Women in Technology

A REPORT OF THE CENTER FOR WOMEN AND WORK FOR THE COUNCIL ON GENDER PARITY IN LABOR AND EDUCATION

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Executive Summary

In a recent survey administered by Stack Overflow, a website popular among software developers, women were only seven percent of respondents.[i] This was a wake-up call to the industry that little is changing when it comes to recruiting and retaining women. Women make up fifteen percent or less of most undergraduate computing departments but make up slightly more, about 30 percent, of women in IT departments. These numbers have been stagnant since the high point of women's participation in computing in the early 1980's.

The declining number of women in computing troubles economists and workforce development experts for several reasons. The technology sector is growing at a faster rate than any other, even disrupting the structure of jobs across industries.[ii] Firms are hungry to recruit women technologists because they provide a valuable perspective they believe can help them to connect with female clientele. New Jersey, in particular, is poised to become a leader in cyber security due to its proximity to one of the largest financial services sectors in the nation.[iii] However, without engagement and increased participation by women in training programs, some experts believe we will not meet workforce demands.

For this study, conducted by the Center for Women and Work (CWW) and commissioned by the Gender Parity Council of New Jersey, we interviewed women in IT and Computer Science fields to identify what programs and resources were most effective for getting them the credentials they needed to succeed. CWW analyzed data from the American Community Survey, the National Center for Education Statistics, and data available from the New Jersey Department of Labor and Workforce Development to assess how women are doing in the technology sector.

Our findings suggest that women experience bias and a lack of family friendly policies. However, training emerged as a significant issue for women in the technology industry because they are more likely to enter the industry after pursuing a non-technology degree, and will likely need to upskill and reskill many times over the course of their career. In order to support women in New Jersey's technology industry, we recommend:

- Expanding non-traditional pathways in technology fields, especially apprenticeships that help women transition into a new career without extensive time out of the workforce for education and training.
- Increase Career and Technical Education (CTE) programs in technology related subjects to get women and underrepresented students engaged early on in their education. These programs offer pathways of study aligned with workforce needs and emphasize real and practical learning.
- Organize a comprehensive list of education and training programs in New Jersey. Our interviews showed that women were drawn to the technology field because they wanted to grow their careers in a high-demand sector. This could reduce confusion among those looking to upskill or utilize a training grant to re-enter the workforce and are a valuable resource to workers across sectors.

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Supporting Women in Technical Fields in New Jersey

In a recent survey administered by Stack Overflow, a website popular among software developers, women were only seven percent of respondents.[iv] This was a wake-up call to the industry that little is changing when it comes to recruiting and retaining women. Women make up fifteen percent or less of most undergraduate computing departments but make up slightly more, about 30 percent, of women in IT departments. These numbers have been stagnant since the high point of women's participation in computing in the early 1980's.

There are several theories for the rise and more recent decline of women in computing. During the early years of computing, programming was conceptualized as support work, and women were often encouraged to pick it up.[v] Additionally, during the 1980's government and large technology and telecommunications firms made free training widely available, easing the pathway into computing jobs.[vi] At this time, computing was just beginning as an academic discipline, but firms across many sectors needed computing professionals. This motivated them to flip workers with degrees from other disciplines, a factor that may also have eased women's entry to the field. Eventually, computing was professionalized and institutionalized into separate academic departments, a phenomenon that has been associated with isolating and marginalizing women.

The declining number of women in computing troubles economists and workforce development experts for several reasons. The technology sector is growing at a faster rate than any other, even disrupting the structure of jobs across industries.[vii] Firms are hungry to recruit women technologists because they provide a valuable perspective they believe can help them to connect with female clientele. New Jersey, in particular, is poised to become a leader in cyber security due to its proximity to one of the largest financial services sectors in the nation.[viii] However, without engagement and increased participation by women in training programs, some experts believe we will not meet workforce demands.

Most initiatives have focused on recruiting women or generating interest in computing concepts at the K-12 level. New Jersey offers students a wide array of enrichment and after school programs related to technology and computer science. The Research and Development Council of New Jersey recently launched a state-wide STEM Pathways initiative that aims to create engagement among students and parents in all things STEM.[ix] However, despite this focus on the K-12 pathway, these programs may not be sufficient to meet the growing demand and may not be addressing key points where women leave the technology pathway.

Only a few studies have focused on women who transitioned into technology careers without following the typical K-12 to college "pipeline." These few studies have shown that women can utilize employer-provided training, non-profit and for-profit training, certification programs, community colleges, and even free online materials to obtain employment in these fields. Despite numerous barriers, including work-life conflict and lack of awareness about careers in technology, many women in New Jersey, have found rewarding careers in Information Technology and Computer Science.

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to identify what programs and resources were most effective for getting them the credentials they needed to succeed. CWW analyzed data from the American Community Survey, the National Center for Education Statistics, and data available from the New Jersey Department of Labor and Workforce Development to assess how women are doing in the technology sector.

Current Research on Women in Computing

A great deal of research has been done on the dearth of women in computing, and yet, little has changed when it comes to the percentages of women in CS and IT.[x] Women have made significant gains in fields like biology, chemistry, and medicine, their numbers have not improved in computing and computer engineering. According to a recent review of the literature on women in computing and engineering assembled by the American Association of University Women, four major factors contribute to this phenomenon.[xi] First, as women and minority students with prior exposure to computing transition to college, negative stereotypes and other biases can push students into other majors. Second, women are also more likely than men to want to see the social significance of their major field of study, and stereotypes about computing can affect their perception. Third, women in IT majors and computing courses often feel like they are outsiders relative to their male peers which may discourage them. Finally, even when women successfully transition from postsecondary education or certificate programs to the computing workforce, they have a higher than average attrition rate in the first 3-5 years of their careers.[xii]

Non-profits and educational institutions are developing programs that target this issue. There are computing camps and after school clubs, and organizations like Girls Who Code that have created national cohorts of women in computing and matched them with corporate sponsors.[xiii] Even the Girl Scouts of America have added a programming badge. However, these programs have only been partially successful because they hinge on an assumption that if women are interested enough in computing, they will be carried through the pathway toward careers. Researchers have noted, however, that women are lost at multiple attrition points along the way, and interventions are needed at levels beyond the K-12 to address this problem.

Women in the Computing Workforce

Just as most interventions to bring women into the computing pipeline exists at the K-12 level, the majority of research on women in computer science also focuses on girls. Much less is known about women as they transition into the IT and CS workforce. Considerably fewer studies have focused on the experiences of women who follow a non-traditional pathway into the workforce.[xiv] These women often work full-time or part-time jobs while pursuing a degree and tend to be older than 25 when they begin college. Sometimes they might not obtain a formal degree until mid-career, but utilize short-term training, or certificate programs, as an entry point into the computing workforce.

If we work backwards, looking at the educational levels of professionals in the workforce, we can see that 29 percent of computing and IT professionals either have some college, a certificate, or an associate's degree. About 44 percent have a bachelor's degree, but only about half of computing professionals have a degree in mathematics, computing, or engineering.[xv] Most workforce development efforts in technology have assumed that if middle school aged children are properly mentored and exposed to computing related concepts while in school, they will be

more likely to be retained in a computing major in college. The percentage of workers without a bachelor's degrees suggests that women, as well as other underrepresented minorities, are not "lost" to the computing workforce if they do not pursue an undergraduate degree directly after high school.

This raises a number of questions. If so many in this workforce do not, at the least, begin their careers with formal schooling, how did they enter their careers? Do these workers rely on training supplied by their employer or do they learn mostly on-the-job? Can they able achieve the highest leadership levels in their companies without specialized undergraduate degrees in computing?

If women did not initially see themselves on the pathway to a technology career, what inspired them to pursue these opportunities later? Are women in different socioeconomic groups more likely to jump on the pathway than others? Are women finding success while working for their degrees on the job? What challenges and barriers do they face? Are they able to find the training and certifications they need to remain competitive? More importantly, what more can be done, from a policy perspective, to help more women take advantage of this nontraditional career pathway into IT and CS jobs?

Methodology

Addressing these questions requires qualitative data and a grounded theory approach. Grounded theory is an inductive and comparative methodology that provides systematic guidelines for gathering qualitative data.[xvi] Because little information exists about why women are drawn into technology careers and training programs after the undergraduate period, this method is applicable to learn more about the experience of women as they transition to a new field. Usually, when applying a grounded theory approach, the researcher stops collecting data when saturation is reached, or when subsequent interviews fail to yield any new themes.[xvii]

To find women in the IT and CS workforce in New Jersey, we advertised to community college students and alumni, industry networking groups, alumni of industry certificate programs, and for-profit and non-profit training programs. Our initial outreach in early 2018 yielded 34 volunteers to be interviewed. We were able to successfully schedule and complete interviews with fourteen women. We circulated our recruitment letter again in the summer of 28 and received 20 additional responses. These yielded another 10 successful interviews. Many of the respondents were unable to participate because of their work schedule and other time constraints. Interviews lasted about one hour on average and were conducted and recorded over the phone. Interviews were transcribed and coded for themes using NVivo Qualitative Analysis Version 11. These overarching themes comprise the basis for the major categories presented below. We have given the women in our study pseudonyms and removed the names of their schools or firms to protect their privacy.

Table 1: Interview Subjects Demographic Information		
Name	Age	Occupation
Cynthia	53	Assistant Vice President IT
Monica	47	IT Professional
Lilian	40	Systems Engineer Consultant
Lucille	38	Platform Architect
Stella	50	IT Specialist
Fiona	21	IT Specialist
Jane	33	Digital Media Manager
Stephanie	29	Consultant in User Experience
Lena	43	Unemployed, Web Developer
Cicely	18	Computing Science Student
Sandra	51	IT Specialist
Melanie	47	Senior Level Executive IT
Alicia	41	Consultant Data Management
Sasha	40	IT Professional
Divine	45	Technology Sales
Anna	35	Unemployed, Web Developer
Andrea	40	Training and Talent Development
Isabella	37	Tech Entrepreneur
Amelia	37	Software Developer
Charlotte	42	Technology Project Manager
Isla	52	Tech Entrepreneur
Olivia	51	Product Manager
Veronica	32	IT Professional
Emma	39	IT Professional

IT and CS by accident

Almost all of the women we interviewed (22 of 24) did not pursue computing-related degrees directly after high school. Some of the interviewees had been completely unaware that professional jobs in technology were available while others were aware but did not believe they were "good jobs." Respondents defined a "good job" in a variety of ways, but overall indicated that this work would not be exciting, fulfilling, or lucrative. These perceptions were true even among women with a very strong attraction to computing in high school and those who had hobbies like programming or robotics.

Educational theory associates strong feelings of competence, or self-efficacy, with student success in different majors.[xviii] Women have traditionally scored lower on math and computing self-efficacy compared to men, despite earning higher grades in these subjects.[xix] The women with whom we spoke in computing rarely expressed doubts about their abilities or competence as students or professionals, but did not identify with technology until they had exhausted other career paths. Some respondents initially took a few courses in community college and others obtained bachelor's degrees in the social sciences, business, and the humanities.

One woman describes immigrating to the United States and trying to get a sense of what career would help her to support herself.

I was from a different country and I'm just trying to find a way to, I guess survive and find a school that um, would be, um, you know, affordable. At the same time to find a subject to study or some kind of degree that would give me pay on a good scale, with a plan to find decent job. Basically what happened at the community college, I started working in that IT lab and that's when I got interested... and I found out that I was pretty good and one of the first of the things that I started with was programming. -Monica

Monica had the opportunity to try out programming in her college's IT department while she took ESL classes. It was through this early experience, outside of her formal education, where she realized that computing might be something she could do for a living.

Many of our interviewees described a similar process to Monica of discovering computing through an entry level job and then gradually pursuing educational opportunities. These included respondents using their entry level jobs to support themselves while they pursued certifications or a bachelor's degree. This was the case for Monica, who obtained her degree in six years by working shifts at night and going to school part-time during the day.

For the women aged 50 or older in our sample, all of whom came from blue-collar backgrounds, technology and computers did not play a role in their academic development. After initial encounters with technology in their workplaces, they were eager to pursue postsecondary courses and certificate programs to gain more knowledge. Cynthia went to work for a company in an administrative role immediately after high school but was invited to participate in a coding boot camp. She began taking computing-related courses in community college while she worked full-time and then her company stepped in to offer her in-house training.

They had a program that would allow their workers, they trained about 10 people, it was a three-month course and they trained them how to be programmers. So this is at the time there were big mainframes and the language, the programming language was Cobol. And so I applied as one of about 300 applicants and at the time I was going to community college while working full time and just starting to take a computer course and I thought, wow, this is, this is really cool...this computer thing. – Cynthia

Through employer encouragement and training, women were able to imagine themselves as having a future career in computer science or technology.

Imagining a computing future was difficult even for women with a strong prior interest in technology. Several had attempted some courses in community college or at a university but completed degrees in other subjects. A few others showed aptitude for a technology career in high school but had difficulty visualizing what their future would be like.

I was really like, I knew the state of the economy, I knew what was going on, but I really had no clue what jobs existed beyond the ones that I was exposed to. So like I knew my mom was a teacher so that didn't help because I was exposed to teachers all my life and you know, my dad did something ambiguous with computers, but like that, you know, obviously, you know, there are doctors, there are lawyers out there, but there, there are so many career paths that exist that you have no concept of it all and then you suddenly you are 18 and it's like, OK, go pick a major and then your [inaudible] and it's like, OK, now go figure out where you're going to do with the rest of your life. And that's, that's lofty without a ton of information, without having, without information. -Stephanie

Several women in our study were mentored by their parents in programming languages or assembled computers as a hobby when they were younger. However, despite having an intimate connection to technology before college, women in our sample did not move smoothly though the educational pipeline. A few respondents who decided to pursue a computing bachelor's while working full-time attribute their decision to a mentor or relative. Without these interventions they believe they would have graduated with degree in other fields. Lilian, for example, had always shown an aptitude for programming and her father worked in technology. Initially, she studied biology until her father urged her to switch.

My father was in it at the time, and I think he was kind of pushing me saying, "Hey, you know, you want to do something with math and sciences, and computers, they're going to need programs." It was, especially at that point, heading into like the year 2000, we had the whole the Y2k thing going on. So, I did that and, you know, I finished up at [name of school] as a computer science major and I did take a job right out of school as an applications programmer. -Lilian

Researchers have sought to understand why women may have strong inclinations and competencies in computing, but do not identify as computing professionals.[xx] Many of our subjects noted that they were simply unaware of all the opportunities and career paths that were available in technology and relied on information from friends and relatives to help guide them into these areas.

Curriculum

Several women in our sample attempted computer science or programming courses in college but found the courses discouraging or unappealing. Due to these unpleasant experiences, they pursued other majors that they found more engaging. These women, often conceptualized as "lost" to the computing pipeline, all eventually found their way into a technology related field. Some believed this put them at a disadvantage in relation to others with computing degrees. They wished they had known about the breadth of technology careers earlier in their education.

I did take computer science classes from time to time. But you know honestly, I was sort of dissuaded from it. I didn't want to be a programmer, but there are other ways to participate in technology. There's two kinds of scopes. There's people who do software development, maybe they program applications and they release those applications out as part of a team. But there's a whole other side of it. There's security and there's infrastructure which is the actual combining of systems and technology together. And I can tell you in my experience women are far less represented in the infrastructure side than they are on the software development side. I just happened to be on the infrastructure side so maybe you know my experience has been a bit skewed but back in college everything was focused on software development. -Lucille

Lucille's comments are indicative of the impression that many students get when they attempt computing courses. Courses that are too narrowly focused on programming at the beginning of the educational pathway can dissuade students who are still trying to determine if they want to make a commitment to the major. Lucille also felt pressure to finish a degree as soon as possible and felt uncomfortable taking a risk with computer science, even though her mother worked in a technology profession.

I didn't think I had much of a proclivity for it either but I do remember taking computer science 101. There were literally two women, me and my best friend, out of about 125 guys in the class. So it wasn't the best environment. And they didn't make it super approachable either. I didn't get into tech support until well into my junior year. And by that point I couldn't change my major. I wanted to graduate on time. So even if I wanted to do more with technology I really couldn't. My parents said I had four years to do so. But you know what I mean I don't think I seen a lot of folks in technology that don't have tech degrees. A lot of music majors log liberal arts programs. -Lucille

Lucille did not feel the need to obtain a formal degree in computing and knows many other professionals who did not follow a traditional pathway. Another woman, Stella, felt pressured to finish up with a degree as soon as possible because she could not balance her classes with all of the travel she was doing for work.

Yeah, I was in the university, in computer science, but I had just bought a house so I had to take care of my house, do home maintenance. I had a job where I was working internationally sometimes traveling at around the same timeframe, so it was very difficult to do it all and something had to give, you know, and so it just wound up being the class, because I didn't want to, you know, I didn't want to lose my job. I had a good job at least getting paid well without having the class. So I was failing at doing everything, all at once you know… -Stella

Stella explained that she had to start and stop her education several different times before she was able to graduate with a degree. When she finally obtained her non-computing related bachelors, she had found a school that offered more online courses with greater flexibility.

The information we received from our respondents suggests two important things can be done to help women in computing. The content of computer science courses should be changed to appeal to students who are less focused on programming and software development. Broadening the

content to include other technology concepts might help to attract students without prior interest in programming. Departments can also help women by bringing in guest speakers from industry to talk about the day to day reality in their jobs.

Two women in the group obtained information technology degrees from universities where their departments were embedded in journalism or business programs. One of these women happened to be the youngest in our sample, only one to two years out of an undergraduate program. She reported having a more engaging and inspiring experience in her early courses, an experience that provided her with an overview of the types of jobs and concepts in the technology sector.

It was a while ago. Um, but I think it kind of showed all the different ways you can use technology, especially in this day and age, like big data and the aggregation of all sorts of information that can be used for trade and business within technology. And from there you go on to take some other intro courses you can take them without having been accepted to the major yet because that was a long process. -Fiona

While many of the women in the sample took courses that they felt were too narrowly focused on programming and software development, Fiona was given a broader understanding of technology that helped her to envision how her interests might fit into the technology workforce. Without the experience that Fiona had, many of the women in our sample obtained a humanities or social science degree because they found these disciplines as less risky or easier to complete on their limited schedule. Many of the women were constrained by time and money to finish their degrees as fast as possible. This pressure was compounded for women who went to school part-time while earning and caring for their families.

Breadwinners

Despite missing their initial opportunity to obtain a technology degree, many of the women were pulled into the technology field because of the desire to be financially successful and independent. At the time of our interview, all but one of the women in our sample were satisfied with the salary they were earning in the technology sector and describe salary as a key reason they were drawn to and remained in this sector despite its many challenges. Some were drawn to technology from another field like economics or finance, fields known for their money-making potential, because they believed there were significantly better opportunities in technology.

Jane, for example, had always enjoyed programming and technology as a hobby and her father introduced her to the Basic computer language when she was high school age. While in college, she decided to pursue a degree in an artistic discipline but turned to her computing hobby when she could not earn enough money as an artist. At the time of our interview, Jane was married without children.

I pretty much did these three things all at the same time. I was in class, you know, doing my studies. I was also freelancing web design and over the summer I freelanced for a local company...doing some basic stuff. So yeah, since I think since it was all really happening at once, I, you know, I didn't really feel that kind of pressure. I got lucky, I will say I got, I think I really lucked out, like I happened to pick a hobby that as it turned out it was a lucrative business decision but that wasn't why I did it, you know, I did it because it was fun. -Jane

Jane described herself as a creative person that wanted to study the arts while she was in college. While she enjoyed programming as a hobby, she never intended for it to become her career. However, she continues to work in the field because of the flexibility and the good pay it offers.

Even Fiona, who was apprehensive entering an IT job directly out of college, felt proud that she was able to earn enough money to pay off student loans and to be independent. She said that she and her parents cried happily when she showed them her recent paycheck reflecting her recent promotion.

Nearly all of the interviewees are the primary earners in their household and were motivated by the need to provide for themselves and their families. Many of the women in the sample were proud of their breadwinner status. Stephanie identifies as a first generation American, and said her motivations reflected her father's values about making money.

Both my parents are immigrants. I'm first generation American and I think they both came here really poor. They were really focused on that whole capitalist American dream. And as a result, my dad really instilled in me this like, you know, make money, be successful, go figure out what your dream is and go get it. And, you know, money's the secret to that. So, from that standpoint, I think that what he instilled in me with that kind of direction, he pushed me into technology because it became like the cool and profitable thing to do, um, but that, that part I think was kind of by chance…the fact that it was technology and not finance. And that's why I went into economics and like you said, male dominated major. But my goal was just be rich and, you know, work hard and make a lot of money and somehow it turned out that I'm a technology consultant, but that's OK. I'm happy with where I am, way happier than I would have been in finance. – Stephanie

Cynthia describes her blue-collar parents and their values regarding money, which she believes contributed to her being drawn to a non-traditional profession for women.

My father taught me how to invest and I'm not to saying that, you know, I'm well off or anything else, it's just that that's what you did. There wasn't sort of this you break out and go see the world and go travel. And, and I've since done that and I've learned a lot, but, um, but yeah, it was this sort of blue collar.

This sentiment is mirrored by many of the other women in the sample that wanting a financially stable career, driven by the need to be independent led them to work in the technology sector. Women in the sample that were single mothers or had struggled with single parenthood at some point during their career, were thankful that their technology skills made them highly employable.

Constantly training

All of the women in our sample described needing to continually train and retrain to keep their skills up to date. Many cited this as a key factor for vetting employment opportunities as they prefer employers who provide lots of financial assistance for certifications and trainings.

However, the need to constantly re-skill or upskill can be draining and taxing, especially when they had work-life conflicts.

Stella, an IT professional, described being recently laid off from the firm that employed her for many years. Many of the women we spoke to had been personally affected by off-shoring and lay-offs, some at multiple points in their careers. Stella became concerned that she was not finding employment fast enough to take care of her mortgage and her family and sought out state-sponsored training opportunities while collecting unemployment. A New Jersey One Stop Career Center helped her to get training in information security. She also took advantage of free online resources to keep her skills up to date.

Olivia, a product manager that experienced a brief period of unemployment also took advantage of New Jersey's One Stop system for training. However, she did not utilize her training grant because the courses were not specialized enough in the particular coding and data management platforms she needed to learn. She found a tech "bootcamp" to be more relevant to her needs.

Four of the women we interviewed sought out training programs on their own because they were disappointed with the opportunity for advancement in their careers. Lena became interested in becoming a web developer when her company began threatening workers who had the most experience with constant lay-offs. Lena's job involved the company's supply chain so she became comfortable working with databases and data in excel and thought a career in technology would suit her.

So I've become really proficient in building my own excel tools. I'm cleaning data, I'm making my own databases. In my last job I was the one who discovered, um, you know, that there were bad joins in our sequel database that stemmed from that table architecture in our database. So, um, I've always had like a really technical piece of my job but technical relative to retail. So I've always been the go-to person for reporting tools and data tools and the go to person for um, you know, any new systems. I've launched product lifecycle management software within the companies that I've worked for. So I've done a lot of project management and a lot of sort of technical liaising with developers. So because I, I found myself liking that more and more, I'm at work when it became apparent that, you know, my experience wasn't valued, that they weren't going to continue to do layoffs. -Lena

Lena decided to enroll in a for-profit coding boot camp on web-development. The course came at a significant expense, but she had done her research and decided that it would be worth it if it helped her to break into a new well-paying career. However, upon graduation she struggled to find a "junior" level job. She felt that the for-profit boot camp had not done enough to assist her with finding fulltime employment.

*Umm also that, when you come into the program, what they don't tell you is that yes, there are a number of, there's a glut of tech jobs out there and there are not enough people to fill them. Not enough **good** people to fill them. What they don't tell you is that very, very few of those jobs are actually junior level jobs. So I have people who are much more capable than I am, who are much smarter than I am, who still don't have jobs. And these are people that I thought would already have jobs. I knew I wasn't going to - I knew I wasn't going to be in the first batch of people to get*

jobs because I am not that good, quite frankly, at this point in my programming career. But there are people who have been doing it for years and are far more knowledgeable than I am. Um, and who were able to build really beautiful things right out of the box for our first few projects and then really knocked it out of the park for their last project who still don't have jobs because the junior level jobs are not there. -Lena

Lena was disappointed when she discovered that, despite the significant cost to attend this full-time boot camp, she struggled to obtain full-time employment. Another interviewee from a boot camp, Alicia, came from a career in public service and relied on a non-profit specializing in workforce development to help her choose an appropriate technology training program. Seeing the intersection of technology and education in a newly emerging field, called EdTech, Alicia decided that she would pursue a full-time training program. The non-profit assisted her before and after the program to ensure she would be able to handle the program's fast pace and continued to provide job placement services upon graduation. The non-profit even provided Alicia with a scholarship that covered nearly all of the tuition. Alicia was not employed full-time at the time of our interview, but she was hopeful that she would be able to find something soon.

When comparing Alicia and Lena, it is clear that the full-time technology boot camps may not be the best solution for women who would like to change careers. The women described their experience in the classroom, 10 hours a day for 12 weeks, as a "struggle to stay afloat" or that they often felt like they were "drowning" in the course material. They both believed their participation would have been impossible if they had children or other family demands. However, Alicia felt positively about her experience because she had support from the non-profit and believed that they were setting her up for success. Lena, on the other hand, felt like it was completely up to her, despite the large financial investment, to find career opportunities.

Work-Life Balance

While the constant need for training in the technology sector caused significant work-life conflict for many of the women, others cited the lack of work-life policies available within their company. Women mentioned needing to identify strategic roles or consulting roles to be able to step back and take care of their children. The "breadwinner" women in our sample relied on supportive spouses or extended family to try and make their careers work.

…my commute to work is eighty-four miles each way... but I do that about three days a week, except this week was four days. Um, and it takes about two and a half hours each way. So, I have a great support system. My husband works from home. When my granddaughter lived with us, he took over most of the responsibilities for caring for her and making sure that, um, you know, she was, she was fed, she was at school, homework was done. He really did most of that work. So, I'm grateful that I have the support system I have. I don't think I could do everything that I want to do without having that support system. – Cynthia

Another woman, Lillian, told us that after she reached a high level of leadership within her organization, she became very discouraged by what she felt was the industry's perspective on work-life balance. Lilian received a bachelor's degree in computer engineering and was given the opportunity, through a partnership between her firm and a major university, to obtain a Master's degree in Computer Science. Despite the significant investment that was made to

develop her for an advanced leadership role, she felt she had to step away because she could not find a way to juggle the needs of her children. The experience left her questioning whether other women should invest their potential in an industry that she believed did not support her.

You know, and I, I'm going to say actually that's one of my issues with (computer) engineering um, I have a young daughter and it's not something I would, I would consider pushing her towards because I feel like they're still very set in the old school ways and any ideas of telecommuting, flex scheduling, job sharing part time. It's just not, I'm just not considered. I think when you're in engineering or IT, you're expected to put in long hours and travel, things like that. And it's very difficult for women to maintain that work-life balance between trying to have a family and also maintaining that. So I think that's why it's very, very difficult field for women. -Lillian

When asked why she believed it was worse in computing than in other fields, she added that she believed the men she worked with had come from a background where women were full-time homemakers.

…that work life balance and having, you know, having a family, it's just very um, it's very, very hard and when you work with men who don't understand it and maybe their wives were stay at home moms so they never had to worry about who was picking up the kids at the bus, or you know, who was taking them to the doctor's appointment because it was all kind of done for them. -Lilian

Work-life balance is an issue that plagues women in a variety of industries. When the percentage of women entering the field is so low, it has the potential to significantly affect the pipeline. Women in engineering and computer science are more likely to leave their careers when they are only 3-5 years into the workforce. Additionally, many of the women we spoke to were financially responsible for their children, grandchildren, and households and were drawn to the field because they wanted to earn a better living. Some women were able to pivot to firms with better support policies but others feared challenging the status quo because these jobs provide their household's sole income.

Bias and stereotyping
Many women in the sample described dealing with an almost daily reminder that they remain a minority within their field. They mentioned throughout their interviews, with a few exceptions, that they were one of only a few women in their educational pathway and again a minority in the workplace. With so few women in the organization they discussed losing important female mentors and male advocates during periods of downsizing and layoffs. Some were concerned that many of the female leaders in their firms are not being replaced.

Women in the study complained about having to explain to clients and colleagues that they were qualified to provide IT support and were frequently greeted with disbelief when they introduced themselves as computing professionals. Monica was so disheartened by her experience with bias in the industry that she advocated for women to do something else.

Um, I had to be better and faster than men. OK. Normally I would be questioned like twice or three times or four times, you know, about a solution that I was proposing, which was valid, which was more efficient and better than all the solutions were being proposed by the guys, but I was the one being put on the... on the spot to explain why and why and expected, to pretty much keep a whole head full of IT knowledge. And it's like, really? And I started getting a really bad attitude. -Monica

However, after a recent takeover of her company, she has seen a change in the climate toward her as a woman.

One of the things I do have more flexibility... I have made some new proposals and changes, um, that um, or actually I didn't have to explain myself four times and nobody puts me on the spot. And they were like, oh ok... maybe we can hop on that and maybe that's an opportunity. Um, you know, so I think they're looking at me right now, like different. Um, but again, this is a different company now. This is recent takeover. So we'll see where it takes me, where this whole thing, um, for, for me, for me it was definitely a, change for, for a little bit. -Monica

Many of the women in our study felt particularly isolated when they attended industry networking events or company-wide social events. They either felt like they could not get the benefits of these mentoring events because their work-life situation prevented them from participating, or they described their male colleagues feeling uncomfortable socializing with them.

So usually when I talk to the sales guys they would just overlook me, you know, and there are times when I would take my husband to those events, you know, so you go and try to introduce yourself and they actually talked to my husband, not to me... and I'm like, I'm really like, seriously? I'm the person you should be talking to not my husband, you know. So there's that. I've run into a lot of that or they're totally, totally overlooking you that you might be good at your job, might even know what you're talking about. Um, yeah, that's why I found out that I have to be faster and better and um, yeah, and louder. - Monica

So I think the challenge though was I relate very well to the men that were there, but I wasn't one of the guys and I wasn't part of the group. And I think that's the interesting, as I see this, it's, that's the interesting thing that I find in a lot of IT organizations or technology where, where I've always been is that I relate well to others. I get along. I'm well respected, uh, but I'm not, you're not part of that male group. And you feel separate from that group itself. Like I always got along with the guys and you know, we went out drinks and all the other stuff. It was very intense and we all helped each other. But there was a connection that made you feel like you were on the outside a little bit, like you just weren't part of the team. They almost didn't... like they didn't know what to do with the girl in the group. -Cynthia

Sandra described actively downplaying her role as mother at work because she fears it will influence her coworkers' and manager's perceptions of her. She describes wanting to be seen as an "IT professional" and, as other research as documented, often women are perceived as less competent and professional when they are known to be mothers.

And, and it's really scary and it's, it's not just it, it's, it's everywhere. It's especially if you have any kids or family complications. I try to really like, like plan and not bring family into the picture at work. Don't talk about them. I don't do anything like that because for some reason I just want to be seen for just an IT professional. And that's it. You know, I don't want to be seen for a, she's a woman and yes her kid is sick, you know, that type of thing. You have a lot of family responsibilities. - Sandra

Melanie also describes having to struggle to prove herself as a woman who was also an IT professional. She believed being a woman made people doubt her knowledge and expertise. Like other women, she felt pressured to ensure that they were not drawing attention to themselves as different.

It was a boy's club…You are often the only female in your team. Sometimes you're one of only a handful in the whole organization. When they saw you and you walked into a meeting, um, based on the way that you look, nobody assumed that you were in IT. So you had to do a little bit more, you know, proving that you have the, uh, the skills and the expertise that, that went on for years. -Melanie

Stephanie expressed concern that as she moves up to a leadership position where there are fewer women, there is more pressure on her to perform well so that more junior women will have an opportunity.

I don't feel like the company is doing a ton of support in some of our more junior women. But you know, now I'm almost feeling like I'm feeling a slight sensitivity to it. Like, am I becoming like the token example or know somebody who can rise up kind of quickly and maybe that's just me being a little crazy. - Stephanie

Rethinking the pipeline

Our interviews with women employed in computing occupations or recently having graduated from computing related training programs paint a different picture of women's aspirations for this sector. While conventional wisdom suggests that women are not interested in computing degrees and occupations, our interviews provided new insights about why women do not make it onto a traditional computing pathway. Under pressure to finish their degrees quickly, women may not want to risk taking computer science courses if they feel they are not adequately prepared. They may also feel isolated as one of the few women in their courses or simply be unaware of the wide range of opportunities available in the field.

Without adequate mentoring about the variety of careers in technology, women may feel uneasy about committing to an expensive degree. Most of our interviewees believed that if they had known about all of the different opportunities in healthcare IT and user-design, they would have been more confident about committing the time and energy to a computer science or information technology degree.

The technology sector faces a paradox when it comes to the women who are drawn to these high paying and fast-growing jobs. These women are often the major financial providers in their

households, but are being held back by the lack of work-life balance policies their firms offer. Respondents we spoke with from the computing side of healthcare or business expressed less work-life conflict than peers that worked in pure IT consulting firms. This may be because the latter are more male dominated and have fewer polices that support work-life balance.

What can be done?

What do the experiences of New Jersey's women in technology tell us about increasing the technology pipeline?

- Women who have degrees in other fields are not "lost" to the technology sector. Companies with a commitment to diversity and inclusion can offer potential employees or employees from other divisions the opportunity to try out an IT role. If these workers turn out to have the aptitude, employers can offer women boot camps or training programs to get them up to speed.
- Women in technology occupations are hungry for opportunities to "upskill," but they have difficulty balancing training programs with family responsibilities. Women prefer online programs, and for some, an associate's degree would be a more realistic course of study than committing to an undergraduate degree. If women are caught up in a cycle of downsizing, they may need access to childcare in order to devote themselves to a full-time training program.
- Technology careers can have a bad image but exposing women who are unsure of their career path to other professional women in technology can help to influence their decision.
- Showing women a variety of technology jobs and roles can help them make better decisions about whether a technology career is right for them. For example, most people might think they know what a programmer or developer does, but they might not be aware of opportunities in Health Informatics, as a User Experience Designer, in Cybersecurity, Quality Assurance, Data Modeling, or E-Commerce.
- Bias takes a toll on the commitment women have to their employers. Being a minority in the field creates pressure that is exacerbated when women's expertise is constantly questioned. Employers can mandate implicit bias training and offer sound diversity and inclusion practices to combat these stereotypes.
- Introductory courses should show students a range of concepts in technology before focusing on programming.
- Educate parents about professional careers in technology so they can help guide their daughter's choices.

Best Practices

The Center for Women and Work reviewed current research on high impact practices for women in computing and technology in both NJ and in other states. In addition, we asked our survey respondents about programs they had utilized or found supportive for pursuing their goals.

Increase Access and Awareness

- Career and Technical Education (CTE) is key to recruiting women and underrepresented minorities into IT and CS. CTE provides training that translates directly to careers and can be offered as early as high school. CTE, unlike other forms of education, emphasizes credentials that have been validated by local industry. Therefore, these programs are

often lead by industry professionals that can provide students, in high school and college, with insight into what computing jobs look like. These programs usually offer credits that can be applied to further study. Career and technical education can provide many women in our study with the information about careers and opportunities earlier on in their educational pathway.

- Public Private Partnerships – several programs utilize public private partnerships to develop computing talent. Usually these firms have developed industry valued certifications that can be delivered through a partnership with a public entity, such as a high school, CTE program, or a state's workforce development board. These partnerships actively recruit participants and offer jobs to those who complete the program. Programs like these are typically low cost, or are heavily subsidized through state training grants, because they serve low-income populations.
- Girls Who Code – works with young women in select regions to promote coding and mentoring at large corporations. Students are supported after the program with mentoring and meet-ups. This program is relatively new, so we don't know whether or not the graduates will remain in the computing workforce, but we do know that these women are persisting to college majors in computing.
- Latinas in STEM – is a nationwide program that works to inspire Latina parents and children about future careers in STEM. Enrichment programs target K-12 girls but also educate parents about the opportunities and importance of computing careers. Latinas are the most underrepresented group in computing, and this program helps to connect young women with role models and mentors that they can relate to.
- Per Scholas – is a non-profit with satellite programs around the country that support underrepresented students' entry and graduation from technology training programs. Students train with a cohort of their peers on soft skills with some technical training before they enter a web development program administered by an external entity. Upon graduation, students are assisted with placement into the technology workforce. Right now, Per Scholas operates in the Bronx, Atlanta, Columbus, Cincinnati, DC, and Dallas. They are working on developing a program in Newark, NJ. They graduate nearly 500 students per year.

Supporting women when they enroll in Tech programs

Single mothers and partnered women in our sample said that it was challenging to enroll in a full-time traditional degree program. They needed to work to support their families and struggled to balance long commutes to degree programs after work and during the weekends. Those that participated in full-time boot camps did so while unemployed and while having strong support from family or spouses. Many lauded the increasing availability of part-time programs and online programs that give them more flexibility while working and caring for children. This was especially salient for the women in our sample that were single-head of household.

While there are many computer science programs at the community college level in New Jersey, only one institution, Ocean County Community College, offers an online computer science associate's degree. This means that for many of the women looking for an instructional program online, they must first be admitted to a Bachelor's degree program at one of the state's three universities. In light of the experience of our interview respondents, women may find an easier entry point at the associates or certificate level. Even many of the state's for-profit technology programs only offer instruction in person.

Researchers have noted that most women and minorities in the United States receive advanced degrees in computer science from for profit institutions because their admissions processes and convenient online schedule are more conducive to balancing work and life. According to the Taulbee Survey, an annual survey of women and minorities in computing, the vast majority of degrees were awarded by the University of Phoenix, an online for-profit. This speaks to the need for flexibility and distance learning opportunities for women entering this field.[xxi]

Make introductory courses engaging

It is clear from the narratives of our participants that women are turned off by university courses in computer science. Even women in our sample that enrolled in full-time university programs found these courses discouraging at the worst, and unengaging at best.

- Harvey Mudd College (HMC) is a science and engineering focused liberal arts college with just under 800 students located in California. Unlike most undergraduate institutions, HMC requires that all first-year students take an introductory computer science course that presents the breadth of the computer science field in addition to the basics of programming. Women are offered research experiences in computer science right after their first year so they can get a feel for computing jobs. They also send women to the Grace Hopper Celebration for Women in Computing where women from all over the world interact with other women and the technology industry. Through these initiatives, the college was able to increase the percentage of women from 12 percent to 40 percent over a three-year period.
- The Douglass-DIMACS Computer Science Living Learning Community for Women at Rutgers University was implemented two years ago to recruit and retain women in computing. First and second year women live together in an all-female residence hall and meet regularly with a graduate mentor in residence. In addition, the women in the learning community participate in a special course that provides them with a broad overview of all of the opportunities and applications of computing concepts.

Employers can help to change the perception of computing jobs

- Work-life balance – technology jobs cross a number of different industry sectors and some sectors are doing better with work-life balance than others. Women in our sample that worked for the federal government or for companies that had a sole technology or software development focus struggled the most with work-life balance. Our interviewees from smaller technology consulting firms, healthcare IT, and firms where technology was not the core mission of the company indicated that their firms were more supportive of flexible work arrangements and the need to balance time with children. Yet, even within the firms with better official policies, women sometimes had to overcome a gatekeeper in their own department that could negatively impact their workload or performance evaluations.
- Implicit Bias – many studies have noted a gender bias among men who work in technology to favor traditional gender roles.[xxii] Implicit bias training can help workers to unlearn these implicit associations that affect colleagues' perceptions of their female peers.

Policy Recommendations

Apprenticeships that target women: Apprenticeship programs offer workers a career path featuring paid-on-the-job training, skills development, and mentorship, while meeting the needs of employers. The apprenticeship model holds significant advantages for women by helping them transition into a new career without extensive time out of the workforce for education and training. Participants earn wages from employers during the training, and get a "hands on" sense of the work without having to enroll in a full degree program. At this time, apprenticeships are not well utilized in the technology industry, but some successful models have been implemented in other states. Washington's successful technology apprenticeship pilot program has recently spread to neighboring states. Participants currently work in jobs at Amazon, Microsoft, Avvo, Comtech, F5 Networks and Silicon Mechanics. Those who have completed the program work in roles like web developer, software developer, network security administrator and others.

The building trades have the most expertise in apprenticeship programs and have successfully implemented pre-apprenticeship and apprenticeship cohort programs targeted to women. New Jersey is home to the Northeast Regional Council of Carpenters' (NRCC) Sisters in the Brotherhood program that offers training to women to enter the trades through women-only cohort programs. These programs offer mentoring and role models along with training to help women overcome barriers in non-traditional fields.

Database of Technology Programs and Trainings: Our interviews showed that women were drawn to the technology field because they wanted to grow their careers in a high-demand sector. However, they faced barriers when it came to identifying training opportunities and programs. Even women with well-established technology careers faced brief stints of unemployment where training was key to getting back on the career pathway. If resources were organized by field in a central location, it could reduce confusion among those looking to upskill or utilize a training grant to re-enter the workforce. Additionally, technology trainings are a valuable resource to workers across sectors and having a comprehensive list would benefit workers beyond those within the technology industry.

Career and Technical Education (CTE): Career and Technical Education programs offer pathways of study aligned with workforce needs that can get students into a technology career before they even graduate high school. These programs emphasize real and practical learning that can help students make connections between computing curriculum, like programming or networking, and a fulfilling future career. The women we interviewed were unaware of the breadth of careers in technology and therefore did not see the value of pursuing a computer science or information technology degree. CTE is a pathway that introduces young people to in demand careers and can expand awareness of jobs that may not yet be on the radar of young women.

New Jersey has an Office of Career Readiness that provides leadership to advance CTE programs and to ensure that women and men are enrolling in equal numbers. Young women, especially women of color, need more information about how CTE can help them to achieve their career goals.

[i] https://insights.stackoverflow.com/survey/2018/

[ii] https://www.mckinsey.com/global-themes/employment-and-growth/technology-jobs-and-the-future-of-work

[iii] https://www.insidernj.com/wp-content/uploads/2017/07/Re-seeding-the-Garden-State-1.pdf

[iv] https://insights.stackoverflow.com/survey/2018/

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[vii] https://www.mckinsey.com/global-themes/employment-and-growth/technology-jobs-and-the-future-of-work

[viii] https://www.insidernj.com/wp-content/uploads/2017/07/Re-seeding-the-Garden-State-1.pdf

[ix] https://njstempathways.org/

[x] The AAUW has summarized this literature in their report, Solving the Equation.

[xi] https://www.aauw.org/research/solving-the-equation/

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[xiii] https://girlswhocode.com/

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[xv] ibid

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[xxi] https://cra.org/resources/taulbee-survey/

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