Atlanta Code Warriors: A CS Engagement Pilot Initiative

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Abstract. The STEM workforce is vastly growing, however, underrepresented groups only account for under 12% of those in science and engineering occupations and for many in these jobs and industries, a 4 year degree is the most reasonable path. It is through this research that we seek to focus and address the challenges that inhibit minority populations in K-12 levels from the motivation and preparation that will align them with future computer science/IT college and career pathway (C-STEM) career fields. Prior research has shown that beliefs around self identity in STEM fields can positively impact behavior and achievement of students in computing disciplines, while increasing African American students belonging can decrease the student achievement gap. The initiatives presented in this paper seek to leverage the inherent value of minority student presence on the campus of a Historically Black institution as a means to normalize student perception of college access and future C-STEM identity.

Key words: mentor, Computer Science, STEM, IT, middle school

1 Introduction

According to the 2017 NSF report on women, minorities, and persons with disabilities in Science and Engineering, Asian and Caucasian populations still dominate the share of degrees in those disciplines. While the STEM workforce is growing, under-represented groups account for under 12 percent of those in science and engineering occupations [1]. Although there is an increase in the numbers of Bachelors and Masters degrees obtained by minority groups in the past four years, there is a need to address the challenges that prohibit students from entering and completing degrees in STEM based disciplines since that is vital in the effort to level the professional field. It is through this work that we

seek to focus and address the challenges that inhibit minority populations in K-12 levels from experiences that increase motivation and preparation that will lead them toward a future in a C-STEM career field.

Prior research has shown that beliefs centered on self identity in STEM fields can positively impact behavior and achievement of students in computing disciplines [2]. Likewise, the research notes that an increase in African American students feelings of belonging can decrease the student achievement gap [3]. The following initiatives presented seek to leverage the inherent value of minority student presence on the campus of a Historically Black institution as a means to normalize student perception of college access and future C-STEM identity.

As a subsequent goal, the presence of African-American mentors, both male and female, served to eliminate any social identity threat from the middle school students. For underrepresented minority students in STEM and higher educational programs, near-peer mentor relationships in educational environments have been shown to optimize student academic performance and social engagement [4, 5]. Near-peer mentors, which are mentors closer in age and class, are instrumental in establishing trust and positive engagements needed for successful mentoring relationships. Near-peer teachers have a better understanding of the age and stage-appropriate context that enables them to better clarify problems for students [6]. In addition to the curricular support provided by the near-peer mentors, they also presented the middle school students with the opportunity to ask their near-peer, AUC mentors questions about career goals, college life, and why they, the student, should choose computing as their career path.

Similar outreach programs have been implemented to improve computer science identity for underrepresented groups. However, very few programs focus on the development of computer science identities in African American, middle school students through mentor-supplemented, computer programing outreach. Measuring sense-of-belonging, motivation, confidence, and satisfaction, multiple outreach programs have been conducted in computer science using pre-post intervention research methods for female groups [5, 7, 8]. Garcia has used the programming language Scratch to implement hands-on coding interventions to diverse populations of high school students. Supplemented with discussions and student-led demos, the interventions improve high school students programming performance and provide knowledge about the social components of computer programming and their application [9, 10].

2 Program Design

Although access to STEM-based curriculum channels are increasing for K-12 students, many middle school students, particularly those who come from low socioeconomic (income?) backgrounds, are often isolated from exposure to broader academic and scientific communities. The main benefit of this program is the exposure to academic (Clark Atlanta University), industrial (Google Atlanta Headquarters), and local school communities for programming efforts. For the pilot program, the focus was on two middle schools, Woodland Middle School

(3/10 low income rating) [Woodland] and Charles Drew Charter School (7/10 low income rating) [11]. Atlanta Code Warriors (ACW) recruited 25 students in addition to a teacher or staff member from each middle school to serve as representatives and coordinators for their school. Moreover, the program recruited AUC faculty as well. All faculty and staff went through an orientation period to learn Googles Computer Science 1st platform(CS First), which provided the curriculum to teach students computer science. The students transportation from the schools to the AUC and Google headquarters was provided as well as breakfast and lunch during the program sessions. Snacks were also provided during the school meetings. In order to maintain engagement in activities, raffles, where participants had the chance to win prizes in the form of gift cards. During the program, Coordination and communication among all parties was provided by Advantage Consulting, LLC., who also supplied a collection of student performance and satisfaction data for the program.

The Atlanta Code Warriors program was born out of the 2016 United Negro College Fund (UNCF) Coding Better Futures Initiative. The program was developed to provide systemic interventions and to increase the number of African-American students in the computer science/IT college and career pathways (C-STEM). Another major effort of this initiative is to increase cross-sector collaborations and access to African-American mentors for the students being served. For this pilot initiative, the industry, higher-education, and K-12 collaborators created the ATL-CS Node, which consisted of partnerships between UNCF, Google, Morehouse College, Spelman College, Clark-Atlanta University, Georgia Institute of Technology, Drew Charter School and the Atlanta Public School Systems.

During this 4-week program, students convened every Saturday. The program began with a kickoff event at Google Headquarters, and, in the following weeks, there were two working sessions. During the working sessions, students worked primarily on CS First, Scratch projects, and additional activities. Most of the activities were team-based, which helped students with developing problem solving skills within a group, and encouraged them to design and build complex projects. The Sound & Music theme was chosen from the CS First platform as a means to address the desire to provide C-STEM engagement in a culturally competent context. Within this theme, students were exposed to computational thinking, coding, problem-solving, and design thinking. Students learned concepts like variables, loops, conditionals, and other procedures used to build programs that incorporated musical themed-interactive multimedia projects.

During the weekday, school meetings were held at each middle school by the staff to continue program activities. The last event of the program was a showcase and celebration at Clark Atlanta University, where students demonstrated their projects and were recognized for their work. Concluding the program, there was a post-program evaluation to learn how it affected the middle school participants views on computer science and their desire to actually pursue a career in computer science or a related field.

Table 1. Pre/Post-Assessment Questions

Questions
1) I am interested in computer science.
2) I do not feel comfortable using a computer to accomplish tasks.
3) I feel confident in my ability to solve difficult problems.
4) Learning new computer science skills is something I do not feel excited about.
5) Having the skills to do well in computer science classes is important to me.
6) I am likely to seek out new experiences and opportunities that I may not know a lot about.
7) I dont see people who look like me in technology/computer science careers.
8) I can see myself pursuing education and/or career opportunities in STEM/STEAM.
9) I am aware of the requirements and skills necessary to obtain a career in STEM/STEAM.
10) I do not like programming.
11) I am most excited about Googles online games for learning computer science skills.
12) I am most excited about the weekly interactive skill-building sessions and group projects.
13) I am most excited about after-school program sessions with teachers from my school.

Note: The table displays the questions on the pre-assessment and post-assessment middle school students completed before and after the Atlanta Code Warriors intervention.

3 Method

Thirty-eight middle school students participated in this research study. The students were provided a pre-assessment to complete, which measured computer science identity in the variables of sense of belonging, computing interest, self-efficacy, and computing knowledge/skill. The pre-assessment also included three questions on the CS1st activities and ACW programming (see Table 1). Each question used a 5-point Likert scale measuring students agreement. After the pre-assessment, students completed the intervention. At the end of the final day, the participants completed a post-assessment, which was identical to the pre-assessment. The results from the assessments were analyzed through a t-test to determine significant variance in program over time.

Table 2. Mentor Student Observation & Program Operations Survey

Questions
1) How effective was the Code Warriors scheduling of events, food/drinks, and communication from organizers?
2) How was your experience mentoring your group of MS students?
3) What was effective in getting the MS students interested in CS education?
4) What did not work in getting the MS students interested in CS education?
5) What could the Atlanta Code Warriors do in the future to better engage students in CS education?
6) Is there anything else you would like to share with us?

Note: The table displays the questions on the post-assessment undergraduate for mentors after the Atlanta Code Warriors intervention.

Sixteen upperclassmen computer science undergraduate mentors completed an open-ended survey during the post-assessment time to record their observations of middle school student behavior and program operations over the course of the program (see Table 2). Three mentors, one from each represented school, were interviewed more in-depth on experiences and rationales for the responses of the mentor survey and their recommendations to improve the program. Results from the open-ended surveys and interviews were analyzed through qualitative content analysis determining codes for student behavior, program operations, and recommendations.

Table 3. Computer Science Identity and Program Satisfaction

Assessment					
Variable		Pre (n=32)	Post (n=32)	t-value	prob
Computing Identity & ACW Satisfaction	M SD	53.25 (7.88)	52.00 (10.82)	2.04	.085

Note: The table displays the results of a t-test analyzing any significant variance between the pre-assessment and post-assessment.

4 Results

There was a dropout of six participants (Pre-assessment n=38, Post-assessment n=32). Only participants who completed both the pre-assessment and post-assessment scores were used. A one-way repeated measure ANOVA was conducted to compare the effects of the CS1st program on middle school students computer science satisfaction. The CS1st program did not significantly affect middle school students satisfaction of computer science at the p¡.05 level two-tailed from pre-assessment (M=53.25, SD=7.88) to post-assessment (M=52, SD=10.82) conditions [t(31)=2.040, p = 0.085] (see Table 3). Holistically, these results suggest that middle school students were not satisfied with the Atlanta Code Warriors program. The students generally were interested in the field of computer science, but not in the practice of programming. The middle school students generally felt a sense of belonging in computer science and STEM, though this did not significantly change due to the program; and had relatively positive informed self-efficacy in career decision making and problem solving abilities. Middle school students were not more excited for Googles programs and sessions.

General observations of middle school student behaviors and program management were conducted from the thirteen mentors, in which student learning and performance was observed. Generally, students completed the motions of

the program in its entirety. Some students caught on to concepts faster than others; many students who took a longer time to understand the instruction grew impatient. Students would lose focus and experienced fatigue at various moments during the program. Additionally, students were lethargic and had trouble getting back to work after heavy lunches. Students did not go above and beyond in learning the functionalities of Scratch. Finally, some students were more prepared (both technically and socially) for the main presentation than others.

The interaction between the students and the mentors was observed as well. Students could comprehend when mentors were not excited or not giving off positive attitude. Students became comfortable with mentor, enough to ask questions about the program activities, but not enough for non-technical questions. Students also took time to get comfortable with each other. Other program experiences in which student behavior was observed and recorded include students being most excited during the first day, some students may have been lost, observed through tardiness in attendance, and some students were notably interested in particular segments such as coding or music; a few were not interested in the program at all.

Although the program ran relatively smooth, there were a few challenges. Students were assigned in groups of three to a single computer, and the assigned computer lab did not have Flash to run the CS1st program, which proved to be ineffective. CS1st on Scratch was separated from supplemental videos, which took additional time going back and forth between the two. Many of the mentors were not familiar with App Inventor or CS1st. Food was delivered significantly late on two days of the program.

Mentors recommended changes to improve a future program, and they suggest that all mentors need to maintain authority with students to keep them focused. A one or two students per computer model should be more effective. Students should be provided a cheat sheet for the supplemental videos so that they would not have to go back and forth between ideas and Scratch. Mentors also suggested that future mentors be better trained in Scratch, should conduct icebreakers for students to learn and be comfortable with each other, and should always come in with a positive attitude. Other recommendations suggested by mentors include providing students with better maps, signs, and human guides so they can navigate campus better, include more breaks to reduce fatigue, show relevant, impressive Scratch demos to motivate students to figure out more functionalities of Scratch, rotate students through activities, and host practice presentations before the final presentation.

5 Discussion

The Atlanta Code Warriors program was not statistically effective in improving computer science identity and computing tool user experience for African-American middle school students. Student learning and performance observations inform computing outreach coordinators that fatigue, focus, and impatience

are challenges and variables associated with disinterest and result-focus rather than process-focus [12–14]. Student exposure to Scratch and similar programs was not assessed, however it can be assumed that students lack of or limited exposure to Scratch made it so students were not aware of what they didnt know, thus there was very little, if any effort associated with trying to create works outside of the box. Additionally, students comfort with the mentors was at the level of a participant and a facilitator, and not of a mentee and a mentor. More energy needs to be exerted from mentors, students, and program design to develop the role of the team facilitator to that of a mentor [4, 5]. Students exhibited varying interest and affinity towards areas of the program such as music, however nothing in the program was designed to allow students to flourish in particular areas.

Overall, middle school students should be informed at orientation of program participation, to try and stay on track, to communicate with mentors and explain why and where they are losing interest, and what they think could make the program more interesting. Students should also be open to interact with one another and their mentors on both program activities and personal affairs. Undergraduate student mentors should ask about and respond to middle school students questions about their personal interests, as well as introduce themselves incorporating their own personal interests. Mentors need also be knowledgeable about CS1st and all program segments, or one segment each and allow mentors to manage that station as students rotate. Additionally, mentors need to incorporate high energy to support students diminishing excitement for the program. Program organizers should expose students to all elements, but also allow students to thrive in the elements in which they are interested. Logistically, having smaller lunches, more rest periods, or a two-snack period structure may improve the productivity of students. It is also always essential to check the technical requirements for any activity and outreach programs plan to execute prior to booking a space, to ensure organizers have capability to run the program.

There were few research limitations in this study. The scale adopted from Googles CS1st program by the Advantage Consulting, LLC. was used to measure computer science identity variables rather than using other established validated scales. Furthermore, though thirteen of the sixteen undergraduate mentors completed the open-ended questionnaire, only three mentors were interviewed to provide more extensive observations. Finally, the small sample size for middle school students is convenient, but not very generalizable.

6 Conclusion

Although the Atlanta Code Warriors program was unsuccessful at improving computer science identity in African-American middle school students, findings from the program can be used to improve future studies. Many of the challenges in the program are easily avoidable; concentrating on interest and process-focused learning is recommended and imperative for successfully improving computer science identity. Mentorship needs to be active in order to be

effective and is suggested to be implemented within the structure of the program to yield positive results. Academic institutions, particularly historically black colleges and universities (HBCUs) partnering with national organizations such as the United Negro College Fund are important in mobilizing outreach for underserved and underrepresented minorities, and for building effective research infrastructures at HBCUs and minority serving institutions.

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