Gannon University Hackathon: A Combination of Virtual and Onsite Education Event to Recruit High-School Students within Cybersecurity Major

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***Abstract*— Hackathon is a popular event designated to boarder participation and perceptions in computing. With the fast growth of Cyber Security major at Gannon University, an innovative Hackathon event targeting high-school students was designed and deployed through both virtual and on-site forms. The virtual hackathon was developed based on OWASP Juice Shop, which was an open-source insecure web application. Students were expected to deploy and "hack" their own website. Scores were evaluated based on the difficulty of hacking tasks. The virtual event provided the maximal broadcasting of Gannon's Cyber Security. Either global or domestic high-school students got an opportunity to experience the challenges in Cyber Security. The on-site hackathon was a one-day event, with both lecturing and testing. Special topics in Cyber Security were delivered in depth. Students and parents had a chance to "meet the professor". Gannon University is hosting the Cyber Security Hackathon in the second year. The University administrators were impressed with the expansion of marketing impact and increment enrollments.**

Keywords—hackathon, K-12 education, cyber security

I. INTRODUCTION

Cyber threats have been known to be prevalent in United States, even the whole world. The impacts in business, community and government have been noticed and addressed by our leaders. In 2019, President Trump signed executive order to grow and strength cybersecurity workforce to secure our nation and promote prosperity [1]. He said, "American built the internet and shared it with the world; now we will do our part to secure and preserve cyberspace for future generations". Before that, many government agencies, including National Security Agency (NSA), Homeland Security (HS) and Department of Defense (DOD), have employed cybersecurity professionals. For example, DOD laid out a plan in 2015 on lookout for cybersecurity talents [2, 3]. Private sectors have been struggling with the cyber war way ahead of government [4, 5]. Faced with this sobering reality, the more resourceful and sophisticated private sector entities are scaling up their own efforts to address cyber threats. The competition and collaboration between private sectors and government enrich the market requirement for cybersecurity professionals [6, 7]. It is estimated as many as 3.5 million unfilled cybersecurity positions by 2021 [8].

Due to the fast growing of cybersecurity job market, national or states education agencies and institutions acted fast. The National Science Foundation (NSF) has recently funded nearly $75 million for cybersecurity research projects in 37 states [9]. The National Security Agency (NSA) doesn't provide grants, but it does provide guidelines for higher education institutions to be designated as Centers of Academic Excellence (CAE) in cyber defense and cyber operations [10, 11]. The number of CAE has been tripled in last three years [12]. To follow the trend, Gannon University, a private school located in Northwest of Pennsylvania, started undergraduate Cyber Security and Cyber Engineering programs in 2019. The University invested 2 million dollars for a new infrastructure and two new programs.

One of the biggest challenges during the establishment of the new programs is the marketing and recruiting. Hackathon is a popular event designated to boarder participation and perceptions in computing. Usually, hackathon is programing-oriented and applied for recruiting Computer Science majored students [13, 14]. Most of hackathons are graded based on rubrics. One of the common problem of Hackathon is to find the common used programming language from different high schools. Also, more labors and coordination are required for rubric grading. Another popular approach is to take the University as the host base for National or regional competition. For example, some success stories have been reported by schools hosting CyberPatriot, which is a National Youth Cyber Competition by the Air Force Association [15, 16]. However, it needs a longer period and cycle, usually years, to build communication networks with local high schools. It does not fit with Universities like Gannon, which does not have strong tradition and connection with high schools in cybersecurity.

After researching and discussion, both school administrators and faculty realized that those traditional methodologies, such as Programming Contest or National Competitions do not satisfy our requirements. The major concerns are, 1) the event or campaign is expected to be broadcasted as much as possible for marketing purpose; 2) it also should be cost effective, because of limited funding resources; and 3) one and only one winner needed to selected due to the rare scholarship incentive from the University. Other related problems, such as how to contact with

high school students efficiently, are also addressed during the design phase of the project.

II. Virtual Hackathon

The first part of Gannon Cybersecurity Hackathon is a virtual hackathon. The purpose of the phase is to maximize the impact and attendance of the event. Students from various geographical distribution still can join the event. Other factors, such as the raise of interests to high school students, are also considered and integrated into the design of virtual hackathon.

A. The Design Phase of Virtual Hackathon

To follow the visions above, minimized software or hardware requirements to users are expected during the virtual hackathon. Furthermore, it is an opportunity to impress students with modern technology. Thus, cloud technology is naturally integrated into the phase. In order to fulfilling the cybersecurity theme of the event, special topics in the disciplinary are considered and researched. Traditional network intrusion or defense projects are usually expensive and difficult to transfer into virtualization.

B. The Solution of Virtual Hackathon

After serious of research, an approach based on OWASP Juice Shop was adopted into our virtual hackathon. The Open Web Application Security Project (OWASP) is a non-profit foundation that works on improving the security of software. OWASP Juice Shop is one of the most modern and sophisticated insecure web applications. It is commonly used in security training, awareness demos, Capture-The-Flag (CTF) and as a guinea pig for security tools. The Juice Shop project encompasses vulnerabilities from entire OWASP top ten along with many other security flaws found in real-world applications.

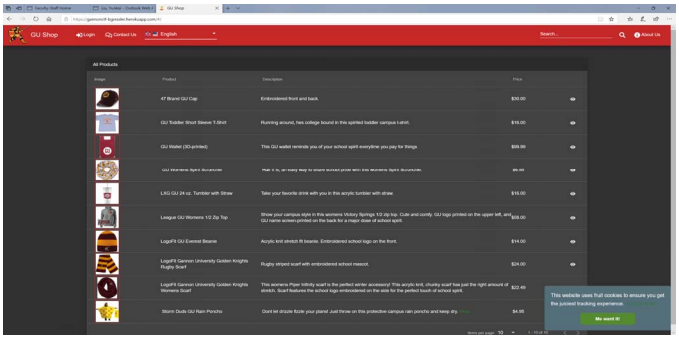

Fig. 1. Screenshot of Gannon Cybersecurity Virtual Hackathon Webpage

In order to fitting the open source project into our requirements, some customizations have been applied. First, the simulation business was changed from a juice shop into Gannon University's gift shop. The webpage background color was modified into University color and lots of products with University mottos are listed on top of webpage. It is consistent with the purpose to expand the visibility of University. Also, the test bank was updated. The OWASP Juice Shop project provided a comprehensive list of challenges with different level of difficulties. The difficulty is marked from one star to five stars. A one-star challenge usually means an easy one; but, a five-star challenge means a task needs deeply understanding of web vulnerabilities and usually requires programming skills. Facing high school students, four one-star challenges and two two-star challenges are picked. And related score board webpage is updated, where users can observe their achievements. The customized project was packed and deployed into GitHub.

Attendees have three hours to finish the virtual hackathon. After filling necessary information, such as names and email address, students need to build a Heroku account first. Then, they follow our GitHub URL to deploy their own insecure website. Following the provided instructions, high school students will "hack" the website with two easy challenges. It is also a process for them to be familiar with our virtual hacktathon challenges and related submission system. Then, students are expected to focus on provided challenges. The deployed website is a Capture-The-Flag environment [Fig. 2]. That means, a banner will popup in the website once a challenge is achieved. Related hash code for the key is demonstrated. Students are expected to submit hashed keys through emailing system.

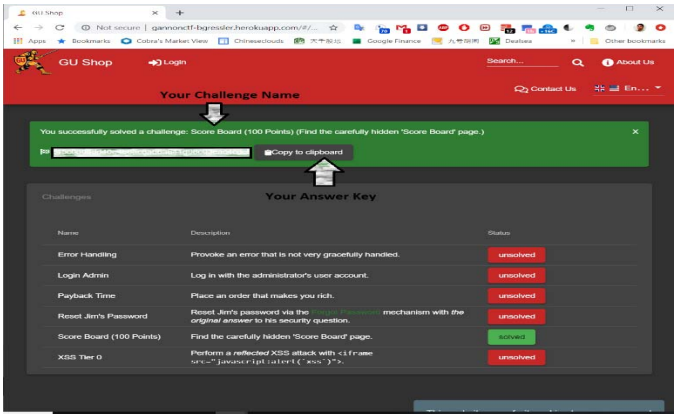

Fig. 2. Screenshot of Gannon Cybersecurity Virtual Hackathon Scoreboard Webpage

C. Analysis of Feedbacks

Gannon University successfully hosted two sections of virtual hackathon in April 13 and April 20, 2019. The weekends are specially picked to make it convenient to high school students. Totally 155 students registered the virtual hackathon. 78 of them actually attended the event. 60 high-school students finished and submitted their answers.

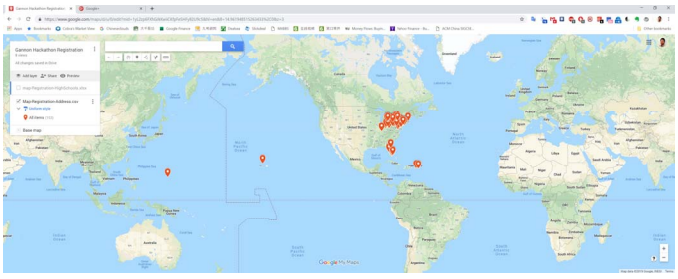

Fig. 3. Geographical Distributions of High Schools attending Gannon Cybersecurity Virtual Hackathon

Before the event, the University's Marketing and Admission office broadcasted the news through Google Ads and Facebook. Based on the geographical distribution [Fig. 3], students from 13 states of United States attended the virtual hackathon. Majority

are located at east coast. There are also students from Virgin Islands and Puerto Rico joined the competition. More than two thirds of the students are first-time contacted by Gannon University.

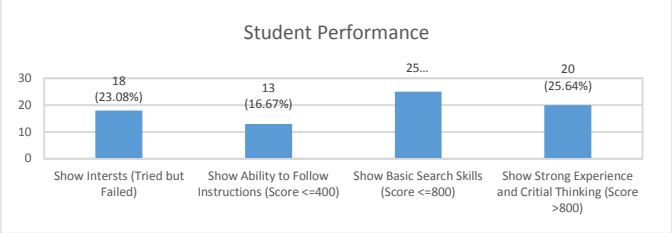

Fig. 4. Student Performance Distribution on Gannon Cybersecurity Virtual Hackathon

The grade of the virtual hackathon is up to 1000 points. The student performance distribution is shown above [Fig. 4]. 23% of students logged into the system, but gave up after reading the instruction. 13 students followed the instruction, deployed the website in Heroku, and attempted to "hack" the website. But no further progress was performed in the "open" questions. About 32% of students showed basic online searching skills and solved some easy challenges. More than 25% of students finished the medium level challenges. They are considered as those who have background in cybersecurity or computer science and enable to find complicate solution themselves.

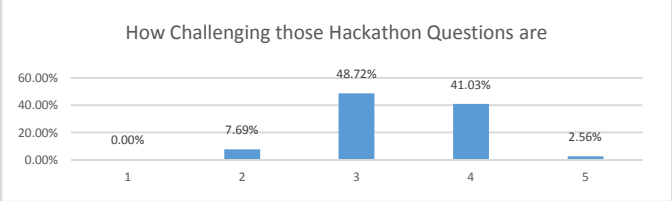

Fig. 5. Student Feedback on the Difficuty of Challenge Questions

After the virtual hackathon, a survey was provided to each student. The survey is a combination of marketing questions and feedback questions. Here, we disclose some interesting results based on student feedback on virtual hackathon.

One of our concern is whether the challenges fit with the knowledge base of high-school students. The difficulty is rated from 1 to 5. One is easiest; and five is the most difficult level. Based on Fig. 5, majority of students consider the challenge questions in virtual hackathon is rationale or a little difficult. The result follows what we expected in the design stage.

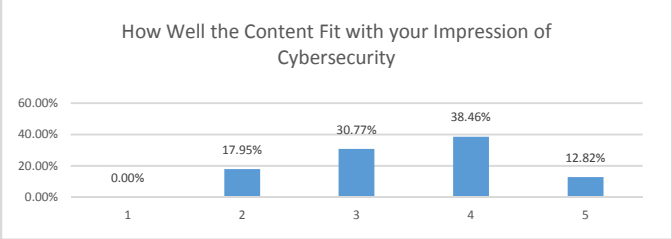

Fig. 6. Student Feedback on the Fitness of Cyberseutiy Theme

Another concern is, whether the format of virtual hackathon fit with student's understanding of Cybersecurity. The fitness level is rated from 1 to 5. One is not fit at all; and five means exactly fit. Based on Fig. 6, majority of students consider the format and topics in virtual hackathon fit with their impression of Cybersecurity. The result follows what we expected in the design stage.

III. Onsite Hackathon

After the virtual hackathon, top performed students are invited into Gannon University for the onsite hackathon. The choice of on-site participants is based on the student performance in virtual hackathon. Obviously, only students located in driving distance accepted the invitations. Different with the virtual hackathon, the onsite hackathon is to allow high-school students "meet with professors" and tour the campus. The major purpose of onsite hackathon is the recruitment; vs. the marketing purpose in virtual hackathon. Of course, the onsite hackathon provides opportunity to demonstrate and practice projects for smaller groups.

A. The Logistic Of Onsite Hackathon

The onsite hackathon is a one-day event. Gannon University decided it as free admission, but by invitation only. Due to the geographical limits, 23 students attended the onsite hackathon.

In the morning, there are two sections delivered by cybersecurity faculty. Each lecture is about 75 minutes. The first section covered the fundamental concepts about cybersecurity, including history and definition of cybersecurity, types of hackers, security ethics, and related career path. More videos and interactive teach methods are integrated in the first section. The second section is more emphasized on hand-on project. The webpage from virtual hackathon was used as practice platform.

In afternoon, a test is given to participants, in order to picking the winner of University scholarship. The test is majorly in a multiple-choice format. It is a simulation of commercial certification exam. The test includes three part, 1) content introduced in the morning sections; 2) fundamental concepts in Computer Science, similar with CompTIA A+ certification exam; and 3) fundamental concepts in Cybersecurity, similar with CompTIA Security+ exam. Students are expected to finish 90 questions in one and half hour.

B. Analysis of Student Feedbacks

Among those 23 participants of onsite hackathon, the winner of Gannon Full Scholarship is a kid from Detroit area, which is five-hour driving distance from Gannon University. It is not common for a school in Pennsylvania to recruit students from Michigan. 10 students who attended our Cybersecurity Hackathon enrolled into Gannon University in Fall semester 2019. Half of them are from out of town.

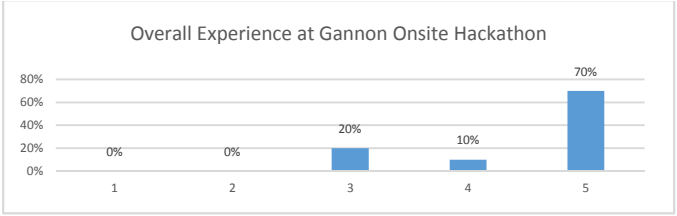

Fig. 7. Overall Experience at Gannon Onsite Hackathon

Based on the post survey after onsite hackathon, most of students are satisfied with the experience. Note, the experience is rated from 1 to 5. One is as the worst experience; and five is as the best experience.

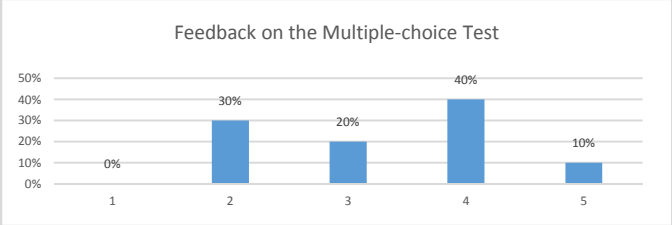

Fig. 8. Student Feedbacks on Onsite Hackathon Test

Students reaction on multiple-choice test in onsite hackathon is reasonable. It is understandable that the traditional multiple-choice form is boring. However, it is also the reality of certification exam of current industry. Note, the feedback is rated from 1 to 5. One is as extremely disappointed; and five is as extremely satisfied.

IV. Conclusion and Discussion

In this paper, we introduced how Gannon University hosted a hackathon event for high-school students interested with cybersecurity major. The event is a combination of both virtual and onsite activities.

First, we need to emphasize that Gannon University is a small teaching school locating at a city with no big populations. The University is tuition-driven. Thus, student enrollment is a key for the business. At the same time, the University is not able to invest a large amount of fund to boost one or two new majors. That is the reason, the hackathon is designed with financial efficiency. Due to the fast pace of business decision, faculty do not have enough time to develop our own system. To adopt an open-source software is our only choice. Actually, only two months was allowed for the project, including collaborating with multiple office from different disciplinary. What we demonstrate here, is not only an education or technical project, but also a comprehensive project in institutional level. We hope our experience can help other schools like Gannon University.

During the development, we tried our best to customize the project with Gannon's unique culture and environment. A general e-commerce website was modified into University gift shop. It fits with the marketing and recruitment purpose of the whole project. And the background of high-school students are fully considered. The "hacking" environment was fun and safe. Students have an opportunity to face an "real" attacking target. The feedbacks show our goal and expectation are achieved.

At the same time, there are some shortcomings of the project. First, the OWASP Juice Shop has been known for years. Some solutions for challenges can be easily found on internet. Also, the test bank is not big enough to support an annual event for several years. Thus, a new system with customable test bank is a necessity from a long term view. Same problem happened on the test of onsite hackathon. On one side, we want to every student to learn and practice; on the another side, only one scholarship is affordable from University. The balance of requirements is a challenge to designers of such project. Currently, we applied the format of certification exam. However, it is obviously not perfect to inspire academic interests among high-school students. Such kind of challenge is not only for cybersecurity area, but for almost all majors.

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