

## **Women in Computer Science**

By: Melany R. Díaz

Advisor:

Dr. Alyce Brady Ph. D.  
Kalamazoo College  
Computer Science

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# 1 Preface

"I had no idea that this was happening around me," he said, as we walked out of a Minorities in Computer Science lecture. "Is there any possible way that I could help? Anything I could do?" He looked at me expectantly.

Was he expecting me to know the answer because I was a Latina woman in Computer Science? I couldn't answer him. Mostly because I didn't know that was happening around me (and to me) either. But the farther away we walked from that conference, the more I started to recognize how the topics mentioned at the lecture showed themselves in my life. All of the anecdotes of professional women and people of color driven away from their careers slowly but constantly began to resonate familiarly with some of the experiences I had already had, only shortly after declaring my major in Computer Science. I couldn't say that the feelings of isolation and inadequacy were on the verge of making me quit my studies, the way that they had forced the professionals in the lecture to leave their careers. The impostor syndromes<sup>1</sup> mentioned at the lecture hadn't yet fostered such impactful forces into my small experience in Computer Science. But they were beginning to show up enough for me to consider exploring a different major.

I remind myself often of how lucky I was to attend that lecture so early on in my Computer Science career. To learn that there were external factors that had forced people that looked like me to quit their careers in computing science, simply because of how they identified. Early on, I decided to stubbornly stay, to give a different face to the discipline, and grew a passion for computing along the way.

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<sup>1</sup>Impostor Syndromes are the collection of feelings of inadequacy that persist even in face of information that indicates that the opposite is true. This condition is often used to describe one of the adversities faced by minorities in Computer Science, typically women, people of color, and people with disabilities.

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I was in no way expected to educate my peer on what he could do to help and aide minorities in computing. We had a pleasant conversation on the topic and moved on. But his question remained in my unconsciousness, what *could* be done?

When the idea for this SIP was born, I had dreamed of writing about diversifying the computing field *in general*. Not just specifying the topic to gender. Because of the sheer size of that topic, I quickly realized I had to narrow my topic down, thus this new topic developed. It is very important for me to note, however, that though this paper focuses on eradicating the gender gap in Computer Science and the diversification of the field in terms of gender, this review is written with the understanding that oppressive constructs (racism, sexism, homophobia, transphobia, ableism, xenophobia, classism, etc.) are interconnected and cannot be examined separately from one another. I would also like to mention that due to a lack of preceding research and available data, a lot of the statistics and demographics illustrated in this report tend to conform to the gender binary, or the classification of sex and gender into two distinct, opposite and disconnected forms of masculine and feminine. Though the finalized paper does not reflect this as much as I had hoped, this report was written with the understanding that in order to fully diversify the field, one cannot simply focus on attracting and retaining more women, but rather rewrite the image of the Computer Science industry to reflect a greater diversity.

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## **1.1 Acknowledgements**

I would like to thank all of the people who have helped and supported me during this process.

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## **1.2 Abstract**

Women have played a crucial role in the evolution of computing, dating as far back as the development of programming in the 1800s. Yet even with this strong historical influence, and the fact that women benefit as equally as men from the services of technology, they are not a strong presence in the developing, designing, and creating teams behind the products. This report will explore some of the influences that discourage women to engage in computing careers and education, offer three proven solutions to these disparities, and describe the implementation and results of these three solutions across different platforms.

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## 2 Research

*“Twenty years ago, a girl could be a secretary, school teacher, a social worker, or a nurse. If she was really ambitious, she could go into the profession and compete with men... usually working harder and longer to earn less pay for the same job. Now come the big, dazzling computers- and a whole new kind of work for women: programming. Telling the miracle machines what to do and how to do it. Anything from predicting the weather to sending out billing notices from the local department store. And if it doesn’t sound like a woman’s work- well, it just is.”*

*-Cosmopolitan Magazine, 1967 [1]*

48 years ago, Cosmopolitan Magazine printed an article advertising for a new and lucrative field for women: Computer Science. The article boasted the high pay grade of the new field, claiming that “a girl senior systems analyst could earn \$20,000 a year – and up!” Considering that in 1967, the average household earned between \$10,000-\$14,999 yearly[2], who wouldn’t be tempted to explore such a high-paying new field? Programming and Computer Science were new to the game, and with strong historical predecessors like Grace Hopper, Betty Holberton, and the early human computers and calculators (another primarily female job) it was natural for these new jobs to be targeting a more feminine audience.<sup>2</sup>

Back to the twenty first century, the Glassdoor<sup>3</sup> List of 25 Best Jobs in America for 2016 shows an impressive majority of employment leaning towards the technologies and science[3]. The list is composed by combining three key factor: number of job openings, salaries, and career opportunities. What started off as a profitable career where an individual could grow and find further opportunities to improve and move up has consistently grown towards an even more profitable (now offering wages of up to \$120,000 or more) and encouraging employment. As the Glassdoor list implies, it

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<sup>2</sup>The Cosmopolitan Magazine article can be found in Appendix A.

<sup>3</sup>Glassdoor is a job and employment recruiting site, hosting a growing database of more than 8 million company reviews, CEO approval ratings, salary reports, interview reviews and questions, benefits reviews, office photos and more.

has also continued to be a field with a high number of job openings and frequent job listings. In fact, there are so many job openings that the technology field is in the midst of a severe work-force shortage. It is estimated that an estimated 900,000 jobs go unfilled, with over 40 percent of software projects canceled due to a shortage of skilled workers, causing an estimated \$4 billion loss in Silicon Valley alone[4].

With the encouraging parameters such as strong demand, endless opportunities and high pay, and a history with such a strong female presence, why is it that even 48 years after the initial call for women programmers, the Computer Sciences are still primarily male? It is estimated that women make up only 18 percent of directors of Silicon Valley's tech companies. Even more startling, they only make up just 27 percent of the digital workforce[5].

Every day, talented women who could make up for the shortage of qualified workers are disaffected or discouraged from pursuing computing careers and the underlying causes of this disaffection are innumerable. The first section of this paper will expose the statistical representation of women in Computer Science, both as users and developers, followed by an exploration and discovery of a few reasons that may be causing these disparities and some proposed solutions. The second section will describe how the topics found in the research process were used in different platforms and venues to encourage more women to stay in the technologies.

## 2.1 Statistics and Demographics

Despite the relative youth of the computer industry, much of which began with female-oriented human computer careers, evidence shows that women have lost ground in the world of computing. In today's day and age, women are utilizing technology in equal proportions to men. Whether it is using the Internet, taking advantage of wearable technology, or installing a mobile app, women use technology as much as men.

According to the Pew Research Center, the demographic of Internet users in 2014 was almost equally split between men and women, as the following figures illustrate.

### Internet users in 2014

*Among adults, the % who use the internet, email, or access the internet via a mobile device*

		<b>Use internet</b>
<b>All adults</b>		87%
<b>Sex</b>		
a	<b>Men</b>	87
b	<b>Women</b>	86

Figure 1: Internet Users Categorized by Gender

### Teen Internet Access Demographics

*% of teens in each demographic group*

		Access the Internet	Mobile Access to Internet (phone, tablet, etc)	Access Internet Mostly on Cell Phone
<b>All teens, ages 12-17 (n=802)</b>		<b>95%</b>	<b>74%</b>	<b>25%</b>
<b>Teen Gender</b>				
a	Boys(n=405)	97 <sup>b</sup>	72	20
b	Girls (n=397)	93	76	29 <sup>a</sup>
<b>Teen Gender and Age</b>				
a	Boys, 12-13 (n=122)	96	70	12
b	Boys, 14-17 (n=283)	97 <sup>c</sup>	73	24 <sup>a</sup>
c	Girls, 12-13 (n=124)	91	72	20
d	Girls, 14-17 (n=273)	95	78	34 <sup>abc</sup>

Figure 2: Teen Internet Access Categorized by Gender

Furthermore, as can be shown in the following figure, except for the cases of LinkedIn and Twitter, women are a majority of social media users.

### Social Media Users Categorized by Gender

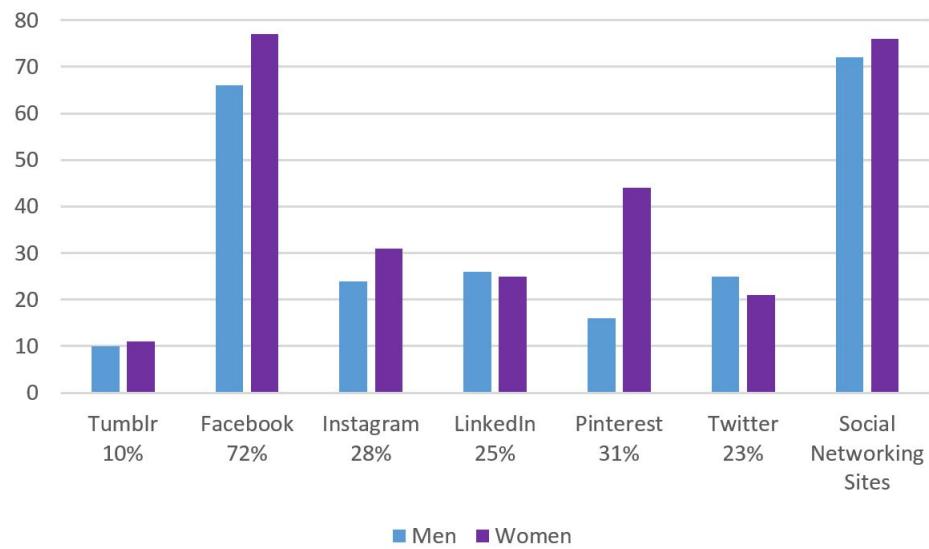


Figure 3: Social Media Users Categorized by Gender

Though Internet and social media aren't the only sectors where women are equally using technology. Take for example one of the more basic of functions: Messaging. According to the PewResearch Report, even messaging and messaging mobile apps are equally distributed by the genders

## **Mobile Messaging Apps Particularly Popular Among Young Adults**

*Among smartphone owners, the % who use messaging apps and apps that automatically delete sent messages*

	<b>Messaging apps</b>	<b>Auto-delete apps</b>
<b>Total</b>	36%	17%
<b>Men</b>	37	17
<b>Women</b>	36	18

Figure 4: Mobile Messaging App Use Categorized by Gender

Even in the field of gaming, which is typically thought of as a very masculine and male-oriented market has its fair share of female users. In a report by Developers Magic, developers are encouraged to understand the audience of their games in order to tailor the product better for their consumers. The report divides games and their respective audiences into different categories: casual and hard-core. Casual gamers tend to entertain themselves with games when the time presents itself, while hard-core gamers will arrange their schedules around gaming[6]. Note the gender differences between Bejeweled Blitz (a game considered casual) and Call of Duty (a game considered hard-core).

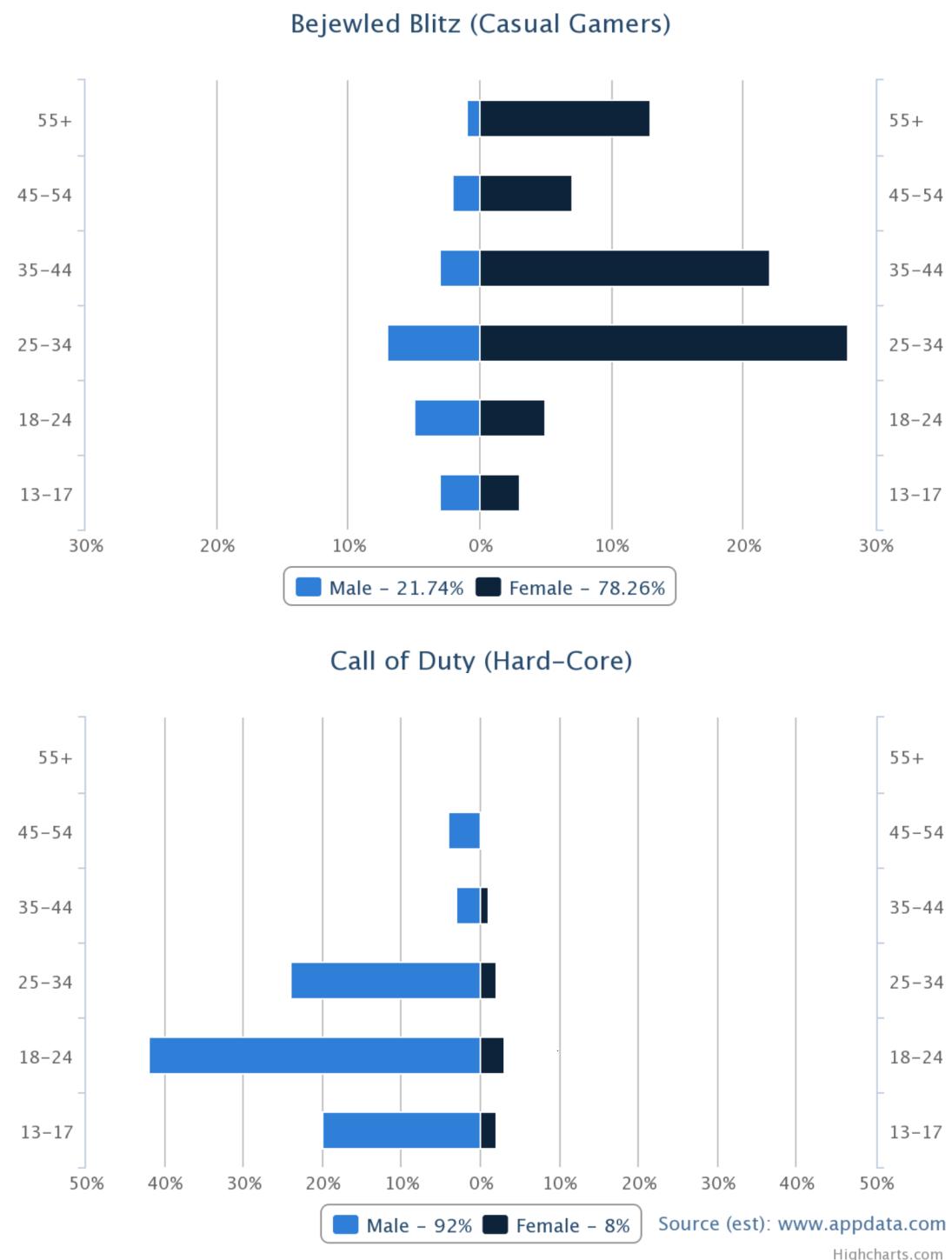


Figure 5: Casual and Hard-core Game Audiences

While the audience of the Hard-core game is primarily male, the audience of the Casual game is primarily female. Gaming in general has a strongly rooted stereotype

that it is oriented towards boys and men. However, the data indicates that this is not always the case, and while some games (like Call of Duty) target towards a male market and audience, gaming itself is enjoyed by everyone.

As a final example, consider the breakdown by gender of the new up and coming sector of Computer Science: wearable technology. Wearable technology has only recently began growing as its own subfield of Computer Science. It aims to bring its customers a fashionable alternative to everyday accessories that are enhanced with technology.<sup>4</sup>

**Activity Trackers and Smartwatch Users  
Categorized by Gender**

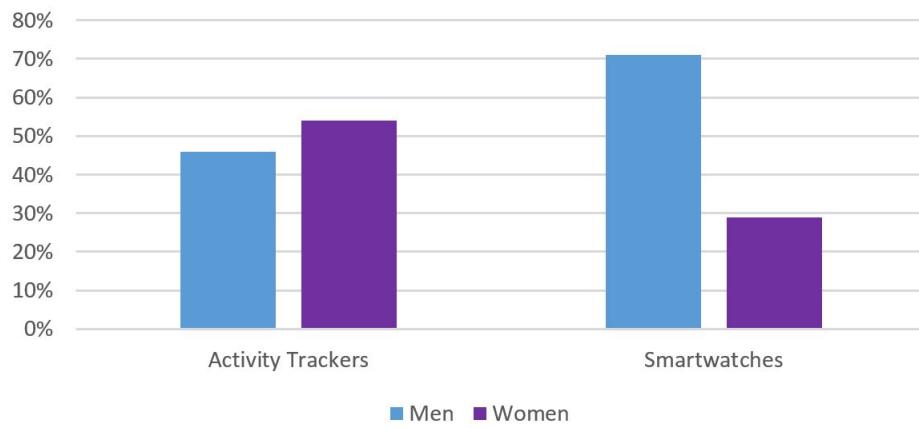


Figure 6: Wearable Technology Users Categorized by Gender

It is important to note, with this example, that women make up the majority of consumers for the activity trackers, while they make up the minority of consumers of smart watches. It can be noted that the design for activity trackers is very gender neutral and can be marketed towards both men and women, whilst the design for the majority of smart watches is very masculine, with huge watch faces and bands that are often criticized for not fitting smaller wrists.

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<sup>4</sup>More information on these figures and statistics can be found in Appendix B and C.



Figure 7: General Design for Activity Trackers



Figure 8: General Design for Smartwatches

These are just a few examples chosen to fully illustrate how both genders consume and interact with the products made in the technology fields. Yet even though the data indicates that women benefit equally (and in some cases more) from the tools technology provides, few women are learning how to invent, create and design the products they are using. Not only are there not a lot of women in the development

teams, but the numbers of women in the workforce and receiving diplomas in Computer Science are dropping.

A recent article on *Fortune* magazine states that In 2013, only 26% of computing professionals were female — down considerably from 35% in 1990 and virtually the same as the percentage in 1960[7]. These startling numbers are reflected throughout businesses across the entire technology sector. Take for example the data published by Facebook's yearly Diversity report.

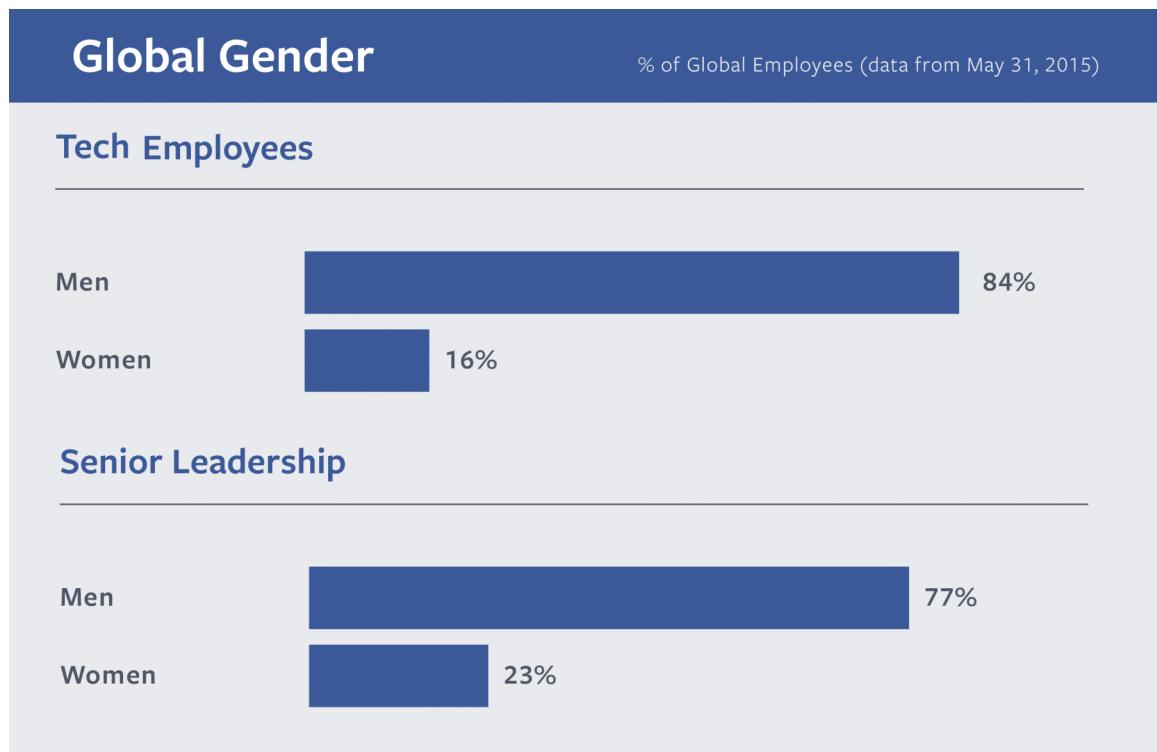


Figure 9: Facebook's Yearly Diversity Data Report

Even though, as previously shown, the percentage of female Internet Users that use Facebook is higher than that of male users<sup>5</sup> As is shown in the figure, as of 2015

<sup>5</sup>the previous data showed that 77% of female Internet users have a Facebook versus 66% of male Internet users.)

women only make up 16% of Facebook's tech employees, and hold barely 23% of senior leadership positions. Similarly, in 2013 Fortune 500 published that only 4% of Fortune 500 CEO's and 16% of board directors were female.

The data indicates that not only are women already low in numbers in the technology field, but they are also driven out of the field in high numbers.

## Despite Job Security and Good Salaries, Mid-career Women Leave The Private Sector

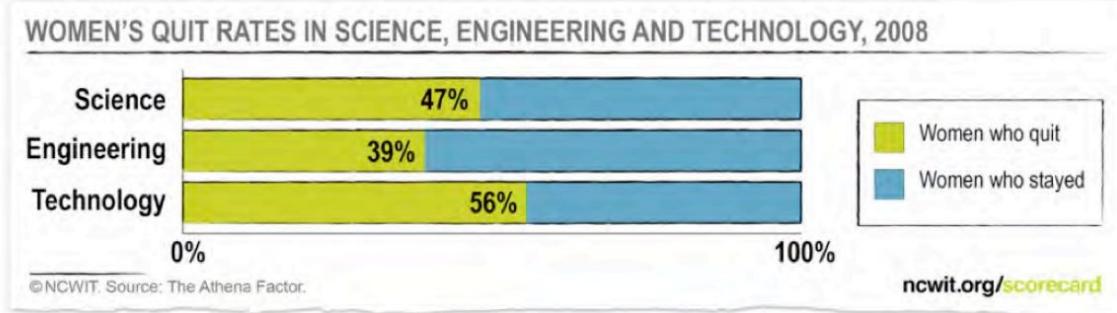


Figure 10: Mid-career Women Leave The Private Sector

As can be shown, out of the Science, Engineering, and Technology sectors, the Technology Sector leads the highest quit rate by almost 10%.

Sadly, these numbers are not only shown in a professional setting. The demographics of women receiving PhDs and undergraduate degrees, as well as the number of women interested in Computer Science to begin with reflect these somber statistics as well, especially when compared to the same data towards men.

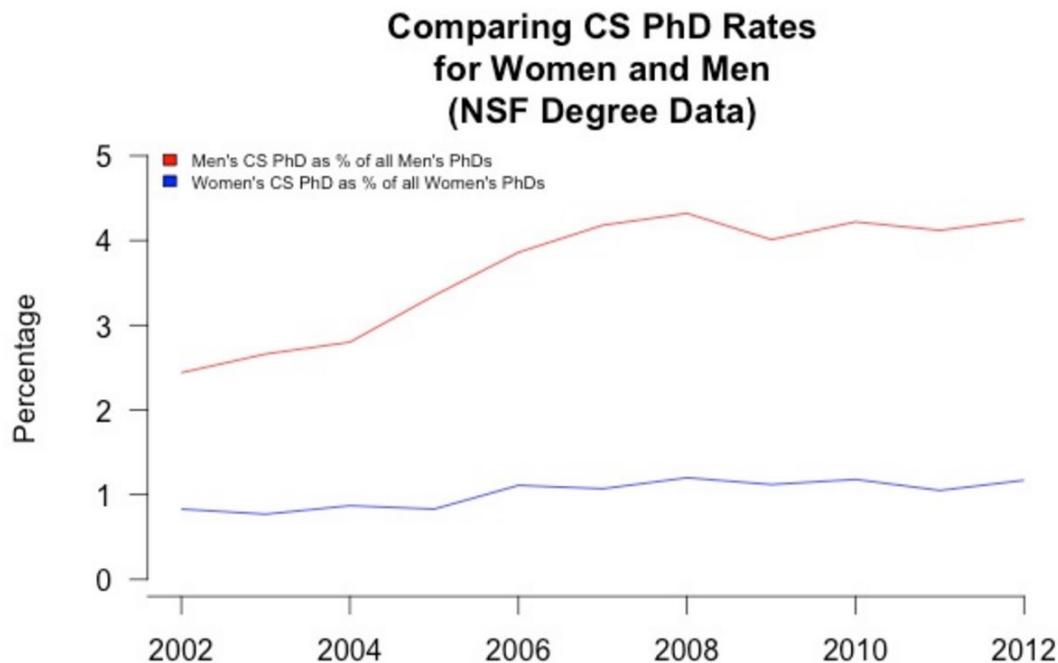


Figure 11: Comparison of Computer Science PhD Rates for Women and Men

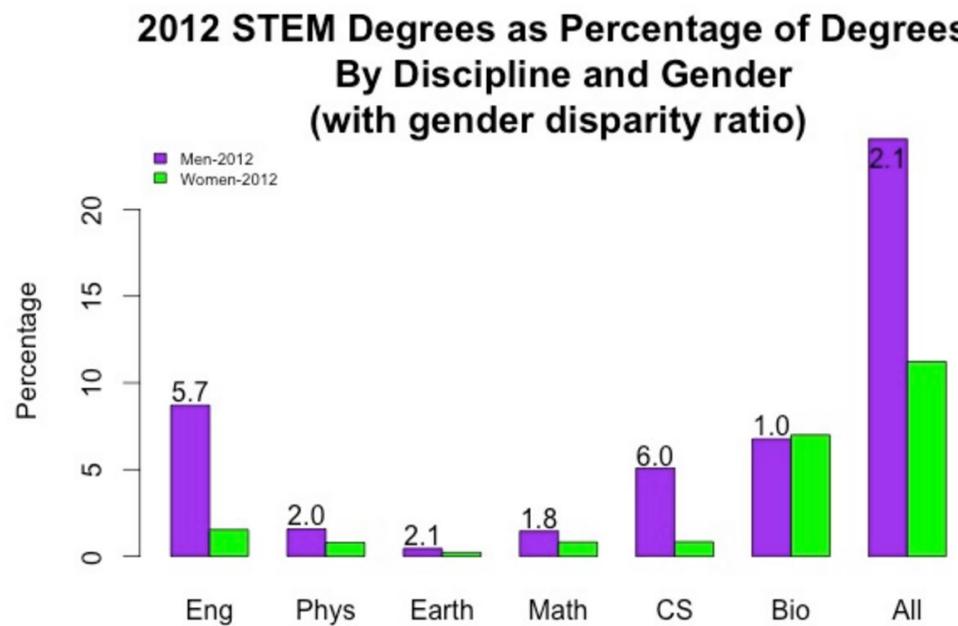


Figure 12: STEM Degrees By Discipline and Gender

## First-year Students Not Interested in CS Major

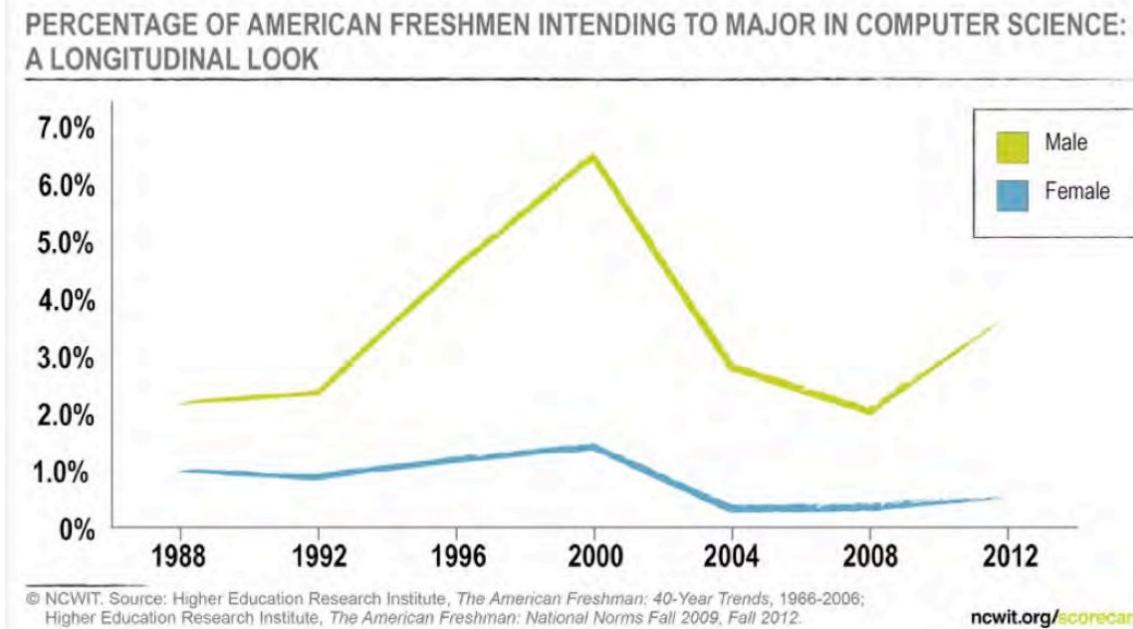


Figure 13: First-year Students Not Interested in Computer Science Major

## 2.2 Literature Review

The following literature review will discuss and analyze three different methods that are researched broadly to reduce the gender gap in the Computer Science discipline. By comparing and reflecting upon studies, articles, and books from different sources, this literature review hopes to provide three concrete, approachable, and proved strategies that can be used to attract and retain more women to the field. I would like to note, however, that though these three techniques were found when searching for methods to eradicate the gender gap in the field, they may also be used to diversify the field in general, and attract other types of underrepresented groups in Computer Science, such as people of color or people with disabilities. This review, however, is not fully intersectional, as it is written with the understanding that all people involved have access to computers and the type of environment where one must work and interact with the computing and programming culture.

## **1. Understanding and Talking About the Issues Relevant in the Field**

Feeling isolated or ostracized is a common frustration among many involved in the technology field. This feeling of inadequacy can be extremely detrimental not only to a person's performance, whether in the classroom or in the workforce, but also to that person's confidence and self-image. Consequently, this factor is one of the greatest influences that will convince anyone to quit in Computer Science. Among the many studies focusing on the reasons women in particular are not retained in technology, feeling isolated and unwelcomed is a common thread.

Unfortunately, due to the nature of the feeling of isolation, it is hardly ever talked about. So even though there could be many people together who each have developed their own complex impostor syndrome, the needed conversation that would show them they belong is muted. It is hard to talk about feeling ostracized with those that may contribute to that feeling unknowingly.

The importance of dialogue, in some form or another, about the adversities that one faces in their personal path in technology cannot be stressed enough. While sharing and listening to multiple experiences, someone who may have been feeling isolated or low in confidence, may be able to realize that those feelings of oppression were not, as they may have believed, self-induced but were actually the unwelcomed results of external factors like implicit bias or wrongful cultural pressures. Additionally, having an honest and open conversation about the experiences and adversities that are faced can help prepare and teach others what to expect, how to handle a problem should one arise, and steps to prevent uncomfortable or discouraging situations.

The study, *Factors that Affect the Physical Science Career Interest of Female Students*

explores five common hypothesis used to encourage female students to pursue careers in the physical sciences. Of the five hypothesis explored, one had a particularly strong positive effect: discussing the underrepresentation of women in physics class. As the report explains, reflection on stereotypes and underrepresentation issues in the physical sciences, may have lead to greater self-realization for the students and may have shown an effect on their choice of a physical science career. These explicit personal discussions regarding any issues faced in pursuing the sciences helped the students realize that any feelings of inadequacy or discomfort they might have stemmed from external norms and pressures rather than from their capabilities, interests, or values. As the report explains, the importance of the students' self-reflection was fostered by interventions that directly counteracted with these students' stereotypic beliefs, and affirmed their personal values more broadly. This consequently resulted in increased engagement, grit, and confidence. In a closing statement, the report concludes "Perhaps engaging in discussions around underrepresentation affords more opportunities for female students' self-realization because the act of discussing may incorporate their perspectives, rather than being inherently teacher centered, and help to affirm their belonging." [8]

Equally as important as having these conversations is the location where they are occurring. Due to the complexities of having a conversation that can put so many in such a vulnerable position, the importance of a safe space cannot be stressed enough. According to the article *Diversity training in graduate school: An exploratory evaluation of the Safe Zone project*, a safe zone provides an opportunity for people to talk, learn, and ask questions in a non-judgmental, safe, and educational environment. Thus, having a safe zone provides an environment where everyone feels comfortable enough to speak and even more so to listen is key to having these impactful conversations. The article emphasizes that in order to be supportive and aware of different iden-

tities, perspectives, and experiences in an ever-diversifying society, we must pursue (and provide) opportunities to learn about these topics from individuals, particularly ones that are stigmatized, marginalized, and largely silenced[9].

While it would suffice to have the conversations on their own, they would be much more influential if they were to occur in a location where everyone involved felt comfortable and safe. Whether this safe space was a classroom with a closed door, a meeting surrounding a meal, or a mentor's office, as long as everybody feels comfortable enough listen and speak, the safe space is created.

## 2. Changing the Image: Combating Stereotypes and Stereotype Threat

### How well would a non-stereotypical computer programmer fit in in a programming environment?

I don't play RPG's, Starcraft, etc. Instead, I prefer Call of Duty and sports games. I lift weights and play basketball. I have pretty high "EQ" and am emotionally aware and sensitive of others' feelings (high empathy, I guess you could say). I enjoy interacting with people on a one-to-one basis (though I am pretty uncomfortable with groups of strangers).

I do like sci-fi ;)

I know stereotypes are just generalizations, but I would suppose there is a high degree of validity in them. I'd really like to work in an environment where I can fit in, instead of feel left out because I'm not "geeky" enough.

Figure 14: Programmer Stereotype Entry in Question & Answer Website Quora

Unfortunately for the Computer Science industry, programmers have earned a rather misleading stereotype that they are distinctively white men with only one type of personality: misunderstood computer geniuses that compensate for their lack of social skills with an incredible ability to compute. The personification of computers themselves. This stereotype originates from years of pop culture, wrongful marketing, and a cultural obsession with transforming successful computer scientists to fit this image. For example, in the movie *Steve Jobs* by director Danny Boyle, Jobs is portrayed as prickly, demanding and unforgiving. He is repeatedly shown to be uncaring and unsentimental when it comes to other people. Throughout the entire movie, Jobs clashes with nearly everyone, as he cares little over whether he is liked or not[10]. In another example perpetuating this stereotype, note the way Alan Turing, the so-called father of computers, is displayed in the movie *The Imitation Game*, by director Morten Tyldum. The film strongly implies that Alan is a genius somewhat inept at socializing: his character doesn't understand jokes, takes common expressions liter-

ally, and seems indifferent to the suffering and annoyance he causes in others[11] all while single-handedly ending World War II with his computational skills. This image contrasts highly with the description of Turing in his biography: a man with a keen sense of humor, close friends, and an inclination to mock bureaucracy and red-tape who was a pivotal role in cracking intercepted coded messages that enabled the Allies to defeat the Nazis, but achieved this by working closely and successfully with a team of highly capable programmers.

This powerful, negative, and incorrect stereotype of a programmer (and of women involved in the computing business) is partially responsible for the lack of diversity in the field. As one considers which field they will enter (or continue in) they reflect upon their performance in it. Thus, as Margolis explains in her book *Unlocking the Clubhouse: Women in Computing*, each student's self-evaluation becomes a critical part of his or her sense of belonging in Computer Science, and the myopically obsessed computer whiz types have become the reference group, a frame of reference for each student's self-evaluation and attitude formation. An exceptionally high level of obsession and expertise has become the expected norm and has raised the bar for the level of knowledge, interest, and expertise identified with Computer Science majors. *Unlocking the Clubhouse* reports a study performed in Carnegie Mellon University where researchers conducted interviews with more than 100 Computer Science students. Margolis explains that in the study, seeing most of their male peers as totally absorbed in computing, produced a fear that "I don't seem to love it as much as the men, and therefore I don't belong," to lurk in many women's doubts[4]. Margolis also found that while the stereotype of the Computer Science student as someone who is myopically focused on computing is rejected by many male and female students, women reported more distress and were more affected by the perceived difference between themselves and their peers. As many as one fifth of the women interviewed

questioned whether they belonged in Computer Science because they felt they do not share the same intensity in focus and interest that they saw in their male peers[4].

The glorification of the myopically obsessed computer programmer can also force a second stereotype where anyone who does not fit this image is not a competent or successful computer scientist. This consequently produces a phenomenon called stereotype threat, a situational predicament where people feel themselves to be at risk of confirming stereotypes about their social group. There are many studies that show that awareness of negative stereotypes associated with how a person identifies inhibits their performance, confidence, and feelings of belonging. One such study, of women experiencing stereotype threat in mathematics, *Stereotype Threat Reduces Motivation to Improve Effects of Stereotype Threat and Feedback on Women's Intentions to Improve Mathematical Ability*, showed that a negative image of a female mathematician impaired women's performance and buffered their self-esteem from negative feedback (therefore causing a reduction to their motivation to improve their mathematical abilities)[12]. The author of the study stresses the importance of identity-safe environments to reduce the impacts of stereotype threat. For example, avoiding the display of any media (such as posters, books, pictures or videos) that imply a certain group of people will over or under perform or any mention that one group may do better.

The singular and obsessive interest in computing is often assumed to be the road to success in computing, ultimately shaping the assumptions of who will succeed and who "belongs" in the discipline. However, according to Margolis' study, over half of the students interviewed linked their interest in computing to other arenas, describing their passion for the field as "computing with purpose." In fact, many students mentioned contextual concerns and links to social concerns as their greatest reason

to study Computer Science. For example, connecting programming to social work, health, or environmental issues. From these results, Margolis claimed that a critical part of attracting and retaining different people to the discipline is providing multiple ways to "be in" computing. Concern for friends, family, and a programmers hobbies should not come at the cost of success in Computer Science, but rather be an integral and important component of achievement.

Computer Science is often associated with number-crunching and quantitative skills. In order to bring more diversity to the discipline, we shouldn't have to fit students and professionals to this image, but rather invoke a cultural and curricular revolution to the way that the field is presented so that different perspectives and values are respected within the discipline.

Additionally, there are many proven ways to combat stereotype threat. According to *Reducingstereotypethreat.org*, performance issues caused by stereotype threat can be reduced or eliminated by several means. The article describes 7 different approaches that work to overcome the adversity: reframing the task, deemphasizing threatened social identities, encouraging self-affirmation, emphasizing high standards with the assurance about having the capability to meet them, providing role models, providing external explanations for difficulty, and emphasizing an incremental view of intelligence[13]. On a more individual level, *Serve.org* published an article researching and confirming an old hypothesis that reflecting on the other values in a person's live beyond school or work can help them reduce the impact of any stereotype threat they may experience within themselves[14].

### 3. Role Models Used to Introduce and Retain Women in Computer Science

The following section will explore the different impacts of a role model as a mean to introduce and retain more women in Computer Science. Surprisingly, the studies researched and discussed here showed very different results for this approach when used to attract women than when used to retain them.

The first study, *Enduring Influence of Stereotypical Computer Science Role Models on Women's Academic Aspirations*[15] focused on the impact of specific role models upon undergraduate women who were not Computer Science majors. The study was founded upon the role model presenting a lecture with the students and then having a 2 minute interaction with each student. The study aimed to discover whether these role models could increase the students' interest in Computer Science. What the researchers found was that regardless of gender, if the role model presented embodied the Computer Science stereotype in appearance they had an immediate and negative effect on the women's interest in the field. In fact, if the role model embodied the stereotype, the women's sense of belonging in Computer Science decreased, especially following the 2 minute interaction.

This article showed that being exposed to stereotypic role models could have a negative impact on student's interest in Computer Science. However, it is hypothesized that being exposed to female role models could counter stereotypes in students, and help them realize their potential to engage in belonging in the science communities. In the previously mentioned study, *Factors that Affect the Physical Science Career Interest of Female Students*, Hazari also explored whether this hypothesis was true. Surprisingly, the research yielded null results with respect to female role modeling. They explain that while it is a common belief that role modeling is necessary for

attracting females, focusing on role models didn't effectively encourage the women simply because seeing a woman in science didn't connect with the subjects. The authors explained that reading an article about a brilliant woman scientist, or hearing stories about a seemingly flawless programmer felt unrelatable, and made the career seem out of reach.<sup>6</sup>

While these studies showed that the exposure to role models didn't seem to peak women's interest in the field, other studies prove that strong and relatable role models can be very effective in *retaining* women in the field. Once they are interested, role models have been shown to be an effective means to continue interest and passion.

For example, the study *Undergraduate Women in Science and Engineering: Effects of Faculty, Fields, and Institutions Over Time* found that the percentage of women among undergraduate science majors was associated with and positively correlated with the percentage of women among the faculty in their fields. In other words, exposure to female role models in the institution they were studying increased the number of female college students who were enrolled in that institution. A final study, *The effect of a role model project upon the attitudes of ninth-grade science students* showed that intervention using female role models was found to improve the attitudes of ninth grade students and that it directly correlated with the students' attitudes towards their field. The study found that female role models in the science classroom was an effective way to maintain students' attitudes towards the topic.

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<sup>6</sup>On the other hand, this study also found that having a supportive teacher and mentor of any gender made a big difference in the students' decision. Researchers found that relationships developed within the context of the discipline were critically important, regardless of the gender of those relationships. A large number of the women studied reported that a person, not necessarily female, influenced their choice of career. Thus, mentors that had built a positive relationship and implemented well-meaning practices were found to be much more influential than role models for students deciding their careers.

The research towards the effect and impact of female role models was very surprising. While female role models made a powerful impact on students that were already interested in the field, they weren't as effective towards introducing and attracting students to the topic. Not as surprising, however, was the role of the mentor, which in both cases showed to have a strong relation towards a student's choice in their career.

## 2.3 Research Conclusion

As was shown in the research, women utilize and benefit from the services of technology as much as (and in some cases more than) men. Unfortunately, the inventors, designers, and creators of these technologies are not as gender diverse as the users and benefactors of them. Even though there is a shortage of employees in the field, the pay is impressive, and the opportunities for career growth are often emphasized, talented women who could work in this discipline are discouraged and disaffected from pursuing computing careers. At the most basic and individual level, women who have the necessary talent and inclination who do not engage with the Computer Science sector are missing the educational and economic opportunities that are so abundant in the field. On a less individual level, non-diverse teams are less likely to produce products that meet the needs of gender-diverse audience. The people behind any technological service define the parameters of that product, since the technical decisions behind that product will be based on the experiences, opinions, and judgments of the team behind it. Hence, when women are underrepresented in the production teams, the resulting product will be made to match the needs and desires of men (even if the targeted audience included women as well.) The design of any product is a reflection of the team behind it. A wildly discussed example of this is gaming, which often reflects on the fears, anxieties and desires of boys and men. However, there are many other historical and shocking examples of when a male majority in the production team created a very male-skewed and biased object. Early voice-recognition systems did not recognize the higher pitches of a female voice (literally silencing women) a problem that still persists today, as many car voice command systems do not register the voices of female drivers. The first models of face-recognition software for videos would not register a female face, as the bone structure, voice pitch, and facial hair was often different than the prototypes used in the development process. In an example combining the gender disparities in engineering and technology, the original

airbags were made to protect an unbelted average-sized male in a 35 mph crash, thus most of the people killed by airbags were children and women (this was rectified *8 years* later in 1998 by the Transportation Equity Act)[16]. Perhaps one of the most current and pronounced examples is wearable technology, the fusion of fashion and technology. If wearables are designed by exclusively (or majorly) men, then even if the intended audience is the general population, the resulting product will have been produced with men in mind. Smart watches are often criticized for this due to their large, masculine watch faces and bands intended for larger wrists. Wearable technology in particular caters to products intimate to their consumer's style and individual fashion preferences. These products need to be optimized for people of not only all genders, but also all skin colors, abilities, body types and ages. This emphasized diversity in the target audience requires an equally diverse development team that can provide input from a broad range of perspectives and experiences. Increasing the number of women in the field wouldn't just benefit the women excluded from it now, but it would help destroy some of the uncovered gender bias that has distorted major technological products and services.

Diversity must be a characteristic of the development teams who are reshaping the world, if the reshaped world is to fit our diverse lives. Unfortunately, many people do not feel as if they belong in the Computer Science world. This impostor syndrome stems from many different factors, such as an exclusive and hurtful image, a misunderstanding of the field, the everlasting impact of stereotype threat, lack of role models, and lack of mentors. Fortunately, there exist many proven and successful strategies to battle these dangerous influences, such as role model and mentor intervention, awareness of the issues prevalent, open communication, community support, and stereotype threat awareness.

In a digitally developing world, working, studying, and understanding technology and computing is a privilege. The lack of diversity in the computing world isn't due to a lack of interest, but due to a harmful and segregating environment. Welcoming more diversity to the computing world will ensure that the products and services created are reflective of the audiences and users benefiting from them. Not only that, but when institutions, like schools and professions, become more inclusive, everyone benefits, not just the newly included groups. One of my favorite examples of this is the curb ramps at the end of sidewalks; intended to help people on wheelchairs, they've become assets that help everyone, such as people with strollers, suitcases, or bikes.

### 3 Taking Action

A lot of institutions recognize the impact having a large imbalance in diversity can cause, and strive to provide structural support and encouragement to prevent homogeneity among its employees, students, or members. They recognize that we cannot simply *wait* for more women to suddenly become interested in computing and create a pipelining influx of new women employers and students, but rather that there are many different ways to provide encouragement and motivation in order to retain and introduce more diversity to the field.

In 2015, the Anita Borg Institute published a list of the top companies for women technologists, listing Bank of New York (BNY) Mellon as the top company supporting diversity. BNY Mellon illustrates many different types of institutional support towards diversity, such as management awareness and training on unconscious bias, holding many employee resource groups such as Prisim, which strives to promote an open and supportive environment for all LGBT employees, WIN (Women's Initiative Network) which aides the professional development and advancement of BNY Mellon's women employees, or IMPACT which helps recruit and retain multicultural employees. BNY Mellon also holds many kinds of special events and programs that help promote diversity and inclusiveness.

As an example of an academic institution that has largely contributed to the diversification of technology and computing, take private research university Carnegie Mellon. *Women@SCS*, or Women at School of Computer Science, is an advisory committee consisting of undergraduate and graduate students, faculty, and alumni of the Carnegie Mellon School of Computing that have collaborated throughout to years to construct an inclusive and supportive environment for the students. Perhaps the group is best illustrated through their website, found at [women.cs.cmu.edu](http://women.cs.cmu.edu).

### **Women@SCS Background**

Women@SCS' mission is to create, encourage, and support women's academic, social and professional opportunities in the computer sciences and to promote the breadth of the field and its diverse community. The Women@SCS Advisory Committee consists of undergraduate students, graduate students, and faculty within the School of Computer Science.

Members of the Committee have initiated many programs, such as the Big/Little Sister program for undergraduates, the invited Speaker Series, professional development workshops, as well as dinners and other social and academic events. Women@SCS also sponsors outreach projects such as "Is there a robot in your future?" workshop for middle school girls, and the Women@SCS Outreach Roadshow with its different versions for undergraduates, for grade school children, teachers, and parents, and TechNights, a free weekly series of workshops for middle school girls taught by our students. In general, the committee strives to promote a healthy and supportive community atmosphere for ALL. Making a difference and solving problems serve as the basic motivating purposes of the organization.

Figure 15: Women@SCS Description

The website provides plenty of resources and information tailored to women at Carnegie Mellon, such as a calendar showing upcoming events, TechNights, outreach programs, conferences, expositions, internships, and special speakers. It also shows information on mentoring and joining a big sister/little sister program, resources for finding a job, career advice, tips on how to find the perfect tutor, and even interviews with Carnegie Mellon alumni and faculty.

### **Welcome**

We would very much like our SCS Alumnae to be a special part of our community. On the occasions when alumnae have joined us as invited speakers or made themselves available for advice, or simply kept in touch, the experiences have been positive and rewarding for everyone. Our women students value the input of alumnae as role models and mentors. So whether you participate on an invited industry panel, help with recruiting, or share your "words of wisdom" via email, there are many ways that you can contribute to our community and we welcome your support. **Please take a few minutes to tell us about yourself and how you may be able to participate in our community by emailing us.**

The [LinkedIn group](#) for alumnae is a good resource to connect with fellow graduates. Feel free to join, or [get in touch with us](#). We're always excited to connect with alumnae, whether it's just for a quick update of what's going on, or a chance to talk more with the younger generation of Women@SCS.

If you know of CMU Alumnae that do not know about our community, please tell them about us! We'll update the information on our alumnae section as we receive input from everyone. If you have news to share, please get in touch!

We can't wait to hear from you!

### **Words of Wisdom from our Alumnae**

College is about people and relationships. I've forged friendships that will last because we've gone through so much together. I've learned that my teachers are just like me, only wiser from years of experience that they're glad to share.  
*Nivedita Chopra, CS Undergraduate Class of 2015*

Figure 16: Interviews With Carnegie Mellon Computer Science Alumni

The Office of Science and Technology Policy, in collaboration with the White House Council on Women and Girls, show one final example of institutional encouragement and empowerment to women in Computer Science. In recognition of the lack of diversity in STEM (Science, Technology, Engineering and Mathematics) the White House published a website, called *The Untold History of Women in Science and Technology* dedicated to sharing the stories of impressive women in the sciences.

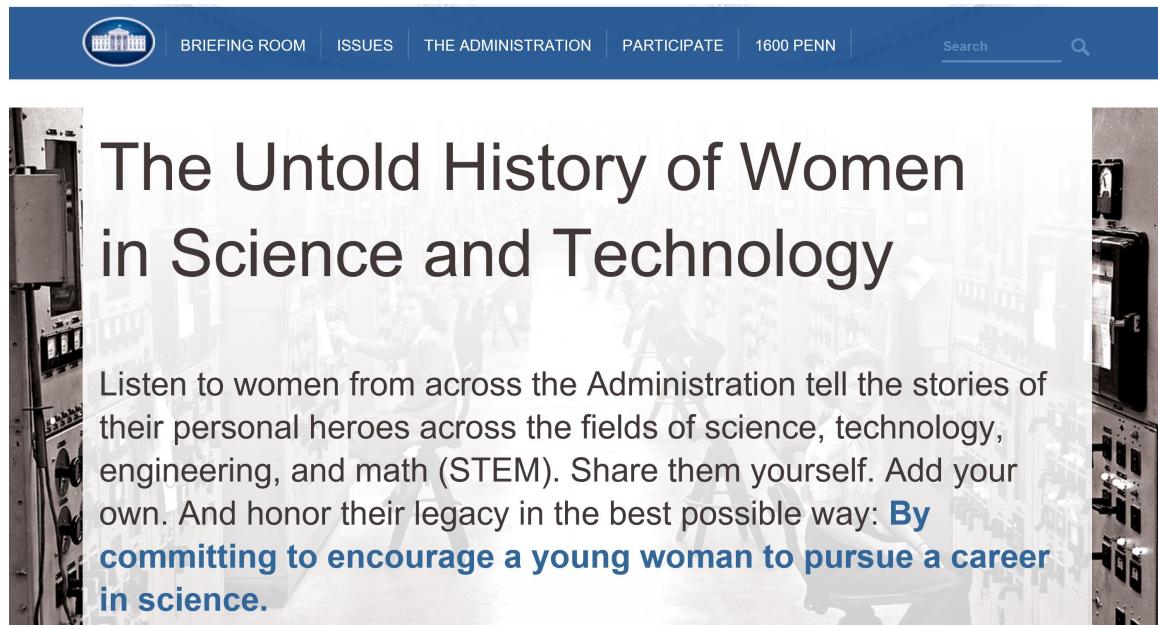


Figure 17: Description of White House Website, The Untold Story of Women in Science and Technology

The website, found at [whitehouse.gov/women-in-stem](http://whitehouse.gov/women-in-stem) shows both a written biography and a sound clip description of impressive women, such as historic Ada Lovelace (considered the first computer programmer and founder of scientific computing) and the ENIAC Programmers (the 6 young women who programmed the first all-electronic computer in World War Two).

### The ENIAC Programmers



As part of a secret World War Two project, six young women programmed the first all-electronic programmable computer. When the project was eventually introduced to the public in 1946, the women were never introduced or credited for their hard work -- both because computer science was not well understood as an emerging field, and because the public's focus was on the machine itself. Since then, the [ENIAC Programmers Project](#) has worked hard to preserve and tell the stories of these six women.

WITH COMMENTARY FROM U.S. CHIEF TECHNOLOGY OFFICER MEGAN SMITH. | SOURCE: [ENIAC PROGRAMMERS PROJECT](#)

The screenshot shows a web page from the White House website. At the top left is a portrait of Megan Smith. To her right is a red play button icon with 'The White House' text. Below the play button is the title 'The ENIAC Programmers (As Told By U.S. Chief Technology Officer Megan Smith)'. To the right of the title is a SoundCloud logo and a 'Share' button. Below the title is a horizontal soundwave visualization. At the bottom right of the page are 'TWEET' and 'SHARE' buttons for Twitter and Facebook respectively. A small 'Cookie policy' link is visible at the bottom left.

Figure 18: Example of White House Website Entry

These three examples, and many others like them, illustrate the three strategies mentioned before that can be used to reduce the gender gap: encouraging community and dialog, changing the image of computing (and the stereotypes with it), and providing role models and mentors. In their own unique combination they use these strategies, among others, to encourage more women to try out Computer Science and to stay involved.

As a second portion to my SIP, I wanted to follow in the footsteps of these leading enterprises, and produce a similar platform for Kalamazoo College. Kalamazoo College offers a couple venues of structure to encourage students in pursuit of their studies, like the Women in STEM lunches, the Women in CS lunches, and the occasional speaker. However, while helpful, these events are strictly occasional. The women in STEM and CS lunches happen once a term or once a year, and in my four years I have only been aware of two speakers addressing the issue: The 2014 Jennifer Mills Lecture with Eileen Pollack (called *How we can (finally) get more women into*

*STEM fields*) and the 2015 Women in CS Lunch with Kalamazoo College Alumni and Google employee Pan Fayang.

The following sections will describe my process and experience building a place at Kalamazoo College whose mission is to make Computer Science more inclusive and diverse. I wanted to follow the examples of structures built before, like those described earlier and others similar. I will be describing what worked, what didn't work, what surprises I found along the way, and the response and feedback received by the community.

### 3.1 Trial and Error

The women in STEM website and the Carnegie Mellon website shared one characteristic that immediately called my attention and attracted me: they showed people in that = community that had accomplished great things and were willing and happy to share their stories. In the White House website, this can clearly be seen, as sharing the stories of accomplished women in STEM is the main purpose of the site. on the Carnegie Mellon website, this is one feature of many, but one that can be seen clearly throughout the site through interviews with the schools faculty and staff, TAs, upperclassmen, graduate students, and alumni.

While both the Carnegie Mellon and the White house website show a picture, description, and contact information for the people featured, the stories on the Carnegie website have a special focus that the White House website doesn't mention: they display more than just professional achievements. On this site, you can find stories of facing adversities, anecdotes of self doubt or impostor syndrome, and how each individual interviewed perseveres. Take for example this quote from Carnegie Mellon alumni Lisa Nelson:

*When I told some of the male students not in the Department that I was majoring in Computer Science, they would look at me as if I "took their spot" and would give me unfriendly looks. I started to feel embarrassed to tell people my major and questioned whether I got into this school just because I was a female. I went to see the Freshman Advisor for Computer Science, Jim Roberts, and said, "If I am in here because I am a girl then I don't want to be here. Please tell me why I am here!" Jim explained to me the admission criteria used by the University and CS department to admit new students and pointed out that gender was not a factor in admittance. He then said to me, "You are here because you are just as qualified as any other student in Computer Science, not because you are a girl." After that, my mindset changed and I no longer felt hesitant to tell people my major.*

This section was particularly attractive to me since I had always been curious about

my predecessors in Computer Science at K. As my career as a student progressed, it became more and more difficult to ignore the fact that many times, women of color like myself were rare in the classrooms. It was not uncommon for me to wonder if there had *ever* been another Hispanic woman to have completed the same track as mine, and if there was, I would have really liked to contact her and get to know her.

It was this need to know about my college's history that fueled the idea of creating a website, not unlike that of Carnegie Mellon. I wanted to gather the stories and experiences of anyone who ever was involved in our department. Find out how they became interested in the field, how they maintained motivation, how they overcame challenges, and where they were currently.

My idea was to find the perfect mixture between the White House website and Carnegie Mellon's and adopt it to Kalamazoo College. Showing the stories and experiences of people in a platform that would raise awareness, provide role models, make people feel included in their communities, and perhaps make connections between students and alumni.

The process for building this website consisted of two parts: designing the website and recruiting participants. For the website design, I wanted to emphasize that the intent was to create a network between alumni and students. Since the Kalamazoo College mascot is the hornet, I thought it would be a good idea to build a sort of hive design where each honey comb represented the individuals. When the user clicked on each person, a full-screen description of that person's story would be displayed, along with a picture and possibly a sound or video clip.

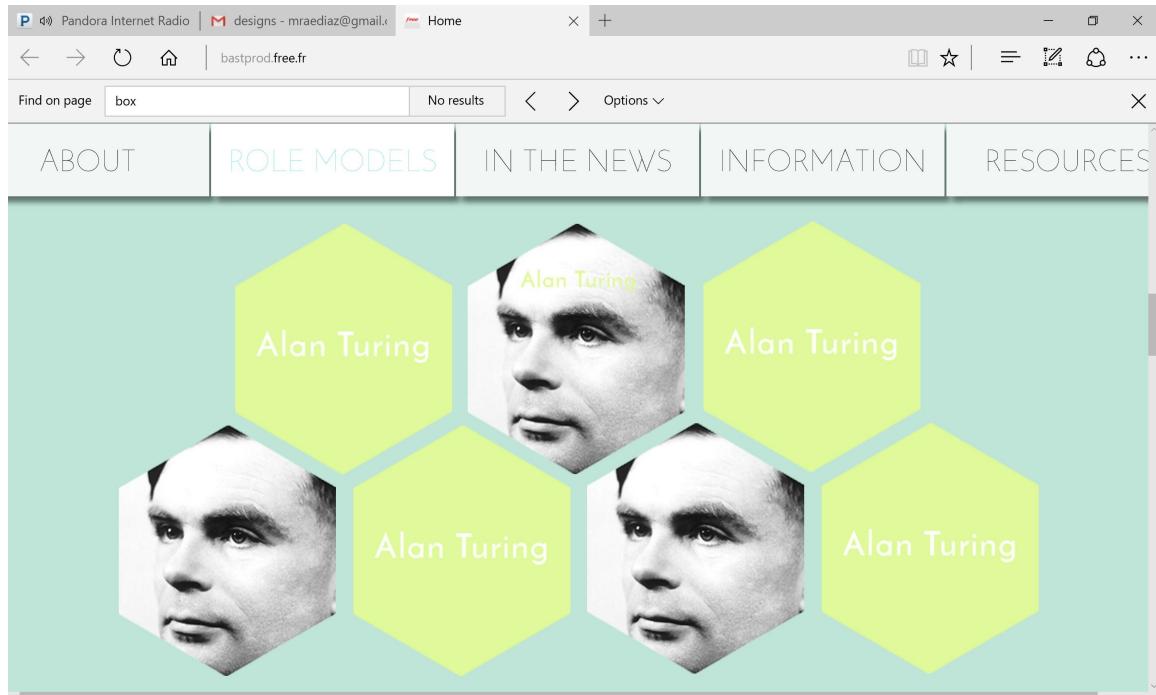


Figure 19: Website Design Idea

As you can see from this picture, I was also hoping to show some other information, such as current events on the topic, information of where to get resources at school (such as TA hours, information on finding a tutor, or office hours for the professors) and a description of the website's mission.

Because this idea involved asking for the stories of Kalamazoo College Alumni, I had to go through the Research Ethics Training (or the IRB Application Process) before anything.<sup>7</sup> The process involved preparing the recruitment materials, defining the research methods, and providing a consent form for all of the participants. I had been planning to post a message on the Technology Guild from the Kalamazoo College Linked In connections and sending out emails and personal messages to the alumni I knew.

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<sup>7</sup>The application can be found in Appendix D.

## RECRUITING MESSAGE

Hello, my name is Melany Diaz and I'm currently working on my SIP, which revolves around getting more students involved in C.S., particularly students of color and women. I have found that one of the greatest reasons that students don't continue their studies in Computer Science, or don't follow a career in the technology field, is because of a lack of role models, peer mentors, and community. For my SIP, I'm building a website that would be able to provide a network for students where they may find some inspiration to continue their careers through finding people to look up to and aspire and a sense of belonging. If you have any experience in computer science or technology, I think you would be a great contributor to this project, and I hope that you will consider participating by adding your biography to this network.

Attached is an example of what a biography in the website would look like. If you are interested in participating, please fill out the survey found through this link: <http://goo.gl/forms/ctet8t34Et>

Thank you so much!

## EXAMPLE BIOGRAPHY



### Melany Diaz

**Relationship to K:** Student, K'16.

**What interests you in the technology field?** In today's day and age, I find that Computer Science is starting to find its way into other disciplines, such as economics, health, linguistics, or psychology. Following KCollege's passion for the liberal arts, I have fostered an interest in topics that range across all disciplines and departments. I love that computer science allows me to continue my various interests while applying them to technology.

As I've learned more about Computer Science, I've began a strong interest in digital safety and cryptography, and am strongly considering following this path after K.

**What is something that keeps you motivated in your field?** I am lucky enough to have a very strong support system that keeps me motivated when the going gets tough, full of family, friends, and colleagues. I often struggle with being one of the only Latina students in my classes. Being both a person of color and a woman, I often feel the pressure of being part of an under-represented group of people in Computer Science. Luckily, I have found strong role models that keep me inspired and a strong community that keeps me involved.

**What is something you wish you had known when you had first began this career?** I really wish I had known how tangible the disparities of the distribution of technology and internet can be felt. Not everyone has access to a computer or to a place where they can learn programming, which has great impacts upon who decides to join this field.

**Do you have any advice for any student debating whether to stay in Computer Science?** Try not to compare yourself to other students! Most people's background in coding is extremely varied and diverse. You'll encounter people who understand the field a lot better than you, and people who don't. Try not to compare yourself to your peers, and don't judge yourself too hard.

**Any other comments:** I am a strong believer of the impact that role models can have on a student to stay motivated.

**Contact info** Contact me through LinkedIn or E-mail.

While I would have preferred to interview each participant individually, I thought an initial start would be best in the form of a survey. In the survey, I was able to receive their official permission to participate, and was able to ask participants questions such as what was their relationship with Computer Science, what had surprised them from the field, and what kept them motivated.

In order to see if this survey would be a successful median to receive entries for the website, I asked my classmates and fellow seniors in our SIP seminar to test-run the survey, and answer it as realistically as possible. Take for example, this entry from Computer Science student, Ariah Lacey:

*I was really surprised by the sense of community between programmers/developers/computer scientists surprised me. It's like a big family when you're working on a team, adding to and debugging each other's code. I wish I'd known that earlier or I may have jumped in sooner!*

-Ariah Lacey, class of 2016

Unfortunately, I was not able to finalize this project, and it had to be closed. There were a lot of factors that went into making this decision. I think the most important followed a conversation with a consultant with the Center for Career and Professional Development (CCPD). After extensively talking with the consultants about this project, we came to a consensus that in order to assure that everyone involved was interested and committed enough to share such sensitive stories, this project needed a lot more structural and institutional support- a factor that was logically improbable at that stage of my SIP.

I still believe that this is an important idea, and that having a digital connection to show support could be an incredible asset to the department. Nowadays, The Carnegie Mellon School of Computer Science is considered a leader in attracting and

retaining women students. In a 2014 article called *How Carnegie Mellon Increased the Proportion of Women in Computer Science From 7% to 42%*, the *Women@SCS* program (along with its website) was listed as one of the top four changes made to the department that attracted more women to Computer Science and also made the culture of the department more inclusive for everyone[17].<sup>8</sup> The Carnegie Mellon *Women@SCS* provided a great example for the website I intended to make for my SIP, and I fully believe that with a bigger team and with more support, it would be a very plausible approach for Kalamazoo College to follow.

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<sup>8</sup>The reasons listed in the article are outreach to high schools, a more inclusive admissions process, a broadened scope of early coursework, and programs that changed peer culture.

### 3.2 SUKUMA

Sukuma is the Swahili word for push and thrust, but over the years it has become much more than that. Sukuma is also the name of a student group at Kalamazoo College that provides a space for students who feel underrepresented in the STEM fields. Through weekly meetings revolving around dinner, Sukuma is a place for underrepresented students to get to know each other, share their experiences, and help encourage each other to continue in pursuit of their degrees. Sukuma was originally founded in Dow, for students studying Biology and Chemistry for students of color. Over the years, however, it had grown and expanded to become a supportive environment for all minority students who needed a supportive community.

As a second resolution for my SIP, I aimed to bring Sukuma to Olds Upton; to create this place for students interested in Engineering, Physics, Mathematics, and Computer Science. In the context of my SIP, I wanted to create a community that displayed the three discussed strategies (changing the stereotypes associated with the discipline, finding mentors and role models, and understanding and talking about issues relevant in each field). However, I didn't want this space to be exclusive to Computer Science students, as I wanted to work as closely as possible with the mission of Sukuma (community) and since the students of these four disciplines already work closely and collaborate with each other it seemed logical to make a space for all of the disciplines rather than just the one.

The process of starting Sukuma in Olds Upton began late summer, right before campus began preparing for the new school year. It began with a conversation the Dr. Regina Truss, Dow's Sukuma faculty adviser, and Dow's Sukuma student mentors. We talked about the history of Sukuma, the benefits of the group, and the possible ways to integrate the group into Olds Upton. We worked with the idea of possibly

having a joint Sukuma, for all science students (Biology, Chemistry, Engineering, Math, Physics and Computer Science) but decided to try a different approach. Having a joint Sukuma, we decided, would need a space bigger than what could be found in either buildings, and would create a group too big to have the intimate conversations the group needed to have. We finally agreed that the best approach would be to continue Sukuma in Dow as it was, and to introduce a similar group to Olds Upton, but tailored to these different fields.

Fall term consisted of finding fellow students who would be interested in mentoring and maintaining the group, allocating funding for the dinners, and finding a faculty adviser who could help maintain the group throughout the years, and who could represent Sukuma on a faculty level.

Winter quarter began ready to introduce Sukuma to Olds Upton. We had found a faculty adviser (Physics professor Dr. Liz McDowell), enough funding to sustain the group for the rest of the school year, and an upperclassmen student mentor for each discipline: Takumi Matsuzawa for Physics and Engineering, Melba Flores for Mathematics, and myself for Computer Science.

Sukuma's original mission was to create a family-like environment where students would meet around a meal, get to know each other, and discuss their experiences as a student at Kalamazoo College. These details have now become traditions of Sukuma.

During winter quarter, we met every Monday for dinner at Olds Upton. We would begin each meeting by introducing ourselves, and sharing what our high and low points of that week were. After these introductions, we had the discussion portion of the meetings. Some example discussions that we had were:

- Strategies for battling test anxiety
- LGBTQA in the Sciences
- Battling stereotype threat
- Asking for help
- Finding your confidence in class
- Current events in Math, Physics, Engineering and Computer Science

We also had two meetings where we had special guest speakers, Dr. McDowell and Dr. Oloo (a Mathematics professor). These two dinners provided a chance for students and professors to get to know each other outside of the classroom. We were able to ask the professors for advice, hear their stories, and share some of our ideas that could help make classrooms more inclusive.

It was very important to me to integrate the three proposed strategies mentioned into the mission of Sukuma. Every meeting, in some way or another, integrated changing the stereotypes associated with the disciplines, finding mentors and role models, and understanding and talking about issues relevant in each field.

### 3.2.1 Feedback from Sukuma Members

At the end of the term, we handed out feedback forms to the Sukuma members. Here are some of the responses we received.

**What were some of the benefits that you think you have gained by coming to Sukuma?**

- Not feeling alone in the hard sciences, and not feeling like I don't belong.
- Learning from people and how they cope with the struggles they face.
- It's really cool to get out of my own box and to get to spend time with such a supportive group. My professors and assignments are difficult, so its nice to talk through stress with a group.
- I like the relaxed environment and friendliness

**What is something you would like to see more of in Sukuma?**

- The conversations are great! I would like to have more conversations like this term.
- I would like to have more professor guest speakers.
- I look forward to talking more about people's experiences (good, bad, challenging, easy...) I think we all deal with so much everyday, though it may seem like all we have time to do is study, so much more goes on in the background. Its nice to take a second to acknowledge it.

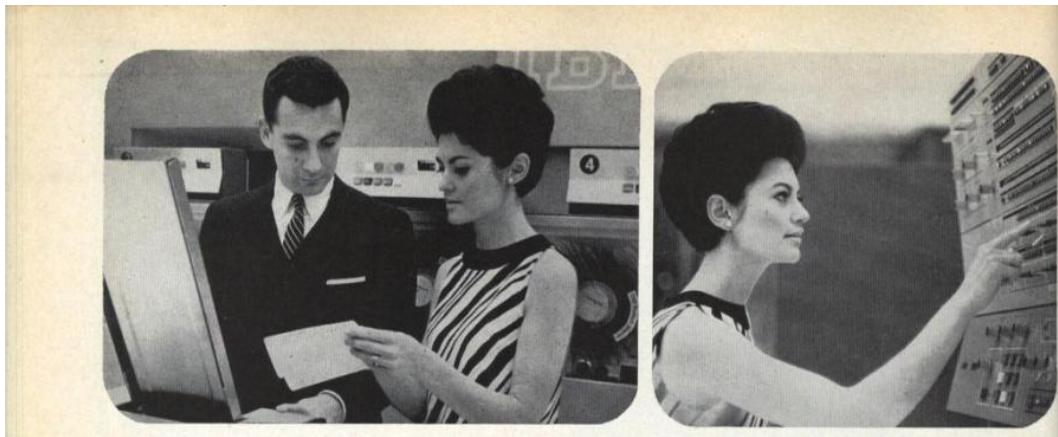
Our first meeting only had two people show up, but as the term progressed, and word got out, we steadily began to grow. By the end of Winter term, we had well over twelve students coming steadily every week. We've already had a lot of students

wondering how they can become mentors next year, and what can be done to better Sukuma and continue it next year.

There's a lot planned for Sukuma's first Spring term in Olds Upton, such as more guest speakers, joint meetings with Sukuma Dow, field trips, and more discussions relating to minorities in the sciences.

## Appendix A: "The Computer Girls"

"The Computer Girls," 1967 Cosmopolitan magazine piece about a weird new field, programming, that was dominated by women. An article on women working with technology.



### The Computer Girls

BY LOIS MANDEL

A trainee gets \$8,000 a year  
...a girl "senior systems analyst"  
gets \$20,000—and up!  
Maybe it's time to investigate....

Ann Richardson, IBM systems engineer, designs a bridge via computer. Above (left) she checks her facts with fellow systems engineer, Marvin V. Fuchs. Right, she feeds facts into the computer. Below, Ann demonstrates on a viewing screen how her facts designed the bridge, and makes changes with a "light pen."

Twenty years ago, a girl could be a secretary, a school teacher . . . maybe a librarian, a social worker or a nurse. If she was really ambitious, she could go into the professions and compete with men . . . usually working harder and longer to earn less pay for the same job.

Now have come the big, dazzling computers—and a whole new kind of work for women: programming. Telling the miracle machines what to do and how to do it. Anything from predicting the weather to sending out billing notices from the local department store.

And if it doesn't sound like woman's work—well, it just is.

"I had this idea I'd be standing at a big machine and pressing buttons all day long," says a girl who programs for a Los Angeles bank. I couldn't have been further off the track. I figure out how the

computer can solve a problem, and then instruct the machine to do it."

"It's just like planning a dinner," explains Dr. Grace Hopper, now a staff scientist in systems programming for Univac. (She helped develop the first electronic digital computer, the Eniac, in 1946.) "You have to plan ahead and schedule everything so it's ready when you need it. Programming requires patience and the ability to handle detail. Women are 'naturals' at computer programming."

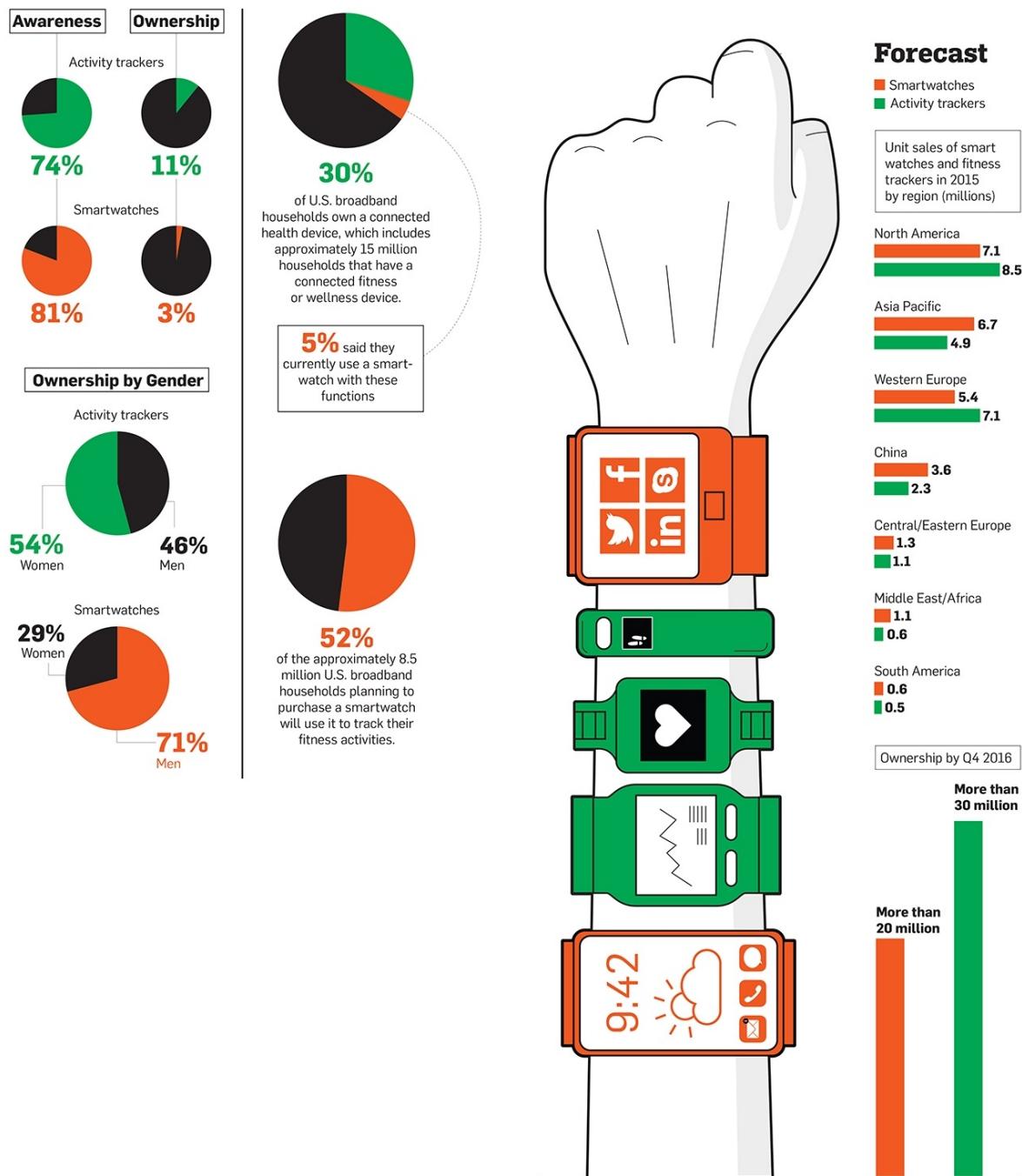
What she's talking about is *aptitude*—the one most important quality a girl needs to become a programmer. She also needs a keen, logical mind. And if that zeroes out the old Billie Burke-Gracie Allen image of femininity, it's about time, because this is the age of the Computer Girls. There are twenty thousand of them in the United (*cont. on page 54*)



Photos by Henry Grossman, Dress by Gino Charles.

## Appendix B: Infographic: Wearable Tech Devices

Infographic: Which Wearable Tech Device Will Win? Demographics and awareness for fitness trackers and smartwatches.



SOURCE: The NPD Group Connected Intelligence  
WEAR Report, Parks Associates, Statista

## Appendix C: Statistics Report of Social Media and Messaging App Users

Exerts from the Pew Research Center Report of mobile messaging and social media use in 2015.

### About This Report

This report is a collaborative effort based on the input and analysis of the following individuals.

Find related reports online at [pewresearch.org/internet](http://pewresearch.org/internet).

Maeve Duggan, Research Associate

Aaron Smith, Associate Director, Internet, Science, and Technology Research

Lee Rainie, Director, Internet, Science, and Technology Research

Andrew Perrin, Research Assistant

Dana Page, Senior Communications Manager

Margaret Porteus, Information Graphics Designer

Shannon Greenwood, Assistant Digital Producer

### About Pew Research Center

Pew Research Center is a nonpartisan fact tank that informs the public about the issues, attitudes and trends shaping America and the world. It does not take policy positions. The center conducts public opinion polling, demographic research, content analysis and other data-driven social science research. It studies U.S. politics and policy; journalism and media; Internet, science and technology; religion and public life; Hispanic trends; global attitudes and trends; and U.S. social and demographic trends. All of the center's reports are available at [www.pewresearch.org](http://www.pewresearch.org). Pew Research Center is a subsidiary of The Pew Charitable Trusts, its primary funder.

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## The Demographics of Social Media Users

The following analysis discusses the demographic characteristics of each of the five social media platforms in the survey.

**Facebook** — 72% of adult internet users/62% of entire adult population

Fully 72% of online American adults use Facebook, a proportion unchanged from September 2014. Usage continues to be especially popular among online women, 77% of whom are users. In addition, 82% of online adults ages 18 to 29 use Facebook, along with 79% of those ages 30 to 49, 64% of those ages 50 to 64 and 48% of those 65 and older.

### Facebook Demographics

*Among internet users, the % who use Facebook*

	Internet users
Total	72%
Men	66
Women	77
White, Non-Hispanic	70
Black, Non-Hispanic (n=85)	67
Hispanic	75
18-29	82
30-49	79
50-64	64
65+	48
High school grad or less	71
Some college	72
College+	72
Less than \$30,000/yr	73
\$30,000-\$49,999	72
\$50,000-\$74,999	66
\$75,000+	78
Urban	74
Suburban	72
Rural	67

Source: Pew Research Center, March 17-April 12, 2015.

**Pinterest — 31% of adult internet users/26% of entire adult population**

Some 31% of online adults use Pinterest, a proportion that is unchanged from the 28% of online adults who did so in September 2014. Women continue to dominate Pinterest – 44% of online women use the site, compared with 16% of online men. Those under the age of 50 are also more likely to be Pinterest users – 37% do so, compared with 22% of those ages 50 and older.

**Pinterest Demographics**

*Among internet users, the % who use Pinterest*

	Internet users
Total	31%
Men	16
Women	44
White, Non-Hispanic	32
Black, Non-Hispanic (n=85)	23
Hispanic	32
18-29	37
30-49	36
50-64	24
65+	16
High school grad or less	25
Some college	37
College+	31
Less than \$30,000/yr	24
\$30,000-\$49,999	37
\$50,000-\$74,999	41
\$75,000+	30
Urban	26
Suburban	34
Rural	31

Source: Pew Research Center, March 17-April 12, 2015.

**Instagram — 28% of adult internet users/24% of entire adult population**

Some 28% of online adults use Instagram, a proportion that is unchanged from the 26% of online adults who did so in September 2014. Instagram continues to be popular with nonwhites and young adults: 55% of online adults ages 18 to 29 use Instagram, as do 47% of African Americans and 38% of Hispanics. Additionally, online women continue to be more likely than online men to be Instagram users (31% vs. 24%).

### Instagram Demographics

*Among internet users, the % who use Instagram*

	Internet users
<i>Total</i>	28%
Men	24
Women	31
White, Non-Hispanic	21
Black, Non-Hispanic (n=85)	47
Hispanic	38
18-29	55
30-49	28
50-64	11
65+	4
High school grad or less	25
Some college	32
College+	26
Less than \$30,000/yr	26
\$30,000-\$49,999	27
\$50,000-\$74,999	30
\$75,000+	26
Urban	32
Suburban	28
Rural	18

Twitter — 23% of all internet users/20% of entire adult population

Some 23% of all online adults use Twitter, a proportion that is identical to the 23% of online adults who did so in September 2014. Internet users living in urban areas are more likely than their suburban or rural counterparts to use Twitter. Three-in-ten online urban residents use the site, compared with 21% of suburbanites and 15% of those living in rural areas. Twitter is more popular among younger adults — 30% of online adults under 50 use Twitter, compared with 11% of online adults ages 50 and older.

### Twitter Demographics

*Among internet users, the % who use Twitter*

	Internet users
<i>Total</i>	23%
Men	25
Women	21
White, Non-Hispanic	20
Black, Non-Hispanic (n=85)	28
Hispanic	28
18-29	32
30-49	29
50-64	13
65+	6
High school grad or less	19
Some college	23
College+	27
Less than \$30,000/yr	21
\$30,000-\$49,999	19
\$50,000-\$74,999	25
\$75,000+	26
Urban	30
Suburban	21
Rural	15

**LinkedIn — 25% of adult internet users/22% of entire adult population**

A quarter of online adults use LinkedIn, a proportion that is unchanged from the 28% of online adults who did so in September 2014. As was true in previous surveys of LinkedIn usage, the platform is especially popular among working-age adults as well as college graduates and those with relatively high household incomes.

LinkedIn is the only major social media platform for which usage rates are higher among 30- to 49-year-olds than among 18- to 29-year-olds. Fully 46% of online adults who have graduated from college are LinkedIn users, compared with just 9% of online adults with a high school diploma or less. The site continues to be popular among the employed – 32% are LinkedIn users, compared with 14% of online adults who are not employed.

**LinkedIn Demographics**

*Among internet users, the % who use LinkedIn*

Total	25%
Men	26
Women	25
White, Non-Hispanic	26
Black, Non-Hispanic (n=94)	22
Hispanic (n=99)	22
18-29	22
30-49	32
50-64	26
65+	12
High school grad or less	9
Some college	25
College+	46
Less than \$30,000/yr	17
\$30,000-\$49,999	21
\$50,000-\$74,999	32
\$75,000+	41
Employed	32
Not employed*	14

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## Who uses social networking sites

*% of internet users within each group who use social networking sites*

All internet users	74%
a Men	72
b Women	76
a 18-29	89 <sup>cd</sup>
b 30-49	82 <sup>cd</sup>
c 50-64	65 <sup>d</sup>
d 65+	49
a High school grad or less	72
b Some college	78
c College+	73
a Less than \$30,000/yr	79
b \$30,000-\$49,999	73
c \$50,000-\$74,999	70
d \$75,000+	78

Pew Research Center's Internet Project January Omnibus Survey, January 23-26, 2014.

Note: Percentages marked with a superscript letter (e.g., <sup>a</sup>) indicate a statistically significant difference between that row and the row designated by that superscript letter, among categories of each demographic characteristic (e.g., age).

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## Internet users in 2014

*Among adults, the % who use the internet, email, or access the internet via a mobile device*

<b>Use internet</b>	
All adults	87%
<b>Sex</b>	
a Men	87
b Women	86
<b>Race/ethnicity*</b>	
a White	85
b African-American	81
c Hispanic	83
<b>Age group</b>	
a 18-29	97 <sup>cd</sup>
b 30-49	93 <sup>d</sup>
c 50-64	88 <sup>d</sup>
d 65+	57
<b>Education level</b>	
a High school grad or less	76
b Some college	91 <sup>b</sup>
c College+	97 <sup>ab</sup>
<b>Household income</b>	
a Less than \$30,000/yr	77
b \$30,000-\$49,999	85
c \$50,000-\$74,999	93 <sup>ab</sup>
d \$75,000+	99 <sup>ab</sup>
<b>Community type</b>	
a Urban	88
b Suburban	87
c Rural	83

Source, Pew Research Center Internet Project Survey, January 9-12, 2014. N=1,006 adults.

Note: Percentages marked with a superscript letter (e.g., <sup>a</sup>) indicate a statistically significant difference between that row and the row designated by that superscript letter, among categories of each demographic characteristic (e.g., age).

\* The results for race/ethnicity are based off a combined sample from two weekly omnibus surveys, January 9-12 and January 23-26, 2014. The combined total n for these surveys was 2,008; n=1,421 for whites, n=197 for African-Americans, and n=236 for Hispanics.

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## Teen Internet Access Demographics

*% of teens in each demographic group*

	Access the Internet	Mobile Access to Internet (phone, tablet, etc)	Access Internet <i>Mostly</i> on Cell Phone
All teens, ages 12-17 (n=802)	95%	74%	25%
<b>Teen Gender</b>			
a Boys (n=405)	97 <sup>b</sup>	72	20
b Girls (n=397)	93	76	29 <sup>a</sup>
<b>Age of Teen</b>			
a 12-13 (n=246)	93	71	16
b 14-17 (n=556)	96	76	29 <sup>a</sup>
<b>Teen Gender and Age</b>			
a Boys, 12-13 (n=122)	96	70	12
b Boys, 14-17 (n=283)	97 <sup>c</sup>	73	24 <sup>a</sup>
c Girls, 12-13 (n=124)	91	72	20
d Girls, 14-17 (n=273)	95	78	34 <sup>abc</sup>
<b>Parent Race/ethnicity</b>			
a White, Non-Hispanic (n=542)	98 <sup>bc</sup>	77 <sup>c</sup>	24
b Black, Non-Hispanic (n=122)	92	74	33
c Hispanic (n=92)	88	63	21
<b>Parent Education</b>			
a Less Than High School/High school grad (n=244)	91	71	27
b Some College (n=192)	99 <sup>a</sup>	71	24
c College + (n=363)	99 <sup>a</sup>	81 <sup>ab</sup>	22
<b>Parent Household Income</b>			
a Less than \$30,000/yr (n=154)	89	66	30 <sup>c</sup>
b \$30,000-\$49,999 (n=155)	94	72	25 <sup>c</sup>
c \$50,000-\$74,999 (n=110)	99 <sup>a</sup>	79	14
d \$75,000+ (n=335)	99 <sup>ab</sup>	79 <sup>a</sup>	24 <sup>c</sup>
<b>Urbanity</b>			
a Urban (n=278)	94	74	27
b Suburban (n=410)	96	72	24
c Rural (n=101)	99 <sup>a</sup>	79	21

Source: Pew Internet Teens and Privacy Management Survey, July 26-September 30, 2012. N=802 parents of teens ages 12-17 and 802 teens ages 12-17. Margin of error is +/- 4.5 percentage points.

Note: Columns marked with a superscript letter (<sup>a</sup>) or another letter indicate a statistically significant difference between that row and the row designated by that superscript letter. Statistical significance is determined inside the specific section covering each demographic trait.

## **Appendix D: Application For IRB Review Of Research With Human Subjects**

About the Institutional Review Board (IRB) and its application:

The first principle of research is to do no harm, however, historically, this principle has not always been followed, thus IRB exists. Doing research, working with human subjects, is a privilege and is one that should not be abused. IRB protects who is being researched, interviewed, observed; IRB also protects the researcher and the institution to which he/she belongs.

This application was started with the hopes of interviewing Kalamazoo College Computer Science alumni in order to create a website connecting students and alumni.

# APPLICATION FOR IRB REVIEW OF RESEARCH WITH HUMAN SUBJECTS

Electronic Submission to Area Reviewer is Required\*

**Principal Investigator:** Melany Diaz

**Title of Project:** Building a Network

**Date application submitted:** 11/11/15

**Status of Applicant (Faculty Member, Administrator/Staff, Student):** Student

**If Student Applicant, provide:**

**Name of on-campus faculty advisor:** Pam Cutter and Alyce Brady

**A faculty advisor must review your application prior to submission for review. Has your advisor reviewed this application? (Yes, No):** No

**Have you completed a research ethics training course or module? (Yes, No):** Yes

If Yes, please indicate when, where, and with whom the ethics training was completed (this might be part of your departmental methods course or as an online module assigned by a faculty mentor/advisor. Examples that satisfy ethics training include completion of PSYC390 Experimental Methods, ANSO245 Qualitative Research Methods, or other courses that have deliberate and substantial ethics training components, or by completion of an online ethics training module such as “responsibleresearch.org” or “phrp.nihtraining.com”): Completed 8/10/15, NIH Office of Extramural Research phrp.nihtraining.com

If No, stop the application process. You may not receive IRB review until you have completed ethics training.

**Is this research part of your SIP (Yes, No):** Yes

**Is this research in connection with a fellowship application? (Yes, No):** No

**If yes, state fellowship:**

**Anticipated graduation year and major:** 2016 Computer Science and Mathematics

**Please provide the following information relating to your application:**

**1. What is the purpose of the proposed study?**

To construct a network of computer scientists through their biographies and to provide a platform of role models and peer mentors that may motivate a computer science student considering changing their major or field of study.

- 1.** Describe the proposed subject sample including expected ages, genders, total number of subjects (including control subjects), and source of subjects. If subjects under the age of 18 will participate in your research, indicate the sample's expected age range.

The subject samples will be current and past Kalamazoo College alumni who have either began or completed their studies in computer science. The source will be through LinkedIn, e-mail, and the alumni connections found at Kalamazoo College.

- 1.** How will subjects be recruited and selected? Please note if any of the following groups will be included as subjects: Prisoners, pregnant women, the seriously ill, or mentally or cognitively compromised adults.

Through e-mail and LinkedIn.

- 1.** Briefly describe all research procedures that will apply to human subjects. Be sure to indicate:

- a. How will subjects be recruited?

Through e-mail and LinkedIn.

- b. Approximately how much time each subject is expected to devote to the research. How will data be collected and recorded (With or without identifiers? What instruments, materials, or equipment will be used? Will audio or videotapes be used in data collection?). Attach copies of all written instruments and/or describe any apparatus with which subjects will be in direct contact. Attach copies of all proposed tests, surveys, or questionnaires used in the research. If the written instrument is not ready at the time the application is submitted, a description of the topics or an approximate script should be submitted. In some cases, more specific details of questions to be used may be required.

I estimate that it will take each subject between 10 and 30 minutes to complete their portion of the research. Data will be collected through a Google Forms survey..

- c. Methods for obtaining informed consent and assent in the case of minors. For minors, indicate how the consent of parents or legal guardians will also be obtained. Attach copies of all materials used to obtain informed consent or assent.

I don't predict that any minors will participate in my study. However, subjects will give direct permission and consent throughout every stage of the study to consenting to participate.

- d. Methods for preserving confidentiality (including plans for storing/disposing of tapes and other data records at the conclusion of the research).

Sensitivity and awareness that subjects may share personal stories. Double checking with subjects that it is okay to share what they present. If not, then digital deletion at the discretion of the subject.

- e. If deception is to be employed, provide a scientific justification for its use and describe debriefing procedures. [If the research is such that debriefing cannot be carried out, the project must be submitted for full committee review.]

Deception will not be employed.

**1.** Indicate any benefits that are expected to accrue to subjects as a result of their participation in the research. In the event that subjects will be paid, describe all payment arrangements, including how much subjects will be paid should they choose to withdraw from the study prior to completion of the research. If subjects awarded extra credit in a course, students choosing to not participate in the study must be offered an alternative extra credit assignment comparable in time commitment/difficulty as the study.

A network and community of similar peoples as well as a sense of accomplishment in becoming a role model or mentor.

**1.** Describe any relationship between researcher and subjects, such as: Teacher/student; superintendent/principal/teacher; employer/employee. If such a relationship exists, how will it affect the subject's ability to participate voluntarily and how will the principal investigator handle it?

Fellow Kalamazoo College students. I believe that since we all have the common knowledge of the SIP process, subjects may be a little more empathetic

**1.** Indicate any grant support (internal or external) or commercial support for the project. Note: All externally funded projects must receive IRB review.

Trevor Hough SIP Award

## CONSENT FORM

*NOTE: The method of research is a survey made on Google Forms. In order to get to the survey, a subject will have to read an introductory page with the consent form and check in a box stating that they have read the consent form and agree to participate. Once the subject checks that box, they will be directed to the survey.*

This research is being conducted to fulfill the degree requirements for Bachelor of Arts at Kalamazoo College, under the supervision of Dr. Pamela Cutter, PhD.

### Purposes of the Study

The purpose of this study is to learn more about Kalamazoo College Alumni and students in Computer Science and to construct a network between them. The goal is to construct a network of computer scientists through their biographies and to provide a platform of role models and peer mentors that may motivate a computer science student considering changing their major or field of study.

### Description of Procedures

This survey involves sharing your experience, history and perspective within the computer science and technology fields. This will take between 10 and 30 minutes for you to complete.

You will be asked to fill out a questionnaire regarding your story with computer science, which will then be used to construct a small biography. You do not have to answer all the questions or follow the questionnaire at all. You will have the opportunity to see the final bibliography composed from your answers before it is used for the SIP.

### Risks and Discomforts

There are no known or expected risks for participating in this study, except for the mild frustration associated with answering the questions or the discomfort of sharing personal details. You may decide at any time to quit the study.

### Benefits

The biography obtained through the questionnaire will be used to form a collection of role models and inspirations that fellow Kalamazoo College students may reference. If you choose to share your contact information, the network provided by the study may be utilized to help further career or educational choices and relationships.

### Confidentiality

Any information about you that is obtained as a result of your participating in this research will be kept as confidential as legally possible. You will have final discretion and say as to the biography published as a result of this research as well as the amount of personal information, such as name, contact information, place of work or study, etc that will result from this research. Neither your name nor any information from which you might be identified will be published without your consent.

### Voluntary Participation

Participating in this project is voluntary. You are free to withdraw your consent at any time. No one will be mad at you if you refuse to do this or if you decide to quit.

### Contact Information

For more information about this research, you may contact Melany Diaz at mraediaz@gmail.com .

I agree to participate in this research, and am aware that I may withdraw my consent at any time.

## METHODS AND INSTRUMENTS

### **Building a Network is a Senior Independent Project by Melany Diaz**

Thank you for filling out this survey!

Please answer these questions only as you are comfortable. While I appreciate complete and thorough answers, I understand that some questions may not require an answer from you. Please feel free to write as much or as little as you feel comfortable. In other words, your response is completely at your discretion.

Thank you again for being willing to become a part of my SIP! Everyone needs a sense of community that can provide people to look up to; thank you for becoming part of that support network.

**What is your name?**

Leave blank if you choose to stay anonymous

**What is your relationship to Kalamazoo College?**

**What interests you in Computer Science and Technology?**

**How did you get involved in this field?**

**What surprised you about working in this field?**

What is something you wish you had known about this field when you first began?

**What is something that keeps you motivated?**

**What advice would you give to a student debating whether to continue their studies in Computer Science and Technology**

**What is one of your hobbies?**

**Do you work? If so, where do you work and what are some of the things that you do?**

**Are there any other things you would like to add to your biography?**

**Would you be willing to submit a picture and/or a video for your bibliography?**

**if yes, please add your email or a way I may contact you to collect the picture/video**

## RECRUITING MESSAGE

Hello, my name is Melany Diaz and I'm currently working on my SIP, which revolves around getting more students involved in C.S., particularly students of color and women. I have found that one of the greatest reasons that students don't continue their studies in Computer Science, or don't follow a career in the technology field, is because of a lack of role models, peer mentors, and community. For my SIP, I'm building a website that would be able to provide a network for students where they may find some inspiration to continue their careers through finding people to look up to and aspire and a sense of belonging. If you have any experience in computer science or technology, I think you would be a great contributor to this project, and I hope that you will consider participating by adding your biography to this network.

Attached is an example of what a biography in the website would look like. If you are interested in participating, please fill out the survey found through this link: <http://goo.gl/forms/ctet8t34Et>  
Thank you so much!

### EXAMPLE BIOGRAPHY



#### Melany Diaz

**Relationship to K:** Student, K'16.

**What interests you in the technology field?** In today's day and age, I find that Computer Science is starting to find its way into other disciplines, such as economics, health, linguistics, or psychology. Following KCollege's passion for the liberal arts, I have fostered an interest in topics that range across all disciplines and departments. I love that computer science allows me to continue my various interests while applying them to technology.

As I've learned more about Computer Science, I've began a strong interest in digital safety and cryptography, and am strongly considering following this path after K.

**What is something that keeps you motivated in your field?** I am lucky enough to have a very strong support system that keeps me motivated when the going gets tough, full of family, friends, and colleagues. I often struggle with being one of the only Latina students in my classes. Being both a person of color and a woman, I often feel the pressure of being part of an under-represented group of people in Computer Science. Luckily, I have found strong role models that keep me inspired and a strong community that keeps me involved.

**What is something you wish you had known when you had first began this career?** I really wish I had known how tangible the disparities of the distribution of technology and internet can be felt. Not everyone has access to a computer or to a learn where they can learn programming, which has great impacts upon who decides to join this field.

**Do you have any advice for any student debating whether to stay in Computer Science?** Try not to compare yourself to other students! Most people's background in coding is extremely varied and diverse. You'll encounter people who understand the field a lot better than you, and people who don't. Try not to compare yourself to your peers, and don't judge yourself too hard.

**Any other comments:** I am a strong believer of the impact that role models can have on a student to stay motivated.

**Contact info** Contact me through LinkedIn or E-mail.

## Appendix E: Poster for Sukuma

**SUKUMA - OU**

Come Join Us!  
Olds Upton Rm 316  
Mondays at 6 PM  
\*Dinner Provided\*

A Common Space  
For Underrepresented Students  
Studying the Hard Sciences

QUESTIONS? For Computer Science, Math, Physics, & 3/2 Engineering Contact:  
Melany (k12md02), Melba (k14mf04), Takumi (k13tm03)

For Biology, Chemistry, & Premed Contact:  
Mindze (k12mm03), Victoria (k12vo01), or Manny (k12ig01)

$f(x)$

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