were one of the top three motivations for choosing a position in IT.

In order to identify more specific aspects that these women working in IT experienced when they were younger (informal or formal education), survey questions asked respondents to identify elements regarding staff, curriculum and learning activities, learning environment, and others they experienced in formal or informal education. Overall, the most frequently selected elements were hands-on experiences, relevant curriculum, engaging staff, and project-based learning opportunities. When asked what they felt the most critical elements to success are, the respondents similarly indicated hands-on activities, relevant curriculum, an engaging staff, and project-based learning opportunities. Elements related to curriculum and learning activities were frequently experienced and noted as critical to successful IT programs. The opportunity to engage in hands-on experiences was the most frequently experienced and most frequently rated as critical. More than half the respondents also experienced a challenging content level and opportunities to work together with other people.

Forty percent of respondents experienced engaging staff in their formal or informal IT education, and an equal percentage considered it to be among the top five most critical elements in ensuring success. Additional elements that were most frequently experienced were career information being shared, parent support of programs, opportunities for participants to take a leadership role and contact with mentors.

IT Attitudes and Interest

Almost half of respondents marked “Not Applicable” in responding to scale questions about their attitude in IT in grades 6-8. They wrote that their attitudes were influenced by their skills and abilities in IT, access to computers at home, IT classes at school, encouragement or exposure by teachers and parents, enjoyment of related subjects, computer games, and time to explore and experiment with technology. Their images of IT were based on what they learned from their parents, the representation in the media, teachers, and who they knew working in IT. However, almost one-third of respondents noted that they were not exposed to technology during these grades and that “nothing” influenced them. After graduating from high school, during college or during work experience, respondents felt slightly less competent in IT-related skills and less comfortable in IT environments.

Twenty-five percent of women did not have a positive view of IT until they had already been in the workforce. Eleven percent of respondents were interested in IT work by middle school, and that group was more likely to participate in IT activities compared to the total group of respondents. For example, they were twice as likely to have access to a computer at school or at home in elementary and middle school. A large number of them played computer games and 31% of this group participated in an informal IT-related education program in middle school, compared with 10% of the respondents as a whole. This group was more likely to have a role model or a mentor—24% had mentors in middle school. Those with an early interest in IT also had slightly higher levels of comfort, and feelings of competence when compared to the total respondent group. They had more positive views of those involved in IT work and felt they had a better understanding of the nature of IT.

Table 1. Comparison of Attitudes of Respondents Participating in an IT-related Program and Those Not Participating

	Middle School Mean		High School Mean	
Topic	**Participated in Informal IT Program**	**Did not participate**	**Participated in Informal IT Program**	**Did not participate**
I felt competent in my IT-related skills	3.8*	3.3	4.4*	3.8
I had a positive image of those involved in IT	4.4*	4.1	4.6*	4.3
I felt comfortable in IT environments	4.0*	3.6	4.3*	3.8
I had a good understanding of the nature of work in IT	2.9*	2.5	3.7*	3.0
I believed work in IT could solve social problems	3.0*	2.7	3.4*	3.1
I believed people in IT did not have a lot of opportunity for social interaction	3.4	3.4	3.5*	3.4

Scale where 1 = Strongly Disagree and 6 = Strongly Agree
** Significant difference (p<.05, two-tailed) between those that did participate in an informal IT program and those who did not.*

Other Influences

The respondents commented on their natural abilities in IT work. They knew they were skilled when they were recognized by an external source, such as a teacher, an aptitude test, or class grades. Through experimenting with challenging material and being successful, they became more confident in their abilities. A smaller portion of the sample did not believe they had any competency in IT and they hesitated to become more involved with computers and technology. One way this was overcome was if the women were able to access a computer at home and they had time to experiment and gain confidence in their skills.

The women reported more encouragement to pursue work in IT than discouragement by people in their lives. Family members, especially fathers, were repeatedly identified as a strong support system and influence on the women's decisions to work in IT. If a close family member was working in a related field, they often brought technology into the home, providing information, exposure and opportunities to interact with IT.

Respondents were asked about their motivating factors for deciding to work in IT. The largest number of respondents was motivated by the intellectual challenge of the field (45%). They also took advantage of opportunities they saw in availability and earning potential. Their abilities or skills working in IT and a genuine interest in the field also motivated a large portion of the respondents.

Summary: Women Working in IT Survey

Many similar factors, influences, and experiences are shared among the respondents, including parent support, hands-on experiences, a feeling of being adept at IT-related activities, having a positive image of those in IT, and having friends with similar interests. This study supports the Expectancy Value Model of career decision making, which holds that individual beliefs, values, and goals have direct influence on choices, and are affected by inputs from the social world. Many of the respondents in this study thought of themselves as adept in working with computers. They played games, and problem solved, which increased their confidence. Their feelings of competence were much further enhanced, though, when other people provided them with positive feedback.

The respondents (N=97) who were interested in IT work by elementary school or middle school indicated higher levels of IT activities during those grades. For example, they were twice as likely to have access to a computer at school or at home in elementary and middle school. A large number of them played computer games and they were more likely to have participated in an informal IT-related education program in middle school and to have a role model or a mentor.

Although a number of women made the career decision to work in IT when they were in college or beginning work, they may have been more likely to decide earlier if they had participated in more IT-related activities. Data show that early IT-related activities and early interest in IT are highly correlated, suggesting that participating in IT-related activities early in life could influence the development of a career interest which could lead girls to pursue more IT experiences and education, and potentially careers. This research has shown a correlation, though, and it would be an interesting follow-up study to look at the causal relationship underlying the relationship of these factors.

Discussion

Most informal IT education programs aim to impact girls' decisions about IT careers. The most common program goal was to increase girls' interest in further STEM education or a career in the field. Programs also aimed to increase awareness of different types of careers and show accurate representations of what it is like to work in those jobs. Programs deliberately offered career education or exposure components, whether it was mentoring, guest speakers, field trips, or information about IT careers. Programs planned activities so participants could gain an understanding of the nature of IT and realize that it allows for creativity, collaboration, and diversity.

Data gathered for this project from informal IT programs and women working in IT-related careers reveal similar findings in the factors that influence girls' career decisions. The focus in this research was to identify practices or strategies that programs could utilize to be most successful in leading more females to IT careers.

Among programs, there is consensus concerning what type of curriculum and learning activities are worthwhile to use in informal education programs. Hands-on and project-based activities and real-world, relevant content were considered to strongly contribute to program success. The experiences of women working in IT further illuminated these findings. Their experiences and what they believed to be critical to an educational program's success

corresponded with the promising practices identified by program representatives. Further, the women who participated in an IT-related education program were significantly more likely to have positive attitudes toward the field during middle school and high school, including feeling more competent in IT skills and more comfortable in IT environments.

The six most highly rated practices from the survey were hands-on experiences, opportunities to work together with other people, opportunities to use technology to be creative and explore, and project-based learning opportunities. They most frequently selected hands-on experiences, project-based learning opportunities, making curriculum relevant/tied to real-life issues, and opportunities to use technology to be creative and explore as the most critical elements.

Overall, the most frequently selected elements that women currently working in IT experienced were hands-on activities, relevant curriculum, engaging staff, and project-based learning opportunities. More than half the respondents also experienced a challenging content level and opportunities to work together with other people. In terms of what was the most critical, women working in IT most frequently selected hands-on experiences, a relevant curriculum tied to real-life issues, project-based learning opportunities (e.g. projects with real-world activities), a challenging content level, and contact with mentors in IT.

Table 2. Practices Most Frequently Identified as a Critical Element by Informal IT Education Programs and Women Working in IT

Informal IT Education Programs		Women working in IT	
Practice	**Percentage Selecting**	**Practice**	**Percentage Selecting**
Hands-on experiences	64.1%	Hands-on experiences	50.6%
Project-based learning opportunities	48.9%	Relevant curriculum, tied to real-life issues	40.3%
Making curriculum relevant, tying it to real-life issues	48.1%	Engaging staff	39.7%
Opportunities to use technology to be creative and explore	45.8%	Project-based learning opportunities	38.7%
Girls-only environments	38.9%	Opportunities to use technology to be creative and explore	30.6%

There are especially strong signs of agreement concerning what type of curriculum and learning activities are worthwhile to use in informal education programs. Hands-on and project-based activities with real-world, relevant content are considered to strongly contribute to program success. This indicates that the development of shared curricular resources would be beneficial for many programs. Research has shown that the amount of experience people have with computers affects their attitudes toward computer-related activities (Gurer & Camp, 1997), so the simple act of girls participating in an informal education program could effectively raise their confidence levels. Responses from the females working in IT showed how time to

experiment and become comfortable with computers gave them confidence to continue in the field. Data showed that early IT experiences and an early interest in working in IT were correlated. Additionally, new research shows that informal education experiences in science can significantly improve outcomes for individuals from groups that are underrepresented in science (Bell, et al., 2009). Results from IT studies show similar signs that informal IT experiences can help participants develop positive schemas of IT-related work and those working in IT. It can help build participants' self-confidence and feelings of competence and promote positive attitudes by providing them with positive experiences and role models.

With the continuous development and increasing access to information technology, it is likely that youth today have different experiences with IT than the women born in the 1960s. Nevertheless, discovering more from the women working in IT today and their participation in various IT activities, their changing attitudes toward IT, and the influences of the people in their lives and their experiences can help inform efforts to involve females of all ages in IT and increase gender equity in IT work.

The most frequently noted practices from the surveys and site visits were collected and written in a guide for dissemination. *The Guide to Promising Practices for Informal Education IT Programs,* published by the National Center for Women and Information Technology (NCWIT), provides detailed examples of practices that engage girls.

References

AAUW Educational Foundation. 2000. *Tech savvy: Educating girls in the new computer age*. Washington, DC: American Association for University Women.

Bartol, K.M. & Aspray, W. (2006). The transition from the academic world to the IT workplace. In J.McGrath Cohoon & William Aspray (Eds.) *Women and information technology: Research on underrepresentation* (pp377-419). Cambridge, MA: The MIT Press.

Bell, P., Lewenstein, B., Shouse, A.W., & Feder, M.A. (2009). *Learning science in informal environments: Places, people, and pursuits.* Committee on Learning Science in Informal Environments, National Research Council.

Birmingham, J., Pechman, E. M., Russell, C. A., Mielke, M. (2005, November). *Shared features of high-performing after-school programs: A follow-up to the TASC evaluation.* The After-School Corporation and Southwest Educational Development Laboratory. Retrieved April 16, 2006 from http://www.sedl.org/pubs/fam107/fam107.pdf

The College Board. (2006). *Advanced placement program: National summary report.* New York, NY: Author. Retrieved June 12, 2006 from http://www.collegeboard.com/prod_downloads/about/news_info/ap/2006/2006_ap-report-nation.pdf

Commission on Professionals in Science and Technology (2006). *STEM Employment Forecasts and Distributions Among Employment Sectors*. CPST Online Publication. Retrieved on September 1, 2007 from https://www.cpst.org/STEM/STEM7_Report.pdf

Crombie, G. (1999). *Research on young women in computer science: Promoting high technology for girls*. Presentation at the annual meeting of the Professional Engineers of Ontario, Women in Engineering Advisory Committee. Markham, ON, May 1, 1999.

Fadigan, K. A., & Hammrich, P. L. (2004). A longitudinal study of the educational and career trajectories of female participants of an urban informal science education program. *Journal of Research in Science Teaching*, *41*(8), 835.

Fancsali, C. (2002). *What we know about girls, STEM, and afterschool programs. New York City:* Academy for Educational Development.

Freeman, P. & Aspray, W. (1999) The supply of IT workers in the US. C*omputing Research Association*. Washington DC.

Froschl, M., Sprung, B., Archer, E., & Fancsali, C. (2003). *Science, gender, and afterschool: A research agenda.* Washington, DC: Educational Equity Concepts and Academy of Educational Development. Retrieved June 29, 2005 from http://www.aed.org/CentersandExperts/froschl.cfm

Gürer, D. & Camp, T. (1997). *Investigating the incredible shrinking pipeline for women in computer science*. ACM Committee on Women in Computing. Retrieved October 11, 2006 from http://women.acm.org/documents/finalreport.pdf

Lee, J. D. (2002). More than ability: Gender and personal relationships influence science and technology involvement. *Sociology of Education,*75, 349-73.

Melymuka, K. (2001, January 8). If girls don't get IT, IT won't get girls. *Computer World.* Retrieved on October 13, 2005 from http://www.computerworld.com/careertopics/careers/story/0,10801,55910,00.html.

National Science Foundation (2006). *Women, minorities and persons with disabilities in science and engineering.* Division of Science Resource Statistics. Arlington, VA: Author. Retrieved June 12, 2006 from http://www.nsf.gov/statistics/wmpd/sex.htm

Penuel, W., & Kim, D. (2000). *Promising practices and organizational challenges in Community Technology Centers*. Menlo Park, CA: VStreets Research Group, SRI International. Retrieved on October 11, 2006 from http://www.sri.com/policy/ctl/assets/images/vStreets_Promising_Practices.pdf

Philips, S.D. & Imhoff, A.R. (1997). Women and career development: A decade of research. *Annual Review of Psychology, 48*, 31-59.

Turner, S.V., Bernt, P. W. & Pecora, N. (2002). *Why women choose information technology careers: Educational, social, and familial influences.* Paper presented at the American Educational Research Association, New Orleans, April 2002.

U.S. Census Bureau (2000). *Employed bachelor's or higher degree recipients, by occupation, sex, race/ethnicity, country of birth, and disability status: 2000.* Retrieved on October 11, 2006 from http://www.nsf.gov/statistics/wmpd/tables/tabh-1.xls

U.S. Department of Labor (2005). Bureau of Labor Statistics. 2005. *Occupational Outlook Handbook*. Retrieved on September 3, 2007 from http://www.bls.gov/oco/ocos042.htm

Xie, Y. & Shauman, K. (2003). *Women in science: Career processes and outcomes*. Harvard University Press. Boston, MA.

Zarrett, N. R., & Malanchuk, O. (2005). Who's computing? Gender and race differences in young adults' decisions to pursue an information technology career. *New Directions for Child and Adolescent Development*, 110, 65-84.

Zeldin, A. L., & Pajares, F. (2000). Against the odds: Self-efficacy beliefs of women in mathematical, scientific, and technological careers. *American Educational Research Journal*, *37*, 215-246.