Cyber Escape Room

A Technical Report submitted to the
Department of Informatics and Networked Systems
at the School of Computing and Information
University of Pittsburgh
Pittsburgh, Pennsylvania

Fall 2022

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Abstract

Cybersecurity is one of the fastest-growing fields in the world, but many people do not have much exposure to the ideas and topics within cybersecurity. After playing an escape room with integrated video elements, our client believed that this would be an interesting way to communicate basic cybersecurity premises. Our escape room uses puzzles and an integrated web app to introduce cybersecurity topics such as phishing and ransomware. The escape room also includes a section to test players' knowledge and ensure that they learn the topics within the room. We did multiple playtests and after each one, we asked participants about the cybersecurity topics that they had learned, and we saw a marked improvement on cybersecurity knowledge.

Our solution was a hybrid analog/digital experience where participants would solve analog puzzles similar to most escape rooms, and enter codes into a digital web app which would play videos to guide participants to the next stage of the escape room. We performed multiple playtests including different participants each time, and made changes addressing the feedback from the previous playtest each time.. A major implication of our project is that this is able to teach cybersecurity concepts and create interest in cybersecurity more rapidly than could be taught in a class or similar learning experience.

1. Introduction

Cybersecurity is one of the fastest-growing fields in the world, with six open positions for every one filled position projected to be a reality by the end of next year. However, most people don't know where to begin, but they do enjoy playing escape rooms. Our client wanted to use an escape room to get people exposed to and interested in cybersecurity.

In order to get people interested in cybersecurity, they need to gain a better understanding of it. This can be difficult as most of its concepts can be a bit confusing, due to cybersecurity using lots of acronyms and other buzzwords alongside technical elements involving hardware and software on varying levels. In order to expose people to some of these topics we needed to make them known in a more interesting manner.

The escape room serves as a form of entertainment for the participants, while also being a means of delivering the information we wish for them to learn. By utilizing an interactive experience that involves cyber security terms into the puzzles, we can have players walking away with a greater understanding of cybersecurity as a whole. Because of this, they may go on to be more interested in cybersecurity and possibly pursue this interest further.

1.1 Problem Statement

Our client, Ahmed Ibrahim, works as a professor at the University of Pittsburgh and has an interest in ethical hacking and cybersecurity. After participating in an engaging escape room, he wanted to develop an escape room experience which would get people interested in key cybersecurity concepts, since many people don't know about cybersecurity in general. The client mentioned that this escape room would be a good opportunity to expose students to cyber concepts. Currently most forms of cybersecurity escape rooms are online as opposed to being in person. Our client wants to create an actual physical experience for players to engage with.

The physical escape room will do more to get people involved with cybersecurity as a whole. For one, being in a physical environment with other people and engaging with the escape room hands on, will help to increase the scale of learning that occurs in the players. By actually interacting with the objects players will better retain the knowledge we give to them.

The second way players will more effectively learn from the escape room, is how they progress through the escape room. The passwords they need to get more clues for later stages of the escape room, are all answers to cybersecurity questions. By having them find these terms and definitions during the experience, they will have the knowledge already in their minds, and answering the questions will cement them, letting players walk away with more knowledge of cybersecurity.

1.2 Contributions

As a team we set out to create a physical escape room that players could interact with that utilized digital elements to make the overall experience more enjoyable and thematic.

Throughout the process all team members' contributions included being present for meetings as well as playtests, assisting in constructing the physical elements of the escape room, as well as assisting others in their tasks if anyone needed help.

Over the course of the semester, our team was able to produce two main elements to the escape room, the physical puzzles that players would interact with and a hosting website. Both of the two elements work in conjunction with one another to create the overall escape room experience.

The website itself has many features for use in the escape room. A timer is present so players know how much time they have left in their attempt, there is a section for entering passcodes with tones to let players know if they were correct, as well as all of the videos used throughout

the experience. The website serves as a way to limit the progress players can make, as they only gain new information for puzzles through solving the current section.

The second part of the escape room is the physical puzzles themselves. The puzzles are designed to be related to the cybersecurity terms that players find in them once solved. For example, the puzzle that explains bruteforcing asks players to brute force a 3 digit lock. In doing this players will relate the terms to what they actually did, and these ideas are remembered when using the website. These two factors work together to help players better understand and retain knowledge of cybersecurity topics.

2. Related Work

When it comes to cybersecurity education and escape rooms, a number of experiences already exist and are available for prospective clients to try out. In terms of cybersecurity learning experiences, there is Living Security's "CyberEscape Online," Devpost's Cybersecurity Escape Room, and "CGI Cyberescape." In the case of Living Security and CGI's experiences, they are intended to be used as tools for teaching company employees about cybersecurity. On the more escape room end, there's Carnegie Mellon University's "Hacked!" and Thales Group's Cyber Escape Room.

Though there appears to be custom-written stories for these experiences, for the most part, they all fall under a similar generic plotline: the players are attempting to hack into something within a certain timeframe. Whether the experiences are meant to be more educational in nature or simply an escape room, the cybersecurity topics seem most often introduced through placing the participants in the position of a hacker either breaking out of a location (the escape room) or stealing information.

Despite these systems' own merits, many use cybersecurity more as a narrative tool than a topic for education. They are, at their core, escape rooms, and any teaching that is done is secondary to the puzzle-solving experience. As for those that focus more on teaching cybersecurity, the experiences are strictly digital—there is no physical or analog element to the experience.

The goal of our project, at its core, is to be educational. Unlike these pre-existing experiences, which are either solely escape rooms or more intended to be training tools in a work environment, our escape room is intended as an engaging gateway into cybersecurity for individuals high school aged or older.

Cyber Escape Rooms

Living Security
Hacked!
Thales Group
Devpost Cybersecurity Escape Room
CGI Cyber Escape

3. System Design

We had two sets of high level goals, one for students, and one for coordinator. Students should be able to undergo a learning experience that engages them with narrative and rewarding puzzles to learn basic cyber security concepts. Coordinators should be able deploy the learning environment easily in a variety of environments and make changes to every one of its elements as they see fit. The site was developed with HTML, CSS for styling, and JavaScript for the interactive elements. We chose these languages because it's commonly used, easy to modify, and clear to understand with a passing glance at a given section.

3.1 System Requirements

It was a challenge, yet critical that we uncover the proper system requirements we needed to develop. Initially, our minimum requirements were to create an engaging play experience, incorporate digital video and interfacing, maintain a basic theme of cyber security, and create an easily editable and expandable structure. Our desired requirements included specific topic learning, such as Open Source Intelligence, a cohesive narrative, and a reactive experience when students engaged with the system. Our optional requirements included varied puzzle systems, robust puzzle opportunities to engage multiple users simultaneously, a leaderboard system for recording and maintaining records for coordinators, and bonus engagement opportunities through hidden objectives.

Our system requirements shifted midway through the process as the project focused shifted more firmly to learning than engagement. This led to an additional minimum requirement being cyber security information retention.

3.2 Sample Code

Our HTML video display, timer, and password input:

```
<div id="main" style="display:none">
    <div id="clock">40:00</div>
    <div id="video-player">
        <iframe id="current-video" src="https://drive.google.com/file/d/1peqO1t_ldzy9vXB78e3mqyNcAvHRqPro/preview" width="640" height="480" allow="autoplay"
    </div>
    <div id="hash-link" style="display:none">
        <div>ENTER THE HASH '0bf63c462a3297f3a2aed67682ca11cb' INTO THE SITE BELOW:</div>
        <a href="https://crackstation.net/" target="_blank">Hash Cracking Site</a>
    </div>
    <div id="code-controls">
        <div id="code-entry-container" class="terminal">
            Enter password:
            <input id="code-entry" class="terminal-text" type="text">
        </div>
        <div>
            <button id="code-submit" class="main-button" onclick="updateVideo(currentCode())">Enter Code</button>
        </div>
        <div id="saved-codes">
            View previous videos:
        </div>
    </div>
    <div id="mission-controls" style="display:none">
        <div>
            <button id="view-results" class="main-button" onclick="showResultScreen()">View Results</button>
        </div>
    </div>
    <div id="mission-controls-l" style="display:none">
        <div>
            <button id="view-results-l" class="main-button" onclick="showLossScreen()">View Results</button>
        </div>
    </div>
</div>
```

JS Video and Password Array and Timer Editing for Coordinator

```
// EDIT THIS LINE TO CHANGE THE AMOUNT OF TIME
totalNumMinutes = 30;

// EDIT THIS ARRAY TO ADD OR CHANGE VIDEOS
// THE CODES MUST BE ENTERED IN THIS ORDER
allCodes = [
    {
        code: '{INITIAL}',
        url: 'https://drive.google.com/file/d/1peqO1t_ldzy9vXB78e3mqyNcAvHRqPro/preview'
    },
    {
        code: 'BOTNET',
        url: 'https://drive.google.com/file/d/1k1E8CnrM-GvojkChj-vWLVj1dYx6TjUg/preview'
    },
    {
        code: 'SECURITY QUESTIONS',
        url: 'https://drive.google.com/file/d/1NZqJuUhLe73pGDTT3n_sp6b_oAWbWQkZ/preview'
    },
    {
        code: 'BRUTE FORCE',
        url: 'https://drive.google.com/file/d/1XCQyPjJOnisU32F7emi4RenslUf69fZK/preview'
    },
```

JS Video Update Function

```
function updateVideo(code) {
    if (gameState === 'play' && (allSavedCodes.includes(code) || code === getCurrentCorrectCode() || code === '{LOSS}')) {
        currentVideo.src = allCodes[getIndexOfCode(code)].url;
        if (getIndexOfCode(code) >= numOfCodesEntered) {
            numOfCodesEntered = getIndexOfCode(code)+1;
        }
        if (code === allCodes[8].code) {
            document.getElementById('hash-link').style.display = 'block';
        } else if (code === allCodes[9].code) {
            gameState = 'win';
            clearInterval(x);
            playSound('win');
            document.getElementById('code-controls').style.display = 'none';
            document.getElementById('mission-controls').style.display = 'block';
            document.getElementById('hash-link').style.display = 'none';
            document.getElementById('clock').style.color = 'yellow';
            document.getElementById('clock').style.borderColor = 'yellow';
        } else if (code === allCodes[10].code) {
            gameState = 'loss';
            clearInterval(x);
            playSound('loss');
            defeatReason = defeatReason === 'unset' ? 'being stupid' : defeatReason;
            document.getElementById('code-controls').style.display = 'none';
            document.getElementById('mission-controls').style.display = 'block';
            document.getElementById('hash-link').style.display = 'none';
            document.getElementById('clock').style.color = 'red';
            document.getElementById('clock').style.borderColor = 'red';
        } else if (getIndexOfCode(code)+1 === numOfCodesEntered) {
            playSound('correct')
        }
    } else {
        playSound('incorrect');
    }
}
```

3.3 Sample Tests

We playtested varying stages of the escape room experience four times: twice during sprint three, twice during sprint four. Through these tests, we uncovered a substantial amount of needed revisions we hadn't considered prior.

Initial tests resulted in a clear need for reduced paper and reading, an overhaul of several developed puzzles and improvements to the quality of audio and video that was recorded for the engagement and narrative videos. Sprint four had a playtest with our client, where the change to minimum requirements came about, resulting in an overhaul of the direction of the experience towards learning and away from the feeling of a traditional escape room.

Test one included three adults within the tech sphere. They struggled to digest and organize the quantity of physical materials provided, and required additional assistance moving them through the experience towards the later puzzles. This initial test also revealed the initial audio and video quality issues.

Test two, done with four additional members of the information science field, breezed through many of the puzzles, and identified pieces of the information we were attempting to get across organically through the experience. It was still lacking in the educational department, however.

Test three was done with the client, and was with four members of the School of Computing and Information. This text resulted in many glaring problems with puzzle structure, basic room layout, and most importantly, lack of educational takeaway. This test resulted in the largest shift and overhaul prior to the fourth and final playtest.

The fourth playtest had two users, each of whom were also within the field. They slightly went over time, but otherwise smoothly and cohesively went through the entire experience without outside assistance in any way. This was the first test involving information retention, in which the users were able to recall key words and phrases presented during testing and showed signs of basic information retention as desired.

3.4 Installation Instructions

To get the site up and running, all that needs to be done is unzip and upload the files to a web hosted repository where the user can make any adjustments from there. New videos will also need hosted through a service, such as Google Drive or Youtube, and can be added and adjusted within the JS file where noted.

Physical deployment of the experience will require transportation of the assets (currently contained within a large plastic box). The website will need to be manually entered on a device while live with audio and video outputs accessible.

4. Results

The system solves the issue of a lack of cybersecurity knowledge and interest in highschool and early college students. The system delivers an introduction to cybersecurity topics in a way that is approachable and can create interest in the cybersecurity field.

We will have to wait to be completely sure, but in theory the result would be that more students develop an interest in cybersecurity and then go on to work in the cybersecurity field.

There is full documentation on using the system and how to edit the included content. The customer is most likely a teacher administering the experience to a class, as such the system is for the most part hands-off apart from setting up the experience and making any desired changes. This allows for the teacher to observe and guide students through the experience effectively. On average, throughout our playtests, participants were able to identify 3 more cybersecurity topics than before they had completed the escape room.

The client for the system should be able to distribute and reproduce the experience easily as the only step required in distribution would be to hand off the physical materials to the customer and point them towards the instructions folder.

5. Conclusions

Simplicity is often a better starting point for complex ideas such as cybersecurity topics. Much of what we started with was needlessly complicated and confusing for a learning environment. Once we streamlined the experience the learning seemed to be much easier for the participants.

That the project is a useful stepping stone into a complex idea, and one that will help to solve the problem of a lack of cybersecurity expertise in the workforce.

The lack of cybersecurity knowledge is a deep threat to many organizations and individuals. As the world becomes even more digitized this threat will only grow without more people entering the cyber security field. The observations made from this work have shown that if you start at a fun, approachable, and enjoyable place you are able to cultivate knowledge around a topic that many find to be not worth their time or not very engaging (hence the current shortage in expertice). The main insight of the project is that it is a great starting point to introduce people to cybersecurity concepts, but it would take time to determine if completing the escape room leads to a greater number of cybersecurity experts in the workforce.

6. Future Work

Our main goal that we would like to work on in the future is the creation of another, more difficult experience that would be played after the completion of this one and after some more traditional teaching about the topics covered in this experience, would provide students with more opportunity to learn about cyber security and give them deeper practical knowledge surrounding cybersecurity topics.

We would also like to perform more playtests in order to better polish the overall experience and enhance student's ability to learn and retain information presented within this escape room.

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