Broaden Cybersecurity Awareness for Middle School Girls via Outreach, Cyber-Games, and Storytelling

To increase the diversity of the cybersecurity workforce in the USA, teaching cybersecurity knowledge and skills to middle school girls is the approach. Despite most middle school students' lack of basic computer science knowledge, we propose broadening cybersecurity awareness through conducting outreach activities, playing cyber games, and telling stories. The curriculum is designed to focus on providing interaction, exposure, and support to every student. Our ideology is to encourage students' learning through these methods. From the survey of the GenCyber camp in 2021 and 2023, respectively, many students were impacted by the program and presented their willingness to seek out cybersecurity as their career goal.

Keywords: *Gencyber; Outreach; Cybersecurity Awareness; Cyber-games; Storytelling*

Introduction

In the United States of America (USA), national economic security is highly dependent upon a strong cybersecurity workforce. Almost all aspects of the infrastructure depend upon the operation of computers and networks. The security of these systems is imperative to the health and protection of our national infrastructure and information assets [JHill2001]. Protecting data and information on computing systems has become even more critical and challenging than ever before. Since the emergence of the Internet and the widespread adoption of web technology, expertise in information assurance has become necessary for many IT professionals. For those working in government agencies, educational organizations, industry, and other businesses, [JSJM2022] the need for security-skilled workers has doubled from 2021 to 2022.

The United States has experienced a serious shortfall of skilled cybersecurity professionals, especially females. To improve the number of female professionals in cybersecurity, one efficient way to cultivate interest in cybersecurity is when they are younger, such as middle school girls. In this paper, we explore the approaches to broaden cybersecurity awareness among middle school girls by exposing them to cybersecurity topics. Most middle school girls have some computer science (CS) skills, but they need cybersecurity knowledge. We faced the challenge of teaching young students with no CS and little Math background cybersecurity concepts and skills in as little as one week. To engage middle school girls in a one-week cybersecurity schedule, we facilitated a learning-centered classroom and designed a cybersecurity education curriculum via outreach, cyber-game playing, and storytelling. Our methodology for broadening cybersecurity awareness in female students is "learning via seeing, playing, and telling".

Columbus State University (CSU), GA has held the summer camp of “Broadening Cybersecurity Awareness for Middle School Students vis

GenCyber Outreach, Games, and Storytelling" four times under the support of the National Security Agency, USA since 2017. The goal of the summer camp was to increase the students' interest in cybersecurity careers and knowledge, fostering their leadership skills as cybersecurity ambassadors. In 2021 and 2023, we only recruited middle school girls as summer campers. By targeting female students, we expect this will ultimately contribute to building a diverse workforce and promoting appropriate online etiquette amongst the participating middle school students in the community of Columbus, GA, and its vicinity areas of Alabama. The girls participating in the program can apply what they learn from the summer camp in their Internet surfing and continue the camp via Women's Cybersecurity clubs within their schools, as well as influence their peers to pay more attention to cybersecurity awareness. The summer camp is designed in three phases: three-day Pre-camp, five-day summer camp, and one-day post-camp. The following will discuss the program's legacy differentiation, students' learning, and assessments.

Program Legacy

Teaching middle school students cybersecurity knowledge/skills is challenging since they may need to gain computer knowledge to start with. Even though some students may know computer operations, it is not enough to prepare them to study cybersecurity skills. The approach taken in this program to broaden cybersecurity awareness for middle school girls is to engage them in outreach activities, playing games, and telling stories. The "learning through seeing, doing, telling, and engaging" method is appropriate for 6th- 8th graders. Storytelling through history is an efficient way to engage students with cybersecurity concepts. Storytelling is a powerful learning tool and has been used successfully across the curriculum to improve content learning gains as well as motivation and problem-solving [SMiller2008, JBaldwin2007, Chung2012]. In particular, storytelling has been used effectively to engage middle school girls in learning programming [CKelleher2007] and we believe it can do the same to gain their interest in learning cybersecurity concepts. Designing the GenCyber camp T-shirt can motivate students to learn the Cybersecurity First Principles, and help them not lose interest in the camp activities. To manage the pre/post camp outreach activities, in addition to director, lead instructor, and school expert, we set up a new position -outreach coordinator whose responsibility is to coordinate all the outreach activities.

Differentiation

The method used for pre-camp activities is "learning through seeing'. Through field trips to the cybersecurity centers of TSYS and Synovus respectively, students can see how data are stored, and how information is processed and secured. They also have an opportunity to hear about what professional women who work in cybersecurity for Synovus Global Payments do and how they prepare for their careers. The field trip to KIA pushed the

student to see the technology and assembly operations of KIA Auto. The method used for camp activities is "learning through doing and telling". During the five days, students have games and tell two stories. Through playing games, and storytelling, students have a firm understanding of the GenCyber cybersecurity concepts and the First Principles. The method used for post-camp is "learning through engaging" which can provide more opportunities for participants to continue their progress after the camp.

Students' Learning

This program is designed to facilitate student-centered learning. All activities serve students through learning by doing. The instructor and teaching assistants work collaboratively to provide a student-centered learning environment. Students can obtain cybersecurity knowledge and skills through GenCyber outreach, games, and storytelling activities. The evidence of student learning can be seen through informal observation, products created by the students, and pre and post-quizzes on cybersecurity topics.

Assessment

To evaluate the effectiveness of the proposed project on student learning outcomes, we used the following approaches.

Survey: A qualitative survey including a pre-camp and a post-camp will be developed to get an insight into students' perspectives on cybersecurity lessons learned. The questions in the pre-camp and post-camp survey primarily focus on cybersecurity knowledge and awareness. We can assess if participants' cybersecurity awareness was broadened by comparing the results of the two surveys.

Assessment Quiz: A small test module was developed for each camp day to assess students' retention of cybersecurity concepts and knowledge. The test modules focused on the assessment of student learning performance in the following topics:

- Online behaviour and ethics of cybersecurity
- Cybersecurity concepts, principles, and online social networks
- Cyber bullying and computer hacking

Activity Products: All the activities are designed in a way that cybersecurity concepts, knowledge, skills are integrated. Completion of the products for each activity is an indicator that students have gained from the process.

Methodologies to Broaden Cybersecurity Awareness

In keeping with Gen-Cyber's goal to "Ignite, sustain, and increase awareness of K12 cybersecurity content and cybersecurity postsecondary and career opportunities for participants," [GenCyber, 2023], the curriculum selection was focused on providing interaction, exposure, and support to every participant. Targeted learning outcomes were determined to help evaluate effective curriculum and pedagogy. These goals included providing participants with the following outcomes;

- Exposure to new experiences
- Engagement and real-world relevance to the concepts of cybersecurity
- Realizing inclusivity and diversity in cybersecurity jobs and classes
- Allowing opportunities to learn and utilize critical thinking skills
- Creating awareness of educational and career opportunities in cybersecurity

Three primary educational areas were selected as the general focus to meet the targeted outcomes; outreach, game-playing, and storytelling. Not only did these pedagogies meet the requirements of the learning targets, but studies have shown these methods are especially effective in educating and engaging minority female students. According to Varma, minority students must perceive that studying computer science is consistent with their view of themselves as members of a group. It is also important they believe they can participate successfully in CS education. When interviewed, students reported liking computer science classes which required creativity and design skills, and showed how new information could be applied to the real world. [Varma, 2006] Lessons were designed and implemented with a focus on the targeted learning outcomes.

Gencyber Outreach

It is widely known that our computer science students do not reflect the diversity of the population at large and that one of the most effective methods for encouraging broader participation is to design and employ outreach activities targeted at K-12 students. [Murphy2005] Considering that the GenCyber Summer Camp is an outreach program, it was imperative to consider the opportunities participants would have within the walls of the university and if these would meet the targeted learning outcomes. To create sustainable interest in cybersecurity, participants needed exposure to new experiences related to the field. Studies have shown that the kinds of outreach initiatives needed to attract and retain female enrolments in higher education computer science majors are those that are socially and culturally located. [Redmond2022] In reviewing how the program could relate to participants socially and culturally it was determined that field trips to local iconic companies would provide exposure to new experiences and provide relevance and engagement in cybersecurity. Three local industries were selected for visitation. Many participants likely know someone, such as family members, who work in one or more of these companies. Female

visitor liaisons and employee ambassadors were selected to interact with the participants in the program. Exposure to women with careers in technology provided a realization of inclusion and diversity in the workforce as well as created awareness of career opportunities in computer science fields.

Within the university classrooms, lessons were planned to implement an informal learning environment. Students were encouraged to work in groups to discuss concepts, share ideas, solve problems, present solutions, and build relationships. Informal education has been shown to significantly increase self-efficacy and a sense of belonging in the computing community among female participants. The role of social participation further enforces these behaviours. [Hiley2023] Including discussion prompts and Think-Pair-Share time into the lessons encouraged the participants to think critically, collaborate, and feel included in the discussions and activities. This further established a sense of belonging and inclusivity in the program.

Cyber-Games

To meet the ever-increasing cybersecurity workforce demand it is imperative to develop and maintain cybersecurity interest in today's youth. To increase engagement and motivation for learning within the classroom, Gen-Cyber camp lessons were developed to include elements of gamification. "Gamification" is the use of game design elements in non-game contexts, it is based on the popularity and attraction of video games. Since games can demonstrably motivate users to engage with them with unparalleled intensity and duration, game elements should be able to make other, non-game products and services more enjoyable and engaging as well. [Detering, 2011] Some of the gamification elements incorporated into the camp include a point system for participating in discussions. Participants were awarded "cyber-bucks" for providing quality answers and actively engaging in discussions. Participants could spend their cyber-bucks to purchase treats. Daily lessons and activities were designed to promote social interaction by grouping participants into teams to problem-solve together and compete against other teams. The goal was to create activities with structured rules that cultivate cooperation and competition in solving problems. Some games were designed to promote creativity and imagination within the participants where the objectives of the activity promoted free-form play and improvisational situations related to the real world and practical application. These learning experiences provide opportunities for self-representation as a player within the team environment. This helps reshape the stereotypical image of cybersecurity professionals and allows the participants to see themselves in this role. Designing "cyber-games" utilizing these concepts contributed to the goals of learning and utilizing critical thinking skills, realizing inclusivity and diversity in the field of cybersecurity, exposure to new experiences, and creating real-world relevance to cybersecurity concepts.

Storytelling

The art of storytelling has been an integral part of human history. From early hunter-gatherer days when people would gather around the campfire to exchange stories, to modern-day movies and digital data that we all enjoy, humans love a good story. Stories inform, educate, inspire, and entertain us daily. [Gallo C 2019] A story does what facts and statistics never can, it inspires and motivates. Storytellers translate complex ideas into practical examples laced with strong emotional connections. The audience tunes in because they see themselves woven into the story. [Boris, 2018] For the GenCyber camp, creating opportunities for the participants to see themselves and others like them as members of the computer science and cybersecurity communities was paramount. If participants could view themselves as capable and accepted members of these communities hopefully it would transition into sustained interest in the subject and propel them to seek educational and career opportunities in the field. Storytelling activities were incorporated into every lesson. Some activities included having the participants create short "Tik-Tok" length skits to act out scenarios relevant to learning objectives. They created a mock court where each person was assigned roles to debate sides of conflicting issues. The young ladies played "choose your adventure games" where participants could select a character and participate autonomously to make decisions to determine an outcome. Opportunities for participants to share their own stories were woven into all activities. The curriculum was designed to include storytelling and story-sharing to increase engagement and inclusivity in all lessons.

In researching effective pedagogy for reaching females, especially minority female students, the concept of "restorying" emerged as a viable concept to have maximum impact on promoting inclusivity and diversity in the stereotypical field of computer science. Restorying is the process of first deconstructing and then reimaging dominant narratives that normalize who someone is or who they might become in the future. [Shaw, 2023] Basically, the purpose is to reshape how someone views their place in a particular field so that they can 'restory' their future. During the outreach field trips, the participants were introduced to and heard educational and career stories from many women, and how they entered their career fields. This provided tangible examples that conflicted with the traditional masculine-dominated stereotype of computer science. Throughout the remainder of the GenCyber camp, these women became the main characters in stories and interjected as examples in situations. This allowed the participants to reshape their perceptions of themselves in the field of computer science.

Curriculum Implementation

We designed the curriculum of the Gencyber program in CSU in three stages: pre-camp, summer-camp, and post-camp.

In the pre-camp, we designed three field trips to TSYS, the KIA automotive manufacturing plant, and the Pratt & Whitney Plant. The campers visited the cybersecurity center to see how their computing systems work and how they defend their network from cyber-attacks. The students may not understand how their defending system works, however, the field trips can motivate the campers' interest in cybersecurity, and push them to pay attention to cybersecurity issues. During the field trips, ethics and the GenCyber cybersecurity concepts, including defense in Depth, Confidentiality, Integrity, and Think like an Adversary, can be emphasized. The goal of pre-camp outreach is not only to prepare the campers for the camp cyber games and storytelling but also to help them gain a deep understanding of the GenCyber concepts and the First Principles. The following Table 1 shows the designed details of the pre-camp activities we used in our 2023 GenCyber program.

Table 1. *Pre-camp Curriculum Design*

Activities / Category	**Pre-Camp-Day 1: Field-trip to TSYS**
Description	On day 1 of pre-camp activities, participants will meet industry professionals from one of Columbus State University's (CSU's) partner companies, Global Payments, and get an intimate look at a technology center's operations and security.
Activities Involved	Participants will meet at Columbus State University (CSU) and travel by bus to the North Data Center of Global Payments for an interactive guided tour of the facility, which includes a technology center as well as credit card embossing and statement printing operations. As part of the activities involved in the tour, participants will hear and ask questions about how the company captures, processes, and protects data on their systems. They will see and experience the many security controls in place. They will also have an opportunity to interact with inspiring professional women who work in cybersecurity for Global Payments and hear about what they do and how they prepared for their careers. After the events of the day, participants will be returned by bus to CSU.
Resources Required	Bus transportation to and from the Global Payments facility.
Learning Outcome	Understanding how a Fortune 500 FinTech company implements the concepts of cybersecurity to protect critical credit card payment data. Understand what kinds of cyberattacks are common to a FinTech company and how they defend against those attacks.
GenCyber Principles/Concepts Addressed	**Defense in Depth; Confidentiality; Integrity; Availability; Think Like an Adversary; Ethics and ethical responsibility; Layering; Least Privilege; Domain Separation**
	Pre-Camp-Day 2: Tour of CSU's Technology Operations and Field-trip to Pratt & Whitney
Description	On day 2 of pre-camp activities, participants will meet industry professionals from CSU's University Information Technology Services (UITS) group, tour the CSU technology facility, and hear the unique challenges of managing and supporting systems and networks for a university. Participants will also visit one of CSU's

	partner companies, Pratt & Whitney Plant, and see the technology and cybersecurity operations of a large regional bank.
Activities Involved	Participants will meet at Columbus State University (CSU) for a tour of CSU's technology facility and a cybersecurity discussion with UITS team members. After touring CSU, participants will travel by bus to the Pratt & Whitney Plant for an interactive guided tour of their facility and a presentation and Q&A session with Pratt's Women In Technology (WIT) group. After the events of the day, participants will be returned by bus to CSU.
Resources Required	Bus transportation to and from the Pratt & Whitney facility.
Learning Outcome	Understanding the unique and diverse responsibilities of a university to support its administrative staff, faculty, and students, while still maintaining security and integrity of important systems and data. Understanding how a large regional banking organization operates and implements the concepts of cybersecurity to protect critical customer and financial data. Understand what kinds of cyberattacks are common to a large regional bank and how they defend against those attacks.
GenCyber Principles/Concepts Addressed	**Defense in Depth; Confidentiality; Integrity; Availability; Think Like an Adversary; Ethics and ethical responsibility; Layering; Least Privilege; Domain Separation**
	Pre-Camp-Day 3: T-shirt Design and Field-trip to Kia Automotive Manufacturing Plant
Description	On day 3 of pre-camp activities, participants will learn the GenCyber Cybersecurity First Principles and Concepts and then design T-shirts using those as the theme. Participants will also visit one of CSU's partner companies, Kia Auto manufacturing.
Activities Involved	Participants will get a presentation of the GenCyber Cybersecurity First Principles and Concepts. Participants will then use their new knowledge to design T-shirts using the Principles and Concepts as the theme of the shirt designs. The T-shirt designs will be entered into a contest and the winning design will be used for the T-shirts provided at the summer camp. Participants will also visit one of CSU's partner companies, Kia, and see the technology and cybersecurity operations of an automotive manufacturer.
Resources Required	Art Supplies; Paper; Bus transportation to and from Kia auto manufacturing facility.
Learning Outcome	Learn the GenCyber Cybersecurity Concepts and Cybersecurity First Principles. Also learn the unique challenges of an automotive manufacturer.
GenCyber Principles/Concepts Addressed	**All Principles and Concepts are introduced and reinforced by the T-shirt activity. The tour will address Defense in Depth; Integrity; Availability; Layering; Least Privilege; Domain Separation**

In the summer camp, we designed five interactive modules reflecting fundamental computer science and cybersecurity topics: Computer Networks, Encryption/Decryption, Malware, Cybercrime, and Ethics. Teaching middle school students cybersecurity knowledge and skills is challenging, especially if they have little or no prior computer knowledge. While some students may be

familiar with basic computer operations, this knowledge is often insufficient for studying cybersecurity skills. Integrating real-world examples alongside their cyber counterparts has proven effective in bridging the gap between abstract concepts and tangible engagement for participants. We implemented a method of learning through observation, practice, and storytelling, drawing from historical examples to better engage and involve the participants. Table 2 shows the details of the five learning modules.

Table 2. *Summer-Camp Curriculum Design*

	Module 1: Security in Medieval Kingdoms: Networks
Description	Participants will learn about networks and security in moving information, as well as physical security, using the analogy of the medieval kingdom.
Activities Involved	Participants will use cardboard and simple materials to create castles and villages in a large cleared classroom. Once created participants will be given a series of challenges to defend (team 1) or attack (team 2) as goods and services are moved throughout the kingdom. As the activity progresses, the analogy will develop that castles represent servers, wagonloads packets, etc.
Resources Required	Cardboard, Legos, tape and other building materials.
Learning Outcome	Understanding of how the Internet works as well as the basics of how attacks are made on information passed through networks. Identification of network components and attack vulnerabilities.
GenCyber Principles/Concepts Addressed	**Modularity; Resource Encapsulation; Layering; Least Privilege; Domain Separation; Defense in Depth; Keep it Simple; Minimization**
	Module 2: Encrypting Through History: How to Hide Your Message
Description	Participants will learn a variety of encryption methods across history.
Activities Involved	Participants will learn about and utilize a variety of encryption methods to hide and decipher messages (including historical methods and modern ones). The activities will be presented game style and require the participants to decrypt messages and then encrypt their own messages. Throughout participants will utilize critical thinking to compare each method for pros and cons.
Resources Required	Recreation of historical encryption devices: https://www.sans.org/reading-room/whitepapers/vpns/history-encryption-730; Linux
Learning Outcome	Explain what cryptography is used for. Identify the basics of encryption and decryption.
GenCyber Principles/Concepts Addressed	**Data Hiding; Layering; Least Privilege; Confidentiality; Keep it Simple; Simplicity; Minimization**
	Module 3: Historical Epidemics: From Humans to Computers
Description	Participants will learn about malware by comparing various kinds of malware to historical epidemics. For example, small pox infected blankets given to Native Americans is akin to a Trojan Horse virus.
Activities Involved	Game and simulation of how infectious diseases spread. Reenactment of various historical epidemics and comparison to malware. Creation of artwork blending historical epidemics with modern malware.

Resources Required	NetLogo, Art Supplies
Learning Outcome	Identification of different types of malware and how they spread
GenCyber Principles/Concepts Addressed	**Integrity; Availability; Process Isolation; Least Privilege**
	Module 4: The Wild West, Gangsters, and Hackers: Protect Yourself!
Description	On day four participants will learn about cyber crime through a comparison with famous criminal and crimes throughout history.
Activities Involved	Mock court (judge, jury, defendants, prosecutor, witnesses)
Resources Required	Prepared cases
Learning Outcome	List damages caused by various cybercrimes
GenCyber Principles/Concepts Addressed	**Defense in Depth; Think Like an Adversary**
	Module 5: Emily Post, Etiquette vs. Ethics, and Online Behavior
Description	On day 5 participants will look at Emily Post's Etiquette rules and see what does and doesn't apply to the virtual world. Participants will then design and implement chatbots that teach users how to behave online.
Activities Involved	Etiquette carousel; ethics vs. etiquette; creating chatbots
Resources Required	Free software for chatbot creation, large sticky paper, post it notes
Learning Outcome	List essential rules for ethical behavior online
GenCyber Principles/Concepts Addressed	**Abstraction; Ethics and ethical responsibility**

Table 3 shows the curriculum designed for the post-camp of the Gencyber program. The general goal of the post-camp is not only to extend the Gencyber camp, but also make the program sustainable, further attract more students to come to next year's program, engage more students in cybersecurity, and become cybersecurity professional in their future careers.

Table 3. *Post-camp curriculum Design*

	Post-Camp-Day: Student and Professional Cybersecurity Clubs
Description	On day 1 of post-camp activities, participants will meet officers and members of local student and professional clubs and see how they might participate in an existing club and/or start a new club.
Activities Involved	Camp participants will meet officers and members of local student and professional cybersecurity and technology clubs. Participants will present summaries of what they each learned during the GenCyber camp. They will also meet and interact with club members, who will describe their clubs and the benefits of membership. Camp participants will be encouraged to join a local cybersecurity or technology club. They will also receive training and encouragement to start new clubs in their respective schools.

Resources Required	Adequate meeting facilities with video projection as needed.
Learning Outcome	Learning how clubs and club members can develop and continue engagement to keep learning about cybersecurity beyond the summer camp experience.
GenCyber Principles/Concepts Addressed	**Various principles and concepts will be addressed based on the presentations of the campers. The club members will also address various concepts and principles based on the discussions and Q&A sessions with the campers.**

Reflections from Gencyber Summer Camp

In the summers of 2021 and 2023, Columbus State University successfully launched all-girls camps titled "Broadening Cybersecurity Awareness for Middle School Girls via GenCyber Outreach, Games, and Storytelling." Our summer camps provided a positive and engaging learning environment, employing effective instructional practices and strategies in cybersecurity for a diverse group of participants. Throughout the camps, students were immersed in the first principles of cybersecurity and awareness through various computer games and activities related to cybersecurity. Emphasizing a 'learning by doing' approach, instructors and assistants worked collaboratively to foster a student-centered classroom. Participants not only acquired cybersecurity knowledge but also developed practical skills through GenCyber outreach, games, and storytelling activities. The successful acquisition of cybersecurity knowledge by the students was evident from their active participation.

The visiting team from the National Security Agency (NSA) offered several suggestions and identified various challenges. The students, in turn, gave valuable feedback about our last GenCyber camp. We have compiled these recommendations, feedback, and challenges into a table for easy reference. The summaries of our reflections and responses are presented in Table 4.

Table 4. *Reflections*

Recommendation/Challenge	How to address each recommendation
More people and more activities to avoid participant fatigue in each afternoon	We will design a project for a group of students for each afternoon class. Avoid lectures in the afternoon class.
Cut the camp time	Since it is required to keep 6 hours for each camp day, we plan to cut the time to "9:00 am to 4:00 pm".
Less lectures, more activities	No lectures in the afternoon time, add more Icebreaker games at the beginning and end of each morning. All the pre/post outreach events are activities.
Reduce the targeted number of participants	We plan to host 30 girls reduced from 60.
Reduce the number of target participants from 60 to 30	Yes, we have reduced the number of students recruited in the new proposal to 30.
Improve the way to market GenCyber program and enhance recruitment	1. Establish connections with each middle school science teacher and ask them to recommend candidates; 2. Host a seminar in some schools to advertise the GenCyber program;

	3. Start recruiting as early as Fall 2022, so the flyer can reach most of the families before Spring 2023.
Cover Ethics and safe online behavior lessons at its earliest time	Ethics and safe online behavior lessons will be added to the first day of pre-camp outreach activity.
Cover GenCyber GCC/FP before the summer camp	GenCyber Cybersecurity Concepts/First Principles (GCC/FP) will be explicitly taught to the participants on the third day of the pre-camp outreach activity by designing a GenCyber T-shirt. GCC/FP will also be emphasized explicitly by connecting to class activity.
It is better to involve TAs to curriculum development and implementation	Teacher assistants will be assigned to the development and implementation of multiple icebreakers for the camp.
Accommodate the campers who finish games early	Prepare more difficult games for the participants who finish early.
Poor sustaining engagement and attention after lunch	To solve the problem, we will add a group project to each afternoon class.
Gauge student understanding and increase their interest	A formal assessment using Kahoot, or other online assessment tools will be added at the end of each camp day.

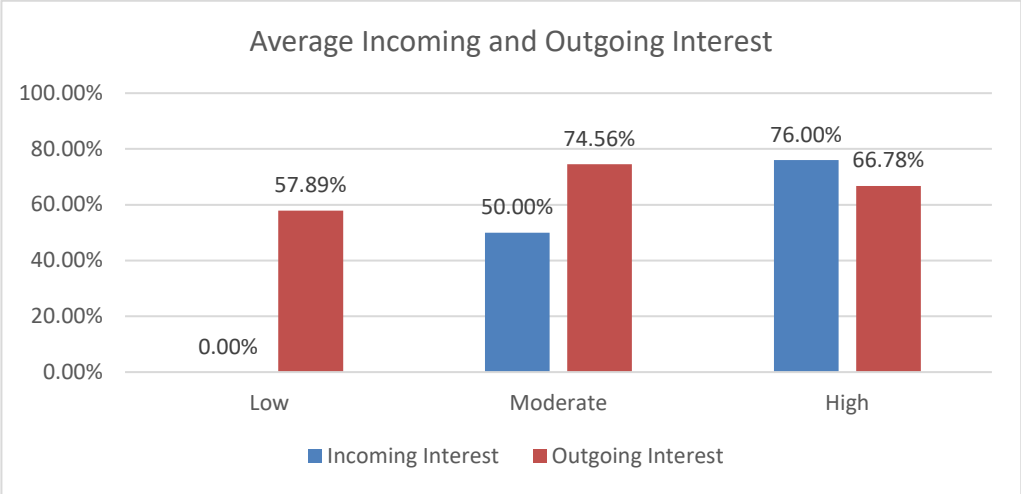
In the post-survey of the 2021 GenCyber Summer Camp, a four-phase model [Hidi2006] was applied to understand the evolving interests of camp participants. This model encompassed various stages of interest development: Triggered Situational Interest, Maintained Situational Interest, Emerging Individual Interest, and Well-Developed Individual Interest. The focus was to meticulously examine camper responses from the end-of-camp survey, aiming to achieve two primary goals. Firstly, the analysis categorized the initial and final interest levels of attendees, alongside tracking the progression of their interest in the field. Secondly, the aim was to assess the effectiveness of the camp in fostering interest, using seven specific constructs complemented by open-ended questions about factors that facilitated or hindered this interest development.

To achieve these objectives, the study employed a detailed approach. The initial or 'incoming' interest level of the campers was gauged using four specific indicators. These indicators primarily focused on distinguishing between intrinsic (internal motivation) and extrinsic (external motivation) reasons for attending the camp, as well as considering any prior engagement with cybersecurity. The 'outgoing' interest level, representing the end state of interest at the camp's conclusion, was assessed through a combination of three elements, with one of these comprising multiple prompts. This assessment was based on campers' self-reported interest in cybersecurity and their expressed intentions to pursue it further. This comprehensive method allowed for a nuanced understanding of how and why participant interest in cybersecurity evolved during the camp. Once responses were compiled, respondents were classified as low, moderate, or high incoming and outgoing interest as follows:

0.00% - 33.33%	Low
33.34% - 66.66%	Moderate
66.67% - 100.00%	High

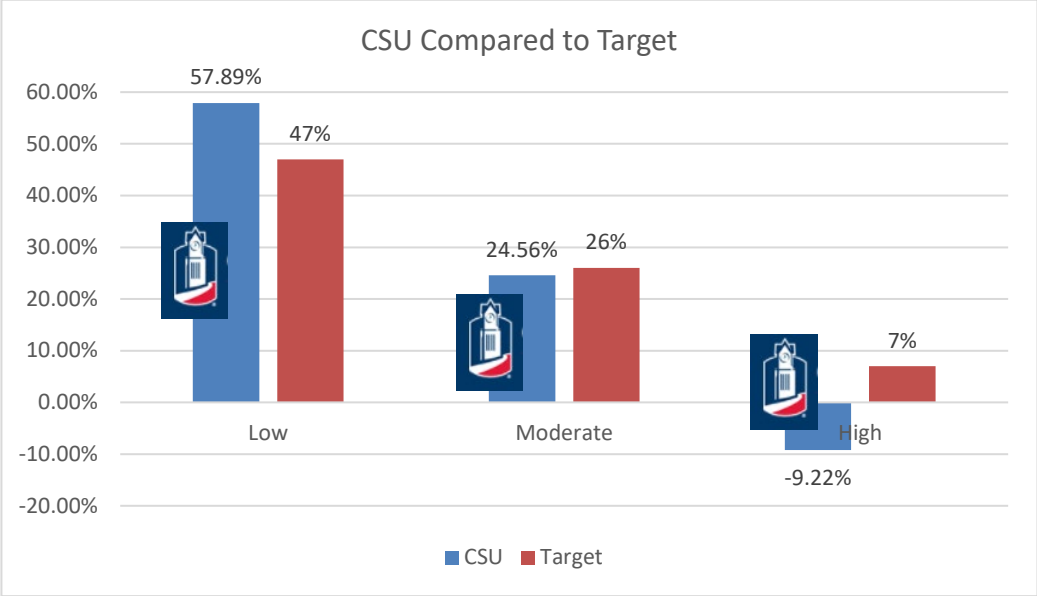
Figure 1 is a bar chart showing the average incoming and outgoing interest levels by group, and interest change for each of the three groups.

Figure 1. *Average Incoming and Outgoing interest in Gencyber Summer Camp 2021*



As can be seen, the group with low incoming interest had a substantial increase. The moderate group had a moderate increase and high incoming interest had a decrease. According to the NSA data for Gencyber summer camps, In 2019, the average increase for each group (low incoming interest, moderate incoming interest, and high incoming interest) was calculated as follows: 47%, 26%, and 7% respectively. The CSU camp compares these targets as shown in Figure 1. Our Gencyber Camp performed above the average for students coming to camp with low interest. CSU performed below average for students coming to camp with moderate, and high incoming interest.

Figure 2. *CSU Compared to Target*



In Table 5, we present the results of a post-survey from our 2023 Gencyber summer camp, specifically targeting 30 middle school girls. The camp focused on engaging participants in cybersecurity games. Feedback indicated that this game-based approach effectively increased the students' cybersecurity knowledge, and their grasp of cybersecurity principles, and raised their awareness of digital citizenship and security issues. From the survey results, we can see that the camp was well-received and valued by the attendees. However, it also highlighted a gap between cybersecurity and the everyday experiences of middle school students. This gap underscores the importance of initiatives like the Gencyber camp in fostering interest in cybersecurity among this age group. The positive outcomes and potential observed in cybersecurity education are driving factors for the future continuation and expansion of more Gencyber summer camp programs.

Table 5. *Summer 2023 Post-camp Survey Questions and Results*

Survey Questions	Score (1 to 5)
1: How interested are you in continuing to study cybersecurity?	3.05
2: How interested are you in getting a job in cybersecurity?	2.25
3: How interested are you in doing research in cybersecurity?	3.09
4: How interested are you in teaching others about cybersecurity?	2.73
5: How interested are you in pursuing professional credentials in cybersecurity?	2.23
6: How interested are you in pursuing a college degree in cybersecurity?	2.65
7: How interested are you in participating in future GenCyber activities?	3.57
8: The instructors were knowledgeable	4.19
9: The instructors were good teachers	4.04
10: The activities were interesting	3.76
11: The lectures were helpful	3.71
12: Some things had to be cut short because of time issues	3.05
13: There was more than enough time to learn everything presented	3.71
14: I learned a lot of things I didn't know about cybersecurity	4.4
15: The camp format was appropriate	4.5
16: I felt welcome and respected	4.05
17: This was a good use of my time	3.8
18: I would recommend this program to a friend or relative	4.2
19: The camp experience was better that I had hoped or expected	4.1
20: The amount of activities was appropriate	3.85
21: The material challenged me	2.8
22: I will share what I learned with friends and relatives	4.00
23: I will participate in follow-on activities related to this camp	4.00

Conclusion and Future Work

It is critical and urgent to build a diverse cybersecurity workforce nationally today. One approach to engage more students in cybersecurity is to equip them with computer skills and cybersecurity concepts from their middle school time. However, we found that it is hard to teach middle school students cybersecurity knowledge due to their limited computer skills. In this paper, instead of directly teaching them cybersecurity, we propose broadening cybersecurity awareness for middle school girls. It is still not trivial to broaden cybersecurity awareness

for middle school girls because 6th to 8th graders have little computer knowledge without any cybersecurity skills. The methodology we took in our Gencyber program supported by the National Security Agency (NSA) of the USA was to reach our goal via outreach activities, cyber games, and storytelling.

We designed our curriculum in three stages including field trips, playing cyber games, and storytelling. From the survey made by the Geycyber team, most students had no idea about cybersecurity, but after the camp, they obtained some knowledge and skills in cybersecurity. After two years of Gencyber summer camp around Columbus, GA, and its vicinity area of Alabama, many parents and students know this program. They present their interests and willingness to attend this camp. In this area, we have more than 12000 middle school students including 6000+ females. With Gencyber-trained female campers and impacts brought back by the girls, this program will certainly, increase the student diversity in cybersecurity majors in colleges.

Due to two successful Gencyber camps, we will continue this program and recruit more students including females and males from more areas around Columbus, GA than before. We will attract more people pay attention to this government-supported program and have more students equipped with cybersecurity basic skills before coming to college.

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