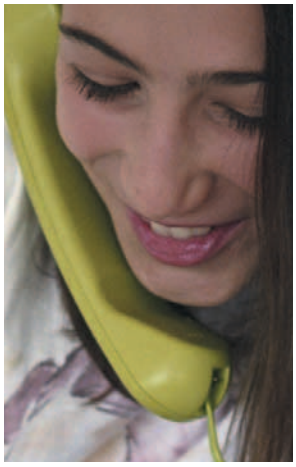
Evaluating Promising Practices in Informal Information Technology (IT) Education for Girls

PHASE III: Women in IT — Survey Results

NCWIT | Girl Scouts of the USA



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Inquiries related to this resource should be directed to Program Collaborations & Initiatives, Girl Scouts of the USA, 420 Fifth Avenue, 15 floor, New York, NY 10018-2798.

To Educators:

Findings inside this report:

- Fewer than 10% of those surveyed said that the media, movies, or books had any influence on them while in grades 6–12.
- Almost 29% of respondents said they became interested in IT either when they entered the workforce or were working in another job.
- During post-high school or college years, 45.8% of those surveyed said that the support of a professor or instructor had had a positive influence on their choices.

For more information, please visit:

NCWIT
www.ncwit.org

Girl Scouts of the USA
www.gsusa.org

Puget Sound Center for Teaching, Learning and Technology
www.pugetsoundcenter.org

National Girls Collaborative Project
www.ngcproject.org

Information technology (IT) is changing the world. Unlike anything since the printing press, IT is revolutionizing the way we work, play, communicate, and learn. Because so few women are inventing the technology upon which our society increasingly depends, we cannot know what problems they would solve or what products they would conceive. Women's lack of participation in the IT workforce also leaves the computing professions with a shrinking pool of qualified professionals. From both an innovation and workforce perspective, women's continued absence in IT has major repercussions for our country's preparedness, competitiveness, economic wellbeing, and quality of life.[1]

The National Center for Women & Information Technology (NCWIT) is implementing aggressive plans to increase diversity in computing fields across the entire academic and workforce pipeline. Over 110 distinguished organizations are members of the NCWIT coalition. Girl Scouts of the USA (GSUSA), a K-12 partner of NCWIT, has been a leader in girl-led and girl-centered programming for nearly a century—helping girls gain exposure to diverse career tracks, including science, technology, engineering, and math (STEM), and preparing them to become leaders of positive change.

GSUSA and NCWIT recently collaborated with the Puget Sound Center for Teaching, Learning and Technology (PSCTLT) and National Girls Collaborative Project (NGCP) to conduct a study on what engages girls to study and work in IT. The study was conducted in three phases:

Phase I: Review a large sample of informal IT education research that has investigated the topic of girls and informal IT education.

Phase II: Identify and evaluate a sample of informal IT education programs that are now being implemented, both within Girl Scouts and in the larger community, to discover promising practices.

Phase III: Survey women currently working in IT to determine what influences in early life caused them to pursue a career in computing. Gaining an understanding of these influences should further influence informal IT education experiences for girls.

The first two phases of this effort were completed in December 2006. Subsequently we created *The Guide to Promising Practices for Informal Education IT Programs*,[2] which describes the top eight promising practices

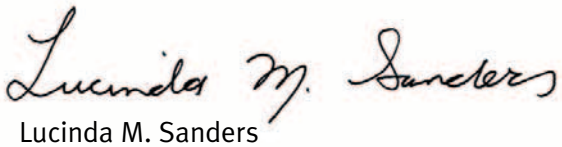
identified in the study and the applications for each practice. Programs exhibiting promising practices were placed into a database of informal education programs, which is now housed on the National Girls Collaborative Project (NGCP) Program Directory website.[3]

Approximately one thousand women from 37 U.S. states completed an online survey during Phase III of this study. Results indicated that the women were motivated by the intellectual challenge of the IT field, their own abilities and skills, earning potential, and a genuine interest in the field. Also uncovered was the importance of having the support of family and friends, early technology experiences, exposure to IT workplaces, access to computers, and hands-on, real-world learning opportunities in IT.

The full results of the Phase III research are presented here. We hope that your program will find this resource useful in your curriculum planning and development.

Sincerely,

Suman Sabastin
STEM Project Manager, Technology and Engineering Initiatives
Girl Scouts of the USA



Lucinda M. Sanders
CEO and Co-founder
National Center for Women & Information Technology

[1] While women's contributions have neared parity in fields such as medicine, math, and law, their progress in IT and computing disciplines has actually slipped:

- Between 1983 and 2006, the share of computer science bachelor's degrees awarded to women dropped from 36 to 21 percent.
- Women hold more than half of professional positions overall, but fewer than 22 percent of software engineering positions.
- Girls comprise fewer than 15 percent of all AP computer science exam-takers—the lowest representation of any AP discipline

[2] http://www.ncwit.org/pdf/Practices_Guide_FINAL.pdf

[3] http://www.ngcproject.org/directory/index.cfm

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EXECUTIVE SUMMARY

This report focuses on the findings of the third phase of a project sponsored by the Girl Scouts of the USA (GSUSA) acting as a hub partner of the National Center for Women in Information Technology (NCWIT). The project was designed to identify promising and effective practices for engaging girls in information technology (IT). Phase three of this project explored what influenced women in IT to obtain their work positions. Overall findings of this project will add to the research data on what practices and structures are effective in IT informal education and more generally for increasing girls' engagement in IT and interest in pursuing an IT career. Phase three project components included a review of relevant literature and the development and administration of a survey to women currently working in IT. The literature review was conducted to identify factors that influence women to obtain positions working in IT and gain a general understanding of similar research. Statistics show women to be underrepresented in the world of information technology, especially in careers. Nearly three-quarters of computing and IT-related occupations are held by men (U.S. Census Bureau, 2006). Survey questions were derived from results of the literature review and input from NCWIT and GSUSA. Quantitative and qualitative data were collected through different types of survey questions and analyzed for this report.

The invitation to take the survey was spread to multiple networks of women working in IT via listservs, newsletters, professional organizations, and word of mouth. The 937 women working in IT who responded to the survey worked in 37 different U.S. states and grew up in 54 different countries. Their average age was 40 and 80% were Caucasian/European American. All but 10% of the respondents had earned at least an undergraduate college degree, most in an IT-related field. Forty-five percent of respondents were motivated by the intellectual challenge of IT. They took advantage of opportunities they saw in availability and earning potential of jobs. They were often driven by their abilities or skills working in IT and a genuine interest in the 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.

FINDINGS

Experiences in IT

The first experience with computers for the majority of respondents was between ages 14 and 25. As IT is a relatively new field, a large percentage of respondents may not have had early access to computers or IT-related activities. Overall, the most common IT-related experiences across elementary, middle, high school, and post-high school/college were access to a computer at school, playing computer games or video games, support or encouragement from parents, and friends interested in the subject.

Respondents also mentioned attending 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. When the respondents were able to access a computer at home, they had time to experiment and gain confidence in their skills. The least common experiences overall were attending a job fair, having a role model and having a mentor, although these experiences increased substantially as the respondents graduated from high school.

Informal Education

When the respondents were able to access a computer at home, they had time to experiment and gain confidence in their skills.

Forty percent of respondents were involved in an informal IT-related education program. On a scale where 1= Strongly Disagree and 6 = Strongly Agree, the mean response to a statement that they had positive experiences was 5.01. Though not necessarily IT-related, the most common youth organization they participated in was the Girl Scouts of the USA, almost half of participants reported being involved in the organization. Asked about their best experiences in informal IT-related education, many women wrote about the opportunity to work with other women, peers, or with friends in networking or social groups. 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 IT during middle school and high school, including feeling more competent in IT skills and more comfortable in IT environments.

In order to identify more specific aspects that these women working in IT experienced when they were younger, 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.

Attitudes toward IT

Survey questions addressed feelings of competency, images, comfort with, and understanding of IT in grades 6–8, in grades 9–12, in their post-high school or college years, and once respondents were working in the field. Of those responding, using a scale from Strongly Disagree = 1 to Strongly Agree = 6, the highest mean was in response to having a positive image of those involved in IT (mean = 4.26). The average woman only slightly agreed that she felt competent, (mean = 3.54) and comfortable in IT environments (mean = 3.76). They were not sure whether they had a good understanding of the nature of the work (mean = 2.67), however almost 58% of those responding disagreed or strongly disagreed with the statement. Additionally, many had what is often classified as negative or erroneous views of the work: just over 50% strongly disagreed or disagreed that work in IT could solve social problems, and 35% of those responding believed that people in IT did not have much opportunity for social interaction.

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In high school, means increased or received higher levels of agreement on each topic. This may indicate that in high school, these respondents felt slightly more competent and comfortable, had a better understanding of IT work and a more positive image of those involved in IT. However, despite the increases, the means were still fairly low, with about 20% of respondents disagreeing or strongly disagreeing that they felt competent in their IT skills and comfortable in IT environments. Understanding of the nature of work in IT was still very low in high school (mean = 3.26), with 37% indicating strongly disagree or disagree and 26% strongly agreeing or agreeing.

In middle and high school, respondents 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. In responding to a scale question where 1 = Strongly Disagree and 6 = Strongly Agree, the mean response decreased slightly after high school. However, respondents felt they had a better understanding of the nature of work in IT and were more likely to agree that work in IT could solve social problems.

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.

Influence by Others

The women reported more encouragement to pursue work in IT than discouragement by people in their lives. Most commonly encouraging were fathers, high school teachers, close male friends, and mothers. Nobody was frequently noted as discouraging or as a negative influence, though 6% of respondents identified a guidance or career counselor as discouraging and about 7% indicated that their grades 6–12 coursework and teachers were either a strong negative or slightly negative influence.

Family members, especially fathers, were repeatedly identified as a strong support system and influence on the women's decisions to work in IT. About 40% of the survey respondents had fathers who held work positions in science, technology, engineering or mathematics (STEM).

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. About 40% of the survey respondents had fathers who held work positions in science, technology, engineering or mathematics (STEM).

Professors and friends were also frequently selected as encouraging, but middle and high school teachers were not as influential. Friends may have been influential by encouraging or supporting the respondents, by exposing them to aspects of IT, or by sharing an interest in IT that they supported together. Not a large percentage of the women responding to the survey had experience with a role model or mentor. After high school, about a quarter of respondents had a role model and 18% had a mentor.

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. As a sample that voluntarily participated by responding to an online survey, we cannot generalize that their answers

reflect those of the entire population of women working in IT. However, the large size of the sample and their diversity in job responsibilities, age, and type of organizations help to increase the reliability of their responses. 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.

INTRODUCTION

Project Background

Evaluation and Research Associates (ERA) of the Puget Sound Center for Teaching, Learning and Technology (PSCTLT) contracted with the Girl Scouts of the USA (GSUSA), a hub partner of the National Center for Women in Information Technology (NCWIT), to identify promising and effective practices in informal information technology (IT) education for girls. Phases one and two of the project included identifying promising practices for engaging 6th through 12th grade girls in informal IT education programs, creating an online directory of the informal IT programs, and completing a review of the literature related to informal IT education and engaging girls. This report highlights the third phase of the project, exploring what influenced women working in IT to obtain their IT work positions.

Overall findings of this project will add to the research data on what practices and structures are effective in IT informal education and more generally for increasing girls' interest and engagement in IT. Specifically, findings from phase three focus on what experiences, factors, and influences lead women to work in the IT field.

Phase three components include a review of relevant literature and the development and administration of a survey to women currently working in IT. The literature review was conducted to identify factors that might influence women to obtain positions working in IT and gain a general understanding of the field. Quantitative and qualitative data were collected through survey questions derived from results of the literature review and input from NCWIT and GSUSA. Detailed analyses and discussion of the survey data collected from 937 women working in information technology are documented in this report.

Theory of Change

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.

There are a large number of programs in the United States that aim to increase 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. There is an increasing amount of literature on what type of experiences lead females to jobs in IT. A goal of this phase of the study is

to add to the research data on what influences women to work in the field. Looking at the life experiences of women currently working in IT will help determine how to provide similar positive experiences to more girls.

The theory of change underlying this project is that certain life experiences influence the career choices of girls and that specific practices are effective when used with girls in informal education programs. Informal education programs that adopt these practices will be more successful in influencing girls' career choices. In phase three, it is presupposed that the experiences of women who are currently working in IT can help inform efforts to better serve girls and increase their interest in pursuing an IT career.

Methodology

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.

In collaboration with GSUSA, an online survey was created using Perseus SurveySolutions 7, a robust online survey software program. The survey collected demographic and basic information about the women and the organizations in which they worked. Additional questions were asked about the respondents' experiences and attitudes toward IT in grades 6–12, after high-school, during college, and once they were working in the field. Respondents were also asked to rate the level of influence of various people such as teachers, parents and experiences such as informal education programs and classes on their decision to work in IT.

A list of promising practices for engaging girls in IT was developed based on the literature from the first two phases of this research study. That list was used in this survey as a checklist of practices that respondents used to indicate whether they experienced any of the practices in their informal or formal education. Practices were organized into staff, curriculum and learning experiences, learning environment and additional practices. Examples included girls-only environment, hands-on activities, the opportunity to be creative and explore, and an engaging staff. A copy of the survey is included as Appendix A. Qualitative data collection included a number of open-ended response questions. Statistical analysis of the quantitative data and content analysis coding of the open-ended survey questions was conducted and data sources were compared.

It was intended that the online survey reach a diverse set of respondents. The survey was "public" instead of "invitation-only," meaning that anybody with

the URL to the survey could access the survey, not only those on a predetermined respondent list. This allowed the survey invitation to be e-mailed and forwarded along multiple communication lines to relevant contacts, list-servs, and professional groups. Initial contacts receiving the invitation on June 27, 2007 included members of the NCWIT workforce alliance and academic alliance, Girl Scout councils across the nation, the National Girls Collaborative Project list-serv reaching supporters of girls in STEM, women working in IT corporations such as Microsoft, Google, Intel, Hewlett Packard, and Motorola, smaller IT companies such as Monster.com and other Internet-based companies, and professional groups such as WITI and Society of Women Engineers.

The survey invitation encouraged recipients to forward the invitation and survey URL to relevant contacts. The initial recipients sent it to individuals and groups that included women working in IT, and it was forwarded again and again in a grass roots effort to reach a wide sample of respondents. The survey team heard from women internationally who had received notice of the survey, and were informed by a number of organizations with a number of female IT contacts or employees that they were publishing the information in their newsletters.

The survey was open from June 27, 2007 until August 15, 2007. Respondent numbers were particularly high in the first two weeks after the initial invitation was sent (400 by July 9, 2007). Project advisors re-posted to a similar list of potential respondents after approximately three weeks as a reminder to fill out the survey or circulate the survey URL. The final number of respondents was 937. It is impossible to calculate the response rate as we do not know how many women the survey invitation actually reached.

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. Potential respondents may have been discouraged by the initial questions that asked them about experiences in their youth; though answer choices did allow for them to indicate their lack of experience or knowledge of the field at various ages, and on a few specific questions they were asked to identify at what ages they became interested in IT.

Background Literature

Statistics show women to be underrepresented in the world of information technology (IT), especially in careers. Slightly over 70% of computer and mathematical occupations are occupied by men (U.S. Census Bureau, 2000).

Female ethnic minorities were even more underrepresented, with only 4% of Computer Scientists female African Americans, 2% female Asians, and 1% female Hispanic (Commission on Professionals in Science and Technology, 2006.). Once women are working in IT, there are still inequities. Ten percent of executives in Fortune 500 computer companies are women (Xie & Shauman, 2003). Women working as full-time computer systems analysts, systems researchers, and computer programmers have high median weekly earnings, averaging $868 per week. Women's earnings in these professions 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).

The number of women qualified to work in professional IT positions is partially determined by the number of women in the "pipeline" toward such careers, meaning those that express an early interest, have positive experiences in education programs or courses in middle school or high school, and pursue a college or advanced degree in the field. At each of these points, women are underrepresented and a number of others "leak" from the pipeline, deciding to pursue another field. Other women become involved in IT later in life, such as through on-the-job experiences.

High school girls are less likely than boys to participate in computer labs, computer clubs and computer science courses (AAUW, 2000) and in 2005, only 15% of students taking the Advanced Placement exam in CS-A (one semester) & CS-AB (two semesters) were female (The College Board, 2006). Among female college-bound high-school seniors taking the SAT in 2006, only one percent—fewer than 5,000 students—indicated computer and information sciences as an intended major. This is a nearly 50 percent decline from 1996, when women comprised one-quarter of all students intending to major in computer and information sciences (College Board, 2006b). In computer science, the number of bachelor degrees awarded to women between 1985 and 2004 dropped from 37 percent to 25 percent. In fact, the number of these degrees awarded to women was nearly the same in 2004 as it was in 1985. 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).

Zarrett & Malanchuk (2005) believe that "occupational choice is a cumulative developmental process in which early experiences of childhood and adolescence are formative and influence later, more proximal influences of youths' career decisions." Similarly, the Expectancy Value Model holds that achievement-related choices and performance are influenced most directly by a set of individual beliefs, values, and goals, which are in turn influenced by inputs from one's social world. In other words, a variety of factors differentially motivate the educational and career choices of girls and boys, including raw talent or ability, individual expectancies and self-perceptions, task values, social variables and environmental factors (Jacobs & Simpkins, 2005).

Factors such as negative perceptions of IT, low self-confidence, lack of positive experiences in IT, and a lack of role models and career advice have also been noted in the literature as contributing to the lack of females in IT (Bartol & Aspray, 2006; Roger & Duffield, 2000). It follows that females who are more likely to work in IT are those who have a positive image of IT, confidence in their abilities, positive experiences, and role models or mentors. The sections below provide details around the factors mentioned above and identified in the literature as relevant to women's career decisions about whether or not to pursue a career in IT.

Perception of IT

Females' perception of IT and computer science are mediated by their experience in the fields and influenced by parents, teachers, and mainstream media images, "Society has a profound impact on young girls' images of themselves and computer science. Unfortunately, most of the images of computer science coming from parents, teachers, and the media are all negative and imply that computing is for men only" (Gurer & Camp, 1998, p.7). If girls are unfamiliar with the nature of work in IT and do not have relevant role models, they do not see it as a possible role for themselves.

Ideas of what careers are appropriate for women and men are formed early (Philips & Imhoff, 1997) and negative consequences are expected for deviance. Parents and teachers have been found to be influential, especially in non-traditional career choices (Dick & Rallis, 1991). 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).

Carter's (2006) survey of over 800 high school students showed that girls are deterred from choosing Computer Science as a major when they believe they would have to sit at a computer all day, or if they are looking for a more people-oriented major. They are more likely to choose Computer Science if they are looking to use computers in another field, have an interest in computer games, or feel they are good at using computers.

In a survey of 7,411 secondary students (3,144 male and 3,399 female), females did not show an accurate perception of the skills or characteristics needed for success in IT: being a team-player and communication skills both received low rankings (Chan, Stafford, Klawe & Chen, 2000). Compared to the males, the females showed lower interest and lower perceived ability. The authors recommend increasing female access to computer activities and sharing career information that would provide them with a better sense of careers in IT.

To investigate the low numbers of women earning Computer Science degrees, Moorman & Johnson (2003) surveyed almost 1000 high school students about their interest in college majors, their own computing ability, and their perceptions of the coursework and people involved. Males rated their abilities higher and were more likely to indicate interest in majoring in Computer Science. Both male and female students perceived Computer Science as a "male" field. Crombie's (1999) survey of 11th grade computer science students showed the strongest predictor of future intentions to pursue IT to be their intrinsic valuing of the field, suggesting that it is important for them to have a clear understanding of the nature of work in IT.

Confidence in IT Skills

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 in 7th grade, 11th grade, and three years after high school. 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. Females across race held significantly lower perceptions of their computer ability in comparison to males, despite similar levels of performance. Three years after high school, those with the highest IT aspirations perceived themselves as being good at math, had taken later IT courses, received encouragement, and did not have negative schemas of IT.

A study of 7th grade girls showed higher levels of discouragement and lower levels of self-confidence compared to boys (Gurer & Camp, 1998). The surveyed students in Canada showed low female scores in interest and perceived

ability in computer science and engineering, both factors that lead to low participation in the fields. Lack of self confidence is a major cause of women leaving computer science (Chan, Stafford, Klawe & Chen, 2000). Women tend to believe they lack the same knowledge that everyone else has already acquired. Even with the same performance on tests or in a course, girls ranked themselves as less knowledgeable and lower in confidence, despite equal or higher levels of performance.

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).

Experiences in IT

Melymuka (2001) found 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, showing that simple exposure or experience is not sufficient to lead girls toward IT careers. Positive experiences with computers and IT, however, are affiliated with other factors that increase the likelihood of girls pursuing IT such as increased knowledge and skills, confidence, and interest. 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).

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.

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.

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.

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. It is also important to note that the influence and input of socializers such as parents, teachers, and peers was among the most important factors for youths' IT career considerations and thus should be a focal point for promoting young people to pursue a computer-related career" (p. 76).

Influence by Others

Women are especially influenced by role models, teachers, and parents. The people in their lives affect their image of IT and who can work in the field, their perceptions of their abilities and skills, and the experiences they have, such an in formal or informal education programs, and computer access. Research shows that women working in IT identify a number of people who encouraged them to pursue and persist in their career path.

Turner, Bernt & Pecora (2002) surveyed almost 300 women working in IT, looking at their educational, social and familial influences. The women reported more encouragement than discouragement by people in their lives. Most commonly encouraging were fathers, high school teachers, close male friends, and mothers. They identified a specific person or persons as having the most influence in steering them toward a career in IT. A number of women working in IT admit they never thought of working with computers until somebody else, such as a teacher or family member, suggested it (Gurer & Camp, 1998). A study by VanLeuvan (2004) investigated factors that led to females' persistence in pursuing a career in these fields and found that encouragement and support of significant others was an important influence.

Quimby & DeSantis's (2006) study of over 350 female undergraduates revealed that role model influence accounted for significant variance in career choices, slightly more than self-efficacy. They cite work tying role model influence to career aspirations, career choice, and attitude towards non-traditional careers. Another study (Dick & Rallis, 1991) looking at influences on career decisions made in high school determined that advice from teachers was more important for females. Of over 2000 participants with advanced math and science coursework, less than one-third the amount of women than men expressed interest in pursuing a career in science or engineering.

Summary

To conclude, women's decision of whether to pursue a career in IT is influenced by a number of factors. It is clear that factors such as role models, perceptions, confidence in IT skills, and IT experiences detailed above are closely related. For example, Zeldin & Pajares's (2000) study of women working in STEM revealed the importance of self-efficacy beliefs. However, those feelings of competence were mediated by experiences in IT and the influential people in their lives. Women's feelings of self-efficacy also affect their views of IT. In the pipeline toward work in IT, women are sorely underrepresented, beginning as early as secondary school. Without the preparatory courses and other formal or informal experiences in IT, women are likely to be under-qualified, uninterested, and often have mistaken perceptions of work in IT. Research shows the importance of personal guidance and advice for encouraging females to enter IT, whether from parents, teachers, or role models or mentors in the field. The lack of confidence of women in their own skills and abilities, that are often independent of actual performance or potential, signifies that support is needed to buoy self-perceptions of skills. This occurs through personal support and from non-threatening experiences where females have freedom to experiment and create using technology. The growth of IT-related occupations and its importance in the global and knowledge economy indicate the need for the involvement of women.

SURVEY FINDINGS

Respondent Demographics

Survey participants were asked about their age, ethnicity, location and type of location in which they grew up. The average age of survey respondents was 40 years old, with a range from 18 to 67. Most respondents fell into the 46 – 50 age bracket (16% of total sample). See Table 1 for ages of survey respondents. Most respondents indicated they were of Caucasian/European American ethnicity (79%). About three quarters of all respondents currently work in positions located in 37 different states of the United States.

Table 1. Age of Survey Respondents

Age	Percentage of Respondents
18–20	0.5%
21–25	8.0%
26–30	13.9%
31–35	13.0%
36–40	14.4%
41–45	14.5%
46–50	15.6%
51–55	8.5%
56–60	6.9%
61–65	1.1%
66–70	0.3%

Respondents were first asked about their ethnicity, and then a follow-up question more specifically asked whether they were Hispanic or Latino. Table 2 shows the breakdown of ethnicity of survey respondents. A large majority of respondents indicated they were Caucasian/European American. The second most common ethnicity of respondents was Asian (10%).

Table 2. Respondent Ethnicity

Ethnicity	Percentage of Respondents
Caucasian/European American	79.1%
Asian	10.4%
Multi-racial*	5.2%
Black/African-American	4.4%
Native American or Alaskan Native	0.5%
Hawaiian or Pacific Islander	0.3%

** Eleven respondents indicated they were Hispanic and/or Latino/Latina, though in a separate question 4.3% of all respondents (40) indicated they were Hispanic or Latino.*

Respondents indicated they grew up in 55 different countries. The majority of respondents were raised in the United States in suburban areas. Table 3 shows the countries in which at least six respondents indicated they grew up. See Appendix B for a complete list of countries indicated.

Table 3. Countries Lived in during Childhood

Country	Percentage of Respondents
USA	75.6%
Australia	3.9%
Canada	2.8%
Great Britain	2.1%
China	1.8%
India	1.7%
Russia	1.0%
Germany	0.6%
Taiwan	0.6%
France	0.8%
Denmark	0.6%

Note: Twelve respondents did not answer; all other countries listed had five or less responses.

Table 4. Type of Childhood Location (Area where respondents grew up)

Choice	Percentage of Respondents
Suburban	59.3%
Urban	22.2%
Rural	18.5%

Work Experience

> *"As a child who entered college in the 1960's I was expected to enter one of 4 'acceptable' female professions—wife and mother, teacher, nurse, or librarian. I wanted more in life and IT has given me the satisfaction I was looking for. It's exciting, fast-paced, ever-changing and constantly stimulating. I have NEVER been bored in my jobs in IT. I've met wonderful people and I've felt that I gave something to my community through my IT work."*
>
> *– Survey Respondent*

Respondents were asked to select the type of organization for which they work in IT. The majority of respondents work in for-profit businesses or corporations. Those who selected "other" as a category made up 3.2% of the responses and when they indicated the type of organization, government contractor, research and development, and national lab had multiple responses. None of those selecting "other" indicated whether those organizations were governmental, non-profit or for-profit. When asked how many employees were in the organizations for which they work, most respondents

indicated they are employed by organizations that have 5000 or more employees. Of those, 86% of the organizations are for-profit businesses or corporations. Seventy-seven percent of all respondents work for organizations that employ 501 or more employees.

Table 5. Type of Employment Organization

Organization Type	Percentage of Respondents
For-profit business/corporation	69.5%
Education	12.1%
Government-employed	6.5%
Not-for-Profit	6.1%
Other*	3.2%
Self-Employed	2.6%

**Other: Repeated answers included government contractor, research and development, national lab.*

Table 6. Number of Employees in Organization

Employee Number	Percentage of Respondents
1 to 25	6.4%
26–50	1.7%
51–100	3.5%
101–500	10.5%
501–5,000	15.7%
5,000 or more	61.2%

Survey respondents' job responsibilities are varied. Categories provided as possible selections in this survey came from a variety of sources including NCWIT, a review of current literature on careers in IT, and GSUSA. IT was defined as all forms of technology used to create, store, exchange and use information in all its forms; the design and use of computers and communications to improve the way we live, learn, work and play. IT careers were defined as technical and professional careers in the design, development, support and management of computers, hardware, software, multimedia, communications, business automation, and systems integration services. Survey respondents were asked to check all categories that applied to their work positions. Table 7 shows the different categories of responsibilities respondents indicated they have in their work.

Table 7. Categories of Work Responsibilities

IT Work	Percentage of Respondents
Information Technology	29.5%
Computer Science/Engineering	21.6%
Information Systems	18.4%
Software Developer	18.1%
Programming	17.9%
Database	14.0%
Computer Systems	13.4%
Internet and Internet Systems	12.0%
Education (IT-related)	11.5%
Software Architect	7.9%
IT Security	7.7%
Communications/networking/specialists/technicians	6.9%
Computer Service and Security	5.1%
Logic and Algorithms	4.6%
Network installation and management	4.4%
Interactive media	3.8%
Information Science	3.3%
Graphic Design/Computer Graphics	3.3%
Artificial Intelligence	3.1%
Hardware Developer	2.6%
Corporate Executive (*e.g.* Chief Information Officer/Chief Technology Officer)	2.3%
Multimedia/video/gaming/animation	2.2%
CAD/CAM	0.6%
Robotics	0.4%

Respondents were asked to enter the zip code of the state in which they worked. A total of 68% of respondents indicated a zip code. Those not responding (30%) may have been from a country other than the United States since the survey was deployed to international settings. Of the 641 respondents that entered zip codes, 37 different states of the United States were represented.

Respondents had been working in IT for less than two years to over 21 years. The most frequent selection was more than 21 years with 28% of respondents selecting that category. Table 8 shows the breakdown of the respondents' number of years working in IT.

Table 8. Years Working in IT

Years Working in IT	Percentage of Respondents
0–2 Years	8.9%
3–4 Years	8.0%
5–7 years	13.1%
8–10 years	14.4%
11–15 years	13.8%
16–20 years	14.0%
More than 21 years	27.8%

In order to gain an understanding of how respondents might have been led to a career in IT, survey administrators asked about non-IT related work. Eighteen percent of respondents selected "none" to indicate they had not experienced non-IT related work. Table 9 shows the categories of non-IT related work including an "other" category.

Table 9. Non-IT Related Work Experience

Non-IT Related Work	Percentage of Respondents
Education and Training	27.5%
Business, Management & Administration	25.6%
None	18.1%
Marketing & Sales*	17.7%
Science, Engineering & Mathematics	14.8%
Other non-IT field	14.6%
Arts	10.4%
Finance	8.6%
Hospitality and Tourism	8.5%
Government and Public Administration	7.7%
Human Services	5.8%
Manufacturing	5.4%
Health Science	5.3%
Transportation, Distribution & Logistics	4.1%
Agriculture Food & Natural Resources	3.4%
Law, Public Safety, Corrections & Security	3.0%
Architecture and Construction	2.6%
Other	11.2%

** Eighteen respondents indicted "retail" in the other category. Survey administrators included these responses in this category.*

Respondents planned to stay in their current job—over 80% indicated they agreed or strongly agreed they would stay. The lowest mean in this section was 4.42 (on a six-point scale where 1 = Strongly Disagree and 6 = Strongly Agree) and that was for being satisfied with the balance between work and

personal time. A mean of 5.01 was indicated for being overall satisfied with their job (84% respondents agreed or strongly agreed). Table 10 shows the means for questions related to work satisfaction.

Table 10. Satisfaction with Current Work

Topic	Mean	Not Answered
Overall, I am satisfied with my job	5.01	5
I am satisfied with the balance between my work time and my personal time	4.42	11
I feel supported by management in my work	4.72	4
I feel supported by co-workers in my work	4.98	8
I plan to remain working in IT	5.07	6

Scale where 1 = Strongly Disagree to 6 = Strongly Agree

Early Experiences

The first experience with computers for the majority of respondents was between ages 14 and 25. This age range suggests that many first computer experiences were during high school or college. It is important to note that for a number of older respondents, technology did not yet exist or was not widely available during their high school or college years. In fact, 70 of the respondents had not used a computer until age 25. Only a small percentage of women, less than 4%, used a computer very early in life, prior to age 5.

Table 11. First Computer Experience

Choice	Percentage of Respondents
Before age 5	3.6%
Between 5–10	17.4%
11–13	16.1%
14–18	30.2%
19–25	25.2%
25 or older	7.5%

Respondents were asked to indicate IT-related experiences they had during the elementary, middle school, and/or high school years. Overall, the most common experiences across age levels were access to a computer at school, playing computer games or video games, and support or encouragement from parents. The percentage of respondents involved in computer or video games is notable since the majority of games are created and marketed toward males (Gorriz & Medina, 2000). Games with features that appeal more to females, such as collaboration, exploration, puzzle-solving and complex social interaction are becoming more available. The least common experiences overall were attending a job fair, having a role model and having a mentor.

Table 12. IT Experiences in K–12 Schools

Topic	Elementary school years (ages 5-10)	Middle school years (ages 11-13)	High school years (ages 14-18)
Access to a computer at school	12.5%	22.3%	48.4%
Played computer games/video games	18.1%	29.4%	33.4%
Support/Encouragement from parents	16.5%	22.4%	39.6%
Access to a computer at home	15.1%	25.8%	35.7%
Support/Encouragement from a teacher	5.7%	11.9%	35.7%
Friends interested in the subject	2.2%	7.7%	31.2%
Participated in informal IT-related programs (*e.g.* tech club, summer or after-school programs)	5.3%	9.9%	17.1%
Had a role model (professional in the field)	5.4%	7.6%	15.5%
Influenced by IT in the media/advertising	1.4%	5.3%	16.3%
Had a mentor in IT (personally known)	3.1%	5.3%	13.0%
Job Fair/Event that included IT	0.4%	1.6%	11.4%

Respondents participated in 5.3 (mean) of the 33 IT activities listed (counting elementary, middle, and high school separately). The women who grew up in suburban areas participated in the most IT activities (mean = 5.66, N=553), followed by those from urban areas (mean = 4.97, N= 206), then rural (mean =4.61, N=174). Respondents with a multi-racial background had the highest mean of the ethnicity groups (excluding Hawaiian or Pacific Islander (N=3) and Native American or Alaskan Native (N=5) due to the small samples). Multi-racial women completing the survey participated in an average 8.15 of the IT activities (N=48), compared to Asian respondents (mean=6.38, N=96), Caucasian/European American (mean=5.03, N=729) and Black/African American respondents (mean=4.93, N=41).

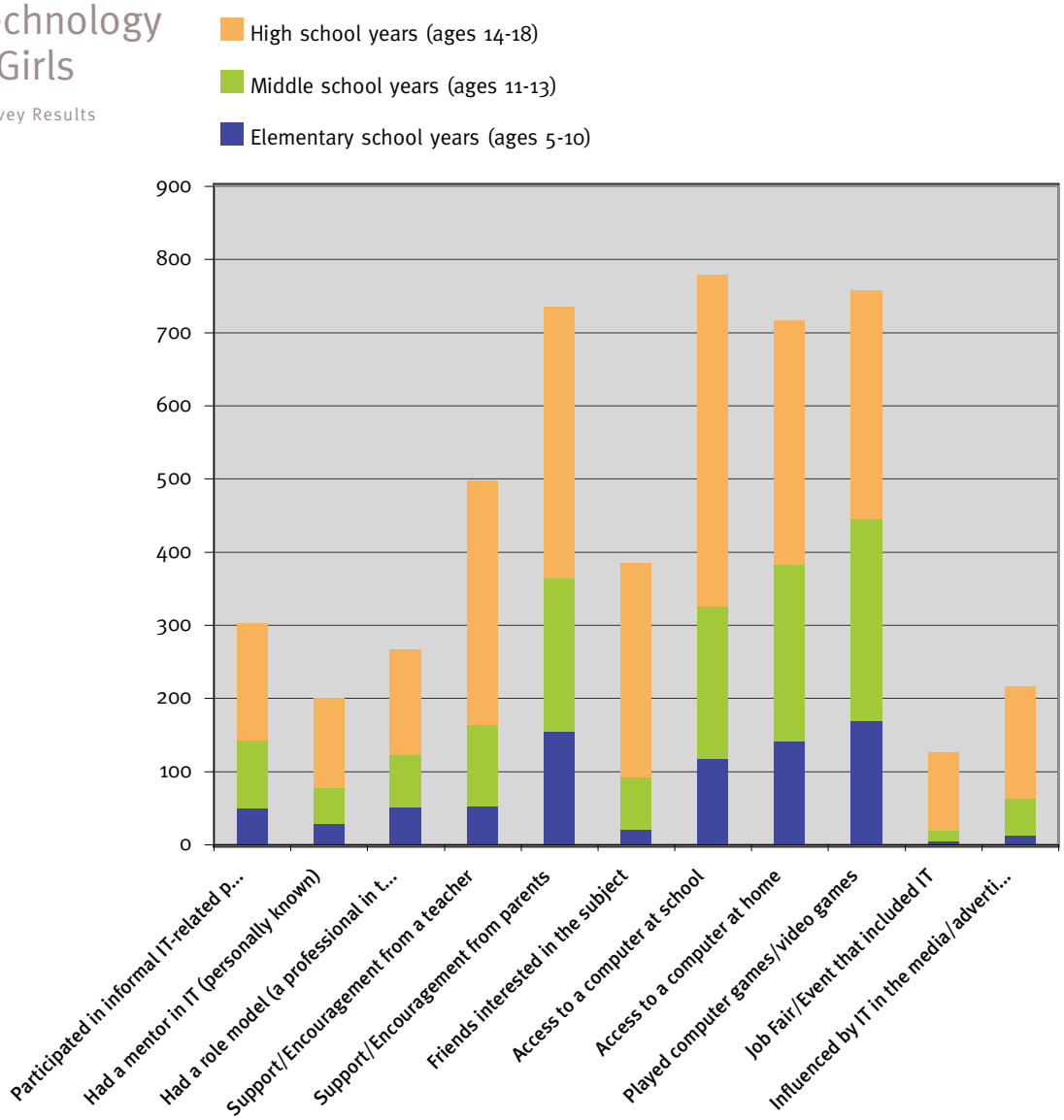
IT-related activities were the least common during elementary school. Only 12.5% of respondents had access to a computer at school, although 15% had a computer to use at home. If the women were involved in technology, it was likely due to playing computer or video games, or receiving encouragement from parents. It is interesting that even at such a young age, 51 respondents (5.4%), indicated they had a role model in IT, and 29 (3.1%) had a mentor. It is possible they were referring to their parents, many of whom worked in STEM careers. It should also be noted that for many, elementary school was many years ago and might not be remembered as distinctly.

In middle school, respondents were more likely to play computer or video games (29.4%), have access to a computer at home (25.8%) or at school (22.3%), although the percentages overall of participating in these IT-related activities is still fairly low. Respondents were least likely to attend a job fair

or event that included IT during these years. As respondents entered high school, the number of those participating in each IT-related activity increased. The most substantial increases were in access to a computer at school, support or encouragement from a teacher, friends interested in the subject and encouragement or support from parents. Many more respondents (16%) were influenced by IT in the media or through advertising. Just over 17% marked that they participated in an informal education program, which will be discussed in more depth later in this report. These data suggest that an effective time for getting females involved is in the later school years, when they are more likely to respond to the influence of those around them, including teachers, friends, and parents, and closer to the age where they will be making education and career decisions. However, the trend could also be due to the availability of technology related opportunities. It is likely that there were more opportunities available for high school students. Increased opportunities in middle school years could possibly function to keep more girls in the IT pipeline.

Respondents who grew up in suburban areas were significantly more likely to have participated in an informal IT program in elementary school and in high school. Additionally, they were more likely to have access to a computer at school in elementary school, and more likely have access to a computer at home when they were in elementary and middle school. In terms of ethnicity and IT activities, significant differences were found in participation in informal IT education programs, which Asian and black/African American respondents were more likely to attend in middle school and high school. Multi-racial respondents were the most likely to have access to a computer at school during their middle and high school years. Although not significant, Caucasian/European American respondents were the least likely to play video or computer games in high school.

Figure 1. IT Experiences in K–12 School



In an open-ended question, respondents were asked to indicate other IT-related activities they participated in during their K–12 years. The most common response was explaining the lack of computer and technology access when they were younger, *"I wasn't aware of computers until I went to college, other than knowing they were needed for the space program,"* or *"No IT activities were available in the 1960s!"* Though there appears to be a lack of technology, nine respondents mentioned being involved in science and math courses or after-school clubs, which they viewed as related to IT.

Other responses included courses at school, involvement in after-school clubs or summer camps, learning how to program, and some sort of work-

related experiences. Over 30 women mentioned the IT-related courses they took, mostly during high school, but some in middle school. Courses ranged from very basic, such as typing, to advanced classes such as Advanced Placement Computer Science. One women recalled early programming courses using MS-DOS computers or punch cards, *"In grade 12 only I took a computer course that involved punch cards and wiring plug boards. OK, I'm old. But that course made my mind up about a career."*

Another woman did not have as positive an experience with the early technology,

> *"In 1975, as a sophomore in high school, I had one programming class which involved marking cards with our code and waiting a week for our printouts and program results. I did really badly, and felt that the 'stupid' computers were to blame. Other than that, I had no computer experience and was not even aware that there were careers in computing during high school. The term **IT** wasn't even in use until I graduated from college."*

A number of other women wrote about learning to program computers, many being vague about how they learned. One respondent recalls checking out library books to learn, and another learned through her own experimentation, *"My parents gave me a HeathKit computer to build in the early 1960s. I really didn't understand what a computer was at that point, but I built it and developed a machine language to program it. I learned that what I was doing was programming in binary at school when I was in 8th grade."* Many respondents mentioned programming at an early age, such as using Basic or Logo and five respondents were involved in programming competitions. Werner, Campe & Denner (2005) state that programming can lead to the development of intellectual capabilities such as sustained reasoning, managing complexity, testing of solutions, and communicating with others as well as fundamental IT concepts such as algorithmic thinking and programming, information organization, fundamentals of computers, digital representation of information, and limits of IT. This is one example of the skills that stem from informal experiences exploring IT.

A common experience for respondents was attending a summer computer camp, most often at a local university, or participating in the after-school clubs or classes offered. Although these fit under the description of informal education in the survey, 22 respondents mentioned it in the open-ended question, suggesting it was a memorable or formative experience.

Sixteen women were able to gain work-place exposure to IT. A few worked at the computer center at school, three held internships, and others had a variety of other jobs that entailed IT-related responsibilities. For example, one woman worked in an office where she observed computer installation and support,

> *"I left school at age 15 and worked in an accounts office which used computers for their Accounting process, I was fascinated and very interested in what the IT people did who did the installation and support. I thought it would be cool to be able to go to different offices all the time and have a company car and meet lots of people whilst working with interesting technology. It influenced me a lot as the people were all very social and friendly and I went back to night school to get more qualifications and then got a job at an IT company. Once I had some more experience, I went to university and gained a degree in Computer Science and made a career of it."*

Another respondent learned advanced programming, which she then taught to other students at her school, *"I attended a summer course given at New York University and learned higher level programming (Fortran and an early version of APL) and probability and statistics. My high school had me teach an after school courses on programming the following academic year."* Finally, another student gained Web site development skills and helped create sites for the sports teams at her school.

Women that did not have such intensive experiences mention being exposed to IT through their parents' work. *"Dad worked at HP, and brought home a small programmable calculator, my first exposure to any kind of computer programming."* One respondent described how her father brought his work home:

> *"I was very fortunate that my father's (accounting) company used a 'mainframe' which processed punched cards and paper tape, and my sisters and I helped out around the office. As products became available, my father proceeded to purchase early-model (IBM) PCs for home/family use and then an early-model (Osborne) 'portable,' so during these early school years, I was able to watch computers "grow up" while I learned a primitive (BASIC) programming language."*

One or two women wrote about using calculators, video cameras, surfing the Internet and being part of online communities, such as Bulletin Boards during their K–12 years.

IT-related Attitudes

The literature review found many studies reviewing the importance of females' attitudes about IT in their decisions on whether or not to pursue education or careers in the field. Wilson's (2002) study of undergraduate computer science students found comfort with computer science was the factor most predictive of success in the course. Positive schemas such as IT helps the world and uses problem solving and negative schemas such as geeky, socially isolating, have been found to be important for women's decisions (Zarrett & Malanchuk, 2005). Beliefs about the nature and value of IT develop early in life, so questions in this section of the survey addressed feelings of competency, images, comfort with, and understanding of IT in grades 6–8 and in grades 9–12.

Grades 6 – 12

Respondents wrote that their attitudes toward IT in grades 6–12 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. However, almost one-third of respondents noted that they were not exposed to technology during these grades and that "nothing" influenced them.

Coding of the open-ended responses was based on ideas that fit into categories. When a similar point was mentioned, it was coded into the existing category. If a single response included a number of different responses, they were each coded, so the actual number of responses shown in Table 13 does not reflect the total number of respondents.

Table 13. Influences on Competence in IT in Grades 6–12

Influence	Number of Responses
NA/Nothing	301
Abilities/Skilled at IT	101
Access to a computer at home	57
Classes in IT	53
Exposure/Information at home or from family	38
Support/Encouragement from teachers	36
Good at math/science	36
Support/Encouragement from parents	31
Freedom to experiment/Play around	28
Was not competent	24
Computer games	20
Enjoyed IT	17
Job experience related to IT	13
Could assist others	13
Internet/Chat/Email	12
Informal education programs (summer/after-school)	12
Friends	12
Typing/Word processing	10
Media/Books	9
Competitive nature	6
Access to a computer at school	5
Mentor	3

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. A large number compared themselves to other students in their classes and realized that they knew more, had more experience, and/or had a better understanding of technology. Through experimenting with challenging material and being successful, they became more confident in their abilities, *"Generally good self-confidence in my technical ability. I knew I could take anything apart and figure it out if I applied the time."* Some believed it was an "innate talent" or they had "had a knack for it."

On the other side, a smaller portion of the sample did not believe they had any competency in IT. They mentioned working hard to try to succeed, or watching others be more successful. Because they did not feel skilled, they hesitated to become more involved with computers and technology, *"I always felt behind because the people around me seemed to know much more about computers." And "I did not have any computer skills other than playing a few computer games. In school, I was afraid to use the classroom computer because I did not know much about computers."*

When the women were able to access a computer at home, they had time to experiment and gain confidence in their skills. A number of respondents mentioned their families owning a computer very early—putting them at an advantage over the majority of their peers. The opportunity to explore and experiment was very valuable,

> *"In the earlier grades, it was very helpful just to have a computer at home. I found it easy to figure out what to do what I wanted—editing text documents, playing games, etc. I also temporarily broke our installation of Windows 3.1 by experimenting with too many internal system files (I was curious what they did), but it boosted my confidence that I was able to fix it by myself (before my parents got home)."*

At school, computer time was often limited. The extended use at home allowed the girls to "play around," *"The fact that I had a computer at home. I learned far more at home than I did during school. I first got a computer to play games on and use simple word processing programs when I was seven years old. This helped immensely."*

Many responses mentioned learning experiences through technology classes at school. These ranged from keyboarding, programming, Web development, to Computer Science. The classes were an opportunity to learn content and practice, as well as to gain confidence in their skills. Looking ahead, taking IT-related courses likely made it easier for these women to enroll in college IT courses. *"I had an introductory programming class using Lego sets and BASIC in middle school, and more advanced (object-oriented C++) programming classes in high school. Having a formal class curriculum that included logic and programming at such an early age paved the way to making learning new IT skills a natural and commonplace (daily) activity for me."* Informal opportunities such as after-school clubs and summer camps also influenced many women, *"I went to computer camp at a very young age and learned some logical coding. I think it's influenced how I've felt about IT at every age. I was also called on by my family to be the tech person in our household: I set up every machine/gadget in our house and trained everyone else to use them."*

At school, respondents were also influenced by teachers who gave them advice, pointed out academic talents, and led them toward learning opportunities related to technology. "My computer teacher was very patient and well-versed in IT and my parents supported learning about technical fields." In a few instances, the respondents specified that their teacher was female. Parents were influential in similar ways, offering encouragement and opportunities, but also more indirectly by exposing their daughters to aspects of IT. Almost 40 respondents wrote they were influenced by their parents or another family

member working or being involved in IT. Most commonly, they mentioned their father bringing home technology for them to play with. It seems that just, "Coming from a family of computer and technology professionals" made them more aware of the nature of IT and the opportunities.

When responding to questions about their attitudes toward IT in middle school, a large percentage of women chose "Not Applicable," signifying that at that age, they did not know enough about the field or have enough experience or exposure in IT to make a decision (shown in Table 13). Typically, 48% of respondents marked "Not Applicable" in responding to scale questions about their attitude in IT in grades 6–8. Of those responding, using a scale from Strongly Disagree = 1 to Strongly Agree = 6, the highest mean was in response to having a positive image of those involved in IT (mean = 4.26). The average woman only slightly agreed that she felt competent (mean = 3.54) and comfortable in IT environments (mean = 3.76). They were not sure whether they had a good understanding of the nature of the work, however (mean = 2.67) almost 58% of those responding disagreed or strongly disagreed with the statement. Additionally, many had what is often classified as negative or erroneous views of the work: just over 50% strongly disagreed or disagreed that work in IT could solve social problems, and 35% of those responding believed that people in IT did not have much opportunity for social interaction.

Table 14. Attitudes toward IT in Grades 6–8

Topic	Mean	Not applicable
I felt competent in my IT-related skills	3.54	48.3%
I had a positive image of those involved in IT	4.26	46.1%
I felt comfortable in IT environments	3.76	47.8%
I had a good understanding of the nature of work in IT	2.67	40.9%
I believed work in IT could solve social problems	2.83	53.0%
I believed people in IT did not have a lot of opportunity for social interaction	3.41	50.1%

Scale where 1 = Strongly Disagree to 6 = Strongly Agree

During grades 9–12, there were still a high number of "Not applicable" responses to the scale questions on IT attitudes, although about half the number as for grades 6–8. Looking again at the respondents who answered on the scale where 1 = Strongly Disagree to 6 = Strongly Agree, means increased or received higher levels of agreement on each topic. This may indicate that in high school, these girls felt slightly more competent and comfortable, had a better understanding of IT work and a more positive image of those involved in IT. However, despite the increases, the means are still fairly low, with about 20% of respondents disagreeing or strongly

disagreeing that they felt competent in their IT skills and comfortable in IT environments. Understanding of the nature of work in IT was still very low (mean = 3.26), with 37% indicating strongly disagree or disagree and 26% strongly agreeing or agreeing. Respondents were more likely to agree that there was opportunity for social interaction (mean=3.45) and believe IT could solve social problems (mean = 3.26).

Table 15. Attitudes toward IT in Grades 9–12

Topic	Mean	Not applicable
I felt competent in my IT-related skills	4.09	29.2%
I had a positive image of those involved in IT	4.47	27.1%
I felt comfortable in IT environments	4.01	28.7%
I had a good understanding of the nature of work in IT	3.26	24.7%
I believed work in IT could solve social problems	3.26	36.2%
I believed people in IT did not have a lot of opportunity for social interaction	3.43	33.1%

Scale where 1 = Strongly Disagree to 6 = Strongly Agree

Respondents were asked about their high school IT class scheduling. Fifty-eight percent of all respondents did not take IT classes in high school because they were not offered. Of those that had the opportunity to take classes, 7.3% indicated they did not take any IT classes.

Table 16. High School IT Classes

Choice	Percentage of Respondents
I took formal IT classes in high school	34.4%
I took no formal IT classes in high school because they were not offered	58.3%
I chose not to take IT classes in high school	7.3%

Sixty-five percent of respondents indicated they took more than the requisite number of science or math classes in High School, while 35% said they took no more than the requisite number.

Table 17. Requisite Number of Science or Math Classes in High School

Choice	Percentage of Respondents
I took more than the requisite number	64.9%
I took no more than the requisite number	35.1%

First Developed a Positive View

Looking at the time period when respondents first developed a positive view of IT and when they were first interested in an IT career, only 10% of respondents had a positive view of IT in elementary school. Most women were undergraduates in college (30% of respondents) before they developed a positive view. A significant number of the women did not have a positive view of IT until they had already been in the workforce.

Table 18. First Developed Positive View of IT

Choice	Percentage of Respondents
Don't have a positive view of IT	1.2%
Elementary school (ages 5-10)	10.0%
Middle school (ages 11-13)	8.7%
High school (ages 14-18)	18.0%
While earning an undergraduate degree	29.9%
While earning an advanced degree	4.4%
When first entering the workforce	11.4%
After working in another field	12.7%

In terms of when respondents were first interested in working in IT, the majority of decisions were made during undergraduate studies (31%), in high school (21%), or after working in another field (19%). Two women described how they learned more about IT during their other work,

> *"I went to high school in the '80s, so computers were not a part of our daily life. After entering the job force I was fascinated by the whole field, and eventually worked my way into the filed through self study and tenacity. It is still a hard field for women, but the numbers are growing. I currently work with three men and three women—this is the first time in my IT career I haven't been the only woman in the group!"*

> *"When I was going through school (elementary, high school and college) computers weren't even in play or mentioned and mainframe stack cards were used for programming. I got interested in IT when I worked as an administrative assistant and had to learn via book how to operate our company's DOS based programs and I'd had no computer experience. I found it fun and challenging and discovered I had an affinity for it."*

A small number, 97, or 10.9%, of respondents were interested in IT work by middle school. Few indicated that they became interested in IT during graduate studies, perhaps because they had already decided their career interest before pursuing an advanced degree.

Table 19. First Interested in IT Work

Choice	Percentage of Respondents
Elementary school (ages 5–10)	4.7%
Middle school (ages 11–13)	6.2%
High school (ages 14–18)	20.8%
While earning an undergraduate degree	30.5%
While earning an advanced degree	6.6%
When first entering the workforce	9.3%
After working in another field	19.3%

The women (N=97) who were interested in IT work by elementary school or middle school indicated higher levels of IT activities during those grades across every item. 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. Large increases were also seen in support from a teacher, which increased from 6% to 24% in elementary school and doubled from 12% to 42% in middle school.

Table 20. Comparison of Elementary or Middle School Interest in IT to All Respondents as a Group

	Total Respondents		Interested in IT Work in Elementary or Middle School	
Topic	**Elementary school**	**Middle school**	**Elementary school**	**Middle school**
Access to a computer at school	12.5%	22.3%	30.9%	52.6%
Played computer games/video games	18.1%	29.4%	50.5%	66%
Support/Encouragement from parents	16.5%	22.4%	54.6%	63.9%
Access to a computer at home	15.1%	25.8%	47.4%	62.9%
Support/Encouragement from a teacher	5.7%	11.9%	23.7%	42.3%
Friends interested in the subject	2.2%	7.7%	10.3%	22.7%
Participated in informal IT-related programs (*e.g.* tech club, summer or after-school programs)	5.3%	9.9%	18.6%	31.0%
Had a role model (a professional in the field)	5.4%	7.6%	17.5%	23.7%
Influenced by IT in the media/advertising	1.4%	5.3%	10.3%	19.6%
Had a mentor in IT (personally known)	3.1%	5.3%	13.4%	23.7%
Job Fair/Event that included IT	0.4%	1.6%	2.1%	9.3%

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. Additionally, they were less likely to agree that IT work was socially isolating. The means of the response groups are shown in Table 21.

Table 21. Attitudes toward IT, Early Interest Respondents and Total Respondents, Grades 6–8

Topic	**Total Respondents Mean**	**Early Interest* Mean**
I felt competent in my IT-related skills	3.54	3.80
I had a positive image of those involved in IT	4.26	4.76
I felt comfortable in IT environments	3.76	4.24
I had a good understanding of the nature of work in IT	2.67	3.13
I believed work in IT could solve social problems	2.83	3.00
I believed people in IT did not have a lot of opportunity for social interaction	3.41	3.08

Scale where 1 = Strongly Disagree to 6 = Strongly Agree
**Interested in work in IT in elementary or middle school*

The subgroup interested in IT work by middle school had a mean age of 33 years, approximately seven years younger than the mean of the whole group, which might account for some of the increases in IT-related activities. However, regardless of the opportunity differences, one can conclude that more experiences in IT contribute to earlier interest in IT as a career path.

Image of IT Work

An open-ended question asked respondents what influenced their image of IT work and those involved in IT when they were in grades 6–12. Some of the images were negative, some were positive, some were more true to reality and others involved stereotypes. This question mainly focused on how their images were formed, however, not always answering what their images were. Again, approximately 20% of the women indicated "Nothing" or "Not applicable," citing the lack of anything related to IT when they were under age 18. Other respondents' images of IT were based mostly on their impressions from their family, the media, a teacher, IT work places, and peers. A large number of women mentioned their father as the main influence of their IT images, often because he held an IT-related job, *"By the time I was in high school, my father had begun using computers heavily in his engineering work, and my positive image of his work influenced my image of IT."*

Movies such as *Star Wars* and *Star Trek* helped form the image that many of the respondents held of IT work. The IT knowledge of a few women consisted of the main IT-related events in the news, such as the space program, and large IT companies or executives such as Microsoft's Bill Gates. Many women had jobs or internships where they met people working in technology and learned what they did. Others had the opportunity to visit and tour work places to gain an impression.

Teachers often provided the women responding to the survey advice or guidance regarding careers. *"My advanced mathematics teacher in high school told me that computers were the field to be in for the future. He encouraged me to learn as much as possible. Also, the instructor for my summer course at NYU was the director of the computer center there and told us much about careers and what we could do with our knowledge of computers."* At school, the respondents noticed who was engaging in the IT-related activities and those people defined their image of who was involved in IT, *"I had a pretty negative image of people involved in IT because at my school, it pretty much seemed like a boys' club full of nerdy boys acting like they were smarter than everyone else and obsessed over video games and bulletin board systems."* One woman commented on a commonly held stereotype of those involved in IT, *"I thought you had to be smart and anti-social to be in computers."*

As a new field, many of the respondents thought its development to be exciting and interesting. *"PCs were just becoming popular and available to the general public when I was in high school, so my image was general awe and wonder at the marvelous things the machines could do. I wanted to be a part of that and learn how they worked."*

Table 22. Influences on Image of IT and Those Involved in Grades 6–12

Influence	Percentage of Respondents
Nothing	23.3%
Parents/Family	13.0%
Media/Movies/Books	9.7%
Teacher	5.8%
Work places (visits or jobs)	3.4%
Peers	3.0%
Acquaintance working in IT	1.0%
NASA/Space Program	1.0%
Informal education experiences	1.0%
Computer or video games	0.9%
From own use of IT	0.7%
Notable people/businesses in IT	0.7%
New, exciting field	0.5%
Role model/Mentor	0.4%
Career education/Counselor	0.4%
Speaker	0.4%

Informal Education Experiences

> *"We didn't do anything computer-related when I was in Girl Scouts, but that was before PCs were widely available. I learned how to treat snakebites, though, and on a metaphoric level that has aided my IT career."*
>
> *—Survey Respondent*

The survey asked respondents about their participation in informal IT and non-IT related programs. The quote above shows how non-IT related programs were influential in their career paths. Sixty percent of respondents were never involved in any informal IT-related education programs. Of those that were involved, 15% participated in one program, but 5% participated in 11 or more.

Table 23. Involvement in Informal IT-related Programs

Number of Informal IT-Related Education Programs	Number of Respondents	Percentage of Respondents
0	561	59.8%
1	137	14.6%
2	79	8.4%
3-5	90	9.6%
6-10	28	3.0%
11 or more	43	4.6%

Though not necessarily IT-related, survey sponsors were interested to know what type of national youth organizations the respondents had been involved with. The most common youth organization they participated in was the Girl Scouts of the USA, almost half of participants. Additionally, another 17 of the participants (2%) wrote under "Other" that they were members of Girl Scouts, Brownies or Girl Guides in other countries, including Canada, Panama and the Netherlands. About a quarter of survey respondents were members of religious or church-based youth groups. One woman found a role model in her informal education instructor,

> *"I was an avid member of the Girl Scouts. I stayed in the program into high school where I was the last member of my troop in a rural area. My troop leader was an excellent role model, a women scientist working in research. While she had no background in computing, she was the person who pushed me the hardest to go to college. She made sure I understood about scholarship programs, that lack of money was not a deterrent to college attendance and that I should not limit my goals. She was the role model that made decide that I could be a scientist (initially a researcher in modeling and simulation), a wife and a mother."*

The respondents did not as often participate in other national organizations, with 8% of participants in 4H, 5% in Camp Fire and around 1% in Big Brother, Big Sister and the Boys and Girls Club. Common responses specified under "Other" by approximately 1% were sports teams, Boy Scouts or Explorers, math club or Olympiad, summer camps, music or dance, YMCA, Junior Achievement, or Odyssey of the Mind.

Table 24. Youth Organizations

Choice	Percentage of Respondents
Girl Scouts of the USA (including Daisy, Brownie, Junior, Cadet, Senior)	47.2%
Religious youth groups	24.1%
Other youth programs	14.0%
4H	8.2%
Camp Fire	4.7%
Big Brother, Big Sister	1.3%
Boys and Girls Club	0.7%
FIRST Robotics/FIRST Lego League	0.6%
Police Activities League	0.5%
Girls, Inc.	0.4%

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. Participating in informal clubs or groups allowed them to meet and form relationships. One woman described how she felt more comfortable after joining a group of other female computer science majors,

> *"We had a women's group that included women CS [Computer Science] and IS [Information Science] majors at our college. That group solidified me wanting to be in IT because I was the only girl in my class and I knew girls were rare and that turned me off at first, but when I got together with other women in the same position, it made me more comfortable and confident that I could do it. I eventually became president of that group and it allowed me to break out of my shell and not only become more social, but also a leader."*

Another woman similarly wrote about how fellow female peers helped her, *"Meeting other girls there who shared both my abilities in the field and my frustrations dealing with men in the field who refused to recognize us."* A number of other women wrote about how they would learn from friends who were interested in technology, *"Activities with OSU's Linux Users Group. We were just a group of friends who happened to use Linux. We would teach each other things and do activities to promote the use of Linux and Open Source such as Linux Installfests, Firefox milestone parties, etc."* Respondents also mentioned conferences, lectures or presentations as enjoyable for similar reasons, such as networking opportunities.

Summer camps were mentioned by 24 respondents as their best experience in informal education. The longer experiences were memorable and usually entailed a variety of activities. If they were held at a college or university, respondents (usually in grades K–12) had the additional opportunity of spending time, learning of opportunities, and becoming comfortable on campus. *"Summer Programs on college campuses. This gave me exposure to college environments and the opportunity to speak with college students and get their perspective on pursuing a career in IT."*

Hands-on activities provided in informal IT programs were mentioned by 12 women as the "best" aspect. *"The opportunity to work hands-on with technology and get insight into what a technology professional would do day-to-day. I was drawn in by the skills that I could develop. I saw cool stuff and I wanted to be able to do it too!"* 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."*

Participants in informal IT-related education had positive experiences. On a scale where 1= Strongly Disagree and 6 = Strongly Agree, the mean response to a statement that they had positive experiences was 5.01, with all but 15 women responding slightly agree, agree, or strongly agree. They were slightly less likely to agree that their experiences in informal programs impacted their decision to pursue work in IT (mean = 4.4).

Table 25. Experiences in Informal IT-Related Education

Topic	Mean
My experiences in informal IT-related education were positive	5.01
My experiences in informal IT-related education impacted my decision to pursue a career in IT	4.40

Other questions asked respondents about the impact of informal education experiences on choosing IT work. Seventeen women (2%) 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. Most of respondents who had informal education experiences indicated that their instructor was neither encouraging nor discouraging (22%). Only 0.5 percent indicated they were discouraging, while 11% classified them as encouraging (66% marked Not Applicable). Almost every woman who participated in informal education marked that the experience and the staff were positive influences on their decision to work in IT. Only 2 to 3% indicated them as weak or strong negative influences.

Table 26. Positive or Negative Influence on Decision to Work in IT

Topic	Strong Negative Influence	Weak Negative Influence	Weak Positive Influence	Strong Positive Influence	Not Applicable
Informal education staff (instructors, program leaders)	0.7%	1.3%	17.7%	11.9%	68.5%
Informal education experiences (such as after-school or summer programs)	0.6%	1.8%	12.0%	13.5%	72.1%

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 the groups, 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.

Table 27. Comparison of Attitudes of Respondents Participating in an IT-related Program and Those Not Participating

	Mean Middle School		Mean High School	
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.*

Successful Elements of Education

Approximately 40% of the women participated in informal education programs and the majority of those indicated that they had positive experiences which impacted their decisions to work in IT. The number of women indicating that they had formal IT education experiences in K–12 schooling that were influential was fewer. In order to identify more specific aspects that these women working in IT experienced when they were younger, survey questions asked respondents to identify elements regarding staff, curriculum and learning activities, learning environment, and others they experienced. The list of elements was generated from a literature review of promising or effective practices in informal IT education for girls. It was originally used in a survey to such programs in order to identify what they believed to be promising practices. Another question asked survey respondents to identify the top five most critical elements to successful IT-related programs or events. Overall, the most frequently selected elements were hands-on experiences, relevant curriculum, engaging staff, and project-based learning opportunities. The following sections cover the responses in each category in more detail.

Staff Elements

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. However, although almost 30% of respondents experienced female (as opposed to male) staff, only 9% of the women indicated that it was a critical element.

Table 28. Staff Elements Experienced

	Percentage of Respondents	
Choice	**Experienced**	**Selected as Critical Element**
Engaging staff	40.0%	39.7%
Female (as opposed to male) staff	28.7%	9.0%
Program Director with strong leadership skills	24.3%	20.1%

Curriculum and Learning Activities Elements

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. In terms of what is most critical, after hands-on experiences, respondents indicated that relevant curriculum and project-based learning opportunities were most vital.

Table 29. Curriculum and Learning Activities Elements

	Percentage of Respondents	
Choice	**Experienced**	**Selected as Critical Element**
Hands-on experiences	68.6%	50.6%
A challenging content level	53.6%	29.6%
Opportunities to work together with other people	51.6%	19.9%
Project-based learning opportunities (e.g. projects with real-world activities)	47.4%	38.7%
Opportunities to use technology to be creative and explore	44.8%	30.6%
Opportunities to use technology to communicate	37.4%	14.6%
Relevant curriculum, tied to real-life issues	36.1%	40.3%
Curriculum materials that appeal to girls	4.8%	4.9%

Learning Environment Elements

Slightly over half of survey respondents (52%) were in education programs with small group sizes. Many were in programs with a low student to staff ratio, which they most frequently identified as a critical element. Very few (5%) of the women surveyed were in programs that were for girls-only, and they similarly rarely selected it as a top five critical component. Up-to-date resources were thought to be very important.

Table 30. Learning Environment Elements

	Percentage of Respondents	
Choice	**Experienced**	**Selected as Critical Element**
Small group sizes	52.0%	26.4%
High-end, up-to-date equipment and resources	36.5%	22.9%
Low student-to-staff ratio	29.6%	15.6%
Frequent affirmation and verbal support from instructors	23.5%	20.1%
Girls-only environments	5.1%	4.2%

To consider the potential influence of attending an all-girls school, a survey question was asked to determine K–12 school attendance. Eighty-five percent of survey respondents did not attend an all-girls school during their K–12 school years. Table 31 shows the number of years respondents experienced all-girls schooling.

Table 31. Attendance at a All-Girls School During K–12 School Years

Choice	Percentage of Respondents
Did not attend an all girls-school	84.9%
I attended an all -girls school for 1 year	0.9%
I attended an all -girls school for 2 years	1.3%
I attended an all -girls school for 3–5 years	5.5%
I attended an all -girls school for 6–8 years	3.8%
I attended an all -girls school for 9–13 years	3.5%

Additional Elements

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. As IT was an emerging field during the time many of these respondents were growing up, it is impressive that more than a quarter of them were exposed to career information. They believed it was a critical element, especially contact with mentors in IT.

Table 32. Additional Elements

Choice	Percentage of Respondents	
	Experienced	Selected as Critical Element
Career information	40.3%	21.4%
Parent support	32.7%	15.7%
Opportunities for participants to take a leadership role	29.1%	18.0%
Contact with mentors in IT (personally known)	28.9%	29.5%
Information on professionals in the field	27.4%	14.0%
Community support	6.7%	4.6%

Post High School/College Experiences

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. In responding to a scale question where 1 = Strongly Disagree and 6 = Strongly Agree, the mean response decreased slightly after high school. However, respondents felt they had a better understanding of the nature of work in IT and were more likely to agree that work in IT could solve social problems. It is possible that their understanding of the nature of IT made them aware of how much they still needed to learn. Overall, on the six point scale, means were not very high, signifying at least some respondents with levels of disagreement to the statements. For example, over 30% of respondents believed that people in IT did not have many opportunities for social interaction.

Table 33. Attitudes toward IT, Prior to Work

Topic	Mean	Not Applicable
I felt competent in my IT-related skills	3.95	4.2%
I had a positive image of those involved in IT	4.51	4.4%
I felt comfortable in IT environments	3.85	3.9%
I had a good understanding of the nature of work in IT	4.16	4.5%
I believed work in IT could solve social problems	3.58	5.6%
I believed people in IT did not have a lot of opportunity for social interaction	3.11	4.8%

Scale where 1 = Strongly Disagree to 6 = Strongly Agree

IT-Related Activities

The respondents were much more likely to have access to a computer during post high school or college, compared with access in middle school and high school. Only 29% of respondents did not have access to a computer at college—likely because they were not common in colleges during that time period or perhaps because they were not attending. About half of these women had friends who were interested in IT and support of a professor or instructor. Many more had a role model and attended a job fair or event, compared to responses about high school, probably since they had more active professional lives. There was a decline in the number of respondents participating in informal programs from high school.

Table 34. IT Experiences During Post-High School or College Years

Choice	Percentage of Respondents
Access to a computer at school	70.9%
Friends interested in the subject	48.7%
Support of a professor/instructor	45.8%
Owned a computer at home	44.2%
Support from parents	40.9%
Played computer games/video games	31.2%
Influence of a role model (a professional in the field)	24.7%
Job Fair/Event	20.3%
Influenced by IT in the media/advertising	19.5%
Participated in informal IT-related programs (*e.g.* tech club or summer programs)	18.0%
Had a mentor in IT (provides personal guidance)	17.8%
Other	20.6%

The most common experiences described in the "other" category were college courses related to IT. Additionally, even if respondents were not majoring in computer science, many courses required use of computers for word processing, etc. A number of women were in jobs which included an IT-related component. In fact, that is where a number of them first had access to computers. They received "on-the-job" training that increased their IT skills. As IT was an emerging field, many respondents were hearing of the "exciting and new" job prospects. This is similar to findings in a survey by Turner, Bernt & Pecora (2002), where respondents frequently mentioned having IT initial on-the-job experiences as an influential experience (Turner, Bernt & Pecora, 2002). Three respondents mentioned taking an aptitude test, which results showed them to be a good fit for IT work. Families also involved in IT continued to be influential, as did self-motivation through interest in the field. Table 35 summarizes responses to the "other" category.

Table 35. Other IT Experiences Post-High School/College

Experience	Number of Responses
Courses/Major in IT	50
Job requirement/Learned on the job	26
Internship	18
None	18
Summer/Part time job	12
Access to a computer at work/through a friend	11
Family influence	6
Tech School	5
Job availability/Money	5
Interest in IT	4
Work study/Cooperative education	4
Aptitude test	3
Program/Scholarship for women in IT	2
College counselor advice	1

College Experience

Table 36 shows the categories and responses related to the level of education of survey respondents. Most respondents completed an undergraduate degree (32%) and 30% completed a Master's degree. The majority of respondents have earned either an undergraduate or graduate degree.

Table 36. Level of Education

Highest Level of Education	Percentage of Respondents
Middle school	0.0%
High school or G.E.D.	1.0%
Technical degree or vocational school	2.3%
Some college	6.0%
Undergraduate degree	32.4%
Some graduate work	12.1%
Master's Degree	30.2%
Some post Master's work	4.7%
Doctoral degree/Other Post-Master's degree	8.4%

Less than 7% of survey respondents did not earn a Bachelor's degree. Thirty-five percent of the respondents majored in a non-IT related field. Of those in IT, the majority received Computer Science degrees or another IT-related degree not specified in this list. Other majors specified below included Engineering (Biomedical, Chemical, Industrial, etc.), Physics, and Business Administration. The national average of females earning computer science degrees is 33%, so this group differs from the normal population. High school

girls are more likely to choose computer science as a major if they are looking to use computers in another field, have an interest in computer games, or feel they are good at using computers (Carter, 2006). Many survey respondents in this study indicated they feel fairly competent in their IT skills and many played computer games.

Table 37. Bachelor's Degree Earned

Choice	Percentage of Respondents
Did not receive a Bachelor's degree	6.7%
Non-IT related	35.1%
Computer Science*	21.2%
IT-related, Other	11.2%
Mathematics	8.2%
Computer and Information Sciences	4.5%
Computer Engineering	4.5%
Management Information Systems and Services	4.1%
Electrical Engineering**	3.4%
Information Technology	2.8%
Information Science/Studies	0.4%
Computer/Information Technology Administration and Management	0.3%
Computer Programming	0.2%
Computer Systems Analysis/Networking/Telecommunications	0.2%
Computer Graphics	0.1%
System Administration/Administrator	0.1%
Web Page, Digital/Multimedia and Information Resources Design	0.1%
Web/Multimedia Management and Webmaster	0.1%

**Five respondents wrote in Computer Science as a response under "Other," which were re-categorized and added to this list.*
*** Electrical Engineering was not a category on the original list, but was specified by 3.4% women under "Other."*

A significantly lower percentage of survey respondents received graduate degrees, but this is still a high percentage compared to an average population. Sixty percent earned advanced college degrees, again, the most in Computer Science. Degrees were also frequently earned in Management Information Systems and Computer, Information Sciences, and Computer Engineering. In the other degrees not included on this list, majors in the Engineering department were common (17 respondents), Education or Instructional Technology (9 respondents), Information Systems or Security (8 respondents), and Project Management (8 respondents). The respondents also received degrees in non-IT fields such as Music or Geography.

Table 38. Graduate Degrees Earned

Choice	Percentage of Respondents
Did not receive a graduate degree	41.5%
Computer Science	14.7%
Non-IT related field	13.0%
IT-related, Other	10.5%
Management Information Systems and Services	2.5%
Computer and Information Sciences	2.3%
Computer Engineering	2.3%
Information Science/Studies	2.1%
Information Technology	2.0%
Electrical Engineering	1.7%
Mathematics	1.6%
Computer/Information Technology Administration and Management	0.9%
Computer Graphics	0.4%
Web Page, Digital/Multimedia and Information Resources Design	0.3%
System Administration/Administrator	0.1%

The respondents overall had positive experiences in their college IT courses. They indicated that they felt supported by professors or instructors and by peers in their IT-related college courses. Less than 7% marked that they did not feel supported, while almost half felt "Very Supported."

Table 39. Support by Professors/Instructors in IT-related College Courses

Choice	Percentage of Respondents
Very supported	43.5%
Somewhat supported	35.6%
Not supported	6.0%

Table 40. Support by Peers in IT-related College Courses

Choice	Percentage of Respondents
Very supported	46.4%
Somewhat supported	32.4%
Not supported	6.7%

Influence by Others

A number of survey questions addressed the influence of others on their decisions to work in IT. Respondents were asked to classify the people in their lives as encouraging, discouraging, or neither, to identify the three most influential people, and, from a smaller list, select whether people were a positive or negative influence regarding their work in IT. Family members were consistently identified as very influential, in a positive sense, in the respondents' decisions to pursue IT. Professors and friends were also frequently selected as encouraging, but middle and high school teachers were not as influential. Nobody was frequently noted as discouraging or as a negative influence, though 6% of respondents identified a guidance or career counselor as discouraging and about 7% indicated that their grades 6–12 coursework and teachers were either a strong or slightly negative influence. Similar results were found in a study by Turner, Bernt & Pecora (2002), who surveyed almost 300 women working in IT. The women reported more encouragement than discouragement by people in their lives. Most commonly encouraging were fathers, high school teachers, close male friends, and mothers. Additionally, the women identified a specific person or persons (rather than an experience or other factor) as having the most influence in steering them toward a career in IT.

The sections on the following page describe the responses about the influence of different groups of people on the women in this survey in more detail.

Table 41. Level of Encouragement Regarding Decision to Work in IT

Person	Discouraging	Neither Encouraging nor Discouraging	Encouraging	Not Applicable
Father	3.0%	26.3%	59.2%	11.5%
Mother	3.0%	31.7%	58.9%	6.4%
Spouse/Partner	1.7%	11.8%	52.3%	34.3%
Male professor/instructor	3.3%	24.4%	51.9%	20.3%
Close male friend	2.3%	29.6%	49.8%	18.3%
Other family members	2.1%	38.6%	47.5%	11.9%
Close female friend	2.1%	36.4%	47.2%	14.3%
Female professor/instructor	1.0%	25.2%	38.5%	35.3%
Role model: male in IT career	0.8%	12.3%	36.6%	50.3%
Mentor, male in IT career	0.8%	11.7%	36.4%	51.2%
Role model: female in IT career	0.3%	11.5%	34.3%	53.8%
Mentor, female in IT career	0.2%	12.0%	29.0%	58.7%
High school teacher, male	2.1%	26.7%	27.6%	43.4%
High school teacher, female	1.8%	32.8%	21.1%	44.3%
Other(s)	1.4%	15.4%	18.2%	65.0%
Guidance or Career counselor	6.4%	30.8%	16.0%	46.8%
Middle school teacher, female	1.5%	35.1%	11.2%	52.2%
Informal education instructor	0.5%	22.1%	11.2%	66.3%
Middle school teacher, male	1.0%	34.4%	11.0%	53.6%

Parents/Family Influence

In the open-ended questions, several respondents mentioned that their parents or other family members influenced their perceptions of IT. If a close family member was working in a related field, they often brought technology into the home, providing them information, exposure and opportunities to interact with IT. Thirty-eight percent of the survey respondents had fathers who held work positions in STEM. The number of mothers involved in STEM was lower (10%), but may be higher than the average percentage of women involved in STEM at that time.

Table 42. Parents Working in STEM

Choice	Percentage of Respondents
My mother worked in STEM	9.6%
My father worked in STEM	38.3%
Neither parent worked in STEM	59.1%
Don't know	0.2%

Parents or family were selected as a strong positive influence on their decision to enter IT by 50% of respondents, and a weak positive influence by 26%. Only 4% of respondents indicated they were a negative influence.

When identifying the top three people in their lives who were most influential regarding their decision to enter IT, the women most frequently chose their father (37%), mother (29%), and a spouse/partner (24%). Additionally, "Other family member" was selected by 15% of the respondents. The high level of influence of family points to their proximal position in the women's lives and their trusted position for providing guidance or advice. The number of fathers involved in STEM work mirrors the number of women marking their fathers as among the top three most influential people in their lives.

Table 43. Most Influential People Regarding Decision to Work in IT (Family)

Choice	Percentage of Respondents
Father	36.7%
Mother	29.1%
Spouse/Partner	23.8%
Other family members	14.5%

Additionally, parents were identified most frequently as encouraging, rather than discouraging in the respondents' decisions to work in IT. Almost 60% indicated that their father and mother were encouraging, and about half indicated that their spouse or partner was encouraging. Despite being the most often identified as encouraging, there were about 30% of the respondents whose parents were neither encouraging nor discouraging, perhaps indicating that often they were not involved. Other family members were also seen as encouraging by just under half of the respondents. One woman described how her family guided her education, *"I lived with my grandparents during high school; my grandfather had been a mechanical engineer and led efforts to integrate CAD systems at Westinghouse in the 1970's. He was instrumental in guiding my education from the time I was small and always tutored me in math (ahead of grade level) and encouraged me to study science and computers."*

No family groups were viewed as discouraging by more than three percent of the respondents.

Teacher/Professor Influence

Behind family members, male professors/instructors were most frequently selected as encouraging of decisions to enter IT work. It is interesting to note that guidance or career counselors were most frequently classified as "Discouraging." Female professors/instructors were the second-most frequently encouraging teacher. However, 35% of the respondents marked "Not Applicable," signifying they did not have a female professor.

Table 44. Level of Encouragement Regarding Decision to Work in IT

Person	Discouraging	Neither Encouraging nor Discouraging	Encouraging	Not Applicable
Male professor/instructor	3.3%	24.4%	51.9%	20.3%
Female professor/instructor	1.0%	25.2%	38.5%	35.3%
High school teacher, male	2.1%	26.9%	27.6%	43.4%
High school teacher, female	1.8%	32.8%	21.1%	44.3%
Guidance or Career counselor	6.4%	30.8%	16.0%	46.8%
Middle school teacher, female	1.5%	35.1%	11.2%	52.2%
Informal education instructor	0.5%	22.1%	11.2%	66.3%
Middle school teacher, male	1.0%	34.4%	11.0%	53.6%

Selections of the top three most influential people regarding the respondents' decisions to enter IT showed a very similar pattern. Again, the teachers from their earlier education years were the least likely to be selected. Male professors were most frequent, followed by male high school teachers. Of course, part of the difference in male professors being selected more frequently than female professors might be due to the lower overall number of female professors in IT related fields.

Table 45. Most Influential People Regarding Decision to Pursue IT. Teachers/Professors

Choice	Percentage of Respondents
Male professor	16.5%
High school teacher, male	7.6%
Female professor	7.3%
High school teacher, female	6.2%
Guidance or Career counselor	3.2%
Informal education instructor (including summer camp leader, troop leader, after-school instructor)	1.8%
Middle school teacher, male	1.4%
Middle school teacher, female	1.0%

Role Model/Mentor Influence

A small percentage of the women responding to the survey had experience with a role model or mentor. After high school, about a quarter of respondents had a role model and 18% had a mentor. Numbers were quite low in elementary and middle school, with a high of 7.5% of respondents having a role model when they were in middle school. The amount of respondents with a mentor was consistently less than those with a role model.

Table 46. IT Experiences, Role Model and Mentor

Topic	Elementary school years (ages 5-10)	Middle school years (ages 11-13)	High school years (ages 14-18)	Post high school or college years
Had a role model (a professional in the field)	5.4%	7.6%	15.5%	24.7%
Had a mentor in IT (personally known)	3.1%	5.3%	13.0%	17.8%

In a list where respondents identified the top three motivators for deciding to work in IT, 57 or 6%, selected encouragement from a role model or mentor in the field. More respondents selected them among the most influential people in their lives regarding their decision to pursue IT. Eleven percent of women indicated a male mentor and 10% indicated a male role model. Those who had a role model or mentor almost always received positive influence on their decision to enter IT. Forty-three percent of total respondents selected that they had a strong positive influence, and only 0.2 selected that they had a strong negative influence.

Table 47. Most Influential People Regarding Decision to Pursue IT

Choice	Percentage of Respondents
Professional mentor, male	11.3%
Role model: male in IT career	9.6%
Role model: female in IT career	9.1%
Professional mentor, female	5.0%

Friends Influence

Friends may have been influential by encouraging or supporting the respondents, by exposing them to aspects of IT, or by sharing an interest in IT that they supported together. As respondents got older, they had more friends interested in IT. In elementary school, 2% of respondents had friends interested in the subject, in middle school, 8%, and by high school, 30% of the respondents had friends interested in IT. After college, half of the survey respondents had friends involved in the field.

Respondents rarely classified their friends as a strong negative influence, although 4% thought their friends had a weak negative influence on their decision to work in IT. Seventy percent of respondents indicated their friends to have a positive influence on their decision. Twelve percent identified a close male friend and 11% identified a close female friend as among the top three most influential people regarding their decision to pursue IT.

Table 48. Positive or Negative Influence on Decision to Work in IT

Topic	Strong Negative Influence	Weak Negative Influence	Weak Positive Influence	Strong Positive Influence	Not Applicable
Friends/Peers	0.3%	4.0%	35.2%	37.7%	22.8%

Working in IT

There were a number of motivating factors for deciding to work in IT. Respondents were asked to indicate their top three motivating factors, marking from a list, or writing in another response. 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. Least motivating factors included encouragement from teachers/professors and geographic location. Only 6% of survey respondents included encouragement from a role model or mentor in the top three, but we know from other responses that less than 18% of the women had a mentor in post-high school years. Responses under "Other" included money, job flexibility, the nature of the work, influence of a supervisor, and company reputation.

Table 49. Top Motivations for Choosing a Position in IT

Choice	Percentage of Respondents
Intellectual challenge of the field	45.2%
Availability of jobs	44.8%
Earning potential	43.4%
My abilities/skills in the field	42.2%
Genuine interest in field	37.2%
Excitement of working in IT	17.9%
Encouragement from parents/family	11.2%
Positive experiences in IT, including non-formal programs	8.4%
Desire to contribute to society	6.7%
Other	6.5%
Encouragement from role model or mentor in the field	6.1%
Geographic location	5.1%
Encouragement from teacher/professor	3.3%

Respondents were asked to categorize a number of people or factors and categorize whether they had a strong or weak negative influence or a strong or weak positive influence on their decision to pursue work in IT. As discussed in the "Influence by Others" section of this report, the people in their lives, especially family and friends had positive impacts on respondents' career choices. Equally as positive were their undergraduate education experiences, which over 70% indicated as a positive influence. Although only about 60% of respondents had a role model or mentor, they were most infrequently a negative influence.

It is also notable how few experiences were a negative influence on their decision to work in IT. The most frequently marked as a strong or weak negative influence was Grades 6–12 coursework or education staff, including teachers and counselors.

Table 50. Positive or Negative Influence on Decision to Work in IT

Topic	Strong Negative Influence	Weak Negative Influence	Weak Positive Influence	Strong Positive Influence	Not Applicable
Parents/Family	1.1%	2.9%	25.3%	50.6%	20.2%
Undergraduate education	1.0%	3.3%	20.7%	52.0%	23.0%
Friends/Peers	0.3%	4.0%	35.2%	37.7%	22.8%
Mentors/Role models	0.2%	0.5%	15.3%	43.3%	40.7%
Graduate education	0.6%	0.8%	9.1%	36.5%	53.0%
Grades 6-12 education coursework	2.0%	5.9%	23.9%	15.0%	53.5%
Grades 6-12 education staff (teachers, counselors)	1.5%	5.9%	25.0%	14.0%	53.6%
Informal education staff (instructors, program leaders)	0.7%	1.3%	17.7%	11.9%	68.5%
Informal education experiences (such as after-school or summer programs)	0.6%	1.8%	12.0%	13.5%	72.1%

Mentioned in an earlier section was a list of people selected as the top three influences for pursuing IT work. A number of participants specified other factors that were most influential in leading them to work in IT, including "themselves." Rather than identifying from a list of influential factors, 44 respondents stated that it was a personal choice, or that they were self-motivated. Employers, managers or supervisors were mentioned by 22 respondents. Many learned on the job or were encouraged by their boss to pursue IT. Co-workers or peers were also frequently noted as influential in their career decisions. Family members other than parents, such as siblings, uncles, grandmothers and daughters were mentioned by 13 respondents. The availability of jobs in the emerging market of the technology boom encouraged many respondents to seek IT-related work.

Four respondents wrote about being recruited into IT work by a recruiter. Others felt like they should respond to the challenge of entering a male-dominated field. A few women noted that they did not "choose" IT, rather, they fell into positions by being trained on the job, or taking, "the path of least resistance." A few women were offered scholarships to study IT.

Survey respondents indicated they were generally satisfied with their current work in IT. Just over 80% of them agreed or strongly agreed that overall, they

are satisfied with their job. They are very likely to remain working in IT; only 5% of the respondents disagreed or strongly disagreed that they would remain in the field. They felt fairly supported by management, and slight more so by coworkers. In terms of balance between work time and personal time, respondents were fairly satisfied, though it was not as highly rated as the other work-related topics. In fact, only 18% of respondents strongly agreed that they were satisfied with the balance between work and personal time and 11% disagreed or strongly disagreed.

Table 51. Satisfaction with Work in IT

Topic	Mean
Overall, I am satisfied with my job	5.01
I am satisfied with the balance between my work time and my personal time	4.42
I feel supported by management in my work	4.72
I feel supported by co-workers in my work	4.98
I plan to remain working in IT	5.07

DISCUSSION

> *"There are many IT professionals who went through school before computers were a common item in the work place — these women are the mentors for the next generation of female IT professionals—their knowledge base and leadership needs to be harnessed so they have an avenue to contribute to bringing more girls into the field of science and technology."*
>
> *—Survey Respondent*

The nearly 1000 women working in IT who responded to this survey had a diverse set of experiences at school, at home, in college, and at work. They grew up with differing levels of opportunities for interacting with technology. Older women responding to the survey wrote about the absence of computers in their lives until they went to college or work. A large number of women chose "Not Applicable" in response to the questions asking them about their feelings on IT in middle school and high school, signifying that at that age, they did not know enough about the field or have enough experience or exposure in IT to make a decision. Almost 50% of the respondents first used a computer between the ages of 14 and 25. Their "IT" experiences when they were younger included an interest and experimentation with math and science, or opportunities to learn on early computers, *"While I had little IT exposure when I was younger, I had plenty of math exposure, excelled in it, and loved it. I received far more encouragement to pursue math from teachers than I ever did for computer science/IT."*

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. Often it was a teacher, instructor, or supervisor offering praise and pointing out that their skills, or comparing their own performance with peers.

Influential People and Experiences

It is notable how few experiences were a negative influence on the respondents' decisions to work in IT. The most frequently marked as a negative influence (strong or weak) was grades 6–12 coursework or education staff, including teachers and counselors. Family members, especially fathers, were repeatedly indicated as a strong support system and influence on the women's decisions to work in IT. When identifying the top three people in their lives who were most influential regarding their decision to enter IT, the respondents most frequently chose their father (37%), mother (29%), and a spouse/partner (24%). Similarly, in Turner, Bernt & Pecora's (2002) survey of women working in IT, respondents reported more encouragement than discouragement by people in their lives. Most commonly encouraging were fathers, high school teachers, close male friends, and mothers.

Almost 40% of respondents' fathers and 10% of their mothers held jobs in science, technology, engineering or math. Respondents wrote about being exposed to the technology being utilized at their parents' or another family member's workplace, or doing technology or science activities in their homes. They likely had a much better image of what work in IT looks like than those without these experiences. Additionally, many respondents had siblings that were "into computers" who they could learn from and develop a shared interest.

Parents also showed support and yielded influence in other ways. A number of respondents mentioned their families owning a computer very early—putting them at an advantage over the majority of their peers. Having a computer at home gave women the opportunity to spend time exploring and gaining confidence in their computer skills. A large number of women mentioned that they enjoyed playing computer games and experimenting with technology. Through these relaxed, self-instigated experiences, they most likely gained

skills and knowledge as well as confidence. Parents may have also been involved in getting their daughters involved in informal education opportunities that included IT activities, such as summer technology camps or after-school clubs. Fiscal support as well as offering words of encouragement are among the ways parents could have influenced their daughters and supported their decision to pursue IT work.

As the respondents got older, they indicated they had more friends who shared an interest in IT. Friends may have been influential by encouraging or supporting the respondents, by exposing them to aspects of IT, or by sharing an interest in IT that they supported together. Asked about the best experiences in informal education, a large number of respondents wrote about events and groups that brought people interested in IT, and often only the women, together. These meetings included networking opportunities, study groups, conferences, or groups of women in college computer science majors. With the lack of role models working in IT, especially for respondents who grew up when technology was not as prevalent and there were fewer technical workers, a group of similar minded friends or peers seemed to offer a support system and further areas of professional growth.

Not many of the women responding to the survey had experience with a role model or mentor. After high school, about a quarter of respondents had a role model, and 18% had a mentor. Those who did have a role model or mentor almost always received positive influence on their decision to enter IT. Forty-three percent of all respondents selected that role models or mentors had a strong positive influence and only 0.2% selected that they had a strong negative influence. It appears that the women without role models or mentors may have benefited from one, especially at earlier ages when they were starting to consider college studies and career opportunities. In the way that parents working in IT-related fields helped the women have a more accurate perception of work in IT, the skills needed, and who can do it, a mentor/role model might have been able to provide that influence. A number of women wrote about influential supervisors at work who may have acted as role models or mentors, encouraging them to take roles involving IT work and guiding them through the process.

K–12 Education

The amount of encouragement perceived from teachers at different levels was highest in the later education years, such as college, with the lowest amount of influence by middle school teachers and informal education instructors. Thirty-four percent of respondents took formal IT classes in high school, but 65% indicated they took more than the requisite number of science or math classes. Access to a computer at high school was the most

commonly shared IT activity of almost half of the respondents. Courses such as programming, even early programming using punch cards, were noted by many as most influential for their feelings of competency in IT.

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 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. This data may indicate that 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.

Education experiences provided many women with evidence that they were adept at IT skills. They knew they were skilled when they compared themselves to their peers, or were recognized by a teacher, an aptitude test, or class grades. Forty percent of respondents were involved in informal IT-related education programs, often computer summer camps, and 60% were involved with national youth organizations. Almost half of participants were members of the Girl Scouts of the USA, and a number of others were involved with internationally based Girl Scouts types of programs, *e.g.* Girl Guides. On a six point scale, the women indicated a mean of 4.4 when asked their level of agreement to the statement: My experiences in informal IT-related education impacted my decision to pursue a career in IT. Almost every woman who participated in informal IT education marked that the experience and the staff were positive influences on their decision to work in IT. Only 2% to 3% indicated them as negative (weak or strong) influences.

One survey question asked respondents to indicate the elements, thought to be promising practices for engaging girls in IT, that they experienced in their informal or formal IT education. Overall, the most frequently selected elements were hands-on experiences, 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. Slightly over half of survey respondents were in education programs with small group sizes.

The respondents also identified what they believed to be critical elements to a successful IT program. Most frequently, they 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. Hands-on experiences being so frequently regarded as critical relates to the women who wrote about gaining confidence through time spent "playing" or experimenting with a computer. Projects that involved a real life application or problem-solving were also valued, especially those that allowed them to help other people.

College Education/ Work Experiences

Thirty-five percent of the respondents majored in a non-IT related field while earning their undergraduate degrees. Of those in IT, the majority received Computer Science degrees. Sixty percent earned advanced college degrees, again, the most in Computer Science. Degrees were also frequently earned in Management Information Systems and Computer, Information Sciences, and Computer Engineering. After family members, male professors/instructors were most frequently selected as encouraging of decisions to enter IT work. A larger number of women indicated they were not first interested in working in IT until during undergraduate studies (31%), or after working in another field (19%), so their college and early work experiences were very significant. They had very positive undergraduate education experience, with 70% indicating it as a positive influence on their decision to enter IT.

Women who were able to have on-the-job experiences with IT considered them to be especially valuable. Many times they held a position with IT-related responsibilities during college, such as part-time or summer work, or internships. Others found their full-time positions shifting to require technical work, and received job training.

One highly motivating factor in deciding to work in IT for the women responding to this survey was the availability of jobs. The respondents were also motivated by the intellectual challenge of the field 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. They felt like they were good at the work and many described themselves as "self-motivated" at pursuing work in IT. "Other" responses included job flexibility, the nature of the work, such as problem-solving, and the influence of a supervisor. During college, respondents were most likely to have a positive image of those involved in IT work and a good understanding of the nature of work in IT.

Conclusion

The 937 women in this study offer glimpses into their early IT experiences, influences, and education. As a sample that voluntarily participated by responding to an online survey, we cannot generalize that their answers reflect those of the entire population of women working in IT. However, the large size of the sample and their diversity in job responsibilities, age, and type of organizations help to increase the reliability of their responses. 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.

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Appendix A: Survey

Survey of Women Working in IT

The K–12 Informal Education Hub of the National Center for Women & Information Technology (NCWIT), led by the Girl Scouts of the USA (GSUSA), is conducting a three-phase study to determine what experiences or factors influence females to pursue a career in information technology (IT). Study results will help guide efforts to increase the number of women entering IT fields. We would appreciate your help in disseminating the survey to as many technical women as possible. Please forward this email to other women you know working in IT.

For the purpose of this survey, information technology (IT) is defined as all forms of technology used to create, store, exchange and use information in all its forms; the design and use of computers and communications to improve the way we live, learn, work and play. Information technology careers are defined as technical and professional careers in the design, development, support and management of computers, hardware, software, multimedia, communications, business automation, and systems integration services.

Current work

1) What best describes your work? (Check all that apply):

- ❑ Artificial Intelligence
- ❑ CAD/CAM
- ❑ Communications/networking/ specialists/technicians
- ❑ Computer Science/Engineering
- ❑ Computer Service and Security
- ❑ Computer Systems
- ❑ Corporate Executive (e.g. Chief Information Officer/Chief Technology Officer)
- ❑ Database
- ❑ Education (IT-related)
- ❑ Graphic Design/Computer Graphics
- ❑ Hardware Developer
- ❑ Information Science
- ❑ Information Systems
- ❑ Information Technology
- ❑ Interactive media
- ❑ Internet and Internet Systems
- ❑ IT Security
- ❑ Logic and Algorithms
- ❑ Multimedia/video/gaming/ animation
- ❑ Network installation and management
- ❑ Programming
- ❑ Robotics
- ❑ Software Developer
- ❑ Software Architect
- ❑ Systems Engineer
- ❑ Systems analyst/ operator/administration
- ❑ Technical management
- ❑ Technical fellow
- ❑ Web design and development
- ❑ Other (please specify) _____

2) In what type of organization are you employed? (if more than one, please select your main position)

- ❍ Self-employed
- ❍ Education
- ❍ Government-employed
- ❍ For-profit business/corporation
- ❍ Not-for-profit
- ❍ Other (please specify) _____

3) What is the number of employees in your organization?

- ❍ 1 to 25
- ❍ 26–50
- ❍ 51–100
- ❍ 101–500
- ❍ 501–5,000
- ❍ 5,000 or more

4) Where is your workplace located? (Enter zip code) _____

5) How long have you been working in IT?

- ❍ 0–2 Years
- ❍ 3–4 Years
- ❍ 5–7 years
- ❍ 8–10 years
- ❍ 11–15 years
- ❍ 16–20 years
- ❍ More than 21 years

6) We are interested in learning about your non-IT related work. Please check all fields from the list below that you worked in and would classify as non-IT in *your* personal work experience. (Check all that apply):

- ❑ None
- ❑ Agriculture Food & Natural Resources
- ❑ Architecture and Construction
- ❑ Arts
- ❑ Business, Management & Administration
- ❑ Education and Training
- ❑ Finance
- ❑ Government and Public Administration
- ❑ Health Science
- ❑ Hospitality and Tourism
- ❑ Human Services
- ❑ Law, Public Safety, Corrections & Security
- ❑ Manufacturing
- ❑ Marketing & Sales
- ❑ Science, Engineering & Mathematics
- ❑ Transportation, Distribution & Logistics
- ❑ Other (please specify) _____

7) Please select the answer choice that best describes how you feel about your current work.

	Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree
Overall, I am satisfied with my job	❍	❍	❍	❍	❍	❍
I am satisfied with the balance between my work time and my personal time	❍	❍	❍	❍	❍	❍
I feel supported by management in my work	❍	❍	❍	❍	❍	❍
I feel supported by co-workers in my work	❍	❍	❍	❍	❍	❍
I plan to remain working in IT	❍	❍	❍	❍	❍	❍

Personal background

8) What year were you born?

- ❍ 1932
- ❍ 1933
- ❍ 1934
- ❍ 1935
- ❍ 1936
- ❍ 1937
- ❍ 1938
- ❍ 1939
- ❍ 1940
- ❍ 1941
- ❍ 1942
- ❍ 1943
- ❍ 1944
- ❍ 1945
- ❍ 1946
- ❍ 1947
- ❍ 1948
- ❍ 1949
- ❍ 1950
- ❍ 1951
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- ❍ 1978
- ❍ 1979
- ❍ 1980
- ❍ 1981
- ❍ 1982
- ❍ 1983
- ❍ 1984
- ❍ 1985
- ❍ 1986
- ❍ 1987
- ❍ 1988
- ❍ 1989
- ❍ 1990

9) In what country did you live for most of your childhood?

Country: _____

10) Was the area you lived for most of your childhood urban, rural or suburban?

- ❍ Urban
- ❍ Rural
- ❍ Suburban

11) What is your ethnicity?

- ❍ Caucasian/European American
- ❍ Black/African-American
- ❍ Asian
- ❍ Hawaiian or Pacific Islander
- ❍ Native American or Alaskan Native
- ❍ Multi-racial _____

12) Do you consider yourself Hispanic or Latina?

- ❍ Yes
- ❍ No

13) Did your mother or your father work in science, technology, engineering or math (STEM) when you were growing up? (Check all that apply):

- ❑ My mother worked in STEM
- ❑ My father worked in STEM
- ❑ Neither parent worked in STEM
- ❑ Don't know

K–12 experiences

14) At what age did you first use a computer?

- ❍ Before age 5
- ❍ Between 5–10
- ❍ 11–13
- ❍ 14–18
- ❍ 19–25
- ❍ 25 or older

15) Select the best response to indicate how you felt about IT when you were **in grades 6–8** (ages 11–13):

	Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree	Not applicable
I felt competent in my IT–related skills	❍	❍	❍	❍	❍	❍	❍
I had a positive image of those involved in IT	❍	❍	❍	❍	❍	❍	❍
I felt comfortable in IT environments	❍	❍	❍	❍	❍	❍	❍
I had a good understanding of the nature of work in IT	❍	❍	❍	❍	❍	❍	❍
I believed work in IT could solve social problems	❍	❍	❍	❍	❍	❍	❍
I believed people in IT did not have a lot of opportunity for social interaction	❍	❍	❍	❍	❍	❍	❍

16) Select the best response to indicate how you felt about IT when you were **in grades 9–12** (ages 14–18):

	Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree	Not applicable
I felt competent in my IT–related skills	❍	❍	❍	❍	❍	❍	❍
I had a positive image of those involved in IT	❍	❍	❍	❍	❍	❍	❍
I felt comfortable in IT environments	❍	❍	❍	❍	❍	❍	❍
I had a good understanding of the nature of work in IT	❍	❍	❍	❍	❍	❍	❍
I believed work in IT could solve social problems	❍	❍	❍	❍	❍	❍	❍
I believed people in IT did not have a lot of opportunity for social interaction	❍	❍	❍	❍	❍	❍	❍

17) Select the type(s) of IT experiences you have had and indicate whether they were during your elementary, middle and/or high school years (ages 5–18). If you did not experience any of the items, leave all boxes in that row unchecked. (Check all that apply):

	Elementary school years (ages 5–10)	Middle school years (ages 11–13)	High school years (ages 14–18)
Participated in informal IT-related programs (e.g. tech club, summer or after-school programs)	❑	❑	❑
Had a mentor in IT (personally known)	❑	❑	❑
Had a role model (a professional in the field)	❑	❑	❑
Support/Encouragement from a teacher	❑	❑	❑
Support/Encouragement from parents	❑	❑	❑
Friends interested in the subject	❑	❑	❑
Access to a computer at school	❑	❑	❑
Access to a computer at home	❑	❑	❑
Played computer games/video games	❑	❑	❑
Job Fair/Event that included IT	❑	❑	❑
Influenced by IT in the media/advertising	❑	❑	❑

18) If you participated in other IT activities during grades K–12, please specify the activity and your age.

_____

_____

_____

19) Did you take any formal IT classes in high school?

- ❍ I took formal IT classes in high school
- ❍ I took no formal IT classes in high school because they were not offered
- ❍ I chose not to take IT classes in high school

20) Did you take more than the requisite number of science or math classes to graduate high school?

- ❍ I took more than the requisite number
- ❍ I took no more than the requisite number

21) Did you attend any all-girl schools in grades K-12?

- ❍ Did not attend an all girls-school
- ❍ I attended an all-girls school for 1 year
- ❍ I attended an all-girls school for 2 years
- ❍ I attended an all-girls school for 3-5 years
- ❍ I attended an all-girls school for 6-8 years
- ❍ I attended an all-girls school for 9-13 years

22) Briefly, what most influenced how competent you felt in IT-related skills during grades 6–12 (ages 11–18)?

_____
_____
_____

23) What most influenced your image of IT work and those involved in IT during grades 6–12 (ages 11–18)?

_____
_____
_____

Post High School/Higher Education

24) What type(s) of IT experiences did you have during your post-high school or college years (age 18 until job entry)? (Check all that apply):

- ❑ Participated in informal IT-related programs (e.g. tech club or summer programs)
- ❑ Had a mentor in IT (provides personal guidance)
- ❑ Influence of a role model (a professional in the field)
- ❑ Support of a professor/instructor
- ❑ Support from parents
- ❑ Friends interested in the subject
- ❑ Access to a computer at school
- ❑ Owned a computer at home
- ❑ Played computer games/video games
- ❑ Job Fair/Event
- ❑ Influenced by IT in the media/advertising
- ❑ Other (please specify) _____

25) What is the highest level of education you have received?

- ❍ Middle School
- ❍ High school or G.E.D.
- ❍ Technical degree or vocational school
- ❍ Some college
- ❍ Undergraduate degree
- ❍ Some graduate work
- ❍ Master's Degree
- ❍ Some post Master's work
- ❍ Doctoral degree/Other Post-Master's degree

26) If applicable, in what field did you earn a Bachelor's degree?

- ❍ Did not receive a Bachelor's degree
- ❍ Computer and Information Sciences
- ❍ Computer Engineering
- ❍ Computer Graphics
- ❍ Computer Programming
- ❍ Computer Science
- ❍ Computer Software and Media Applications
- ❍ Computer Systems Analysis/Networking/Telecommunications
- ❍ Computer/Information Technology Administration and Management
- ❍ Data Modeling/Warehousing and Database Administration
- ❍ Digital Communication and Media/Multimedia
- ❍ Information Science/Studies
- ❍ Information Technology
- ❍ Management Information Systems and Services
- ❍ Mathematics
- ❍ System Administration/Administrator
- ❍ Web Page, Digital/Multimedia and Information Resources Design
- ❍ Web/Multimedia Management and Webmaster
- ❍ IT-related, Other (please specify) _____
- ❍ Non-IT related

27) If applicable, in what field did you earn a graduate (M.A., M.S., Ph.D) degree?

- ❍ Did not receive a graduate degree
- ❍ Computer and Information Sciences
- ❍ Computer Engineering
- ❍ Computer Graphics
- ❍ Computer Programming
- ❍ Computer Science
- ❍ Computer Software and Media Applications
- ❍ Computer Systems Analysis/Networking/Telecommunications
- ❍ Computer/Information Technology Administration and Management
- ❍ Data Modeling/Warehousing and Database Administration
- ❍ Digital Communication and Media/Multimedia
- ❍ Information Science/Studies
- ❍ Information Technology
- ❍ Management Information Systems and Services
- ❍ Mathematics.
- ❍ System Administration/Administrator
- ❍ Web Page, Digital/Multimedia and Information Resources Design
- ❍ Web/Multimedia Management and Webmaster
- ❍ IT-related, Other (please specify): _____
- ❍ Non-IT related

28) If applicable, did you feel supported by professors/instructors in IT-related college courses?

- ❍ Did not attend college IT-related courses
- ❍ Very supported
- ❍ Somewhat supported
- ❍ Not supported

29) If applicable, did you feel supported by peers in IT-related college courses?

- ❍ Did not attend college IT-related courses
- ❍ Very supported
- ❍ Somewhat supported
- ❍ Not supported

30) **Prior to working in IT**, please indicate how you felt about the field.

	Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree
I felt very competent in my IT-related skills	❍	❍	❍	❍	❍	❍
I had a positive image of those involved in IT	❍	❍	❍	❍	❍	❍
I had a good understanding of the nature of work in IT	❍	❍	❍	❍	❍	❍
I felt comfortable in IT environments	❍	❍	❍	❍	❍	❍
I believed work in IT could solve social problems	❍	❍	❍	❍	❍	❍
I believed people in IT did not have a lot of opportunity for social interaction	❍	❍	❍	❍	❍	❍

General influences

31) Please specify whether people in your life were encouraging, discouraging, or neither encouraging nor discouraging regarding your decision to work in IT. Select "Not Applicable" if any of the choices below were not present in your life.

	Discouraging	Neither Encouraging nor Discouraging	Encouraging	Not Applicable
Father	❍	❍	❍	❍
Mother	❍	❍	❍	❍
Other family members	❍	❍	❍	❍
Close female friend	❍	❍	❍	❍
Close male friend	❍	❍	❍	❍
Middle school teacher, female	❍	❍	❍	❍
Middle school teacher, male	❍	❍	❍	❍
High school teacher, female	❍	❍	❍	❍
High school teacher, male	❍	❍	❍	❍
Guidance or career counselor	❍	❍	❍	❍
Informal education instructor (including summer camp leader, troop leader, after-school instructor)	❍	❍	❍	❍
Female professor/instructor	❍	❍	❍	❍
Male professor/instructor	❍	❍	❍	❍
Mentor, female in IT career	❍	❍	❍	❍
Mentor, male in IT career	❍	❍	❍	❍
Role model: female in IT career	❍	❍	❍	❍
Role model: male in IT career	❍	❍	❍	❍
Spouse/partner	❍	❍	❍	❍
Other(s)	❍	❍	❍	❍

32) Which three people in your life would you identify as the most influential regarding your decision to pursue IT as a career? Select a **maximum of three.**

- ❑ Father
- ❑ Mother
- ❑ Other family members
- ❑ Close female friend
- ❑ Close male friend
- ❑ Middle school teacher, female
- ❑ Middle school teacher, male
- ❑ High school teacher, female
- ❑ High school teacher, male
- ❑ Guidance or career counselor
- ❑ Informal education instructor (including summer camp leader, troop leader, after-school instructor)
- ❑ Male professor
- ❑ Female professor
- ❑ Professional mentor, female
- ❑ Professional mentor, male
- ❑ Role model: female in IT career
- ❑ Role model: male in IT career
- ❑ Spouse/partner
- ❑ Other (please specify) _____

33) Indicate how much positive or negative influence the following factors were in your decision to obtain a position in IT. Select "Not Applicable" if any of the choices below were not present in your life.

	Strong Negative Influence	Weak Negative Influence	Weak Positive Influence	Strong Positive Influence	Not Applicable
Parents/family	❍	❍	❍	❍	❍
Friends/peers	❍	❍	❍	❍	❍
Grades 6–12 education coursework	❍	❍	❍	❍	❍
Grades 6–12 education staff (teachers, counselors)	❍	❍	❍	❍	❍
Informal education experiences (such as after-school or summer programs)	❍	❍	❍	❍	❍
Informal education staff (instructors, program leaders)	❍	❍	❍	❍	❍
Undergraduate education	❍	❍	❍	❍	❍
Graduate education	❍	❍	❍	❍	❍
Mentors/role models	❍	❍	❍	❍	❍

35) In your experience, what are the five most critical elements to successful IT-related programs or events? (Select a **total of 5** across all categories):

Staff:

- ❑ Program Director with strong leadership skills
- ❑ Engaging staff
- ❑ Female (as opposed to male) staff

Curriculum and Learning Activities:

- ❑ Relevant curriculum, tied to real-life issues
- ❑ Project-based learning opportunities (e.g. projects with real-world activities)
- ❑ Curriculum materials that appeal to girls
- ❑ A challenging content level
- ❑ Opportunities to use technology to be creative and explore
- ❑ Opportunities to use technology to communicate
- ❑ Hands-on experiences
- ❑ Opportunities to work together with other people

Learning Environment:

- ❑ Small group sizes
- ❑ Girls-only environments
- ❑ Frequent affirmation and verbal support from instructors
- ❑ Low student-to-staff ratio
- ❑ High-end, up-to-date equipment and resources

Additional elements:

- ❑ Contact with mentors in IT (personally known)
- ❑ Information on professionals in the field
- ❑ Career information
- ❑ Opportunities for participants to take a leadership role
- ❑ Community support
- ❑ Parent support
- ❑ Other: _____

36) At what point in your life were you first interested in working in IT?

- ❍ Elementary school (ages 5–10)
- ❍ Middle school (ages 11–13)
- ❍ High school (ages 14–18)
- ❍ While earning an undergraduate degree
- ❍ While earning an advanced degree
- ❍ When first entering the workforce
- ❍ After working in another field
- ❍ Other: _____

37) At what point in your life did you first develop a positive view of IT?

- ❍ Don't have a positive view of IT
- ❍ Elementary school (ages 5–10)
- ❍ Middle school (ages 11–13)
- ❍ High school (ages 14–18)
- ❍ While earning an undergraduate degree
- ❍ While earning an advanced degree
- ❍ When first entering the workforce
- ❍ After working in another field
- ❍ Other: _____

38) What were your top three motivations for choosing a position in IT? (Select a **maximum of three**):

- ❑ Availability of jobs
- ❑ Excitement of working in IT
- ❑ Genuine interest in field
- ❑ Intellectual challenge of the field
- ❑ Desire to contribute to society
- ❑ My abilities/skills in the field
- ❑ Encouragement from parents/family
- ❑ Encouragement from teacher/professor
- ❑ Encouragement from role model or mentor in the field
- ❑ Earning potential
- ❑ Positive experiences in IT, including non-formal programs
- ❑ Geographic location
- ❑ Other(s) (please specify) _____

Informal Education

Informal learning is any non-school education or enrichment opportunity, including after-school or summer programs, museum-based or community-center based programs or events, girls' clubs, one-day outreach events, etc.

39) How many different informal IT-related education programs did you participate in?

- ❍ 0
- ❍ 1
- ❍ 2
- ❍ 3–5
- ❍ 6–10
- ❍ 11 or more

40) Select the response that best describes how you felt about your informal education experiences.

	Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree
My experiences in informal IT-related education were positive	❍	❍	❍	❍	❍	❍
My experiences in informal IT-related education impacted my decision to pursue a career in IT	❍	❍	❍	❍	❍	❍

41) Briefly, what do you recall as your best experiences in informal IT-related education?

_____
_____
_____

What youth organizations did you participate in? (Check all that apply):

- ❑ Girl Scouts of the USA (including Daisy, Brownie, Junior, Cadet, Senior)
- ❑ Boys and Girls Club
- ❑ 4H
- ❑ Camp Fire
- ❑ Girls, Inc.
- ❑ Big Brother, Big Sister
- ❑ Police Activities League
- ❑ Religious youth groups
- ❑ FIRST Robotics/FIRST Lego League
- ❑ Other youth programs, Please specify:_____

Additional Comments:

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Appendix B: Respondent Country as a Youth

9) In what country did you live for most of your childhood?

Country	Number of Respondents	Percentage of Respondents
USA	708	75.6%
Australia	37	3.9%
Canada	26	2.8%
Great Britain	20	2.1%
China	17	1.8%
India	16	1.7%
(Not Answered)	12	1.3%
Russia	9	1.0%
France	8	0.8%
Germany	6	0.6%
Taiwan	6	0.6%
Denmark	6	0.6%
Ireland	5	0.5%
South Africa	4	0.4%
Spain	3	0.3%
New Zealand	3	0.3%
Italy	3	0.3%
Hong Kong	3	0.3%
Philippines	3	0.3%
Singapore	2	0.2%
Netherlands	2	0.2%
Malaysia	2	0.2%
Indonesia	2	0.2%
Venezuela	2	0.2%
Barbados	1	0.1%
Belgium	1	0.1%
Belize	1	0.1%
Brazil	1	0.1%
Bulgaria	1	0.1%
Costa Rica	1	0.1%
Iran	1	0.1%
Israel	1	0.1%
Jamaica	1	0.1%
Kenya	1	0.1%
Korea, South	1	0.1%
Greece	1	0.1%
Guam	1	0.1%
Guyana	1	0.1%
Democratic Republic of the Congo	1	0.1%
Saudi Arabia	1	0.1%
Sri Lanka	1	0.1%
Suriname	1	0.1%
Panama	1	0.1%
Poland	1	0.1%
Puerto Rico	1	0.1%
Macao	1	0.1%
Martinique	1	0.1%
Mexico	1	0.1%
Moldova	1	0.1%
Norway	1	0.1%
Romania	1	0.1%
Ukraine	1	0.1%
U.S. Minor Outlaying Islands	1	0.1%
Yugoslavia	1	0.1%
Vietnam	1	0.1%