Naeem Hossain
123 Main Ave,
New Brunswick, NJ 08901

April 23, 2017

Mrs. Amy Qu
Software Engineer & College Liaison
Google
76 9th Ave
New York, NY 10011

Dear Mrs. Qu:

I hope that you are doing well. My name is Naeem Hossain and I am a software engineer attending your alma mater, Rutgers University. I am currently a member of a team of students at Rutgers University named “Women Who Code” (WECode) that aims to improve the enrollment and retention of women in tech. While the tech industry is a lucrative field, it has one of the worst gender gaps with regards to women of any industry. According to the United States Equal Employment Opportunity Commission, women in tech are underrepresented by 12% when compared to all other industries. Researchers such as Sarah-Jane Leslie write that women are deterred from entry starting in Middle/High School. Rosemary Edzie from the University of Nebraska explains in a study that confidence gaps due to gender norms, a lack of resources, and limited support networks are the root cause of why girls aged 12-17 are deterred from pursuing higher tech fields. One particularly bad area is the Freehold Regional School District in New Jersey, of which less than 1% of female graduates pursue tech. However, afterschool computer science learning programs for middle/high school women, like Girls Who Code, have seen success in providing education to over 11,000 young women, raising the interest rate of computer science by 32% and maintaining a net budget surplus of $6 million. As such, the plan of this project is to replicate the infrastructure and success of programs such as Girls Who Code and Microsoft TEALS in order to motivate and empower the female students at the Freehold Regional School District (FRSD) to pursue computer science. This is done through an afterschool 2-hour mentorship program over the academic year, hosted at local schools/libraries to teach introductory computer science by experienced mentors. The price of this plan is about $7500. We are seeking funding for this project through the Google Educational Research Grant, for use in future expansion across FRSD communities. Modi Kamla et. al from the Girl Scout Research Institute write in a report that afterschool programs such as this are the key to ensuring that young women do not fall behind in the tech surge, and are able to access opportunities on the same level as their male peers. The endemic problems that deter women from computer science, such as poor confidence, a lack of resources, and no role models are all mitigated or solved in part by this program.

Sincerely,

Naeem Hossain
WECode Organizer

“A Proposal to Improve the Enrollment and Retention of Women in Computer Science”

Submitted by Naeem Hossain

Mrs. Amy Qu
Software Engineer & College Liaison
Google
76 9th Ave
New York, NY 10011

April 23, 2017

Scientific and Technical Writing; Sarah Hlubik

Abstract

The tech industry is a lucrative field. However, it has one of the worst gender gaps with regards to women of any industry. According to the United States Equal Employment Opportunity Commission, women in tech are underrepresented by 12% when compared to all other industries. Researchers such as Sarah-Jane Leslie write that women are deterred from entry starts in middle/high school. Rosemary Edzie from the University of Nebraska explains in a study that confidence gaps due to gender norms, a lack of resources, and limited support networks are the root cause of why girls aged 12-17 do not pursue higher tech. One particularly bad area is the Freehold Regional School District in New Jersey, of which less than 1% of female graduates pursue tech. However, afterschool computer science learning programs for middle/high school women, like Girls Who Code and Microsoft Technology Education and Literacy in Schools (TEALS), have seen success in providing education to over 11,000 young women, raising the interest rate of computer science by 32% and maintaining a net budget surplus of $6 million. As such, the plan of this project is to replicate the infrastructure and success of programs such as Girls Who Code and Microsoft TEALS in order to motivate and empower the female students at FRSD to pursue computer science. This is done through an afterschool 2-hour mentorship program over the academic year, hosted at local schools/libraries to teach introductory computer science by experienced mentors. The price of this plan is about $7500. Funding will be provided in full through the $250,000 Google Educational Research Grant.

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Introduction

As a sophomore in college, I worked as a volunteer debate coach for underprivileged students in Newark, New Jersey. One of my students, an intelligent and vibrant young woman, asked me what I studied and what my postgraduate ambitions were. I said that I was learning computer science to become a software engineer, and asked her if she was interested in the field. She replied, “I’m not that good at math or programming, I probably won’t be good at computer science”. Herein lies the problem afflicting women not only in STEM (Science, Technology, Engineering, and Math) fields, but also technology-related fields as a whole – they are deterred from ever entering the industry. MIT professor Ellen Spertus (discussed later) attributes the root causes of this phenomenon to a lack of female role models, oppressive societal/gender norms, and scarce opportunities available to young potential technology students (Spertus, 1991, p. 3). Princeton researcher Sarah-Jane Leslie (discussed later) also notes that these factors condition women into possessing a “confidence gap”, which afflicts the few women who enter tech and pressures them into sentiments of inadequacy. This is especially seen in areas such a the Freehold Regional School District (FRSD), which sends a disappointing few number of young women into postsecondary tech-related endeavors, even compared to the national average (Freehold Regional High School District, 2016, p. 4). Seeing these problems affect not only the greater tech industry, but also my local communities has motivated me to propose a solution to the problem – an afterschool computer science tutoring program that provides an adequate tech education to young women, and motivates them to pursue the field on their own. Researchers such as Rosemary Edzie and the aforementioned Sarah-Jane Leslie extensively research and compile data from across the nation in order to uncover the root causes of why women don’t enter STEM fields at the same rates as men. They generally (although not explicitly) point to tutoring/mentorship programs as a way to solve for poor female enrollment and retention in STEM fields, including tech. In fact, there are several existing model programs that accomplish this. Girls Who Code and Microsoft’s Technology Education and Literacy in Schools (TEALS), both afterschool outreach and tutoring programs, have seen wild success in their respective communities. Girls Who Code saw a net revenue increase, a substantial boost in the reported confidence of young female students, and an increase in confidence (Girls Who Code, 2015, p. 8). Microsoft TEALS reports similar results, as well as an organized community effort – over 1100 hours invested in each class, 750 volunteers from over 400 companies, and 10% increase proficiency in computer science classes and exams (Microsoft Philanthropies, 2017, p. 2). The costs of implementing an afterschool program in FRSD (one class for middle-school and one class for high-school) are $7500 over the course of an academic year. The costs are relatively low because equipment is provided by schools in the form of media centers/computer labs, the teachers will be volunteers, and teaching computer science does not require extensive amounts of supplies aside from a computer, pencils, paper, and a whiteboard with markers. The program has numerous benefits, discussed in detail later. However, these include substantial increases in the willingness to learn and pursue computer science, increased role models in the tech industry, and better gender diversity. In the long term, this will help to motivate even more afterschool tutoring programs outside of the FRSD educational community, and inspire young women to unlock their potentials by giving them the tools to succeed as entrepreneurs, inventors, and students.

Problem

This is a very serious and pressing issue within the industry. The National Center for Women in Information Technology (NCWIT) conducts a national survey of hundreds of female tech-industry members, compiles data from educational, state, and company employment reports, and finds that only 18% of undergraduates in information technology (IT) and computer science-related fields (CSRF) were women (National Center for Women in Information Technology, 2012, p.16). It further discusses that this number is decreasing steadily (National Center for Women in Information Technology, 2012, p.16). Dr. Mokter Hossain's research from the US-China Education Review supports this theory – the number of female students selecting computer science as a major declined by 43% between 2005-2007 (Hossain & Robinson, 2012, p. 444). Ellen Spertus from the MIT Artificial Intelligence Laboratory Technical Report (AITR) conducted a national study of over 60 educational institutions, 6 developmental psychologists, and hundreds of women in the field to determine why there are so few women in the tech industry. Her research noted that the cultural biases against women pursuing careers in IT/CSRF (Information Technology/Computer Science-Related Fields) are deeply rooted in societal and educational institutions (Spertus, 1991, p. 1). She adds that women are conditioned at young ages to believe that computer science is for men (Spertus, 1991, p. 4). This ultimately has a drastic effect on the number of women who take math and computer science courses in high school, which not only reinforces the stereotype that women do not belong in IT/CSRF, but also puts them at a comparative disadvantage when pursuing such subjects at a postsecondary education level, as their male peers already have tech experience. Another hurdle to female enrollment and retention involves sexual harassment and discrimination at many tech companies. A striking example of this came to light in February of 2017, when Susan Fowler, an ex-software engineer at Uber (a taxi-tech company), alleged that the company allowed rampant harassment of its female employees (Kuchler, 2017). The same article details Fowler's experiences of sexual advancements by a manager, and cites that the percentage of women engineers declined rapidly over 2 years. Trae Vassallo and colleagues from the Women in Tech initiative explain that Fowler's experiences are not outliers (Vassallo et. al, 2017). Their findings gather insight from hundreds of women within the Silicon Valley tech community. The results of their survey are detailed below in Table 1. [1]

Table 1: Survey of women in IT/CSRF within Silicon Valley

NEGATIVE EXPERIENCE	**PERCENTAGE OF WOMEN WHO HAD NEGATIVE EXPERIENCE**
Excluded from networking events because of gender	66%
Experienced questions to male peers that should have been addressed to them	88%
At least one unwanted sexual advance	60%
Multiple unwanted sexual advances	50%
Afraid of personal safety because of work-related issues	33%

Not satisfied with course of action taken by management after reporting	60%

The most notable component of this literature is that women reported feeling more secure among female coworkers. This highlights the need for more women in the industry to serve as role models, whistleblowers, and leaders to show that they are capable of performing to the same level of their male peers. Indeed, the aforementioned report from Ellen Spertus at the MIT AITR concludes that this lack of women results in a vicious cycle that deters female newcomers to the field (Spertus, 1991, p. 5). She adds that it ultimately contributes to the chilling effect that hurts female participation in the tech industry. Furthermore, this problem creates an economic issue. The aforementioned Center for Women in Information Technology study cites that at current graduation rates, U.S. computing graduates can only fill about 30% of high-skilled IT jobs (National Center for Women in Information Technology, 2012). It corroborates that women remain an untapped resource for filling these positions.

Despite the seemingly obvious issues in post-graduate tech, research suggests that the problem manifests in early education. This makes the population young women at the middle/high school level. A report compiled by the Southern Poverty Law Center reveals that girls begin losing interest in pursuing IT/CSRF during middle school (Southern Poverty Law Center, 2012, p. 2). The same study furthers that cultural stereotypes of IT/CSRF being “men’s fields”, stereotypes that women aren’t good at STEM (science, technology, engineering, and mathematics), and an erosion of confidence in personal abilities are what deter young women from pursuing IT/CSRF. Kamla Modi and colleagues from the Girl Scout Research Institute provide what is likely the most startling statistic on female retention from grade-school to post-secondary education and beyond – 74% of high school girls across the United States are interested in fields related to IT/CSRF, but only 20% enter the tech industry (Modi et. al, 2012, p. 2). Their research also suggests that female students who are seriously interested in STEM related fields such as computer science appear to have better support networks and resources available to them. These include mentors, supportive parents and teachers, opportunities to meet people from STEM fields, and events/competitions/clubs that are related to their field of interest (Modi et. al, 2012, p. 10). Further results from the national survey of young women in middle/high-school are compiled and included in Table 2. These results compare answers between female students who are interested in STEM, female students who are not interested in STEM (NON-STEM), and the percentage disparity between the two groups. [5]

Table 2: Survey of young female students’ interest in STEM

SURVEY QUESTION	**STEM**	**NON-STEM**	**% DISPARITY**
“Whatever boys can do, girls can do”	97%	91%	6%
“I’m smart enough to have a career in STEM”	68%	63%	5%
“If I enter a STEM field, then I will have to work harder than a man to be taken seriously”	57%	N/A	N/A
“I would feel uncomfortable being the only girl in a group or class”	47%	N/A	N/A

As seen in Table 2, the common link between higher confidence, ability, and ambition of the STEM-interested students is that they have access to resources in STEM fields. In essence, the literature posits that girls who are not interested in STEM experience a lack of peer support, opportunities/resources to do things related to computer science (such as coding), or school clubs/activities where they could gain a better conception of what the field is about.

In short, the lack of women in tech is a problem to be addressed at the middle/high-school level, and the report suggests that providing resources and programs to improve female STEM retention at schools is the key to improving postsecondary retention. For example in its annual report, the Freehold Regional Schooling District (FRSD) details how a record few female students (350 out of a total female population of 6,000) surveyed had any interest in pursuing IT/CSRF (Freehold Regional High School District, 2016, p. 4). Unsurprisingly, the district does not have a strong tech community for students to benefit from, few opportunities or events related to computer science, and there are no clubs/activities that can help foster an interest in the field. Ultimately, this means that educational institutions need to work harder in order to foster environments that encourage women to enter IT/CSRF. This is something that, according to the research of Spertus, will help to balance out the gender gap in tech and encourage more women to enter the industry (Spertus, 1991, p. 5). In cases such as the FRSD, it will help to embolden a generation of young female computer scientists to actualize their potential as engineers, thinkers, students.

Paradigm

The lack of women in tech, specifically at institutions such as FRSD, needs to be solved for two key reasons. First is detailed in the aforementioned experiences of Susan Fowler and backed by the research of both Ellen Spertus and Sarah-Jane Leslie. A lack of female workers leads to a vicious cycle where women are discriminated against and deterred from engaging in the industry (Spertus, 1991, p. 10). Thus, fostering a culture and community of women in tech helps to combat oppressive behaviors by providing role models, support networks, and displaying that women are capable of performing the same jobs that men are. Second, as detailed previously in the NCWIT study, there is a crisis in the industry where only 30% of IT/CSRF careers can be filled at current graduate rates (National Center for Women in Information Technology, 2012). However, the same report from the National Center for Women in Information Technology concludes that women remain a potential source for filling these jobs. Thus, ensuring that more women enter the tech industry has the dual purpose of ensuring that companies can hire adequate numbers of IT/CSRF laborers, as well as providing high-paying jobs (U.S. Equal Employment Opportunity Commission, 2016, p. 3). Despite these daunting statistics, there are model programs to emulate. The most successful of these (discussed later), is the national program "Girls Who Code", which seeks to improve the gender gap of women in computer science through mentorship programs, and summer workshops, at local high schools across the country. Microsoft TEALS is another national middle/high school outreach program that connects students to technology-literate instructors, and aims to spark interest in computer science at the local level.

Section 1. Prominent Researchers

<u>Sarah-Jane Leslie</u> [2]

Sarah-Jane Leslie, professor of philosophy and education at Princeton University conducted a study to determine why women did not enter STEM fields as often as their male counterparts. It is a national meta-study compiled from academics of 30 disciplines in STEM, and data from over 5000 women at various educational institutions/fields (Leslie, 2015, p. 263). This report finds that the most common factor inhibiting women from entering STEM are "belief scores", or the quantity of self-perceived qualifications that an individual possesses for a certain task (Leslie, 2015, p. 264). These "belief scores" are the most important indicator for retention and success of women in any field. Leslie's study found that if an employment opportunity requires ten qualifications, and a male candidate possesses five, then he is likely to apply for the position (Leslie, 2015, p. 264). However, a female candidate is less likely to apply out of a perception that she is "not qualified enough", even if she possesses the same number of qualifications as her male counterpart, (Leslie, 2015, p. 264). Professor Leslie isolates other factors, such as socioeconomic status and race, to discover that this lack of confidence is the strongest explanation why women do not pursue educational paths or careers in STEM (Leslie, 2015, p. 265). Leslie's research ultimately provides a thorough explanation of why females do not enter IT/CSRF, which can be used to tailor a list of solutions.

<u>Rosemary L. Edzie</u> [3]
Furthermore, Rosemary L. Edzie from the University of Nebraska-Lincoln attempted to provide solutions to the lack of women in STEM. Edzie's study employed mixed-methods sequential exploratory research study that surveyed hundreds of female STEM enrollees across the nation, and then compiled the results into a cohesive analysis. Her report echoes Dr. Leslie's; there is a statistically strong relationship between self-efficacy and persistence in a given field (Edzie, 2014, p. 12). Her research goes one step further to explain why the confidence gap exists – a lack of female peers and role models to depend on, limited access to pre-STEM exposure due to societal norms discouraging girls to explore STEM, and limited support from teachers/mentors (Edzie, 2014, p. v). The report concludes that mentorship opportunities, higher numbers of female educators and role models, community events that improve morale to pursue career paths, and networking tends to build confidence in young women to pursue IT/CSRF, and thereby reverse the effect of gender inequality (Edzie, 2014, p. 23). In essence, Edzie's report gives a thorough analysis on the root causes of women in technology. Her suggestion to foster community mentorship programs, encourage female role models, and host community events such as hackathons are the correct path towards fighting the gender gap in tech.

<u>Ellen Spertus</u> [4]
Ellen Spertus is a researcher writing in the MIT Artificial Intelligence Technical Report (AITR). In her report, she used established psychology, surveys in the form of news groups directed at women in computer science (out of a sample size of 150 responses), and data from nationwide studies conducted with at least 1200-response sample sizes. (Spertus, 1991, p. 77) Based on her data, she gives two primary reasons explaining the lack of women in computer science. Her first explanation describes how gender roles and stereotypes disproportionately affect women (Spertus, 1991, p. 12-17). She gives examples about how "career-related success" actually deters women from pursuing computer science out of a self-conscious bias towards "outperforming" male peers, concerns about being "normal or feminine" since "being a nerd isn't girly", and self-denial of one's abilities in the face of success ("Imposter Syndrome") (Spertus, 1991, p. 16). Her second explanation details how sexist humor, uncomfortable "locker-room atmospheres" (where women are constantly harassed by male peers), and breakdowns in communication between

peers (i.e. Women who begin comments "hesitantly" are perceived as "unfocused or unsure") lead to environments which discriminate against female computer-scientists (Spertus, 1991, p. 21-24). This can be clearly seen in the recent case of Susan Fowler, who experienced and reported all of the problems that Spertus discusses in her paper (Kuchler, 2017). Despite these problems, Spertus's research generalizes that educational institutions need to focus on three things in order to combat the gender gap in the tech industry (Spertus, 1991, p. 50). First is overcoming the aforementioned "Imposter Syndrome" through instilling a sense of self-affirmed confidence (Spertus, 1991, p. 51). Second is to promote female mentorship programs that establish role models (Spertus, 1991, p. 53). Third involves creating "fellowships" or special programs set up to promote women in tech, and provide resources to help them succeed in the face of unequal hardship (Spertus, 1991, p. 55).

Modi Et. Al [5]
Kamla Modi, Judy Schroenberg, Kimberlee Salmond, and other colleagues from the Girl Scout Research Institute conducted original quantitative and qualitative research in order to understand the causes of female underrepresentation in STEM fields, which encompasses IT/CSRF (Modi et. al, 2012, p. 31). The qualitative research draws data from eleven focus groups in diverse communities across the United States, in collaboration with local Girl Scout chapters (Modi et. al, 2012, p. 31). A total of 140 girls from a mix of racial/ethnic backgrounds participated in the focus groups. The quantitative research surveys a national sample of over 850 young women aged 14-17, all from diverse backgrounds and ethnicities at a statistically significant 95% confidence level (Modi et. al, 2012, p. 31). Their research concludes that although 74% of young women across the country are interested in STEM fields and subjects, many of them are deterred from entering STEM fields due to a few key factors. First involves stereotypes of girls "being bad at math and science" (Modi et. al, 2012, p. 6). Second is that workplace environments are inhospitable to the needs of women – the study cites that women comprise 20% of post-secondary engineering graduates, but only 11% practice engineering in the country (Modi et. al, 2012, p. 7). Even worse, only 26% of women with a STEM college degree have entered a STEM career (Modi et. al, 2012, p. 7). Modi et. al concludes that there are a three main ways to reengage young women with STEM (and IT/CSRF) (Modi et. al, 2012, p. 29). First is to encourage young women to "ask questions about the world, problem solve, and use natural creativity" (Modi et. al, 2012, p. 29). Second involves fostering "internal assets" such as self-esteem, initiative, and work ethic through tutoring and mentorship (Modi et. al, 2012, p. 29). Third is to expose and maintain interest in STEM over time so that young women are able to see it as a viable study and career option (Modi et. al, 2012, p. 29).

Section 2. Models of Success

Girls Who Code
Next, Girls Who Code runs a highly successful model program that can be replicated locally at the middle/high school level. Girls Who Code is a national non-profit organization dedicated to closing the gender gap in IT/CSRF. It correctly identifies that women "drop out" of pursuing computer science programs between the ages of 13-17, and tailors its approach to fostering a number of programs for young women in local school communities (Girls Who Code, 2015, p. 2). According to the 2015 expense report, the organization maintained expenses of around $6.7 million, and assets (through the form of grants/donations from individuals, schools, companies, and local governments) at about $16.5 million – doubling its assets from the 2014 fiscal year

(Girls Who Code, 2015, p. 8). This means that the entire national organization maintains about a $10 million net profit, and is still growing as a very lucrative model for empowering young women in IT/CSRF. Indeed, this is seen through the 57 top tech companies such as Google, Facebook, and Amazon that have pledged to hire Girls Who Code alumnae (Girls Who Code, 2015, p. 3). Women who leave the Girls Who Code program are 67% more likely to pursue a major in IT/CSRF, and the number of program students has grown from less than 1000 in 2013, to over 11,000 in 2015 (Girls Who Code, 2015, p. 2). Girls Who Code has established itself in school communities across the United States, from Seattle to Newark (Girls Who Code, 2015, p. 2). Indeed, this seems to be a very successful model to emulate. The main program, called the "club program", offers free weekend/after-school mentorship for 6-12th grade girls, along with "all the resources necessary to run them" such as computers, internet access, etc. (Girls Who Code, 2015, p. 3). Club programs encourage and teach young women of all technical skill levels to use computer science to positively impact their community, and are held in two-hour sessions in schools, libraries, and community centers. Such activities include teaching beginner coding projects and hands-on tutoring from one of the 10,000 Girls Who Code alumni mentors (Girls Who Code, 2015, p. 4). The report finds that each club program costs approximately $1,600 to run over the course (September - May) of an academic year, and all 350 hundred local club programs have had 100% success of being fully funded by contributions from local colleges, businesses, and individuals alongside government grants (Girls Who Code, 2015, p. 8). The results of the clubs is apparent, as 65% of participants say they are considering a major or minor in IT/CSRF because of Girls Who Code – an increase of 32% from the average (Girls Who Code, 2015, p. 4). Ultimately, Girls Who Code provides a successful model for use in improving the participation of women in tech at FRSD.

Microsoft TEALS

Finally, Microsoft TEALS (Technology and Education Literacy in Schools) runs a similar program to Girls Who Code – albeit co-gender and with more cooperation between the program and local school district administrations (Microsoft, 2016, p. 2). The TEALS program aims to improve computer literacy and provide opportunity by teaching beginner-mid level computer science literacy to students through in-school teacher partnership programs - these are typically over the course of an academic year (Microsoft, 2016, p. 2). It does not charge fees from partner schools, but asks them to distribute stipends and reimbursements to volunteers for travel and support (Microsoft, 2016, p. 2). The total cost is $5000 per program per year, and each school typically has one program (Microsoft, 2016, p. 2). The partner schools provide supplies, and students are encouraged to bring their own laptops to code and learn on (Microsoft, 2016, p. 2). Additionally, educational resources such as coding tutorials, textbooks, and programming tools are provided for free download in the courses (Microsoft, 2016, p. 6). Computers are provided through school media centers and libraries, similar to the proposed method in this paper (Microsoft, 2016, p. 2). TEALS usually provides 2-4 volunteer instructors to teach and assist local teachers in providing a computer science education, and it assumes that partner teachers have no-entry level computer science knowledge (Microsoft, 2016, p. 2). Perhaps the most notable aspect of the TEALS program is its ability to recruit numerous volunteers. The program details that partner school alumni, local tech businesses, city economic development councils, and local colleges often provide more than ample numbers of volunteers when prompted by a letter, email, or phone call (Microsoft, 2016, p. 11). These volunteers receive brief vetting to ensure that they are computer-literate (similar to the program proposed in this paper), and are then connected with partner schools (Microsoft, 2016, p. 11). Although an official budget could not be found, it is safe to assume that the program at least breaks even as it has been able to expand 450% since its inception in 2009 (Microsoft Philanthropies, 2017, p. 2). Overall, the program has found vast success; Over 80% of teachers found TEALS volunteers helpful in learning CS content, TEALS students scored 10% higher on standardized computer science exams and courses, 750 volunteers from over 400 different companies joined the program to teach computer science, and over 2700 female/underrepresented minority students received an education through the program (Microsoft Philanthropies, 2017, p. 2). Ultimately, the TEALS program is wildly successful and many aspects of its model, including partnerships with local schools, recruiting/vetting volunteers, and providing a competent computer science education to young women all inspire aspects of the program suggested in this paper.

Plan

Section 1. Overview & Timeline

<u>Overview</u>

The plan is to focus on the FRHSD local middle/high school community in New Jersey, begin a comprehensive, beginner-friendly instructional program that aims to pique interest in IT/CSRF among young women, and ensure that they receive ample opportunities to pursue the field. This paper proposes an afterschool instructional program in the problematic Freehold Regional School District. The program draws elements from Girls Who Code and Microsoft TEALS. The instructional program will be have two classes – one for middle and one for high school students. It will be launched in coordination with the FRSD administration in October of the 2017 academic school year, and it will end in in April of 2018. It will be funded by the Google Educational Research Grant under the grant's premise of "expanding computer science education in local communities" (Google, 2017, p. 1). There are several steps involving logistics, planning, volunteer recruitment, processing, advertising/announcing, and finally launching the program that are all summarized in Table 3, and discussed in detail underneath.

<u>Timeline</u>

Table 3: Plan outline

TASK	OBJECTIVE	TARGET DATES
Work with FRSD staff on logistics	This is the initial setup process piques interest and allocates classrooms, times, students, and supplies for next academic year.	May 21 – October 23, 2017
Advertise program to FRSD students and instructors at local colleges	The methods of advertisement have been described in the budget justification. Additionally, clubs and organizations such as the Undergraduate Student Alliance of Computer Scientists (USACS) at Rutgers	June 10, 2017 – September 31, 2017

	University already have a teaching program in place at the HEROES Academy in New Brunswick, as well as a surplus of volunteers. Advertising will be done in coordination with the USACS Community Outreach Chair and Social Media Chair.	
Process Applicants	The program will process and organize applications for both students and instructors.	October 1 – 10, 2017
Announcements	The program will send out confirmations to both instructors and students, telling them which school to go to as well and clearing up logistical questions.	October 17 – 25, 2017
Launch	The program will launch and start teaching the fundamentals of computer science to young women across the FRSD.	October 31, 2017 – April 30, 2017

Section 2. Steps

Cooperation

The very first step involves outreach from program architects such as myself to FRSD administrators, and will take place from May 21-30. This includes the Principal/Vice Principal, FRSD School Board, FRSD Computer Science/Technology Education teachers, and many more. The Microsoft TEALS program provides an in-depth explanation of this outreach phase (however, this program will be organized by an external group – myself and WECode); “Schools that send a standalone email to their school community typically have great success in finding interested and qualified volunteers. You can send the letter from the principal at the school-level or from the superintendent at the district-level” (Microsoft, 2016, p. 11). Reaching out to administrators and pitching the mentorship program, especially after displaying models of success that are revenue-neutral or positive will show administrators that there exists a pressing issue that needs to be solved, that there is a viable plan, a way to fund that plan, demand for the program at some level, and finally a way to track the results (as explained in the next few steps).

Planning/Logistics

The next step (from June 10, 2017 – September 31, 2017), involves planning and coordinating logistics with the FRSD school community on setting up the program. Many of the logistics regarding the school district and schools are based on my own experiences in attending the FRSD school system from the K-12 levels. The architects of the program (myself and WECode) would host in-person and virtual meetings with FRSD administrators and organizers twice each

month, starting in June to ensure that everyone is up-to-date and ready to implement the stages of the program. There are five steps involved in this process.
The first step is determining which schools should host the program, as the FRSD district encompasses multiple high schools and middle schools. The most likely candidates are Freehold Township High School and Manalapan High School for high school mentorship, and Barkalow Middle School for middle school mentorship. This is because of their centralized locations and large, advanced libraries and media centers.

The second step involves coordinating with the official academic and school schedules on allocating dates and times for library/media center use. It is unlikely that many school organizations use the entire media center afterschool, and even if they do, they do not meet every day of the week. An example mentorship program would occur every Monday/Wednesday afterschool from 3:30 pm – 5:30 pm in Freehold Township High School/Barkalow middle school. During these classes, a group of students (ranging from 10-40 students) would split into groups between 2-4 instructional volunteers (per program) and learn in a basic classroom style. This involves the teacher explaining concepts on a whiteboard, projector, or desktop sharing, and then encouraging students to try the concepts on their own. According to Microsoft TEALS, the best results were found when instructors were given a weekly topic and allowed to use their own teaching style adapted to the needs of the students (Microsoft, 2016, p. 13). Additionally, about 1-2 hours of instruction is ideal for retaining younger students' attention, and ensuring that they get out in time for dinner (Microsoft, 2016, p. 12). As a side note, it is usually prudent to avoid hosting afterschool programs on Fridays, as the FRSD afterschool bus system usually does not run on Fridays. Parents can drive or carpool students if the program is not hosted at their middle/high school.

The third step builds an advertising campaign with the help of the school administration, local students, and parent organizations. Much of this involves morning loudspeaker announcements, flyers on school boards as well as guidance/main/teacher offices, advertisements on the school/district website, and word of mouth. The Microsoft TEALS handbook writes that cooperating with teachers and guidance counselors is usually the most effective way of organizing advertising campaigns, as both groups have a grassroots way of advertising within their school communities (Microsoft, 2016, p. 12). The end goal of the advertising should be to inform students, teachers, and parents about the program so that they can spread it via word of mouth (Microsoft, 2016, p. 13). Ultimately, Microsoft TEALS ranged from 10-40 applicants per program, so this program expects the same.

The fourth step involves selecting course and curriculum material. Over the course of the program, students will have 40 afterschool sessions, split over 20 weeks from November - April (after accounting for breaks and other holidays). Since the course is catered for novice computer science students, it will need to be simple, yet efficient. The most effective teaching method involves cycling the curriculum (i.e. switch from internet one week, to data structures/algorithms the next). As such, about 10 instructional sessions will be devoted to each of the four basic subjects. They are basic programming, rudimentary algorithms and data structures, Internet technology, and problem solving. These will be slightly adjusted between the middle/high school programs, but will still cover the basics. For programming, Java is an easily installed, comprehensive programming language that is popular, simple to learn, and widely accessible.

Simple algorithms/data structure lessons are widely accessible via Khan Academy, AP Computer Science curriculum, and the volunteers. Volunteers will teach Internet literacy, as it is difficult for students to learn from Internet resources if they do not know how to use the Internet. Finally, problem solving will be drawn from free, online resources such as “Cracking the Coding Interview” (by Gayle McDowell), “Blown to Bits” (by Abelson, Ledeen, Lewis), and the Khan Academy. Additionally, instructors are allowed and encouraged to create problems that cater to their specific group, as this allows students to develop at their own pace (Microsoft, 2016, p. 10).

The fifth step involves allocating, subsidizing, and preparing volunteers for their class assignments. This will be discussed in detail in the next section.

Advertising Volunteer Recruitment/Vetting

This step will take place from June 10, 2017 – September 31, 2017 (a month before the program launches). Competent volunteers are the backbone of the program, so ensuring that students receive the best mentors is key. Mentors will preferably be women from local universities. Alumni, teachers, and industry professionals are also welcome. According to Girls Who Code, volunteers should be over the age of 18, available 5-6 hours per week (including travel and prep time), comfortable learning alongside their students, and are passionate about the program’s mission to promote women in tech. (Girls Who Code, 2015, p. 1).

As discussed in Table 3, the Rutgers University Undergraduate Student Alliance of Computer Scientists (USACS) already has a university-level mentorship program that (from my own experience as a USACS officer) boasted 200 mentees and 100 mentors in its year of launch. That number of mentors is steadily growing as more USACS mentees are encouraged to contribute back to their community and become mentors. Ultimately, the instructional program at FRSD can draw from this huge pool of mentors for a few reasons. First, many Rutgers University mentors have experience in teaching basic concepts to their mentees. These include programming, data structures, algorithms, and problem solving. Second, the FRSD is a 30-minute drive from Rutgers University, making travel to and from the instructional program quick and convenient. Third, USACS has been focusing efforts in recent years to expand diversity and outreach outside the Rutgers computer science community (RCSC), and the FRSD instructional program is a perfect opportunity for such outreach. Fourth, the RCSC is already very enthusiastic about promoting women. An example of this is HackHers (organized by Rutgers Women in Computer Science), a 24-hour coding event held for members of the Rutgers community with the goal of promoting women in computer science (De, 2017). This coding event drew hundreds of women and over 600 competitors from the community (De, 2017). It also fostered relations, taught novices how to code, and promoted women in tech (De, 2017). In essence, many members of the community would be enthusiastic in volunteering for the instructional program, judging from the success of established efforts at the university level.

Furthermore, there must be some way to advertise the need for mentors to the RCSC. This is likely easier than advertising the program to middle/high school students in FRSD, as the RCSC has a weekly newsletter sent out to all members of the community. Incorporating the need for mentors in this newsletter would be the best way to advertise for volunteers. Additional advertising routes include reaching out to the RCSC network of alumni, collaborating with the USACS Social Media Chair on advertising via social media, asking members to volunteer at weekly USACS meetings, and making announcements before the start of IT/CSRF classes. Perhaps there can be more incentives if Rutgers offers course-credit for participating in the instructional program, but that is up to the Rutgers administration. Ultimately, the instructional program only needs 10-20 mentors to run, something that is easily within the grasp of the RCSC.

Additionally, we can advertise to members of the greater tech community. Companies such as Microsoft, Facebook, and Google already send mentors through TEALS (Microsoft, 2016, p. 9). In fact, the TEALS handbook suggests reaching out to partner schools (like the FRSD) to recruit local members; "While TEALS does high-level recruitment nationally and regionally, we require our partner schools to actively participate in recruiting local volunteers" (Microsoft, 2016, p. 11). Collaborating with FRSD in recruiting local volunteers, such as reaching out to alumni or technology-education teachers is a good way to start local support networks and volunteers for the instructional program.

Finally, volunteers will be vetted on proficient computer science knowledge. For Rutgers students, this involves proof that they passed basic CS courses such as Intro to Computer Science and Data Structures. For non-Rutgers individuals, this means taking a basic proficiency test. TEALS sets some basic standards knowledge for data structures/algorithms, programming, Internet use, creativity, and capability as an instructor (Microsoft, 2016, p. 11). At least one architect of the instructional program will vet and interview each volunteer candidate, either via virtual call or in-person. School administrators are strongly encouraged to sit in and participate in the interviews.

Advertising/Announcing/Processing

While advertising towards both students and volunteers was discussed at length previously, the time frame was not. The program will be aggressively advertised (by both FRSD and the architects) starting in June of 2017. These advertisements will continue up to September 31st, the last day for young women to register for the afterschool instructional program. A logistics team of architects and FRSD staff will formed by the end of June, and will be dedicated to processing and organizing the applications. Although the program technically begins on October 31st, it is prudent to allot a month for the final stretch of organization and logistics, such as determining which instructor the students will receive, and perhaps accepting late applications. From October 1 – October 10, the program will process applicants and allot them an instructor and instructional location. From October 17 – October 25, the program will send confirmations to both instructors and students via email. They will be told which program to attend. The logistics team will also answer any questions that students or instructors may have.

Launch

On October 31, 2017, the program will launch. It will continue until April 30, 2017 for a total of 40 lessons (accounting for breaks and holidays). The program will end in time for finals, so that both students and instructors will be able to prepare for final exams. Additionally, students may take days off for health or study purposes.

Measuring Success

Perhaps one of the most important parts of the program – the logistics team will shifts its focus after program launch to craft email surveys and send them out to students/parents on a monthly basis. Additionally, instructors will quiz students on the curriculum, satisfaction, and interest in pursing computer science at least twice a month (the grades will only be used for analytic purposes). These grades will keep track of students' progress in each of the four basic topics over time, as well as their interest in IT/CSRF. The logistics team will keep track of students' progress over time, and email them an optional progress report at the end of each month. Ultimately, the surveys are an easy way to keep track of both the students and the overall program. They can be used as a data point to promote future instructional programs at more schools.

Price

Overview

The budget for the plan is very simple since instructional material involves basic teaching supplies, volunteer subsidies for travel, and additional computers for instruction. The patron, Google's Educational Research Grant, funds this.

Budget

Table 4: Budget Outline

ITEM	QUANTITY	UNIT PRICE	TOTAL
Lenovo M23 Chromebook laptop	30	$179.00	$5370.00
Transportation (gas, bus, train, etc.) subsidy for mentors/teachers (maximum subsidy allocation per week)	60	$30.00	$1800.00
Teaching supplies (whiteboard markers, notepads, pens, pencils, etc.)	a. 144 dry-erase markers b. 3 large dry-erase whiteboards c. 120 notepads d. 300 pcs. Chalk e. 432 pencils w/ erasers	a. $73.98 b. $82.08 c. $86.60 d. $29.40 e. $29.97	$302.03

Budget Justification

FRSD is a large schooling district, so a few centralized schools that are close to the others for afterschool activities such as Freehold Township High School and Manalapan High School will be ideal locations. Both of these schools have large media centers/computer labs, so there will be widespread access to computers. Despite this, the budget allocates 30 Lenovo M23 Chromebook laptops for emergency situations in which the media center is either preoccupied or the computers are not working. Additionally, the members of the program will be encouraged to bring their own laptops and coding devices for optimal learning. All of these measures are taken to ensure that each individual student is not left without a computer to learn from, and can always participate in the day's activities. Another benefit of the program is that the instructors are volunteers from local colleges, which means that they do not need to be paid a salary. However, travel subsidies are allocated in the event that instructors need financial support for gas, train tickets, bus tickets, etc. This is done to ensure that the instructors are not only able to access the event, but also so that they are incentivized to keep coming. In fact, previous afterschool learning programs such as TEALS, and Girls Who Code see a surplus of volunteer instructors and have to ration them because travel is covered and people are eager to teach the next generation of students. Finally, the budget allocates for basic instructional supplies. Afterschool tech programs are very cost-effective namely because they don't require any resources beyond a computer and teacher to teach basic skills such as coding, data structures, etc. However, chalk and whiteboards are allocated in the event that the media center/library does not have them for instructional use. Additionally, students may need to etch out concepts using a traditional pen/notepad. These are provided as well. Finally, advertising costs are essentially free for two reasons. First, Freehold Township High School and Manalapan High School have built-in advertising systems such as morning announcements, advertising boards in hallways, and approved afterschool programs on the club website. Second, website setup and hosting is both easy and free with a somewhat competent web-developer, such as a volunteer from one of the local university clubs.

Discussion

Measure of Success

As discussed before, the instructional program at FRSD will use both email and in-person surveys. The email surveys will be sent at the end of each month. Additionally, instructors will quiz students on the curriculum, satisfaction, and future interest in computer science at least twice a month. The quiz grades will be collected and analyzed for improvement in computer science proficiency over time, program satisfaction, and future interest in computer science over time. Finally, instructors themselves will be surveyed at least once a month to see how satisfied they are with the course curriculum, program direction, and suggestions for improvement. Their feedback will be recorded and analyzed. There are multiple advantages to using surveys and quizzes for feedback. First, they are easily accessible, quick to complete, and anonymous. Second, they provide very valuable data on subtle program improvements over the course of its implementation. Third, feedback can be used to empirically gauge important data such as proficiency, satisfaction, and interest over time. Fourth, expanding the instructional program will require proof of success – most likely in the form of survey statistics among many other datasets.

Benefits to young women at FRSD

There are numerous benefits to young women at FRSD, as quantified by both Girls Who Code and Microsoft TEALS. First, they receive a satisfactory computer science education. This is important because only 10% of schools offer any for of computer science classes, which means that the vast majority of students, especially women, don't have access to a proficient computer science education (Microsoft, 2016, p. 22). Outreach such as the instructional program help to fill that void of a competent computer science education for those who need it most in our communities. Second, the students in the instructional program are exposed to role models such as their instructors. These role models can inspire students to view computer science and tech as an accessible and acceptable field for women. Third, this helps to overcome the "confidence gap" seen in the research detailed previously. If young women are able to receive an adequate computer science education and have success in subjects previously thought to be impossible, then it is likely that they gain confidence in pursuing computer science as a career. Girls Who Code documents these benefits in their own program. In 2016, Girls Who Code boasted about 27,600 female students, and 84% stated they were likely to pursue a career in tech, up from the average of 32% (Girls Who Code, 2016, p. 6).

Benefits to women in tech

Improving the enrollment and retention of women in the tech industry is likely an arduous process – but it can be accomplished. Since women between the ages of 12-17 are the most likely to drop out of a career in tech, then focusing on that younger demographic of prospective female tech workers ensures that there are more women entering IT/CSRF at the postsecondary level (Modi et. al, 2012, p. 31). Ellen Spertus writes that more women in the industry helps to foster more inclusive environments, stimulate the flow of fresh ideas, and inspire more women to entre the industry (Spertus, 1991, p. 50). In essence, focusing on inspiring the next generation of women in computer science at the middle/high school level helps to make the industry a better place for women as a whole.

Short-term goals (1-year)

The short-term goal of the instructional program is multifaceted. First is to improve the number of young women who are interested in computer science from around 30% (cited previously) to around 60% Doubling the number of women interested is a reasonably feasible task given the success of paradigm models. Second is to provide an adequate computer science education to the students within the instructional program – something detailed in the paradigm and plan sections of this proposal. Third is to spark an interest in computer science within the FRSD. This way, even if the program does not continue past its initial year, the community is at least aware of the problem concerning women in tech. Finally, the last short-term goal of the program is to provide female role-models that inspire women. According to Rosemary Edzie, seeing female peers who have succeeded can inspire younger generations to do the same (Edzie, 2014, p. 23).

Long-term goals (1-year)

There are two simple, long-term goals of the program. The first goal is to improve the interest, enrollment, and retention of women past postsecondary education. The NCWIT cites that only 18% of undergraduates in IT/CSRF are women (National Center for Women in Information Technology, 2012, p.16). Meanwhile, Dr. Mokter Hossain writes that female computer science enrollees have been dropping steadily (Hossain & Robinson, 2012, p. 444). The second long-term goal of the instruction program is to expand to other schools within the state of New Jersey, and inspire more young women to pursue IT/CSRF. This will help to combat the worsening gender gap within the tech industry, according to Spertus (Spertus, 1991, p. 50).

Conclusion

Ultimately, the afterschool computer science program held at Freehold Township High School and Manalapan High School will provide young middle and high school women the skills, attitude, and motivation to succeed in an industry with poor gender performance. Modi Kamla et. al from the Girl Scout Research Institute write in a report that afterschool programs such as this are the key to ensuring that young women do not fall behind in the tech surge, and are able to access opportunities on the same level as their male peers. The endemic problems that deter women from computer science, such as poor confidence, a lack of resources, and transparent role models are all mitigated or solved in part by this program. Similar initiatives such as Girls Who Code have seen growing net surplus of revenue, over 100 more women per program interested in pursuing computer science, and an overall 40% increase self-confidence. This program aims to achieve similar results by using the same methods. With a model of success, it may be possible to replicate the program across New Jersey school districts and provide an adequate computer science education that teaches and inspires young women. The next Margaret Hamilton or Grace Hopper might be able to find her inspiration in the role models provided by instructional programs like the ones offered at FRSD.

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Appendix A: Detailed Researcher Methodologies

[1] Trae Vassallo and colleagues from the Women in Tech initiative explain that Fowler's experiences are not outliers (Vassallo et. al, 2017). Their findings gather insight from hundreds of women within the Silicon Valley tech community. The results of their survey are detailed in Table 1.

[2] Professor Leslie conducts a meta-study compiled from academics of 30 disciplines in STEM. She reports that "belief scores", or the quantity of self-perceived qualifications that an individual possesses for a certain task, are the most important indicator for retention and success of women in any field. Professor Leslie isolates other factors, such as socioeconomic status and race, to discover that this lack of confidence is the strongest explanation why women do not pursue educational paths or careers in STEM. (Sarah-Jane Leslie, et al., 2015, p. 263-265).

[3] Rosemary L. Edzie from the University of Nebraska-Lincoln describes that the lack of women in computer science and STEM is a "national crisis. She surveys thousands of educators, students, and researchers and compiles their results into a cohesive analysis. The report concludes that mentorship opportunities, higher numbers of female educators and role models, community events that improve morale to pursue career paths, and networking reverse the effect of gender inequality (Rosemary L. Edzie, 2014, p. 20-23).

[4] Ellen Spertus from the MIT Artificial Intelligence Laboratory Technical Report (AITR) conducted a national study of over 60 educational institutions, 6 developmental psychologists, and hundreds of women in the field to determine why there are so few women in the tech industry. Her research noted that the cultural biases against women pursuing careers in IT/CSRF are deeply rooted in societal and educational institutions (Spertus, 1991, p. 1).

[5] Kamla Modi and colleagues from the Girl Scout Research Institute provide what is likely the most startling statistic on female retention from grade-school to post-secondary education and beyond – 74% of high school girls across the United States are interested in fields related to IT/CSRF, but only 20% enter the tech industry (Modi et. al, 2012, p. 2). Further results from the national survey of young women in middle/high-school are compiled and included in Table 2. These results compare answers between female students who are interested in STEM, female students who are not interested in STEM (NON-STEM), and the percentage disparity between the two groups.

[6] William Gaudelli from the University of Central Florida gives a nuanced perspective on teaching young students about technology and CSRF. He writes that teachers and mentors must be flexible and adapt to new trends within the tech community. He concludes that industry professionals and older college mentors might have an edge due to their daily use of resources such as coding languages, frameworks, and community networking (Gaudelli, 2006, p. 110-114).