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Utilizing Culturally Responsive Strategies to Inspire African American Female Participation in Cybersecurity

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Abstract

The number of African American females participating in cyber fields is significantly low. Science, technology, engineering, and mathematics (STEM) education requires a new approach to student engagement to increase African American female participation in cybersecurity. The most common approach to engaging more African American females in STEM is to provide students access to professional images or role models active in STEM; however, more is needed. More race-centered strategies beyond role modeling are necessary to attract and retain African American females in STEM. Research studies show that integrating personal experiences and making cultural connections can help improve student participation in STEM from underrepresented populations. In 2021, faculty in the Center for Cybersecurity Assurance and Policy at Morgan State University developed and implemented the GenCyber "Females are Cyber Stars" (FACS) Summer Camp. This initiative targeted female African American students in Baltimore public middle schools. Thirty-nine girls participated in the virtual program during the summer of 2021, and 25 girls engaged in the in-person program during the summer of 2022. The program's goals were to increase female students' interest in cybersecurity and exposure to the security of IoT (Internet of Things) devices in a smart home environment. The GenCyber FACS Summer Camp incorporated culturally responsive strategies to engage the participants in an inclusive and interactive setting. Participants were given pre- and post-program surveys to assess learning outcomes and examine the impact of using culturally responsive teaching strategies. The results showed that the girls reported increased knowledge and a gain in interest in cybersecurity and computing. This paper discusses the summer program and curriculum, culturally responsive teaching strategies deployed, student learning outcomes, and perceptions of cultural responsiveness assessed in the GenCyber FACS Summer Camp.

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Introduction

Meeting the future cybersecurity challenges requires the United States to utilize all its available workforce talents. There is a need for nearly three million cybersecurity professionals and staff. According to the ISC^2 Cybersecurity Workforce Study report, almost 60% of organizations report that they are at an extreme or moderate cyber risk due to high staff shortages (International Information System Security Certification Consortium, 2018). Although women are a significant resource pool, the technology industry has historically done a poor job recruiting women in cybersecurity and other tech areas (Maurer, 2019). To address this deficit, concerted efforts were made to recruit and retain females in the cybersecurity industry by providing educational, networking, and mentorship opportunities. As a result, women constitute roughly 25% of the male-dominated cybersecurity workforce (Freeze, 2022). Experts in the industry suggest companies can lessen the gender gap in the cybersecurity field by partnering with schools to educate girls, inspiring girls and women to pursue technology courses, explicitly marketing career opportunities to women, and promoting women to high-level cybersecurity jobs to provide role models for these new workers (Maurer, 2019).

Women have earned about half of all bachelor degrees, but the proportion of degrees awarded to women in computer science and engineering in 2016 is the lowest (Hamrick, 2019). The ISC^2 Cybersecurity Workforce Study report notes that women working in cybersecurity currently account for about 24% of the workforce (International Information System Security Certification Consortium, 2018). According to another ISC^2 study on race and ethnicity, 26% of the cybersecurity workforce identified as a minority, of which 17% were female and 9% identified as African American (Reed et al., 2018). These numbers show that underrepresented minority female participation in cyber fields remains relatively low. To make an impact, female enrollment in engineering, computer science, and IT programs must increase considerably to ensure that the necessary graduates are ready to join the cyber workforce. Although there has been much discussion and effort put into growing the numbers, the undergraduate female engineering and computer science enrollment remains much lower than desired at approximately 24% and 29% at a national level (Hamrick, 2019). Considering underrepresented minorities, particularly African Americans, female enrollment in engineering is only 2.5% and 6% in computer science (Hamrick, 2019).

Low participation in science, technology, engineering, and mathematics (STEM) is not unique to African American females; it also extends to other races. When analyzing the problem of African Americans' low attainment in STEM, one major issue is the lack of access to educational institutions that prepare African Americans to matriculate through a STEM program successfully. Urban public schools are typically underfunded, which leads to deficits in instructional resources, staffing, and extracurricular activities (Grimshaw, 2020). These schools lack the necessary resources to prepare African American students to be successful in STEM, which requires tremendous resources. Darling-Hammond (1998, p. 2) states, "The educational system is one of the most inequitable in the industrialized world, and students routinely receive dramatically different learning opportunities based on their social status." Shapiro (2003) contends that there is a strong correlation between race and social status in America. Another issue is the way STEM is traditionally taught. Researchers and educators suggest redesigning the educational experience for African American STEM learners. Holly (2021) recommends discussing the achievements of African Americans in the area of STEM, emphasizing social skills and teaching with sociopolitical awareness; Prime (2019) proposes implementing a race-visible pedagogy; and Burbanks et al. (2020) advocate for African-centered education in STEM by incorporating African history and culture. In other words, these researchers and educators recommend considering the racialized experiences of African American learners in American society in every aspect of their STEM education. That is, the choice of content, the instructional practices, the teacher/student interactions, and the assessment practices are all designed in consideration of the experience of Blackness in contemporary American society.

A growing body of literature builds on the work of African American educators (Gay, 2002; Hammond, 2015; Hollins et al., 1994; Ladson-Billings, 1995) to emphasize how centering the ideas, values, and customs of African American people can enrich STEM education (Coleman & Davis, 2020; Madkins & Nasir, 2019; Prime, 2019). The takeaways from these proven approaches are (a) the need to reframe the cause of difficulty for African American students learning STEM, (b) embedding cultural knowledge of African American people increases African American students' engagement and comprehension, and (c) African American cultural knowledge transforms conceptions of STEM knowledge and teacher practice. The works of Adjapong and Emdin (2015) and Brown (2019) have shown that when African American students are allowed to participate in the learning setting in a natural way, previously excluded students engage at a high level, demonstrating competence and enthusiasm.

One approach for African American learners to actively participate in an inclusive, productive, and engaging classroom environment is for instructors to adopt a culturally relevant pedagogy. Ladson-Billings (1995) pioneered this pedagogical approach based on her research into effective teaching methods for African American learners. Her findings underscored the impact of educators who integrated strategies fostering positive cultural and ethnic identities, the ability to identify and analyze social inequities, and the encouragement of increased academic achievement. As Muñiz (2019) highlighted, this approach positively influenced classroom participation and increased overall academic engagement. Building on Ladson-Billings's work, subsequent researchers introduced the concept of culturally responsive teaching (CRT), advocating using students' ethnic backgrounds and experiences in daily instruction to enhance interest in and comprehension of the content. Implementing culturally responsive strategies demonstrated favorable outcomes, including heightened academic success, increased interest in school wide activities, and improved attendance (Muñiz, 2019).

The utility of CRT strategies has increased to offer tailored instruction and spark interest in STEM among African American youth. EdAnime Productions offers the Conscious Ingenuity program, which provides African-Centered STEAM Education (ACSE) to K-12 students (Conscious, n.d). EdAnime Productions and the Uhuru Academy, in partnership, offer the Uhuru Academy Conscious Ingenuity (UACI) Summer STEM Camp which exposes 2nd to 12th grade students to African STEM history and electrical engineering (Uhuru, n.d.). B-360 is a nonprofit organization that uses dirt bike riding to teach K-12 students math and science (B-360, n.d.). Students are also exposed to coding, 3D printing, robotics, and dirt bike construction and maintenance. Math Thru Music is an educational program that utilizes DJing, music, and a STEM curriculum to improve problem-solving skills and mathematical ability (5Starr Enterprises, n.d.).

This paper details the CRT strategies utilized for the GenCyber "Females are Cyber Stars" (FACS) Summer Camp to teach cybersecurity concepts to African American girls interested in STEM. The lessons, instructional materials, and additional strategies are described. The participants completed pre- and post-program surveys for implementers to assess the impact of CRT strategies. The survey questions and an analysis of the survey results are provided.

Program Description

Morgan State University hosted a GenCyber FACS Summer Camp for African American female students who attend public middle schools in Baltimore. The goals of the program were to

- increase African American female students' interest in cybersecurity,
- utilize effective strategies to teach cybersecurity concepts to African American female students,
- impart best practices for safe online behavior, and
- expose students to GenCyber cybersecurity concepts using Internet of Things (IoT) devices commonly found in the smart home.

Target Population

Universities employ intervention programs to help increase African American female enrollment in computer science and engineering. Interventions that include mentoring, role modeling, and out-of-school enrichment programs such as summer camps are examples of ways to draw girls to STEM areas. Research shows that capturing more female student interest in cybersecurity requires student engagement during the middle school years (Young et al., 2019). The GenCyber FACS Summer Camp specifically targeted African American female students due to their low involvement in the STEM field. Female minorities represent a potentially untapped resource for increasing and sustaining a diverse STEM workforce. Creating avenues to strengthen African American females' mathematics and science skills is imperative, which can only be realized if addressed before middle school (Young et al., 2019).

Recruitment efforts were centered around partner schools within the Morgan Community Mile and schools with a working relationship with the Morgan State University School of Engineering due to the high African American population amongst the surrounding middle school population. We extended recruitment efforts to middle school programs in Baltimore County to help meet our participant numbers. Recommendations from local school administrators and community partners were also considered.

Marketing

Culturally relevant imagery was intentionally utilized on marketing materials for the GenCyber FACS Summer Camp. Camp announcements and web advertisements contained images of middle school-aged African American girls adorning clothing and hairstyles unique to the target demographic. Images of ethnically matched teachers and staff engaged in technology were used to promote a congenial environment for the participating youth. Studies have concluded that representation can increase student interest, engagement, and achievement (Gershenson et al., 2021). Marketing efforts to the target population included

- mailing printed flyers to middle school principals in the Morgan Community Mile, with a focus on Baltimore City public schools,
- sending emails to middle school guidance counselors and technology teachers,
- posting information on the Center for Assurance and Policy (CAP) website with associated links on the Engineering, Computer Science, and Information Systems Department web pages,

- posting flyers and advertisements to the social media pages of the School of Engineering, Engineering Alumni Group, and community partners, and
- distributing press releases from institutional university relations staff disseminated electronically.

Faculty and Student Facilitators

Ethnically matched engineering faculty members and student facilitators were essential to the summer program. Faculty members were highly regarded members of the CAP housed on the campus of Morgan State University. Each faculty member possessed a four-year college and postgraduate degree in electrical and computer engineering. Student facilitators were current graduate students working alongside CAP faculty members. Each student facilitator possessed a four-year college degree in electrical and computer engineering. Student facilitator selection was based on their level of knowledge of cyber concepts and their desire to work with young girls. The makeup of the team is listed below:

Program Director: Provided overall supervision of GenCyber camp, including activity planning and implementation.

Program Coordinator: Facilitated camp marketing, recruitment, and registration; managed daily camp activities and program office.

Lead Instructor: Provided development of cyber course curriculum related to camp theme and oversaw course content delivery to participants.

Curriculum Developer: Provided K-12 pedagogical expertise in student assessment and a framework for curriculum and teaching practices.

Camp Instructor: Delivered course content to participants, conducted knowledge checks, and deployed exit tickets.

Student Facilitators: Assisted Instructor during lessons and hands-on activities, provided feedback to Program Coordinator and Instructor as needed, and served as role models to camp participants.

Program Implementation

The GenCyber FACS Summer Camp was an engaging learning experience for African American female students aged 11 through 15. Thirty-nine students participated in a half-day, two-week virtual program in 2021, and 25 students participated in a full-day, one-week face-to-face program in 2022. General camp schedules are shown in Figure 1. Each session began with a "huddle" to build relationships within small groups and encourage positive social-emotional development. The sessions focused on building self-esteem and self-confidence and fostering a positive self-image. After the huddle, students were given a technical lesson on one of the six cybersecurity concepts: *Confidentiality*, *Integrity*, *Availability*, *Defense in Depth*, *Think Like an Adversary*, and *Keeping it Simple*. Students participated in a group activity following the lesson to increase their understanding of the concepts discussed during the session. At the close of each session, students completed formative assessments by providing reflections on concepts learned for the day.

The program was designed to provide middle school female students with active learning experiences under the guidance of graduate student facilitators and STEM faculty. In other words, our goal was to include many interactive activities and projects for participants to complete in small groups. The activities were related to everyday items students encounter in their homes to help draw connections between the concepts learned in the classroom and real-world contexts. Students routinely worked in groups to explore the Smart Home use case to demonstrate mastery of the six cyber concepts by exploiting and defending a designated home automation device. Students participated in active cyber-related discussions with African American female engineering practitioners.

Program Curriculum

The GenCyber FACS Summer Camp curriculum framework was centered around curricula from Common Sense Media and CYBER.ORG (Common Sense, n.d.; CYBER.ORG, n.d.). Common Sense Media provides free K-12 ready-to-teach lessons on digital citizenship and online safety. Most of the curriculum material had to be complemented with information from books, journals, and periodicals. The supplemental curriculum material included videos, animations, and cartoon avatars depicting cultural images and social connections related to the participants' demographics. All Common Sense Media lessons used within the GenCyber FACS Summer Camp met standards for Common Core English Language Arts (ELA), American Association of School Librarians (AASL), the International Society for Technology in Education (ISTE), and Core SEL Competencies (CASEL). Common Sense Media curricula contain lesson plans, lesson slides, student handouts, assessments, and take-home resources for family engagement. CYBER.ORG's curricula were used within the GenCyber FACS Summer Camp program to provide lessons focused on the six GenCyber cyber security concepts. CYBER.ORG provided its curricula and allowed Morgan State cyber faculty access to a robust library of cyber-based

VIRTUAL SCHEDULE					
TIME	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5
8:30 AM – 9:00 AM	Registration/Check-In	Morning Huddle with Mentors or Tech Talk w/ Cyber Professional	Morning Huddle with Mentors or Tech Talk w/ Cyber Professional	Morning Huddle with Mentors or Tech Talk w/ Cyber Professional	Morning Huddle with Mentors or Tech Talk w/ Cyber Professional
9:00 AM – 9:50 AM	Welcome & Orientation	Cyber Lesson	Cyber Lesson	Cyber Lesson	Field Trip
9:50 AM – 10:00 AM	BREAK	BREAK	BREAK	BREAK	
10:00 AM – 11:20 AM	Cyber Lesson	Hands-On Cyber Activity	Hands-On Cyber Activity	Hands-On Cyber Activity	
11:20 AM – 11:30 AM	BREAK	BREAK	BREAK	BREAK	
11:30 AM – 12:00 PM	Hands-On Cyber Activity	Reflections	Reflections	Reflections	Reflections
**Note: Activities were modified during the second week to include a post-camp survey, final student presentations and the closing ceremony.					

F2F SCHEDULE					
TIME	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5
9:00 AM – 9:10 AM	CHECK-IN & DAILY AFFIRMATION				
9:10 AM – 9:35 AM	Welcome & Program Expectations	Morning Huddle with Mentors	Morning Huddle with Mentors	Morning Huddle with Mentors	Morning Huddle with Mentors
9:35 AM - 9:50 AM	Pre-Survey	CYBER SPOTLIGHT: African American Women in STEM			Post-Survey
9:50 AM - 10:00 AM	BREAK				
10:00 AM – 11:00 AM	Cyber Lesson & Hands-on Activity	Cyber Lesson & Hands-on Activity	Cyber Lesson & Hands-on Activity	Cyber Lesson & Hands-on Activity	Cyber Lesson & Hands-on Activity
11:00 AM - 1:00 PM	CAMPUS TOUR & LUNCH				
1:00 PM - 1:40 PM	Cyber Lesson & Hands-on Activity	Cyber Lesson & Hands-on Activity	Cyber Lesson & Hands-on Activity	Cyber Lesson & Hands-on Activity	Cyber Lesson & Hands-on Activity
1:40 PM - 2:30 PM	Hands-on Activity	STEM Professional	STEM Professional	STEM Professional	Hands-on Activity
2:30 PM - 3:00 PM	Student Choice Activity & Class Dojo Reflections				CLOSING ACTIVITY

Figure 1. GenCyber FACS daily schedules.

curricula and activities. CYBER.ORG has created cyber curricula targeted at middle and high school students. Curricula from CYBER.ORG contain instructor teaching plans, hands-on learning activities, and PowerPoint slide presentations that cover GenCyber concepts. The GenCyber FACS Summer Camp lead instructor utilized Common Sense Media and CYBER.ORG instructor lesson plans as a template for creating lesson plans regarding the GenCyber concepts, online safety, and cyber ethics. CYBER.ORG's curricula introduced students to foundational coding concepts through project-driven, hands-on modules and integrated Microbit for student interaction with sensors.

As noted above, students learned about six cybersecurity concepts: Confidentiality, Integrity, Availability, Defense in Depth, Think Like an Adversary, and Keep it Simple. The six cybersecurity concepts and topics about online safety, cyber ethics, and digital ethics were reinforced in the curriculum activities, as shown in Table 1. Students focused on learning about various cyberattacks and countermeasures used to protect against cyberattacks through encryption and password generation during the first two days of the program. Students utilized information gathered from the technical lessons and the hands-on activities. They applied the knowledge they learned to initiate attacks and countermeasures on an IoT device each day of the program. Additionally, students participated in activities that helped them draw connections between the concepts learned in the classroom and real-world contexts. The curriculum facilitated a learner-centered classroom because students were provided opportunities to engage with the academic content by participating in games, small groups, case studies, developing software code using Python, discussions, and presentations.

Classroom Management and Student Interaction

CRT strategies were the bedrock of the GenCyber FACS Summer Camp curriculum regarding instruction, activities, classroom management, and teacher–student and facilitator–student interactions. The objective of utilizing culturally responsive strategies was to connect students' culture and life experiences to support comprehension and engagement. One CRT strategy included ethnically matched instructors, student facilitators, and professional speakers. This strategy has been proven to increase student interest, engagement, and achievement (Gershenson et al., 2021). Another strategy was to incorporate an empowerment activity to address the social-emotional needs of African American girls. Each session began with activities that increased self-confidence and self-esteem. Studies indicate that African American girls participating in afterschool programs promoting pride in Black culture are more connected and involved in school (Eckart, 2017).

Table 1
Camp curriculum overview incorporating the GenCyber FACS Summer Camp concepts.

Category	Topics	Example activities
C1: Defense in Depth	T1: IoT Network Security: What are the varying levels of security? How are firewalls, antivirus software, VPNs used to protect IoT network? T2: Passwords: How can passwords be used to secure information?	- Instructor presentation - PBS game - 'How secure is my password?' activity
C2: Confidentiality	T1: Cryptology: What is cryptology? T2: Encryption: What is encryption? How can encryption be used to keep information protected?	- Instructor presentation - Sending, sniffing, and encrypting wireless packets using the Microbit - Sending, sniffing, and encrypting wireless packets using the IoT device
C3: Availability	T1: Denial of Service: What are denial of service attacks? How can systems resist against these attacks so that use is uninterrupted?	- Instructor presentation - Game 'UNO-DoS' - Implementing a DoS attack using the Microbit - Case studies
C4: Integrity and Think Like an Adversary	T1: Understanding elements of information security T2: Identify different types of security threats and attacks such as hacking, a replay, and brute force attack T3: Replay and brute force attack: How can data be retrieved by unauthorized users? How do digital signatures and authentication protect against unauthorized use?	- Instructor presentation - Google Hack - Video - Implementing a replay attack using the IoT device
C5: Summer camp final project	T1: Secure smart home with IoT devices: How can devices in the home be subject to security attacks? How can devices in the home be protected from security attacks?	- Student presentation of various rooms in a home with an IoT device
C6: Cyber Ethics	T1: Ethical Use of Computer Technology: What is cyber ethics? What is appropriate technology use? T2: Copyright: How to acquire online content legally and ethically	- Instructor presentation - Videos - Case studies - Student discussions (Think-Pair-Share)
C7: Online Safety	T1: Protecting Privacy T2: Creating Passwords T3: Cyberbullying T4: Phishing T3: Digital Citizenship	- Instructor presentation - Complete IROC2's cyber safety - Risk assessment - Videos - Student discussions (Think-Pair-Share)
C8: Digital Citizenship	T1: Digital Footprint T2: Social Media & Relationships T3: Talking Safely Online	- Video case studies - Student discussions (Think-Pair-Share)

Incorporating images of African Americans throughout the instructional materials was another strategy used within the GenCyber FACS Summer Camp. African-centered psychologists, such as Wilson (2014) and Kambon (2003), have noted the adverse effects of displaying nonrepresentative imagery to African American children. They assert that inundating African American children with positive self-imagery builds self-esteem, strengthens self-identity, and increases confidence. Another CRT strategy utilized was to incorporate the students' personal experiences—lessons incorporated everyday items from the home that students could quickly identify and relate. Because African Americans are communal, employing cooperative learning through hands-on activities requiring problem-solving was another strategy. Studies show African American students strive in communal learning environments (Seiler & Elmesky, 2007).

In 2021, Zoom was the selected video conferencing platform to facilitate real-time aspects of the GenCyber FACS Summer Camp curriculum. The communication software created a virtual classroom wherein students received instruction, completed activities, and participated in discussions. Zoom also afforded the instructor the ability to conduct small group sessions. Student facilitators assisted the instructor with daily monitoring of break-out rooms and chat features. All sessions

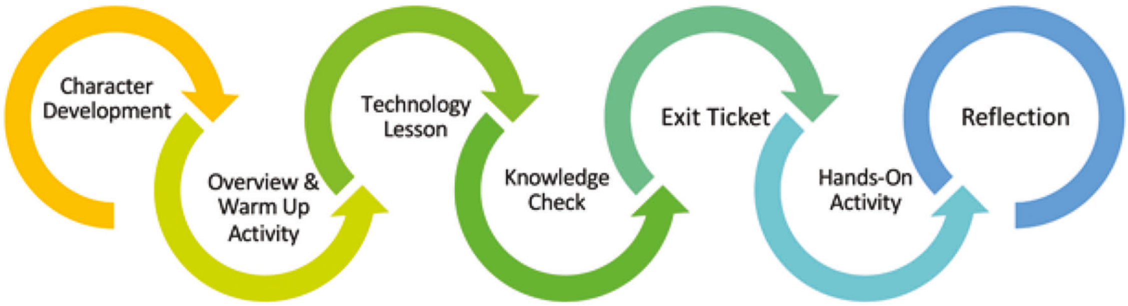

Figure 2. GenCyber FACS lesson flow.

were recorded and made available to participants upon request. In 2022, the camp was conducted in person rather than virtually.

In 2021 and 2022, the instructor used PearDeck to deploy each lesson (see Figure 2 for lesson structure). PearDeck is an interactive presentation program to increase student engagement and monitor apprehension of instructional objectives. The instructor incorporated additional online instructional tools such as Google Slides and Class Dojo in each lesson. Google Slides is an online program used to create, modify, and collaborate on presentations in real time. Class Dojo is an online platform that builds cohesive classroom communities and provides teachers and student facilitators opportunities to give parents daily feedback about classroom performance. The presentation software allowed the instructor to incorporate images relevant to the students' culture to teach technical skills. Visual components (e.g., video, bitmoji, emoji) are directly related to the students' background and life experiences during instruction. Students were provided opportunities to collaborate with peers using the above-mentioned instructional tools and completed activities to address social-emotional development.

Student Assessment

A key component in a culturally responsive classroom is student assessment and feedback. The curriculum developer integrated proven teaching strategies to ensure the camp instructor allowed students to reflect, assess their understanding of concepts at checkpoints, and obtain feedback. Formative and summative assessments were used throughout the program to assess student knowledge and comprehension. Examples of formative assessments incorporated in each lesson included low-stakes quizzes, student polls, and exit tickets. Participants also engaged in open-ended discussions with peers to help increase comprehension of learned concepts and encourage critical thinking.

At the end of the program, summative assessments given to participants included a cumulative activity and a final student project. An interactive learning tool assessed cybersecurity topics introduced throughout the camp. The final project required students to explore the Smart Home use case collaboratively to demonstrate their understanding of the six cybersecurity concepts noted above. Like the home illustrated in Figure 3a, the smart home included five different rooms (i.e., bedroom, living room, laundry room, kitchen, and garage). Each student team implemented cyberattacks and countermeasures associated with a specific IoT device in a home's room. The home IoT devices of interest included a smart light switch, thermostat, motion detector, and garage door opener. Students accessed and utilized virtual machines to connect to the Raspberry Pi(s) portion of the isolated network in Figure 3b.

Finally, evaluation surveys were administered at the beginning and the end of the camp sessions in both years. In terms of learning, 100% of the girls in 2021 and 78% in 2022 reported learning *a lot*. Comparing their pre- to and post-camp responses, in 2021, they jumped from 10% knowing *a lot* about cybersecurity and computing before the program to 70% knowing *a lot* after it. In 2022, the jump was from 4% to 44% reporting knowing *a lot* about the topic. Most gained some self-reported knowledge: 80% in 2021 and 87% in 2022.

In terms of engagement, 100% of the girls in 2021 and 57% in 2022 reported enjoying the program *a lot*. Comparing their pre- to post-camp responses, in 2021, 40% of the girls reported at least some gain in interest in the topic, and in 2022, 69% reported at least some gain in interest. In 2021, 40% of the girls reported being at least *somewhat likely* to seek further engagement with cybersecurity and computing, whether by talking about it, looking for more information, pursuing further education in and out of school, or seeking information about jobs in these areas. In 2022, these figures ranged from 44% to 57%, being at least *somewhat likely* to engage with cybersecurity and computing in these ways.

The program survey results showed more engagement and learning during the virtual program in 2021 than during the in-person program in 2022. In the fall of 2021, there was a challenging transition from virtual to in-person learning in the overall school system (i.e., standard K-12 classes and out-of-school programs). Instructor observations suggested that the adjustment from virtual to in-person classes resulted in a more disruptive learning environment in which increased distractions may have inhibited the retention of new concepts. Increased engagement and learning are expected this summer

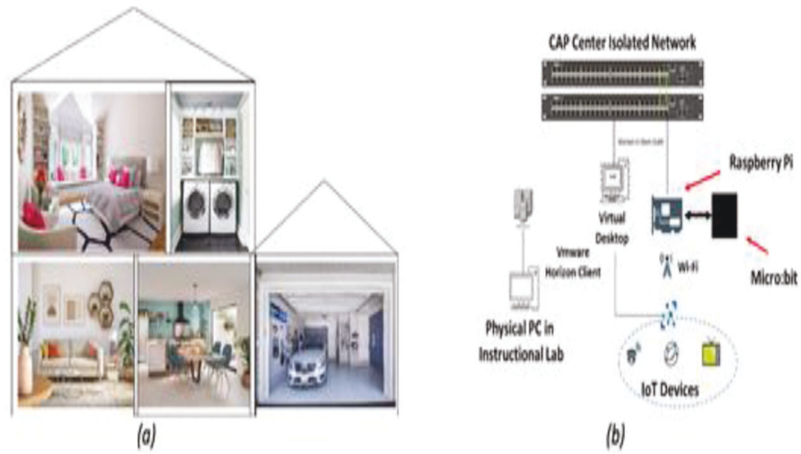

Figure 3. Illustration of (a) the Smart Home scenario and (b) the computer network to facilitate cyberattacks and countermeasures using IoT devices.

Table 2
Responses to 2022 evaluation survey CRT items.

Culturally responsive teaching practice	**% who "agree" or "strongly agree"**
The program instructors, staff, and administration understand and respect cultural differences.	100%
I feel that the instructors believe that all participants can learn, and they try to ensure that all participants do learn.	100%
I was given help when I didn't understand.	100%
My instructors speak about contributions that my culture has made to cybersecurity and computing.	100%
Diverse identities are represented in the lessons and activities.	96%
Participants are free to share concerns and pressing issues.	96%
I feel that instructors use words that I understand and relate to in order to teach lessons.	96%
It was inspiring to see women who looked like me in positions of power and influence.	92%
I feel that participants are treated fairly.	91%
It was motivating to see others who looked like me.	87%
I was recognized for my strengths.	84%
I feel that the instructors use creative ways to teach lessons.	83%
The personal development activities helped me to gain confidence and improved my self-esteem.	83%
My instructors use what I already know about cybersecurity and computing to help me understand new ideas.	82%
My instructors communicate with my parents about what I am learning.	73%

now that students have had more time to become reacclimated to in-person learning. In 2022, specific items addressing CRT were added to the evaluation survey. As shown in Table 2, all or most of the girls agreed with all 15 items.

Future Work

The 2021 survey results demonstrate that the program can be effectively deployed in a virtual format. Therefore, to broaden access to the program, we plan to add a virtual component to engage African American girls beyond the in-person program in Baltimore. The program will be available via an online video conferencing platform. Lessons will be delivered via PearDeck and allow virtual and in-person students to interact. Supplies would be delivered to the home of each virtual participant. A teaching assistant would be designated to assist the girls online with the hands-on activities.

Conclusion

This paper has provided an approach to implementing CRT strategies within a summer camp environment. A culturally responsive framework was utilized to promote learning, growth, and achievement among the African American female participants in the GenCyber FACS Summer Camp. We used culturally relevant imagery on marketing and curriculum materials, daily engagement with ethnically matched faculty, student facilitators, and professional cyber speakers, including social-emotional learning activities, and incorporating interactive activities to connect STEM to everyday life.

These combined methods provided participants with an inclusive and engaging environment to further their learning and interest in STEM and cybersecurity. They were practical, as attested by the results of the program surveys.

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Author Bios

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Dr. Michel A. Kornegay (Reece) is a Senior Professional Staff member in the Air Missile Defense Sector (AMDS) at Johns Hopkins University Applied Physics Laboratory (JHUAPL) in Laurel, Maryland. Dr. Kornegay received her doctorate in engineering and a B.S. in electrical engineering from Morgan State University, and an M.S. in electrical engineering from The Pennsylvania State University. Before joining JHUAPL, for 16 years, she was an Associate Professor within the Department of Electrical and Computer Engineering at Morgan State University. Dr. Kornegay has a proven track record of recruiting, retaining, and mentoring underrepresented student populations at the pre-college, undergraduate, and graduate level in cybersecurity and wireless communication areas.

Mrs. LaDawn Partlow serves as the Director of Academic Engagement and Outreach for the Cyber Security Assurance and Policy Center at Morgan State University. She earned both a bachelor of science and a master of engineering in electrical engineering from Morgan State University. Mrs. Partlow also serves as the Program Director of the Verizon Innovative Learning Program as well as the Engineering Explorations STEM for Girls Program, which both focus on providing minority middle school youth with hands-on learning experiences using advanced technology, app development software, 3-D design techniques, and entrepreneurship skills. Mrs. Partlow has also served as an online course development specialist responsible for the creation, organization, and delivery of several web-based electrical engineering courses offered at Morgan State University. Her technical expertise includes web-based learning, online course development, information management, systems integration, and 3-D simulation and modeling.

Ms. Charnee Bowens is an educator with over nineteen years of experience educating students in need of specialized learning supports. She served as a specialist in the public school system and assisted general educators with differentiating and modifying instructional materials for students. Ms. Bowens received her undergraduate degree in psychology from the University of Maryland, Baltimore County, and graduate degrees in special education and educational leadership from Concordia University and the University of Phoenix. She currently mentors and educates students in Career and Technology Education programs in her school district. Ms. Bowens' educational expertise includes designing, differentiating, implementing, and evaluating academic programs designed for students from grades K-12.

Dr. Karen Gareis is a Senior Research Associate at Goodman Research Group, Inc., in Cambridge, MA, where she evaluates a range of educational programs, including formal and informal science education, arts education, fellowship, and professional development programs, and education and outreach initiatives for groups ranging from museums to public television to NASA missions and for children, teens, and adults. Dr. Gareis received her doctorate and M.A. in social psychology from Boston University and a B.S. in psychology with minors in linguistics and anthropology from the University of Illinois at

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Dr. Kevin T. Kornegay received a B.S. degree in electrical engineering from Pratt Institute, Brooklyn, NY, in 1985 and M.S. and Ph.D. degrees in electrical engineering from the University of California at Berkeley in 1990 and 1992, respectively. He is currently the IoT Security Professor and Director of the Cybersecurity Assurance and Policy Center for Academic Excellence in the Electrical and Computer Engineering Department at Morgan State University in Baltimore, MD. His research interests include hardware assurance, reverse engineering, secure embedded systems, and smart home/ building security. Dr. Kornegay serves or has served on the technical program committees of several international conferences, including the IEEE Symposium on Hardware Oriented Security and Trust (HOST), IEEE Secure Development Conference (SECDEV), USENIX Security 2020, the IEEE Physical Assurance and Inspection of Electronics (PAINE), and the ACM Great Lakes Symposium on VLSI (GLSVLSI). He serves on the State of Maryland Cybersecurity Council and the National Academy of Sciences Intelligence Community Science Board Cybersecurity Committee. He is the recipient of numerous awards, including the NSF CAREER Award, IBM Faculty Partnership Award, National Semiconductor Faculty Development Award, and the General Motors Faculty Fellowship Award. He is currently a senior member of the IEEE and a member of Eta Kappa Nu and Tau Beta Pi engineering honor societies.

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