

Cybersecurity Summer Camp for Middle School Underrepresented Minority (URM) and Female Students

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Introduction

There is a strong and urgent regional need to increase the production of qualified cybersecurity professionals in the workforce. According to the U.S. Bureau of Labor Statistics' Occupational Outlook Handbook, jobs related to Information Security Analysis with responsibilities to plan and conduct security measures to organization's computer networks and systems are rated as one of the fastest-growing jobs in the United States through 2020-3030 [1]. Georgia Department of Labor predicts a similar trend and forecasts a 16.5% increase in Computer and Mathematics occupations in the state of Georgia through 2028 [2]. More specifically, Information Security Analysis occupations are expected to increase by 34.0%, a rate way higher than the average for all occupations in the state (15.5%).

In line with the nationwide trend, there is an identical statewide and local pressing demand to stimulate and sustain the interest in STEM careers for K-12 students, particularly for URM and female students, with many 'dropping out' of the STEM career trajectory starting in middle grades. In the state of Georgia, there is a significant disparity between the number of computing degrees and certificates awarded to students of color compared to White students and that awarded to female students compared to their counterparts; only about one-third of such degrees are awarded to the students of color and around 40% to females [3]. According to the National Girls Collaborative Project (NGCP) [4], there exists a large gap in the K-12 Mathematics and Science standardized test performance among students of different racial backgrounds. NGCP also reports a significant gap in the percentage of male and female high school students earning credits in STEM-related technical courses (data for 2019). It has been emphasized in a number of researches [9, 10] that these URM and female students enter college without the needed content background in grades 6-12 or the enthusiasm to pursue STEM majors. They need more encouragement starting in middle grades to keep STEM careers as real options.

Recognizing the fact that participation and interest of URM and female students in the Computer Science area are significantly low, the main focus of this paper is to share the experience and describe the year-long activities, including a week-long intense 'GenCyber Summer Camp' on cybersecurity, organized by Savannah State University's Engineering Technology Department to provide the participants with career counseling on cybersecurity and training in Cybersecurity Concepts and Ethics through hands-on activities, guest lectures, and other professional development presentations. Savannah State University has been organizing this camp since 2018 (except 2020 due to the COVID-19 pandemic), and the funds for conducting the activities are being supported by the National Security Agency (NSA) and the National Science Foundation (NSF). The participants for the program are the middle school students from Savannah-Chatham County Public School System (SCCPSS) and Bryan County Schools. The paper will also share the major challenges of this program and how the camp activities have positively impacted young minds and increased their interest in computer science and cybersecurity fields.

Marketing of the Camp

The program is marketed through communicating with local and surrounding middle school staff and administration. This recruitment process has been successful for us over the last six years. It was determined that the most effective strategy is to visit the middle schools, distribute fliers, and talk to the guidance counselors, principals, and students personally. Camp information is also distributed to all webmail users of Savannah State University. In addition, we included Savannah State University's Outreach and Career Development Office in our recruitment effort as well to advertise the program and reach out to a greater number of student population. In the last two years, we have also purchased a subscription to 'Peachjar' (<https://ms.peachjar.com/>), a marketing service used by the local school system to propagate the program information directly to the parents. The program website provides camp information and a registration page.

Selection of the participants

As our goal is to enroll a higher percentage of URM and female students in the program, participants were selected through a thorough evaluation of student interest and need, with strong consideration for applicants on the basis of gender and underrepresented minority status. Students with very little cybersecurity and/or computer science knowledge were not excluded from the applicant pool to have a large number of applications. More than three-quarters of students in the local school systems are URM with a Black majority, and in middle schools, this proportion is approximately 78% [5], so our recruitment pool for targeting URM students is very strong. We aim to recruit at least 75% URM participants and have successfully achieved that target in the last six years. We also give preference to female students in our selection process to increase their number. The female participants in our previous programs were in the range of one-quarter to one-third of the overall participants. Our program's overall target is recruiting 50 students from grades 6-8, particularly URM and female students from the local schools. A waiting list is maintained so openings can be quickly filled to ensure that our target participant number is maintained if there are dropouts before the program starts. On average, around 40 to 45 students actually participated in all activities in the past six year's camps.

As a strategic plan for recruiting campers and retaining them throughout the program, we set as one of the requirements to be admitted to the GenCyber program, students must attend the pre- and post-camp outreach activity days. We conduct two 6-hour pre- and post-camp activity sessions; the pre-camp sessions are conducted on two Saturdays in March/April, and the post-camp sessions are conducted on two Saturdays in August/September. Participants must attend the pre-camp activity sessions to be admitted to the summer camp. Also, by requiring students to attend the post-camp activity sessions, we try to keep their interest alive and motivate them to pursue a career in cybersecurity. The curriculum for the post-camp activities is more advanced than that of the pre-camp and summer camp activities to ensure that they learn new materials.

The program personnel

The program is led by two professors from Savannah State University, who are assisted by two middle school teachers from the local school districts. The team from Savannah State University has over 10 years of experience in STEM training for middle and high school students. They

worked in summer programs with middle and high school students under the Army Educational Outreach Program – Unite (AEOP-UNITE) [6] and Engineering Information Foundation (EiF) [7] programs. The two middle school teachers, who serve as the classroom instructors for the program, also serve as the K-12 pedagogical experts to support the Savannah State University professors in developing and delivering the program curriculum to ensure that the curriculum meets assessment and pedagogical criteria. Having middle school teachers involved in the program is key to implement the program activities effectively. Throughout the program, they take high-level concepts, introduce them, and find ways to reach students at their level. They also adjust the curriculum daily during the camp to meet the needs of the students and their learning.

During the summer camp, we hire eight student mentors to support the instructors with the software/hardware configuration, practice all pre/post-camp and summer camp activities to ensure usability, and supervise the campers. These students are rising seniors in Computer Science and/or Engineering Technology with a minimum GPA of 3.0. It is important for young women to see a woman take a leadership role. To serve this purpose, we employ at least 40% of our mentors as female students. They serve as ‘role models’ to the female participants.

Overall, our program consists of a team with a 1:3.5 ratio of the program staff to students.

Curriculum and description of the summer and pre- and post-camp activities

The GenCyber summer program at Savannah State University is conducted on the first week of June each year (Monday through Friday). Each day, the camp runs from 7:30 am to 4:00 pm, with a 10-minute break between the activity sessions and a lunch break from 12:00 pm to 12:30 pm. Guest speakers are invited on days 1, 3, and 5 to provide expert instruction and conduct outreach about high-paying careers in cybersecurity, ethics, social engineering, forensics, etc. Each student is provided with a Raspberry PI, IoT sensors, and Ozobot to perform the lab activities. Microbits and drones are assigned to a group of two students to perform specific lab activities. In addition, campers get the opportunity to program and test that in NAO robots using block-programming.

The curriculum, instructional materials, and learning strategies are designed as appropriate for the participants at a middle school level. The program is aimed to stimulate and encourage the students through the use of peer collaboration and group activities and relies upon the use of reliable technology that supports the curriculum. The curriculum also serves to introduce the six GenCyber Cybersecurity Concepts: (1) Defense in Depth, (2) Confidentiality, (3) Integrity, (4) Availability, (5) Think Like an Adversary, and (6) Keep it Simple [8]. Students complete a variety of hands-on activities to facilitate the learning process and to verify the GenCyber Cybersecurity Concepts learned.

In our most recent summer camp, we arranged a series of presentations throughout the program. The presentations are listed below:

Presentations by the Program Personnel:

1. Programs offering degrees in cybersecurity in local colleges and in the state of Georgia

2. Early college/dual enrollment programs (Georgia's Move On When Ready (MOWR) program)
3. How to make college life affordable - available scholarships
4. A recap - Why should you choose a Cybersecurity/STEM profession?

Guest speaker presentations:

1. Preparation for Computer Science, Cybersecurity and Engineering professions
2. What is cybersecurity? Why is it important? What is the market for Cybersecurity professionals?
3. Careers in Cybersecurity

The pre- and post-camp outreach activity sessions are conducted in collaboration with Savannah State University's Outreach and Career Development Office, whose one major goal is to provide early exposure to STEM programs and scholarly opportunities for K-12 pipeline participants. The pre-camp outreach sessions are scheduled on two consecutive Saturdays in March/April each year. These two sessions are conducted for the students who commit to attend the entire program, including the summer camp and post-camp sessions. The primary goal of the pre-camp outreach activities is to provide the students with cybersecurity awareness, information about opportunities in the field of cybersecurity, and introduce them to at least two of the GenCyber Cybersecurity Concepts by completing hands-on activities. We also conduct two post-camp outreach sessions each year on two consecutive Saturdays in August/September. These sessions allow students to recap all GenCyber Cybersecurity Concepts. In addition, students complete several hands-on activities to demonstrate the knowledge they obtained during the pre-camp and summer camp. As a strategy of our retention plan, we set as one of the requirements to be admitted to the summer camp, students must attend the pre- and post-camp sessions. The curriculum for the post-camp activities is more advanced than the pre-camp and summer camp activities to ensure they learn new materials.

Tables 1, 2, and 3 in Appendix A represent a set of sample summer, pre-, and post-camp activities and schedules for Savannah State University's GenCyber program. The detailed information for each activity can be assessed from our program website. The resources for the 2024 camp can be found at <https://cscnt.savannahstate.edu/gencyber/resources.html>.

Assessment

During each day of the summer camp, we assess the participants' performance and their basic understanding of the contents taught, including Cybersecurity Concepts and the activities' functionality. We give a pre-assessment test each morning to check the existing knowledge and determine the areas of significant misconception for the topics to be covered on that day and ensure our student mentors are aware of these misconceptions and can help guide the participants' learning throughout the lessons and activities to clear these up. We discuss the correct answer and explain why the other answers are incorrect. At the end of each activity, instructors reassure understanding of the Concepts by conducting activity questions and short quizzes. In addition, a post-assessment quiz to assess each day's performance is conducted at the end of the afternoon session. We analyze the post-assessment quiz results to determine if some

Concepts need to be reviewed the following morning. We use Kahoot, an online game learning-platform to conduct the daily pre- and post-assessment quizzes.

Challenges

We faced several challenges over the years at different stages of the program. We were able to overcome those by employing some strategies; some of them are highlighted below:

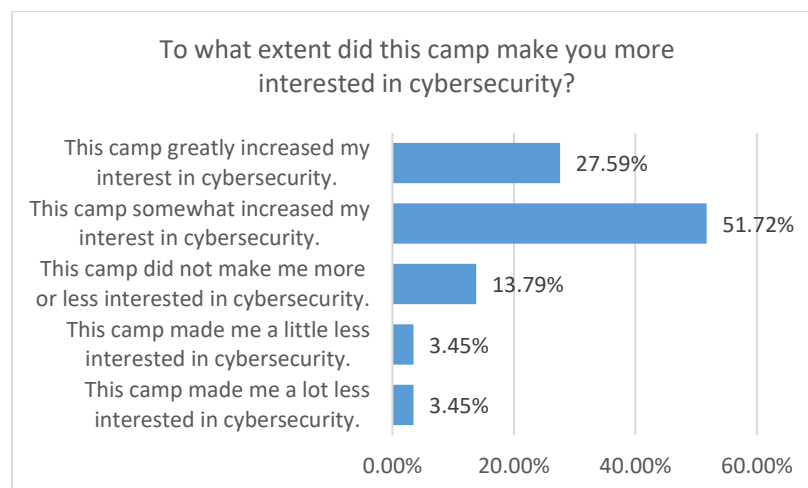
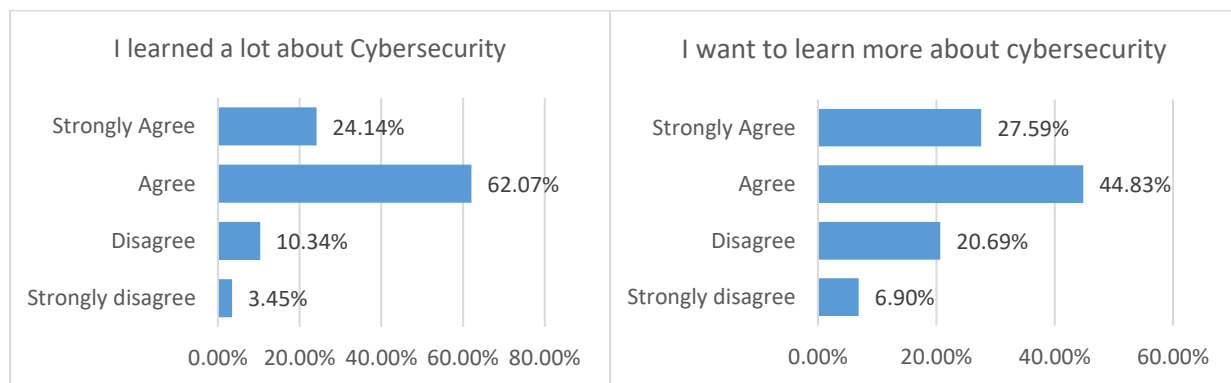
- (1) Recruiting enough female students was challenging in the first couple of years of the program. We were not able to recruit more than 25% female participants. After that, we have implemented several strategies to increase the participation of female students in our camp. First of all, we have given preference to female students in the selection process. We included the two female K-12 teachers and two of our female student mentors to serve as 'role models' to middle school girls in the recruitment team. It is important for young women to see a woman taking a leadership role. The inclusion of two female K-12 teachers and two female mentors in the team served that purpose. Most importantly, we were able to employ our online marketing service 'PeachJar' effectively to propagate the camp information to the parents of more female students. All of these efforts have resulted in a higher number of female participants in the camp in the last several years; the percentage of female students increased to an average of 32% from 25% in the first two years.
- (2) Recruiting enough student mentors was also challenging for us after 2020. After the pandemic, many students probably got used to online classes; most of our undergrad students were not staying on campus and taking courses in virtual mode. The initial target was to recruit 10 Computer Science Technology students as mentors, but we were able to get only 6 students in 2022. To have an adequate number of student mentors in 2023 and 2024, we have expanded the recruitment pool; we recruited and trained not only Computer Science Technology students, but also students from other Engineering Technology programs in our department to maintain an appropriate ratio of campers and mentors.
- (3) One major challenge for the post-camp outreach sessions has been bringing all summer camp participants back for the post-camp events. Providing some additional incentives to the participants, such as distributing free training kits and gift cards, has significantly increased the number of participants for the post-camp sessions in the last two years.
- (4) During the program's first three years, university professors used to conduct the classes. It was challenging for them to manage the middle school students. Starting from the fourth year, we hired two middle school teachers each year and trained them on the hands-on activities to conduct the classes. We were unsure how the inclusion of the school teachers in the instruction team would work. Amazingly, they became the key personnel to run the instructional part at the correct age-appropriate level. They know how to manage a classroom and have that respect for a positive learning environment.

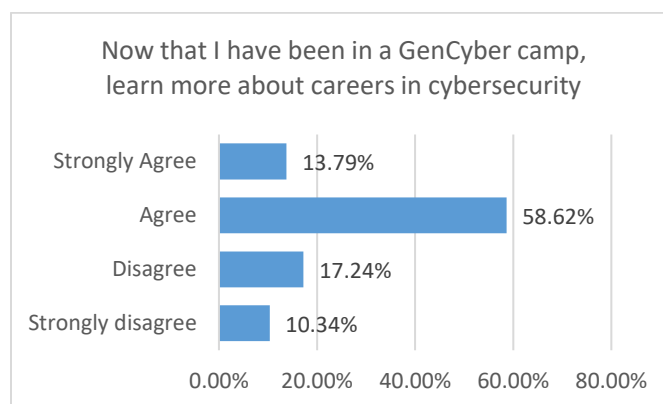
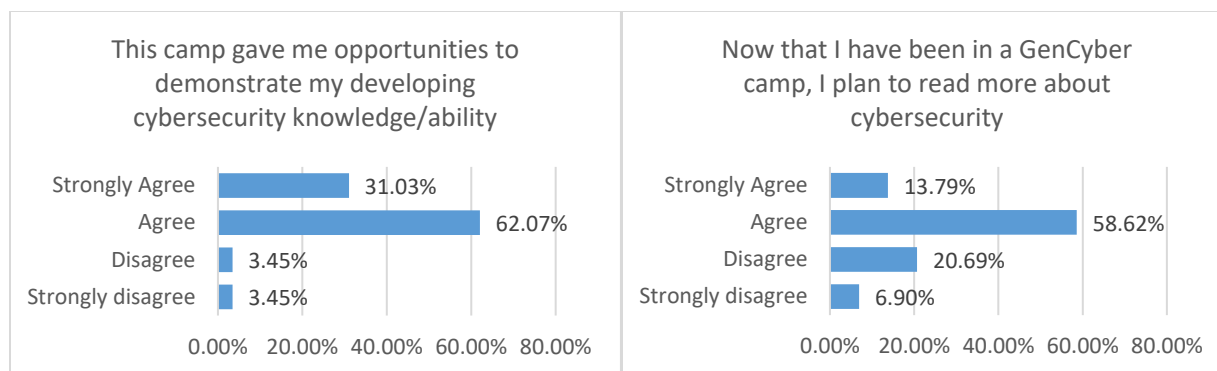
Feedback from the participants

At the end of each year's program, the GenCyber Program Office conducts an online survey among the participants and shares the results with organizing institutes. We feel that our program

has indeed contributed to increase the number of students interested in the cybersecurity field over the last six years. This was evident from the positive feedback we received from our participants each year. As an example, the summary of the data and the corresponding graphs collected by the GenCyber Program Office after the 2018 summer camp is provided below:

- 86.21% of the campers either agreed or strongly agreed with the statement: “I learned a lot about cybersecurity”.
- 72.42% of the campers either agreed or strongly agreed with the statement: “I want to learn more about cybersecurity”.
- 79.31% of the campers confirmed that ‘This camp greatly increased my interest in cybersecurity’, or ‘This camp somewhat increased my interest in cybersecurity’.
- 72.42% of the campers either agreed or strongly agreed with the statement: “Now that I have been in a GenCyber camp, I plan to read more about cybersecurity”
- 93.10% of the campers either agreed or strongly agreed with the statement: “This camp gave me opportunities to demonstrate my developing my cybersecurity knowledge/ability”.
- 72.42% of the campers either agreed or strongly agreed with the statement: “Now that I have been in a GenCyber camp, I plan to learn more about careers in cybersecurity”.





Last year, we conducted a survey among the parents of the camp participants. This was a one-question survey conducted via Google Forms with the question, “In a few sentences, please share your experience as a parent about the 2024 SSU GenCyber Summer Camp. What are the things you liked most? What are the things we could do better?” The parents also provided positive feedback, some of which are listed here:

- “Great experience! My daughter learned a lot, came home enthusiastic every day, definitely eager to continue and learn more in the field.”
- “It was a great experience. My son was able to get exposure which he really enjoyed. He would be really excited to talk about what he learned every day when I picked him up.”
- “My child had a wonderful learning experience. She enjoyed the GenCyber camp. She would love to participate in more programs like this.”
- “...really enjoyed the camp. His favorite part was coding a game He enjoyed the speakers and instructors. He is looking forward to the post camp in September.”
- “We loved hearing our son’s excitement about the things he learned! We truly appreciate being a part of the program!”

Conclusion

The main focus of this paper was to share the experience of the activities, challenges, and successes of the ‘GenCyber Summer Camp’ program funded jointly by NSA and NSF and organized by Savannah State University for local middle school students since 2018. One-on-one conversations with the participants and the encouraging responses to the post-camp survey

revealed that the activities might have had a positive impact on the young minds that can help them make career decisions in the future.

To create an impact in the local community, we will emphasize on cybersecurity education and careers in cybersecurity as our continued effort to increase cybersecurity awareness in the local community when we visit them for our recruitment events and as guest speakers during various school events. With the support from the College of Sciences and Technology, we plan to establish a 'Cybersecurity Club' for our students to promote cybersecurity awareness within our campus community. We also plan to institutionalize the project's activities to train young students and motivate them for cybersecurity careers, after the grant period is over. Support will be sought from internal funds (College of Sciences and Technology and President's Office) and external grants. We also plan to share the project's accomplishments with industry and community leaders and seek their support to conduct similar activities every year. The team is committed to mentor at least two middle school groups to prepare them for the Annual Regional Science and Engineering Fair and Savannah State University's Annual Research Day each year.

Acknowledgment

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References

- [1] U.S. Bureau of Labor Statistics, 2023, “U.S. Bureau of Labor Statistics, Occupational Outlook Handbook.” [Online]. Available: <https://www.bls.gov/emp/tables/fastest-growing-occupations-alt.htm>.
- [2] Georgia Department of Labor, 2023, “Georgia Department of Labor, (GA-DOL): Get Occupational Trends.” [Online]. Available: <https://dol.georgia.gov/get-occupational-trends>
- [3] Georgia Statewide Afterschool Network (GSAN), 2023, “Building Georgia's STEM Workforce.” [Online]. Available: <https://www.afterschoolga.org/wp-content/uploads/2019/10/Afterschool-Issue-STEM-Final.pdf>
- [4] National Girls Collaborative Project, 2023, “STEM Statistics: K-12 Education.” [Online]. Available: <https://ngcproject.org/resources/stem-statistics-k-12-education>
- [5] Public School Review, 2023, “Public School Review.” [Online]. Available: <https://www.publicschoolreview.com/georgia/savannah-chatham-county-school-district/1301020-school-district>
- [6] AEOP United States Army Educational Outreach Program, 2023, “AEOP Unite.” [Online]. Available: <https://www.usaeop.com/program/unite/>
- [7] Engineering Information Foundation, 2023, “Engineering Information Foundation (EiF).” [Online]. Available: <https://www.eifgrants.org/>
- [8] GenCyber, 2024, “Inspiring the next generation of cyber stars.” [Online]. Available: <https://public.cyber.mil/gencyber/>
- [9] J., Welsh, “These are the 7 Things Keeping Women out of Science Career,” *Business Insider*, 16 Oct 2013. [Online]. Available: <http://www.businessinsider.com/7-things-keeping-women-out-of-science-2013-10>. [Accessed Feb 18, 2025]
- [10] J. S. Ceci and W. M. Williams, “Why Aren’t More Women in Science: Top Researchers Debate the Evidence,” *American Psychological Association*, 2007.

Appendix A

Sample activities and schedule for Savannah State University's GenCyber Summer, Pre- and Post-camp.

Table 1: GenCyber summer camp schedule

Time	Day 1	Day 2	Day 3	Day 4	Day 5
7:30am – 8:00am Sign-in					
8:00am – 8:40 am	Kick-off of camp, Pre-assessment quiz, Icebreaker <u>Lecture:</u> Intro to Cybersecurity Concepts 1, 2, and 3	Pre-assessment quiz <u>Lecture:</u> Recap of Cybersecurity Concept 6	Pre-assessment quiz <u>Lecture:</u> Recap of Cybersecurity Concepts 2 and 3	Pre-assessment quiz <u>Lecture:</u> Recap of Cybersecurity Concepts 2, 3 and 4.	Pre-assessment quiz <u>Lecture:</u> Recap of Cybersecurity Concepts 1, 3, and 4
10 min. BREAK					
8:50am – 10:20 am	Activity 1 –_Computer hardware <u>Title:</u> Intro to computer components; Intro to MicroBit microcontroller	Activity 1 – Python Programming <u>Title:</u> Intro to programming concepts; Intro to variables and objects.	Activity 1 –_Network Fundamentals <u>Title:</u> Intro to Packet Tracer: SOHO network	Activity 1 –_Robotics <u>Title:</u> Intro to NAO programming	Activity 1 – Intro to Visual Programming <u>Title:</u> Intro to visual programming to configure/program robot
10 min. BREAK					
10:30am – 11:20am	Activity 2 –_Software <u>Title:</u> Intro to computer software	Activity 2- Python Programming <u>Title:</u> Intro to programming concepts (continue...)	Activity 2 – Network Fundamentals. <u>Title:</u> Packet Tracer simulation to create mid-size network.	Activity 2 – Robotics <u>Title:</u> Intro to NAO programming (continue...)	Activity 2 –_Ozobot Programming <u>Title:</u> Program the Ozobot to complete certain tasks.
11:25 am – 11:55am	<u>Guest Speaker:</u> Dr. Qian Chen Expert on Cybersecurity – at UTSA		<u>Guest Speaker:</u> Former SSU Chief Information Security Officer		<u>Guest Speaker:</u> Savannah Chatham Forensic Officer
30 min. LUNCH					
12:40pm – 1:10pm	<u>Lecture:</u> Intro to Cybersecurity Concepts 4, 5 and 6	<u>Lecture:</u> Recap of Cybersecurity Concepts 1, 2, 3, and 4	<u>Lecture:</u> Recap of Cybersecurity Concepts 4 and 5	<u>Lecture:</u> Recap of Cybersecurity Concepts 3 and 4	Activity 2 (cont.) - Ozobot challenge course <u>Title:</u> program robot to complete certain tasks
1:15pm – 2:20 pm	Activity 3 - Raspberry PI <u>Title:</u> Intro to hardware and	Activity 3 – Intro to Symmetric Key	Activity 3 – CoDrone	Activity 3 - Raspberry PI <u>Title:</u> Web server activity	<u>Lecture:</u> Recap of all six Cybersecurity Concepts

Time	Day 1	Day 2	Day 3	Day 4	Day 5
	software security using Raspberry PI and IoT sensors	<u>Title:</u> Intro to Python programming using Raspberry PI	<u>Title:</u> Intro to drone programming		
10 min. BREAK					
2:30pm – 3:25pm	Activity 4 - Challenge Activity <u>Title:</u> Raspberry PI and IoT sensors to build a secure infrastructure.	Activity 4 - Challenge Activity <u>Title:</u> Simulation of a DoS (Denial of Service) attack using Raspberry PI and Python.	Activity 4 - Challenge Activity <u>Title:</u> Create your own obstacle course using drone	Activity 4 - Challenge Activity <u>Title:</u> Web server activity and DoS simulation attack.	Post-assessment quiz; Assessment survey; Awards and Certificates distribution; Closing Remarks
3:30 pm – 3:40pm	Post-assessment quiz	Post-assessment quiz	Post-assessment quiz	Post-assessment quiz	
3:40 pm - 4:00 pm CHECKOUT					

Table 2: Pre-camp activity session schedule

Time	Pre-camp activity day 1	Pre-camp activity day 2
7:30am – 8:00am	Check-in	
8:00am – 8:30am	Presentation: General info about 2024 GenCyber program. Presentation: Expectations from the participants of 2024 GenCyber program	Presentation: Programs offering degrees in cybersecurity in local colleges and in the state of Georgia.
8:30am – 9:15am	Guest speaker: Careers in Cybersecurity	Presentation: How to make college life affordable - available scholarships
15 min. Break		
9:30am – 12:00pm	GenCyber Concept (Defense in Depth) <u>Activity Session 1:</u> Introduction to network and information security. Packet Tracer Network simulator to implement a SOHO network environment and simulate network packets transmission between LANs.	GenCyber Concept (Keep it Simple) <u>Activity Session 1:</u> Introduction to Visual Programming using a drone and Ozobot.
Lunch Break: 45 min.		
12:45pm – 3:00pm	Activity Extension 1: Network Sniffer/Scanner to capture data in the network.	Activity Extension 1: Drone programming to complete an obstacle course.

Table 3: Post-camp activity session schedule

Time	Post-camp activity day 1	Post-camp activity day 2
7:30am – 8:00am	Check-in	
8:00am – 8:45am	Guest speaker: Preparation for Computer Science, Cybersecurity and Engineering professions	Presentation: Early college/dual enrollment programs (Georgia's Move On When Ready (MOWR) program) Presentation: A recap - Why should you choose a Cybersecurity/STEM profession?
15 min. Break		
9:00am – 11:45am	GenCyber Concept (Availability) <u>Activity Session 1</u> : Beacons using MicroBit for transmission between two devices.	GenCyber Concept (Keep it Simple) <u>Activity Session 1</u> : NAO Programming: object avoidance
Lunch Break: 45 min.		
12:30pm – 3:00pm	GenCyber Concept (Confidentiality) <u>Activity Session 2</u> : Encryption and Decryption using Python	GenCyber Concept (Keep it Simple) <u>Activity Session 2</u> : Ozobot Evo Programming: racetrack challenge.