MOTIVATE: An Opportunity to Impact African American High School Girls

Introduction

As of 2010, across all science and engineering (S&E) degree levels and fields (including physics, mathematical sciences, and CS), 26.4% of the labor force with S&E degrees is older than age 50, and by age 61, about half of the general S&E labor force will no longer be working full-time [25]. This statistic highlights the fact that the S&E workforce is aging (and growing slowly), requiring that a substantial number of S&E jobs be filled in the coming years. The US has also recognized that the lack of a diverse workforce compounds this shortage of talent and is cause for additional alarm. The lack of diversity results in a loss of innovation and range of perspectives and expertise, reducing our Nation’s capacity to address the mounting technical challenges needed for future growth. Specifically, women continue to earn CS degrees at low levels. In 2008, of the roughly 20% of women who were awarded bachelor’s degrees in CS, only 5% were minority women [33]. This lack of ethnic diversity within gender diversity compounds the exigent need to promote and support minority women into the S&E pipeline.

In this paper, we describe a framework for educational African American (AA) high school girls. To make computer science education more inclusive, it is important that it appeal to diverse students, particularly African Americans. Our framework – which we call MOTIVATE – is based on a combination of factors that, taken individually, have been shown to positively impact computer science students. The MOTIVATE framework is designed to investigate how to best attract and retain African American (AA) girls to computing, and it will also enable the collection of data that will provide further insight into this unique population. As a result of this research, the MOTIVATE framework will serve to (1) implement a program for high school-aged AA girls learning CS, (2) collect data on the experiences of AA girls in high school to understand the set of factors that contribute to their attraction to and retention in CS, and (3) disseminate the validated program to support geographically diverse AA girls.

Using the MOTIVATE framework, we will investigate the following research question:

How can we broaden the participation of African American high school girls in computer science? We know that the numbers of women and minority students of computer science is low, and there are few indicators of what makes these students more inclined to show interest and even participate in classes that teach computing. Using the MOTIVATE framework, we expect to include a large number of AA girls in our camps, which is a feat unto itself. We will also engage our program participants in richly qualitative and evaluative analyses that will help us develop empirical-based rationale for what encourages AA girls to persist and succeed in learning computer science. This result has wider implications in larger society as the technology sector struggles to retain expertise and insight from underrepresented groups in developing solutions that, increasingly, are being used by more diverse user groups.

Scope

We have chosen to focus our efforts on students in high school rather than middle or elementary school because of the need to provide students in high school with both an understanding of what CS is as well as adequate preparation for success upon entering college as a CS major. Though many programs focus on exposing students in middle and elementary school to CS through activities such as programming, game design, or robotics [3, 12, 24, 27], we recognize that while these programs pique student interest in CS, there are few courses in their middle or elementary schools to sustain their CS-related activities throughout the school year. Furthermore, we believe that providing CS education activities – that promote technical and non-technical development – to students in high school will ensure that they are not only adequately prepared to enter CS degree programs, but they also have the self-confidence and peer-network required to persist in the discipline. Since many high schools do not offer CS instruction, we
view the implementation of the MOTIVATE framework as a bridge that helps to transition students from their current K-12 understanding of “Computer Science” to the academic and practitioner definition of “Computer Science”.

With respect to AAs as underrepresented minorities in CS, the most recent data available reveals that in the US, 3.6% of undergraduate, 1.6% of master’s, and 1.2% of doctoral degrees were conferred to AAs [34]. Though it is expected that fewer individuals actually pursue a terminal degree in CS, it is clear that at every point in the pipeline, the number of AAs are underrepresented (in proportion to their percentage in the US) [21, 34]. One particularly popular effort to enhance the rigor of the high school math and science curricula and expand access to rigorous curriculum is increasing AP course taking in the STEM content areas. In 2012 (in the US), of the 1,014 AA students taking the AP CS exam, only 252 were women, compared to 13,320 Caucasian students and 1,976 Caucasian women students [1]. Furthermore, in the previous five years, AA women have had the lowest pass rates (score = 3, 4, or 5) of all women students taking the CS AP exam [1].

We are investigating the retention of AA girls as they represent a demographic who are among the least represented in computing even though a survey conducted by Girl Scouts revealed that AA girls have the highest level of interest in CS careers as compared to their Caucasian and Hispanic peers [23]. It is not clear why this group’s rate of degree completion (at all levels) remains disproportionately low. Through the MOTIVATE program, we expect to contribute towards the understanding of how to attract, retain, and prepare AA women in CS serving to bridge the gap between research and AA girls.

**Approach**

The MOTIVATE framework is comprised of five components, each of which is known to impact student success in education. The components are presented briefly below, with a discussion of how the MOTIVATE program integrates these three components into a singular program to serve AA high school girls. Figure 1 shows our logic model for the MOTIVATE program, including the five components (C1-C5) of the model in the activities column.

![Figure 1 MOTIVATE Logic Model](link)
Component 1: Technical Skill Development
Access and experience (or lack thereof) have long been cited as factors contributing to girls having less confidence with computers and thus not choosing to enter computing fields [2, 8, 15]. In mixed-gender environments, boys tend to dominate computer use leaving the girls to act as bystanders. As a result, boys get more experience with the computers [15]. This lack of experience manifests itself in girls reporting lower self-confidence and a dislike of computing [15]. However, research has also shown that when provided with equal access, girls perform as well as boys [15]. While there are disparities in technology access across race, gender, and even class lines, we now know that AA high-school students are interested in learning CS [13, 14]. In today’s age of Internet ‘connectedness’ through social media, and smartphone apps, students want to learn more about how to develop their ideas for these interactions. In our research, we expect to better understand those factors that contribute to the retention of AA girls in computing.

Component 2: Parental Support
School-age students spend approximately 70% of their time outside of their classrooms [4]. This presents a precious opportunity to facilitate continuing education activities for students. Parents, then, play an integral role in supporting their children’s education inside and outside of the school. Parental involvement has been shown to improve (and sustain) academic performance [19, 20], and when parents engage within the larger external school community (such as after-school programs), the students, parents, and community all benefit [9, 26, 30]. The MOTIVATE framework integrates support to parents, which will help to ensure that students maintain strong levels of commitment and engagement.

Component 3: Non-Technical Skill Development
There is evidence that attitude, self-esteem, and morale all impact student academic achievement as much as cognitive development [17, 18, 20]. These non-technical skills, also called character, can also help computer scientists solve problems. Learning CS often requires soft skills like cooperation, communication skills, discipline, and resilience, which prepare students for tackling obstacles head-on. To encourage non-technical skill development, participants will prepare presentations on a topic they have most enjoyed during the program (i.e., programming, algorithms, robotics, etc.), and they will participate in a showcase that will occur at the end of each workshop. This will give them the opportunity to self-reflect and share how they overcame challenges during the course of their learning.

Component 4: Mentoring
The effects of mentoring have long been cited as beneficial for both the mentor and the mentee: higher salary and better career satisfaction for the mentee [7, 10] and for the mentor, an enhanced reputation for developing new talent [16, 65]. There is also evidence that the degree of similarity in race and gender mentoring (whether perceived or actual) can affect the quality of the mentoring, such that the more similar one perceives the other to be, the more the other person is liked [6, 59]. In the context of CS, peer mentoring and affinity groups have been encouraged as a means to support underrepresented students [42, 56]. This peer-based model also extends to pair-programming, which helps student pairs (and sometimes groups of three) solve computing problems more efficiently and with increased confidence [5, 32].

Component 5: Informal Education
Many after-school and out-of-school programs have been shown to predict academic and social competence, particularly among middle school students [11, 29]. In fact, the structured skill-building aspect of these informal education activities helps adolescent students learn to focus in “the zone”, achieving flow, which helps them to excel academically [6, 31]. More specifically, students who report higher “flow-like engagement” in their high school math and science classes were more likely to report higher grades in college [28]. Thus, out-of-school programs afford rich opportunities for educational advancement for students. Our goal is that our participants will develop themselves in ways that will help them excel academically and socially.
Conclusion

Comprehensive approaches to broadening participation in computing, especially for those at the intersection of race and gender, should include multi-faceted programming. There are many factors that contribute to whether African American girls choose to enter and persist in the CS pipeline. Some factors speak to her experience as a female while others as an African American. We believe that both should be addressed, with equal attention.

To that end, research methodology used to investigate this issue should utilize both quantitative and qualitative data to answer ours and similar questions that focus on determining the factors that encourage AA girl participants to persist in computing (broadening participation). We believe that analysis of such data will uncover prominent themes that speak to students’ attitudes relative to computer science.

Furthermore, the use of structured interviews will engage students in conversation about their experiences and help to uncover what otherwise might not be obvious in observations of student’s activities. This kind of rich analysis will enable us to tell a more comprehensive story about AA girls and their experiences learning computer science. We also expect that, as a result of sharing their stories, that AA girls will find their own voice as they better understand how they can impact their own education in high school, college, and beyond.

References


