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## Teaching Cyber Security and Forensic Concepts Through Game-Based Learning



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## Abstract

With Cyber become an ever growing part of our lives, it is important younger students have an awareness of how things work and what dangers they may face. From securing data on their computers to fending off suspicious emails, it is important that aspects of cyber security are taught in education. This project intends to develop a game to aid in a students learning progression towards a better understand of how to protect themselves in this ever growing cyber world. Through real-life simulations and examples, this game provides key information for a student to put into practice away from the classroom environment and an insight into forensics in the real world.

Classrooms today are unlike that of 10 years ago. In this case, new methods of teaching are needed to incorporate the vast amount of technology available. One method that can be of great benefit to a students learning is game-based learning. Through research and design, this report will give you an understanding of how this game, through game-based learning, links into the Welsh curriculum and how the product of this project can be beneficial to young students living in Wales.

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# 1. Introduction

With a new curriculum set to be introduced into Wales late next year, students will be introduced to new and existing concepts. With the released guidelines, this game will be developed to fit into the 2022 Welsh School curriculum, offering students a game which will be fun and enjoyable, as well as motivate them to learn about Cyber. Without clear guidance or examples, students may struggle to apply concepts to real life scenarios. Through this project, I aimed to tackle this by offer informative information to aid in a students learning and also offer real life scenarios for them to better understand these concepts place in the real world.

From my initial plan, the problem I identified was that some pupils can lack interest in things and this can affect their ability to concentrate which itself will affect their ability to take in information. To tackle this problem, this project will aim to produce an interactive and informative game to get pupils engaged and enjoy learning different security and forensic concepts. It is from this aim, that the different aspects within the design and develop of the game have been developed.

From this initial aim, this project had a number of secondary aims that would develop a game that is both fun and informative, to educate young students in Wales about cyber security and forensic concepts. These aims influenced the project from the start and were taken into account at every key stage.

These aims were:

- Incorporate into the game the four concepts: Passwords, Email Safety, Symmetric Cryptography and Crime Scene Analysis
- Inform the student about the technical side of these concepts and real life applications
- Design the game to meet a selected age groups curriculum aims and progression step goals
- Provide information to students in an interactive way
- The game should challenge the user and where possible, increase in difficulty
- From start to finish, user interaction should guide the game and allow them to navigate smoothly
- Include in the game a range of Sprites and backdrops to set the scene and offer different visuals and interactivity

The game will cover four key concepts while using a variety of game play and difficulty. The game itself will consist of a number of mini games with each paired up to relate to a concept, which will educate students on real life scenarios.

With a world becoming more and more digitised, it is important students understand and are able to safely use the cyber world that is developing around them. This project will look at the education system within Wales, identifying key elements within the new Welsh Curriculum, to better align this game in a way beneficial to the student audience and their development in their education. Game-based learning will be at the heart of the game, taking into account its key features to ensure the game is beneficial to anyone using it.

Based on the research done during the research stage of this project, I have identified an age group of students that this project is aimed at. With the four concepts being compared to the new curriculum, students ages 10 – 12 will have the most benefit. For them, the concepts involved will be

in line with what their age group will be learning and experiencing during their education and the game developed in this project will be a another source of information.

This project will be using an agile approach that applies design thinking methods to ensure each stage in the development of the game was the result of thorough research and well thought out designs followed by implementation and user testing. The research was key in influencing the design process and the resulting implementation and so each key aspect of the game was covered for use during these stages. Research into the curriculum, as well as serious games and game development platforms, took place at the start of the project and its results would influence what followed. This research was one of the main deciding factors in the decision to use Scratch, the block based programming platform.

Once the platform had been decided and a clear understanding of what was required had been established, the specification and design stage started. The specification layout the main elements of the game, including the functionality which would be required. The designs for the game took a considerable amount of time. To avoid any issue with Copy Right, if a graphic wasn't available in the Scratch Library, I would design and draw everything on my computer myself. The concepts during the design stage began to materialise in storyboards and interfaces which were then implemented into the game.

Implementation was an incredibly challenging task as the number of objects and backgrounds within Scratch grew and so did the complexity of what had to be coded. Everything was implemented in an order similar to the design stage, following along and implementing backdrops and ideas as I progressed through. I applied for Ethics approval as I planned to test the game on a focus group of students under the age of 18 and it was approved. The focus group was with Cardiff Technocamps Code Club and provided me with useful feedback. I gained a lot of insight into what students of the targeted age group thought and valuable feedback for edits to the game. This feedback has been developed in the testing and results part of this report.

Both the game and the accompanying resources will be a learning point for students and so the research and design parts of this project are key to accomplishing this. From the Welsh Curriculum, to game-based learning and game development platforms, each area of this project was well informed and kept the core concepts relevant throughout.

## 2. Background

There is soon to be a huge reform within the Welsh Education system. What follows is information important to the understanding of the incoming new Welsh Curriculum and its elements of Cyber, as well as a look into what Game-Based Learning is and its use in education through serious games. From my initial plan, the problem I identified was that some pupils can lack interest in things and this can affect their ability to concentrate which itself will affect their ability to take in information (Prakash 2018). To tackle this problem, these several key areas were identified and within this section, these areas will be explored. I will be detailing my research into different cyber security and forensic concepts as well as research into game development platforms. To see what is currently on offer in this area of cyber and game-based learning, after researching the concepts I will be see what is on offer in relation to them. Each of these will have an important role in influencing the design of the game and key aspects throughout this report will refer back to elements in the research.

### 2.1 2022 Welsh School Curriculum

Due to be rolled out in September 2022, a new school curriculum will be introduced in Wales after the Curriculum and Assessment Bill was passed by the Senedd this year. This new curriculum means schools and practitioners are able to design their own curriculum and content within their individual schools, although it must follow a series of guidelines. If I am to develop a game which is to benefit students at a certain point in their education, it is important to understand what a student will know and the skills they will be developing at key intervals. Through research into the curriculum, I am able to pinpoint areas and sections of a learners progression to tailor the game to. This new curriculum has many aspects but there are two which I feel are the most important in understanding what a young learner will be experiencing. The curriculum can be split into two key components:

- The Four Purposes which is the heart of the curriculum and is designed to guide it.
- The 6 Areas of Learning and Experience which supports the Four Purposes.

These two areas will be important in focusing information in a meaning full way to fully challenge a learner and develop their knowledge and skills. With the vast amount of information available to incorporate in this game, it is important that the information that is included is concise and relevant.

#### 2.1.1 Four Purposes

These purposes should be the starting point and aspiration for a schools curriculum design(Welsh Government 2020b). With this in mind, a schools curriculum should aim to support their learners in the Four Purposes and develop children and young people as” (Welsh Government 2019a) :

1. Ambitious, capable learners, ready to learn throughout their lives
2. Enterprising, creative contributors, ready to play a full part in life and work
3. Ethical, informed citizens of Wales and the world
4. Healthy, confident individuals, ready to lead fulfilling lives as valued members of society

These statements should guide children’s aspirations and aid in their development to becoming successful learners.(Welsh Government 2019a) Through learning and teaching, students will develop four necessary skills while progression to achieve the Four Purposes. Through the game developed in this project, I aim to aid in the development of one of the skills – Critical Thinking and Problem Solving (Welsh Government 2020b) . This skill has great potential to aid a student in their education because

problem solving skills are used across subjects throughout a students learning and within the curriculum. Particularly with this game and layout in the design stage, many aspects will involve problem solving and will be referred to later in the report.

### 2.1.2 Areas of Learning and Experience

All subjects have been split into six Areas, with this project relating to the Area of Science and Technology which incorporates computer science. With this new curriculum, students between the ages of 3 and 16 will be directly affected by this change within education. These Areas are the starting point for a school to develop their curriculum and have been designed to support learners to realise the Four Purposes (Welsh Government 2019a) . For this game to aid students in their learning, it must incorporate key elements of the curriculum to be beneficial to their education. It is the elements within the Areas of Learning that have influenced my choice on the age group to target the game at which will be discussed later.

To understand how students will be exposed to cyber, it is important to first look at the design criteria for Science and Technology. To be able to develop a beneficial game, it will need to reflect the core elements in a students learning within the new curriculum. There are three key elements taken into consideration when designing a school's curriculum which ultimately influence a student's learning progression and the key principles they will be exposed to.

These are:

- Statements of What Matters
- Descriptions of Learning
- Principles of Progression

### 2.1.3 Statements of What Matters

It is mandatory that a school's curriculum design must cover all Statements of What Matters and the key concepts must be incorporated in an appropriate way for student engagement. Over the six Areas, there are 27 statements and six of those are specific to Science and Technology. These six statements capture the key aspects for learning for students in Wales within this Area and it is important that this project reflects that. The most relevant of these statements for computer science being:

- Computation is the foundation for our digital world

Schools must use these statements to guide the development of curriculum content, and relevant to this project, using them to select experiences, knowledge and skills (Welsh Government 2020d) . These experiences, knowledge and skills enable learners to understand the statements of what matters.

### 2.1.4 Descriptions of Learning

"Descriptions of Learning provide guidance on how students should progress within each of the statements of what matters"(Welsh Government 2020e). These descriptions are in the form of progression steps and are spread over several years so learners can increase their development over time. Each learner is different and each will learn at their own individual paces so these progression steps only broadly relate to five ages(Welsh Government 2020e). These ages are 5, 8, 11, 14 and 16



which correspond with the five steps, with step one broadly aimed at 5 year olds and step 5 broadly at 16 year olds. These are the steps which influenced the decision to aim the game at 10 to 12 year olds as the age for step 3, being 11, is not restrictive to that single age. These progression steps and their links with cyber will be discussed shortly.

### 2.1.5 Principles of Progression

It is important to understand how progression is made to incorporate elements into the game, in relation to the progression steps. This new curriculum places emphasis on student progression. The Principles of Progression state how learners make progress in their learning throughout the curriculum (Welsh Government 2020d). These progressions point to the curriculum as a whole as well as to individual topic areas and they are used as informative methods for teachers in their approach to the progression of their students. To tailor the game, it is important to know what the Science and Technology progressions are and how they impact students learning. The Science and Technology progressions are (Welsh Government 2020a) :

- **Increasing breadth and depth of knowledge** – learners should explore and experience increasingly complex ideas and concepts that sit within the Statements of What Matters.
- **Deepening understanding of the ideas and disciplines within areas of learning and experience** – Iterative approaches to problem solving from computer science can be beneficial to all sciences.
- **Refinement and growing sophistication in the use and application of skills** – Investigation, exploration, analysis, problem-solving, and design are key skills required as learners work along the continuum of learning in this Area.
- **Making connections and transferring learning into new contexts** – Learners should be able to make links between knowledge and experiences in other Areas, as well as outside the classroom.
- **Increasing effectiveness as a learner** – With the development of skills related resilience, it is important to enable learning through a ‘trial and error’ approach.

The new Welsh Curriculum clearly points out the expectations for learners and what they need to be exposed to during their progression. These 5 key elements are an important part for the designing of the game and have been taken into account with the related progressions steps. Progression steps provide reference points for the pace of progression (Welsh Government 2020d) . Below is an extract of Cyber in the progression steps that will influence the designing of the game.

### 2.1.6 Progression Steps – Learning

This element broadly sets out at what stage in a learners progression they should be learning about a specific aspect within the curriculum. For the game, I am focusing on up to a progression level 3. With this being said, the key learning aspects being taken away are(Welsh Government 2019b):

#### **Cyber Security**

Step 2 – “I can use credentials securely to keep information safe”

Step 3 – “I can describe how computers communicate, and share data and resources securely”

There is a second set of progression steps called Planning for Learning, which suggests that learning can be enriched through developing links between other statements through the Science and Technology Area of Learning and Experience. To use in this project, I have only identified one step which will influence the game:

Step 1 – Learners need to experience keeping digital information safe and private.

## 2.2 Cross-Curricular Skills

Literacy, numeracy and digital competency are mandatory cross-curricular skills that are extremely important to learning and have the power to unlock knowledge(Welsh Government 2020c). It is then very important to look at cross curriculum skills and take these into account. Digital competency will be a mandatory element within the 2022 curriculum and must be embedded in the learning process for students. Progression steps also come into play when looking at this competency and its relation to steps 1, 2 and 3 in the principles of progression steps.

Citizenship and the understanding of ones place in the digital world is an important concept within the digital competency. It is important for young students to understand the risks to them and the precautionary steps to take to protect themselves and their sensitive information. As explained previously, progression step 3 is the target for the game. The progression up to step 3 includes information about identifying what information they have is private and when they can disclose this information.(Welsh Government 2020c) This area of the competency also has goals of teaching students how to defend themselves from online identity threats in relation to email phishing scams. Numeracy will feature within the game and involve the students problem solving with numbers. Making connections between computer science topics and their usability of numbers is important to show learners how different subjects can interact with each other such as with maths. These aspects are important, such as the phishing scams, and will play a role within the game.

## 2.3 Security and Forensic Concepts

With the focus on putting across different security and forensic concepts, it was important to understand the various types and what would be relevant to young learners and their links with the Welsh Curriculum. At this stage in the project, it is important to identify key features to inform the learners about. This section will mention some important information that will need to be incorporated in the concepts use in the game.

Before beginning the research, I had in mind a forensic concept which had been taught to me this academic year. During the forensic module, we learnt about first responders and what they did when they arrived at a crime scene as well as what takes place back at the lab with items. If incorporated in the right way, this concept could be very fun. Write blockers and disk imaging tools are an important part of computer forensics but ideas behind them may be too advanced if the basics have not been covered. From thinking about the potential game ideas and relating to the research done into the curriculum, I settled on the idea of crime scene analysis. This concept involves the different items used in daily life, such as mobile phones, which can be relatable to younger learners. As well as my

knowledge from the module, this crime scene investigation guide contains lots of useful information which I can use to help accurately design the information in the game (U.S Department of Justice 2001). Even with the how old the document is, the key aspects contained will still be relevant. I will need to ensure I explain what makes specific items important. By including this concept, I also hope to give students an idea of a type of job within cyber. Within the curriculum, the progression step 3 wants learners to understand how computers communicate and share resources safely. This reminded me again of something learnt during the security module which I knew was a basic concept and could be broken down into learnable stages. Symmetric Cryptography is a basic concept in relation to securing messages when sending them over the internet. From experience in teaching other cryptography methods as a STEM ambassador, I know that these concepts can be fun if used in the right context. When using this concept in the game, I will need to ensure I separate each stage and incorporate key terminology.

Mentioned in the digital competency is phishing scams and how students should learn about protecting themselves. I thought this concept was very important as these scams come in different forms, such as emails, texts and phone calls(NCSC 2020), and can sometimes be very convincing . Especially as we are now seeing scams to do with Covid-19 vaccines(NCSC 2020), the criminals behind these scams are constantly evolving them and students need to have an awareness of how to identify them. Even when some of these scams are obvious, such as the Prince of Nigeria scam, many people still fall for them every year(Cummins 2020). Only two years ago, these Nigerian Prince scams were earning hundreds of thousands of dollars a year(Leonhardt 2019). It will be important to explain the specific signs which can help identify these dangerous messages such as bad spelling and grammar. I chose to incorporate this concept into the game as it is a very relevant topic for younger learners to understand the dangers and importance of protecting their personal data.

In relation to protecting data, it is important to look at the basics that young people may not know. With the need to keep a high level of security around their personal data, passwords are an essential front line to ensuring this is created properly(Panda Security 2018). As passwords are not just specific to one type of account, they can be used for mobile phones, computers and social media accounts, it is important that they are strong enough to protect these aspects. With a growing number of young children using online sites, such as social media, it is important they know the steps to take to protect not just their computers but their online accounts too(Young 2019). Looking at the requirements on the Panda Security website(Panda Security 2019), the key features for what makes a strong password, such as length, will be essential in developing a learners knowledge in this concept.

## 2.4 Related Products

It was important to see if any games had been developed which either contained the concepts I planned to use or could be influential in my game design. Inspiration for the game to teach the password information was found in a game called Cyber Defence Quiz (Keeley 2020). Unfortunately, this game could not be played as it required Adobe Flash Player which is no longer supported. From the image and description, the game seemed to be about creating passwords for characters based on information that the game gives. This idea of passwords and having use them in relation to information given in the game seemed like a good idea and is something that influenced the design stage for this concept.

A game by Living Security (Living Security [no date]) requires you to compare emails and select the one that you feel is the most like a phishing email. It uses good graphics and incorporates the features of what to look out for in a phishing email as well as has good interactivity. This is a good example of

how to incorporate the information about these scams into a game and is something to learn from and take inspiration during my design stage.

## 2.5 Game-Based Learning

This concept of teaching through games aims to motivate and engage students to positively impact their learning process. As technology develops, teachers are seeing new and improved way to teach students. Game-based learning is an area that is continuing to grow and it is expected by 2025 the global game-based learning market will reach 28.8 billion dollars(Adkins 2020). With this being said, it is unlikely game based learning will fade away anytime soon.

The core concept behind game-based learning is teaching through repetition, failure and the accomplishment of goals(Cahill [no date]). This will play a key role in how the user will play the game. Through this and trial and error, I hope for the game to ingrain the knowledge of the concepts within the learners. Studies have shown that gamified formats of training used within companies has improved knowledge retention(Gamelearn Team [no date]). It is important that students can retain the information and as well as this, I aim for the game to teach them useful information which can be used in real life.

There are three main characteristics of game-based learning(Gamelearn Team [no date]):

1. The learning process takes place through different and attractive scenarios
2. The learning process is based on overcoming different challenges
3. The learning experience is positive and interesting

I agree with these characteristics and will implement them into the design of the game. This type of teaching involves the use of informative and interactive games known as 'serious games' or 'educational games'.

### 2.5.1 Serious Games

The definition of a serious game is "a game designed for a primary purpose other than pure entertainment"(What are Serious Games? 2016).These types of games pursue a goal of improving a students engagement and making the learning experience more positive as well as improving memory and information retention(Gamelearn Team [no date]). They promote a higher engagement and immersion and keep the player going through the game using rewards, story progression and other feedback methods(Grendel Games [no date]). It is important that if I am to create a serious game, I incorporate all the characteristics and features of one. Features such as a story is a very important as without it, a user will become less interest as there is no understanding of why they are doing what they are doing. Given a scenario or topic, a serious game can be developed to fit a certain need just like any other game.

When thinking about serious games, it was important to do some research into what makes a good serious game as this information will be important later during the design stage. The features to making a good serious game are(W [no date]):

1. Develop good learning objectives
2. Interactivity
3. Environment
4. Experimentation

5. Consequences
6. Challenge the learner

I feel that a game with these features will perform very well and will also aid in the design stage by setting criteria to meet.

## 2.6 Platforms

To create this game, research into development platforms was essential with Unity and Clickteam Fusion being both good candidates. Clickteam Fusion is a script-free programming platform that can be used to develop interactive games. It has a range of features such as a large library of premade graphics, the ability to import files for your own graphics and a complete development studio(Clickteam [no date]). The game had a free version and a paid for version, with the free version having fewer capabilities. This was a let down and as I have only ever created a very small game with it in the past, I was unsure if the free version would be able to develop any advanced games. As I have said, I have used it before but only once and so my knowledge is very limited and that with the lack of knowledge about the reduced features, this meant I didn't see this after research as a viable option.

Unity had potential as it is a real-time 3D development platform and everything created on the platform I would own.(Unity [no date]) Unity states it can make amazing visuals and has real-time rendering(Unity [no date]) which was attractive as this would be a very visual game and having a platform with this ability is a huge positive. The issues I had with Unity is that I have never used it before and looking at YouTube tutorials, it was very unlikely I would be able to develop my skills to a decent level to create this game in the time frame I had. I chose not to go with Unity because of this.

## 2.7 Scratch

A platform that came to mind when taking on this project was Scratch. I have experience with Scratch and this coupled with the knowledge of its features and what its capable of made it ideal. Before settling on Scratch, it was important to see what else was on offer and to way up the pros and cons between development platforms. The following information will detail what Scratch is and its features, which will help you to better understand the design and implementation stages in this report.

The game is created and hosted on the block-based coding program called Scratch. Scratch allows the creation of many projects including stories, animations and games through an interface known as the programming interface or editor mode. This main interface features categories containing listed code blocks, a coding space to connect those blocks, an animation screen to view code play out and a character and backdrop section. Within Scratch, characters or objects are referred to as 'Sprites'. A Sprite is a character or object which can be individually coded and can interact with other Sprites. Each Sprite will have its own coding screen, where code blocks placed will be unique to that Sprite. The platform also has a library of pre-drawn Sprites and backdrops, but for this project very few were relevant. These feature have made this platform very attractive due to the simple layout. 'Sprite' is a noteworthy word as it will be used regularly throughout this report to reference different characters and objects.

Costumes play a huge role on Scratch and will play a role in this project so it is important to give details about them. The look of a Sprite is down to its costume. A Sprite can have many costumes and these costumes can be cycled through during a game, using code, to give the Sprite different looks. These costumes can be anything such as images, drawings and even text as you will see.

A main benefit from using Scratch is its high shareability. Other than the programming interface, Scratch has a game screen for users to use when playing the game. This screen shows no code, only the game window and has both an instruction and notes box for the creator to write in. Through the game screen, you are able to share the project so it is visible to the public. From this screen, you are able to see how many people have played the game, any comments they have left and if anyone has remixed the game which is making a copy for their own account. Multiple users can play the game simultaneously on the Scratch website making it ideal for large class group. Scratch also has a desktop version as well as the online version.

### 2.7.1 Constraints

From experience using Scratch, I have identified a potential problem. Scratch has very little in terms of design and development of characters and backdrops. This game will have many different characters and objects as well as background changes, so this issue can impact greatly. When designing parts of the game, this issue would be considered. The best alternative would be to design characters and backdrops on another program and upload them into Scratch.

## 2.8 The Colour of Cyber

In preparation for designing colour schemes for the game, I did some research into what colour best resembles cyber. From this Forbes article(Lawson 2019) it states Cyber is cyan blue or #235594 to be exact. Research into this is important as during a design stage, a colour scheme will be created to help with the development of the games features and objects. Colours play a role in setting the scene, drawing resemblance between things and also telling a user whether something is right or wrong, good or bad.

### 3. Specification

The specification and the requirements for this game are clear and have been influenced by the research in this report as well as involve aspects from my initial plan. The overview for the game is for it to be an interactive experience, featuring information relevant to the four concepts which is followed by interesting and challenging mini games. The mini games will vary in content and design, with the focus of the user applying the information they had seen before playing. The interactivity aspects should allow the users to navigate and make decisions based on the information they will experience, using varied methods of interactivity.

#### 3.1 Requirements

Based on my background research into game-based learning and serious games, I have identified certain requirements and features that are needed within the game to aid in a well performing serious game. Each requirement is followed by a description of its intended impact within the game and to the users.

Must have game requirements:

**1. Clear Start to Finish Navigation**

- The user must be able to navigate through the game, easily accessing the information and the mini games, all the way through until the end. Navigation objects must be clear and stand out, making it known what each will lead to. Through testing, all objects must be usable and have the intended outcome for a student to engage with issue free if possible.

**2. High Level of Interactivity**

- This is important to avoid disillusion within users of the game. Where possible, users interaction should be the main driving force behind progression and reaching the end of the game. This interaction should vary in style.

**3. Varied Environment**

- While being consistent with a theme, the environment of the game should offer varied scenery and assets which intrigue users. Varied environments should relate to concepts involved, and where possible, direct a users progression through the game.

**4. Experimentation**

- This is a very important to both serious games and game-based learning as seen in the research. Through repetition and trial and improvement, users should be encouraged to experiment within challenges and put their knowledge to the test in game types other than single answer. Multiple answer questions can give users this chance to engage with trial and error.

**5. Consequences through Incorrect Interaction**

- In relation to experimentation, users incorrect interactions should have some consequences. Whether that be in the form of point deductions or time penalties, these consequences should positively motivate a user to try their best while play. Consequences

should influence the user to think carefully before acting so they apply their knowledge to the questions.

#### **6. Challenge the Learner**

- A student should feel challenged while playing the game as without this, they can become disillusioned. The game should focus on guiding the user to apply the knowledge they have gain while playing, to solve a variety of challenging puzzles which should vary in difficulty. These puzzles should challenge the user enough for them to understand the concepts involved but should not be too difficult that they put the user off wanting to engage with said concepts. With the varied difficulty, game types for the same concept should try to increase the difficulty from one game to another.

#### **7. The Learning Experience Should be Fun and Interesting**

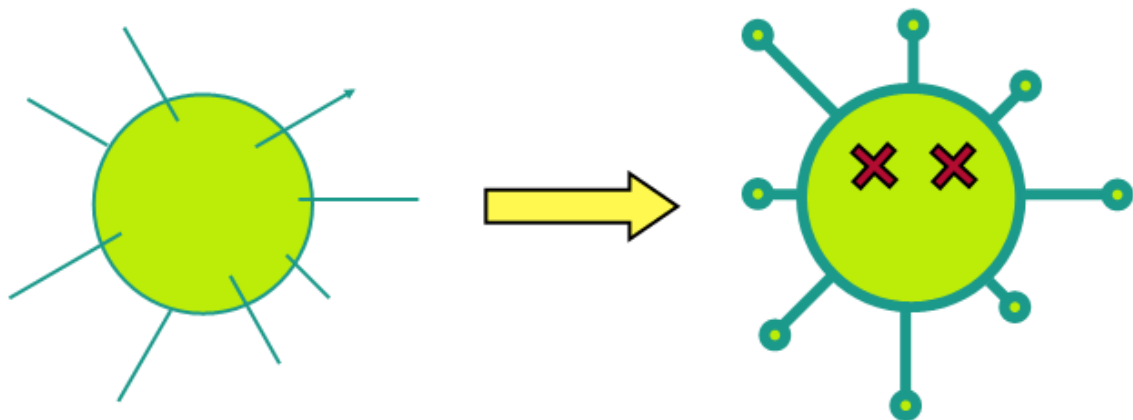
- To motivate the user to continue playing through to the end, the game should be enjoyable and what they are experiencing should be interesting. Combined with the concepts, the user should enjoy what they are doing and should be interested in the information being presented to them.



## 4. Design

The following information walks you through the design stage of the game. The design stage will follow a similar path to which the player will progress through the game. The game consists of several mini games which relate to different concepts with different information, so the design stage is very important. Within this section you will read about the design of the story and theme in relation to the research, the main menu page and interface design and how it leads into the different mini game, the design of the different mini games themselves and their interfaces and the design of how the game will end along with the timer and constraints. All these things will show you how the requirements in the above section have been integrated into the design of the game. The last part of this section will briefly describe the design of the classroom resources to accompany the game. It should be noted, the designs seen in this section were either used as they are in the game or were developed upon and adapted during implementation. The core ideas for the look of each section of the game remained the same between design and implementation.

The design process involved brainstorming ideas and sketching drawings to develop upon. All the images seen in this design section will be the end result of the design process and the final graphics which would be implemented into the game. Before looking at the rest of the design section, Figure 1 below gives you a visualisation of how my ideas were developed from initial simple graphics to the final product. The image is a virus which will be used during one of the maze challenges as will be explained in this section. Most of the graphics seen in the game will have started out very plain and will have been built upon to achieve their final look.



**FIGURE 1 - EXAMPLE OF HOW THE FINAL DESIGNS WERE ONCE INITIAL DESIGNS**

During this section, you will also see Sprite and backdrop drawings. As stated earlier, all designs in the game will be either drawn by myself or will be used from the library of Sprites and backdrops that Scratch offers. This way, there will be no issues with using Copy Right designs or objects that others have created.

## 4.1 Story and Theme

From brainstorming and research, I have settled on the theme of cyber and police. During my research, I found that a good serious game needs a story and this is something I will have consistent throughout. From this, I have developed a story that will give relevance to the concepts used and why students are playing the mini games. The game is based around cyber and the police force, with the role of the student being to aid the police cyber crime department to take on their extra work load. This extra work is the mini games themselves, which are all themed around police and crime. This theme of cyber and police is the main influence for the name of the game, Cyber Officer. The name relates to the main story and is relatable to the main use of the concepts involved. The story will run consistent through the game, with the introduction setting the scene and informing the students.

In relation to the story development, I have developed the idea that the mini games will be known as 'Cases'. Each concept will have two Cases, Case 1 and Case 2, which the user will have to complete. When first playing, the Cases will be locked and to unlock each concepts Cases, the users will have to go through the Info sections associated with these Cases. I have designed it this way to ensure users read through the information and apply that knowledge to the games. It is designed to try and stop users just playing and guessing without the chance to take in any information.

## 4.2 Colour Scheme

Colour is very important in a game, it can be used to tell you when you're right and wrong as well as set the scene. Before developing any official designs, it was important to develop a colour scheme that would have an impact on them, as having a good colour scheme helps design key objects and backgrounds to relate to each other. From my background research, I discovered from a Forbes article that the colour of Cyber is cyan blue or the code #235594 (Lawson 2019). A website called Coolors allows you to create colour palettes based on specific colours. The website then randomly generates different palettes of colours it thinks works well together, which you can group together into a larger palette. Below in figure 5 is a colour palette I designed through the website that will be used for different aspects in the game. Not all colours will be used but its helpful to have a variety available to pick and choose from. In the colour palette, the blue on the left of each row is the colour blue of Cyber #235594 and the colours to the right are the websites choice of selected colours that work well with it and each other.

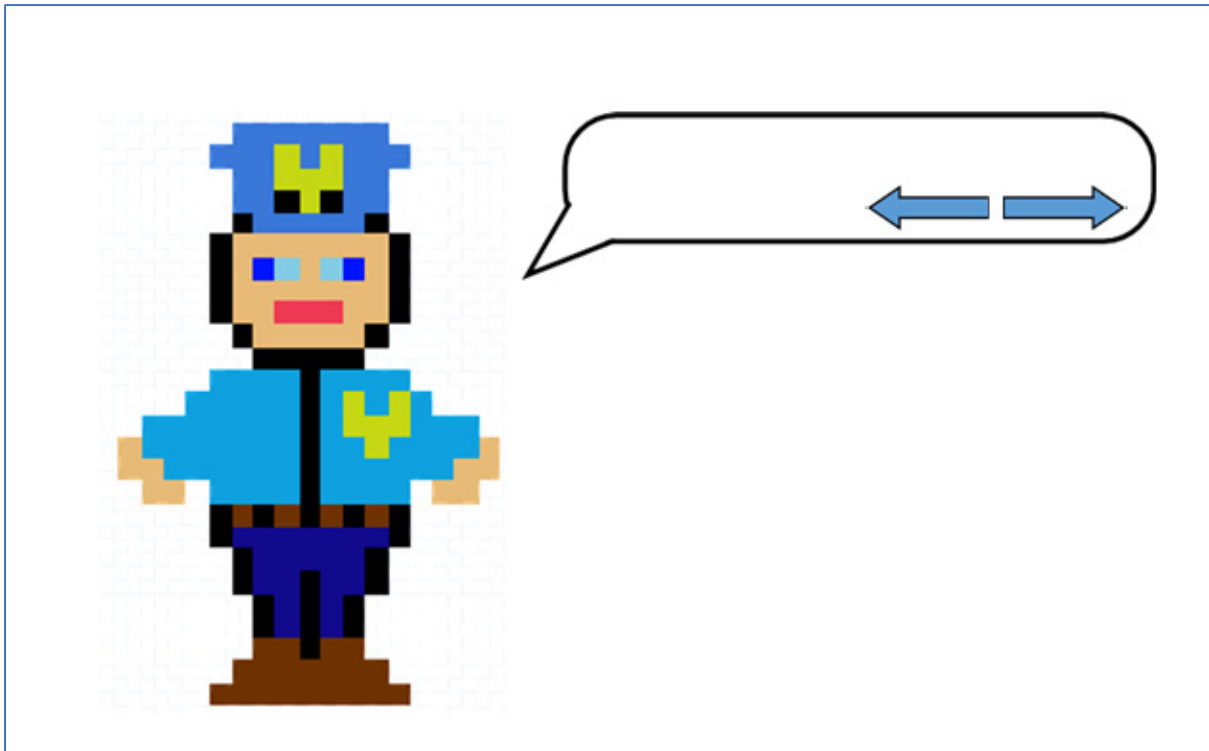


**FIGURE 2 - COLOUR CHART FOR USE IN THE DESIGN**

### 4.3 Concept Information

The focus of the game is to inform users and put across information for them to learn from and then for them to deploy that information to complete the cases. With that being said, getting information across to the user is very important. Without clear information and instructions, the user will struggle to play or understand the game and may not learn anything. Instead of screens displaying blocks of information, I created a character in the form of a police officer, to act as guide to the user who introduces them to the game and who is also the one offering all the information. The police officer uses a speech bubble with interactive arrows which the user can use to cycle back and forth through the information being given. This police officer will be with the users through the game and is a character that will interact with the students as explained more later on.

When creating the police officer character, it was very important to have it resemble a police officer upon first glance. If not, the character would not fit into the design or story of the game. The initial design of the police officer was not very advanced, as I had attempted to draw them hands free myself. From research into character design and development, I came across a website that I ended up using called Piskel. This website allowed me to create a character that clearly resembled a police officer with a fun and unique look. Each object within the Information sections of the game can be seen below in Figure 6. These objects I plan on developing as Sprites so I can individually code them and tailor their interactions.



**FIGURE 3 - DESIGN FOR HOW THE INFORMATION WILL BE PUT ACROSS TO THE USER**

During these information sections, I plan on having demonstrations and other animations happening when related text is shown. This will help to improve motivation, giving some more life to these scenes and keeping students enthusiastic to play.

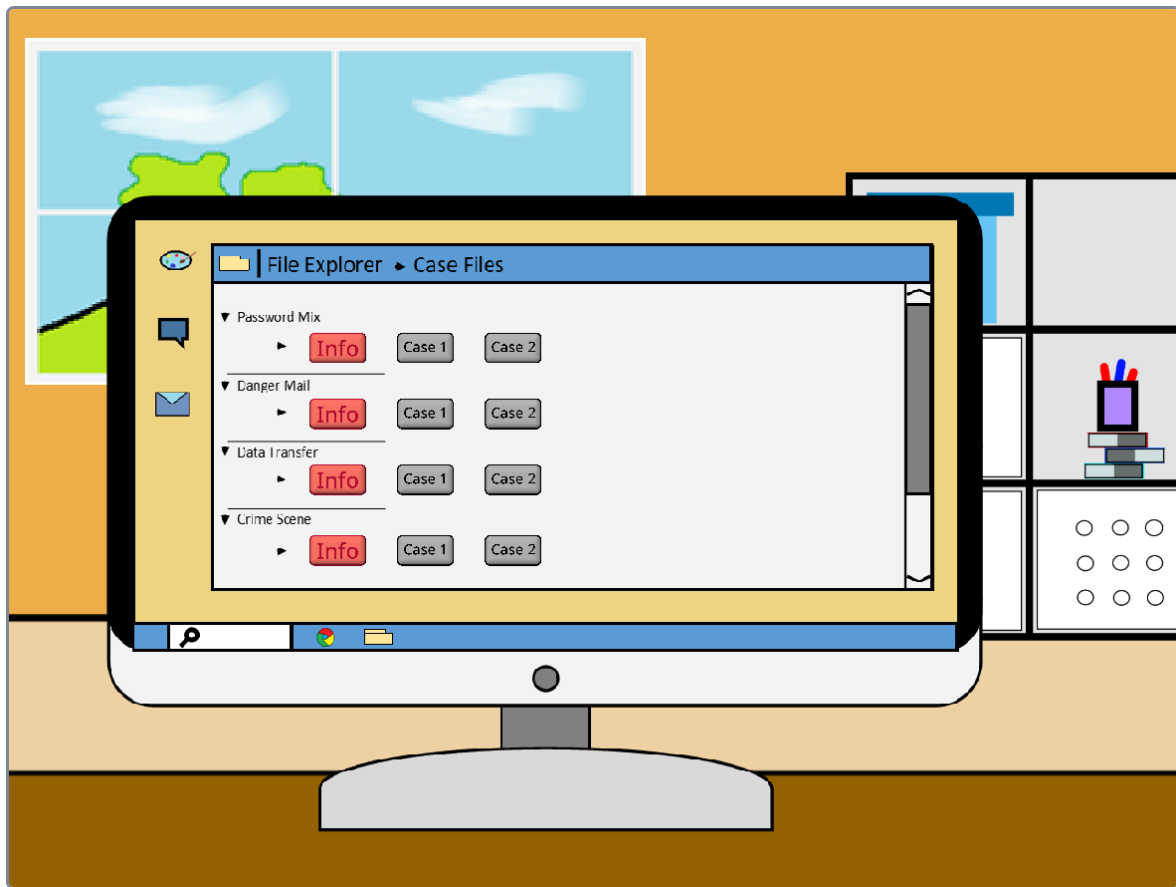
## 4.4 Main Menu Design

The main menu is incredibly important to the game as this is where students will first go before starting any of the Cases. This menu needs to clearly display all Cases within the game and their playability, allowing users to navigate. An aim as stated in the introduction is to have user input navigate them through and within this menu, students will have the choice of what Cases to do in the order they like. Each option to start a Case will need to have a specific colour to identify whether it is playable. As stated before, this is important as users must first go through the information sections of each concept to unlock the playability of the associated Cases. It is also important that a button has a look which shows it has been played. For the play through of the game, I intend for each user to only have to play each Case once but they can view the Info sections as many times as they like.

### 4.4.1 Interface

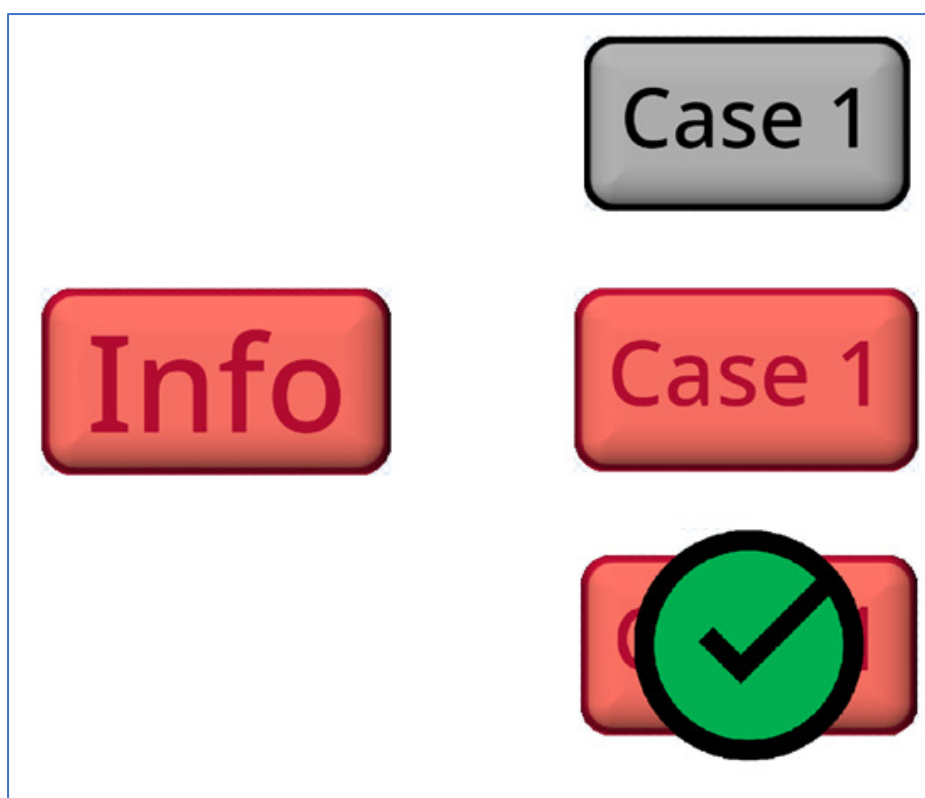
The interface has been designed to resemble a computer monitor in use. This was influenced by the story and relates to what users are doing at that point in the game. This main menu is what the users see before starting any of the Cases. It was therefore very important that it is fun and motivates users to continue to progress through the game. This design will be used as a backdrop so that it sets the scene for interactive Sprites to be placed on top. Within the game, this main menu will be referred to

as 'Desk' in relation to the story and why the main menu is a computer monitor. Below in Figure 7, you can see the design for this interface with the interactive buttons.



**FIGURE 4 - MAIN MENU INTERFACE DESIGN WITH THE BUTTON DESIGNS IN THEIR PLANNED POSITIONS**

The buttons on the main menu interface are very important and the students must be able to tell apart which buttons do what. As there will be two types of sections the user can go to for each concept, an information section and the two playable Case sections, the buttons to go to these sections must be distinguishable from each other. Each button will be a Sprite as this will mean each can be coded and be a separate object to each of the other buttons. As stated before, I plan on having the Information section be viewable as many times as the user likes. This will mean, if they forget some information or are still confused about something later on, they are free to go back and view this section again. Due to this, the buttons to take a user to the information section for each concept will only have one look as it will always be pressable. For the Cases, they go through three stages: Unplayable, Playable and Completed. Below in Figure 8 is a design for each button which will be incorporated into the game during implementation. The design of the information button can be seen and also the three different looks for the Cases buttons. The Case buttons go in order from top to bottom being Unplayable, Playable and Completed.



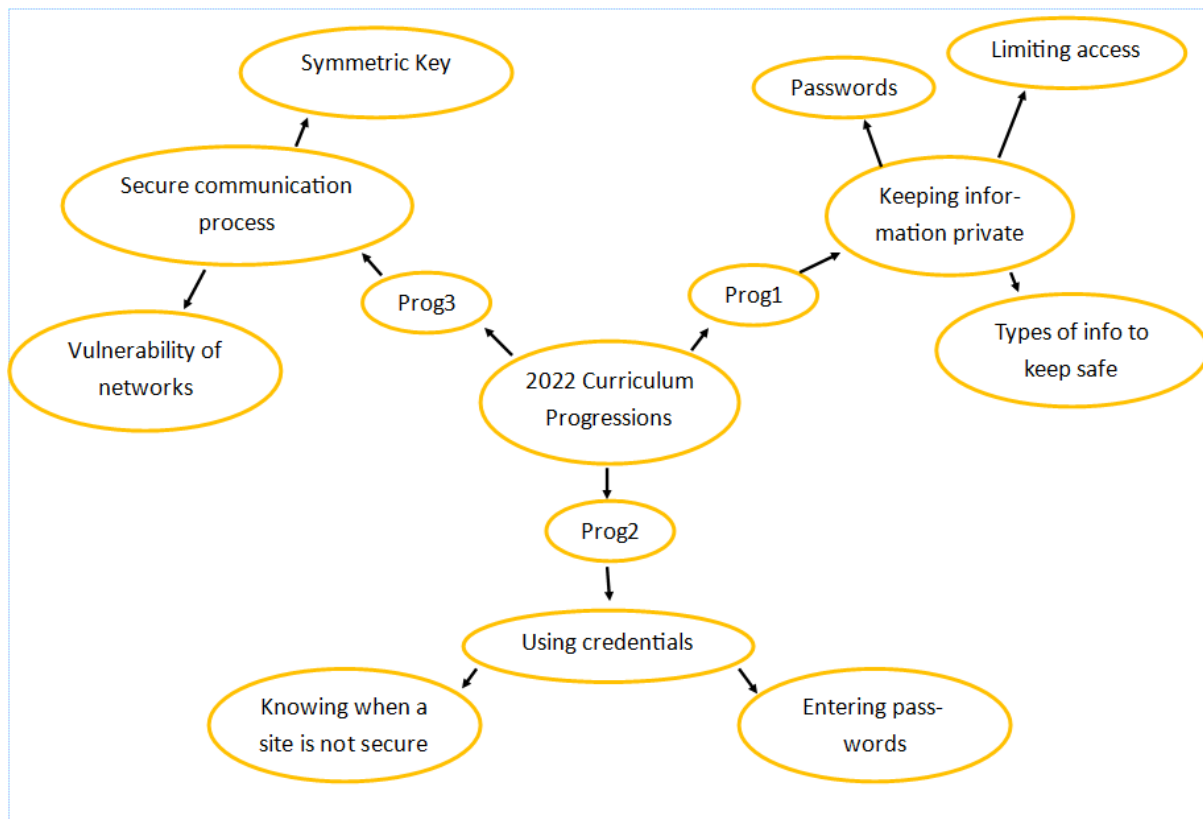
**FIGURE 5 - THE SINGLE INFO BUTTON DESIGN AND THE 3 CASE BUTTON DESIGNS**

## 4.5 Case Designs

I will now discuss and explain the Case designs and the use of each of the four concepts. The discussions will contain a description of what each concept teaches, how it relates to the 2022 Curriculum Progression Steps, how the concept will be used in the game and some of the important information it will cover. The designs of the cases are very important as each concept will have a different type of interactive game. Ensuring the games test the knowledge is critical to the success of the games as well as an important design of increasing the difficulty from Case 1 to Case 2.

As each Case will go to a different section than each other within the same concept, I plan on using the backdrop feature of Scratch to develop each section for the Cases. Only one backdrop can be shown at once and so these can act as different areas in the game. The Cases will consist of Sprites which will only appear when the backdrop they are linked with becomes active, stopping any mix ups between Cases. Each backdrop is able to have a different look and this is important for setting the scene for the different concepts involved. The backdrops themselves aren't interactable, they only remain in the background and the Sprites I plan to have will be developed to have all the functionality.

Below in Figure 9 is a mind map that was created during the initial brainstorming, coming up with ideas relating to the concepts and curriculum. These ideas were developed further and resulted in the Case game ideas which will be discussed next.



**FIGURE 6 - INITIAL MIND MAP TO SHOW THE RESULTS OF BRAINSTORMING THE PROGRESSIONS AND THEIR POTENTIAL CONCEPTS FOR USE IN THE GAME**

#### 4.5.1 Passwords

This concept is important in providing information to students on how to create strong passwords to protect their information and data. Relating to the curriculum and progression steps 1 and 2 from the research in this report, students at these progressions should know how keep some information safe and have experience with credentials in this process. Through this concept, they will learn about passwords to give them an understanding of how to protect their information. At the age group 10 – 12, many students may already have developed their own passwords, and if so, they will be able to relate to this concept and apply the knowledge learnt to potentially improving those passwords. This teaches students the importance of strong passwords and what it takes to create one. They will learn about the types of things passwords protect, why they need to keep their passwords safe and an example of a strong and weak password to visualise the difference. One feature of strong passwords they will be taught is not to base them on personal information such as names or ages. This information has influenced the design of the game, which will be explained below.

The cases will involve students being presented with passwords and criminals personal information which is inside a file. They will have to compare the passwords to the criminals information and then match them up. This is to teach students that developing a password based on knowledge people may know about them, can weaken their password strength. During this design stage, I envisioned the game as a type of trial and error. The students must match up the passwords with the criminals files they match and then see if they are correct. If not, the game will indicate its not correct and the students will have to try a new pattern of matching passwords and criminals information. This method

of trial and error was influenced by the core concept of game-based learning being learning involving repetition, failure and accomplishment as noted in the research.

With the design above, I had planned for the game to be mouse use only. The students would have to click and drag Sprites on the screen as well as click the files to view the contents. Below in Figure 10 is the initial design for how the passwords Cases will look. Each password will be clearly identifiable and peoples information will be inside the different files which will be displayed in a structured way. Figure 10 is the design for Case 1 and with Case 2, I plan on increasing the number of passwords and files as well as the complexity of the passwords. At this stage, I had developed what passwords I was going to use as well as the information within the files.

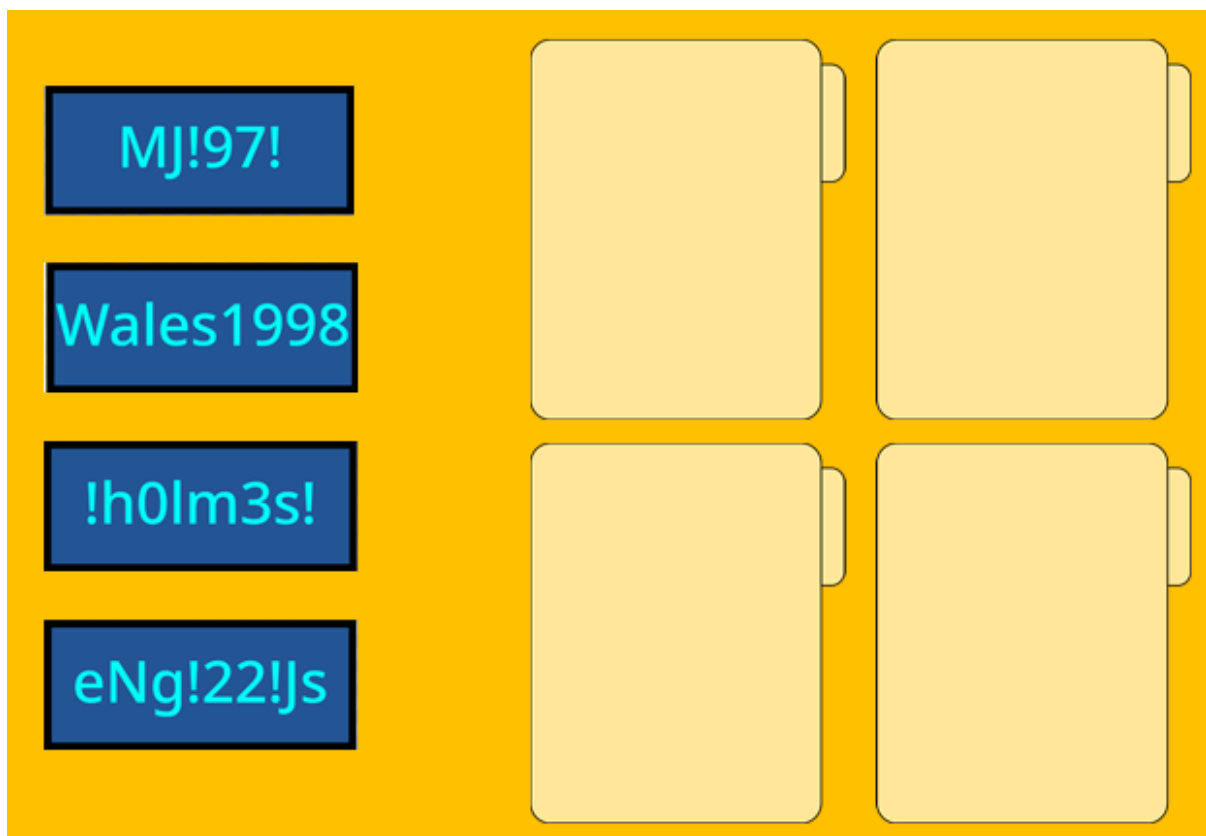


FIGURE 7 - DESIGN FOR THE LAYOUT OF THE INTERFACE FOR PASSWORD CASE 1

#### 4.5.2 Email Safety

Emails play a huge part in most peoples lives. In 2020, the number of email users globally reached 4 billion and this number continues to climb(99firms [no date]). It is important to teach young students the types of dangers posed by emails they receive. Both Cases will be about Phishing Scams. A recently published article put the number of phishing emails sent each day at 3 billion(Palmer 2021). With this many being sent daily, a student will likely come across one at some point if or when they use emails. This concept has been chosen as it links in well with the progression mentioned in the passwords Cases design above as phishing scams are usually after personal information which a student should keep safe. This concept is mix of progression steps 1 and 2 as well as linking to the digital competency which includes an aspect about phishing scams. The information stage for this concept will go through information that relates to email safety and the signs to look out for when receiving a suspicious email



that could be after their private information. All this is aimed at students better protecting their personal information and data.

The design for the Cases is to resemble emails and the interaction with them. This design for the Cases is to have a list of emails which the user would have to sort through. Each email would have features such as sender name and email address, subject and email contents. The user would have to use what they learnt about the different signs to look out for in a phishing email and apply this to the emails in the Cases to identify which could be unsafe. They will then need to make a decision if the emails are safe or unsafe, selecting the correct option. The signs that the emails are phishing scams would be very closely related to the examples shown during the information stage. Like the password Cases, I intended for this game to be a mouse use only game but instead of click and drag, there would be some options to choose and the user would need to click the correct one.

Below in Figure 11 is the design for the initial interface that the user will see. For users to be able to transfer the knowledge they learn in this game to real life scenarios, I have loosely mirrored what normal emails would look like.

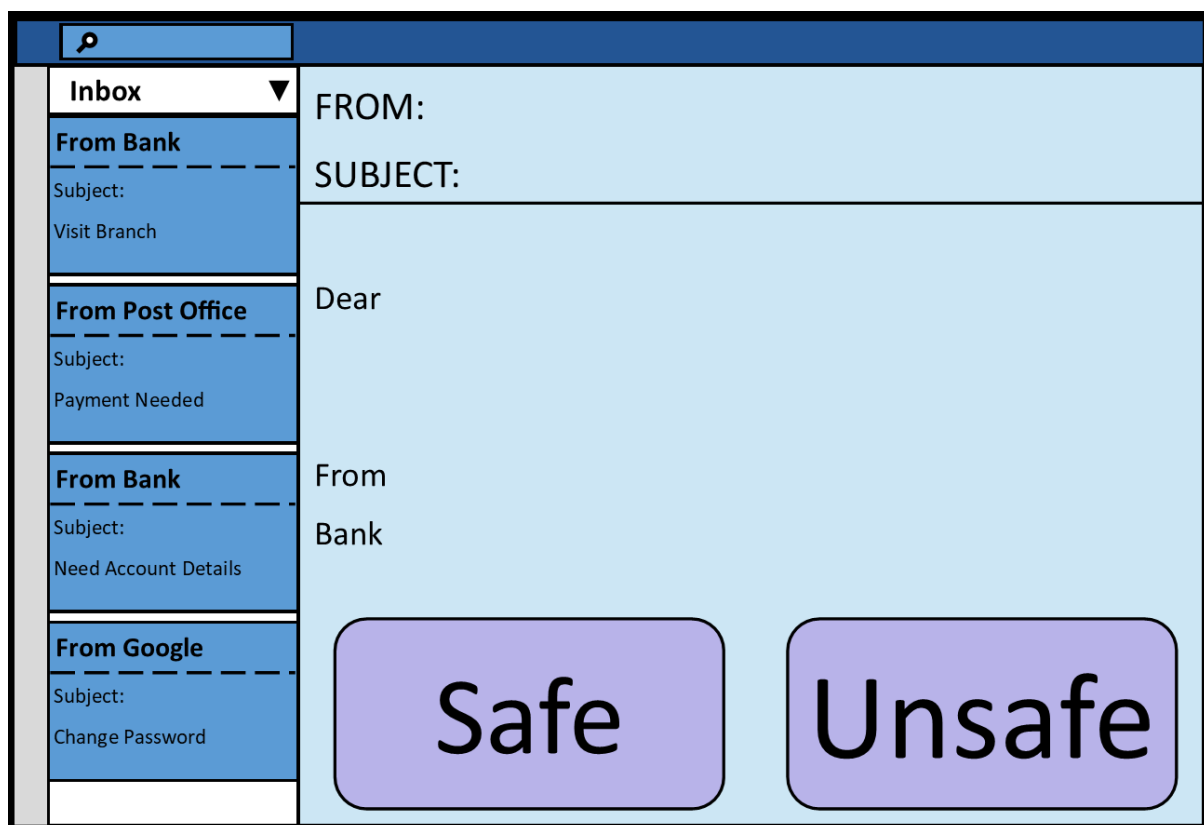


FIGURE 8 - DESIGN FOR THE INITIAL INTERFACE FOR THE EMAIL CONCEPT CASES

#### 4.5.3 Symmetric Cryptography

This concept and the information involved has relations to the progression step 3. This step wants students to learn about how computers communicate and how they share data and resources securely. My design for the concept is to have emphasis on how this works with sending a message over the internet. The user would be told about important phrases such as what the Key is and the

reason this type of cryptography is called symmetric cryptography. Both the encryption and decryption stages would be described fully and how to go from one to the other with numbers. The concept can be broke down into different stages which is what I have planned for the Cases. Both Cases are going to have different views of the process and different types of interaction. Useful diagrams will be used during the information section to help students visualise the processes involved.

For these Cases, I have incorporated maths into it which will be used to further explain the concept. My plan was for the user to have to send a number to a different computer. I used numbers as it is an easier way to show the encryption and decryption working and with it being a complex concept, with a number I could use simple ones. The use of numbers can also help with incorporating the cross curriculum numeracy into this computer science based topic.

For the Cases, the user will need to select the options to encrypt a number and then send it as well as the Key. With emphasis being on the Key being sent securely to the message recipient, after the message has been sent, I plan for the user to have to guide the Key safely through a maze to a different computer. This was to visualise that the Key needs to be sent safely through a different channel to what the ciphertext was sent through and that it needs to get there safely. This point would be raised in the information section and emphasised. Once the Key has reached the other side, the student would then be presented with the ciphertext and plaintext numbers and the Key would be blank. The students would be given some options of what the blank could be to go from ciphertext to plaintext and examples of this would be given during the information section so the students would have an awareness of what to do.

This Cases will be the most complex to play out of the four types. I intended to have a mix of mouse control where the user would have to click things and also select options. The maze section of these Cases would be all controlled using the arrow keys on the keyboard. Going from Case 1 to Case 2, the level of challenge increases through different mazes and increased number size and complexity. It was important to challenge the users but not make it too hard that it was demotivating.

Below is a basic design for the initial screen when a user sends the ciphertext in Figure 12. Below that is Figure 13 which shows a basic maze design that will influence the colours used and positioning of Sprites in the Cases during the implementation. It is worth noting that the animation screen size of Scratch is limited so these mazes will not be massive or extremely long. That is why the maze below in Figure 13 is just for reference. The maze will be developed on Scratch during the Implementation to ensure it fits into the animation screen and that the Sprites can fit also.

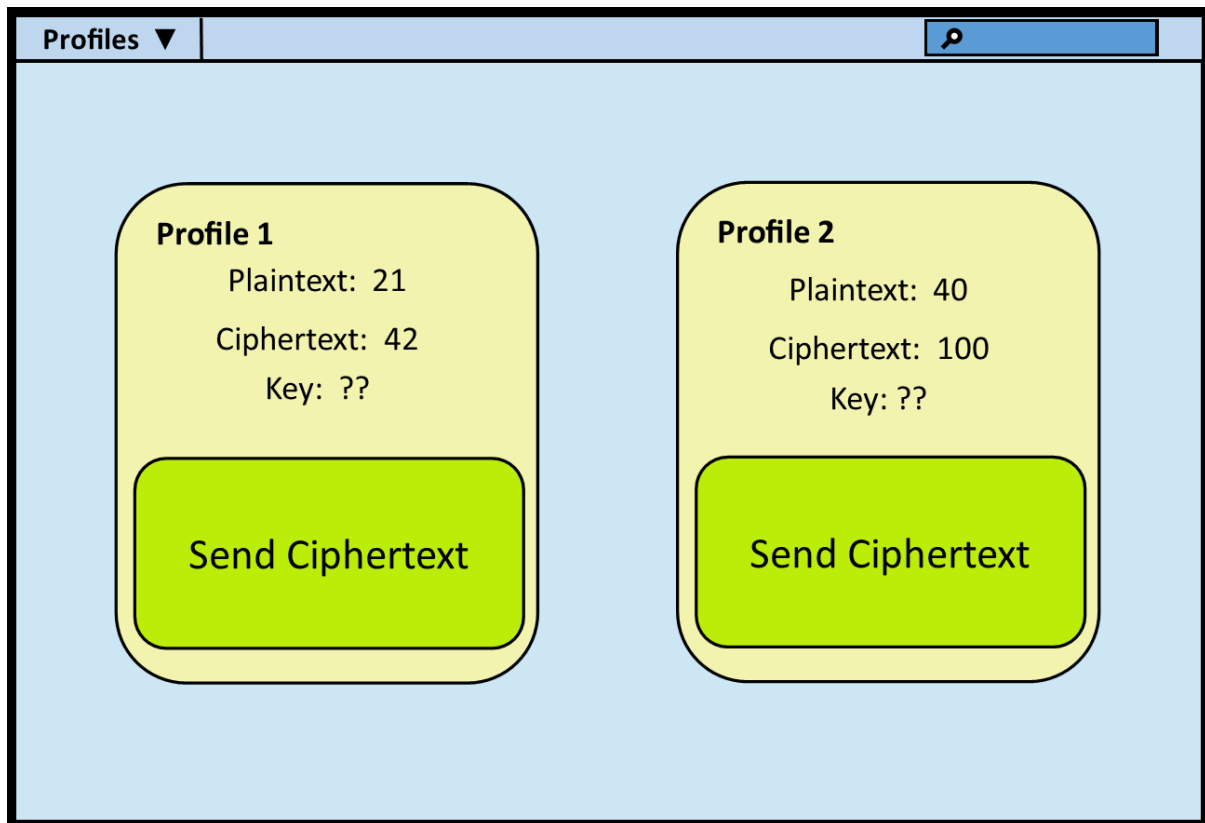


FIGURE 9 - INITIAL DESIGN FOR THE SYMMETRIC CRYPTOGRAPHY CONCEPT THE USER WILL FIRST SEE

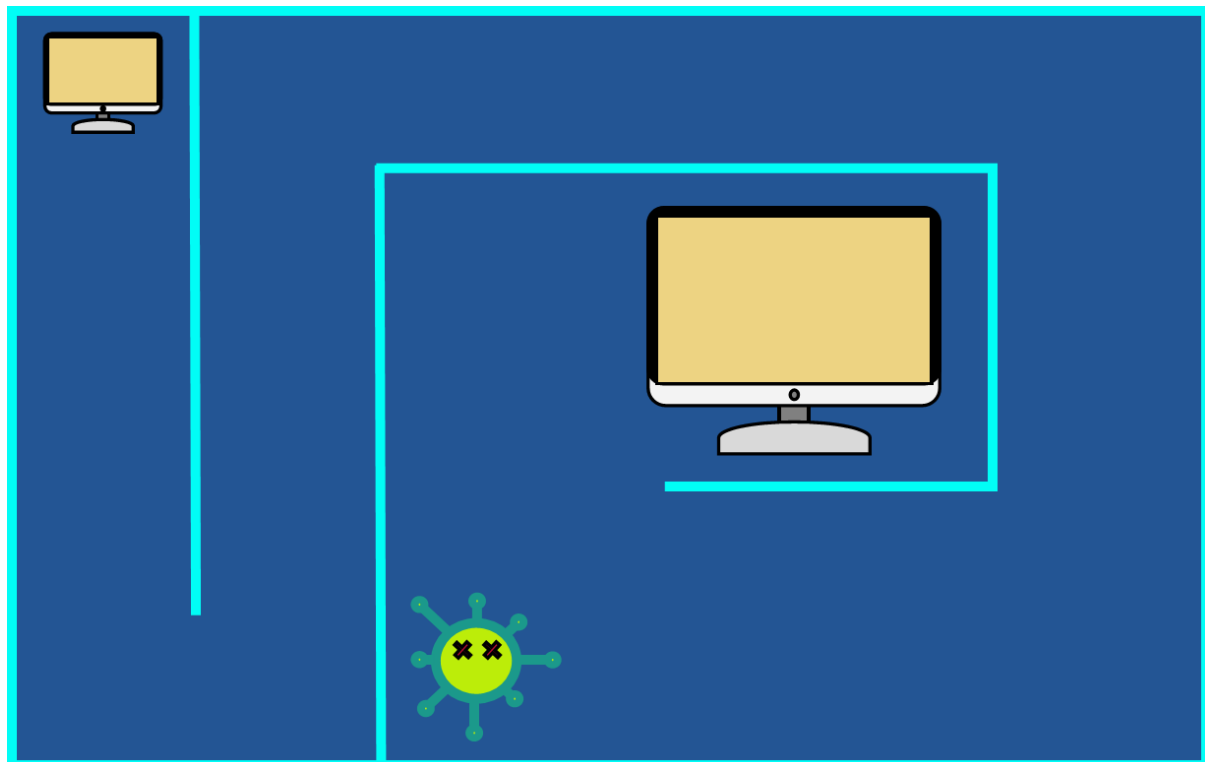
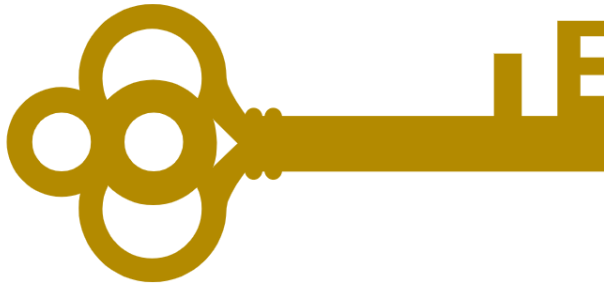


FIGURE 10 - DESIGN FOR A MAZE TO BE USED AS REFERENCE DURING IMPLEMENTATION

For the Sprite being controlled in the maze or obstacle course, I will be using a Key from the Scratch Library as seen below in Figure 14 . This Key is already designed but is blank with code meaning I am able to code it to follow the commands the user gives through the arrow keys. This Key is perfect to stay on topic and remind the user it is the Key they have just sent.



**FIGURE 11 - THE KEY FROM THE SCRATCH GRAPHICS LIBRARY WHICH WILL BE USED IN THE GAME**

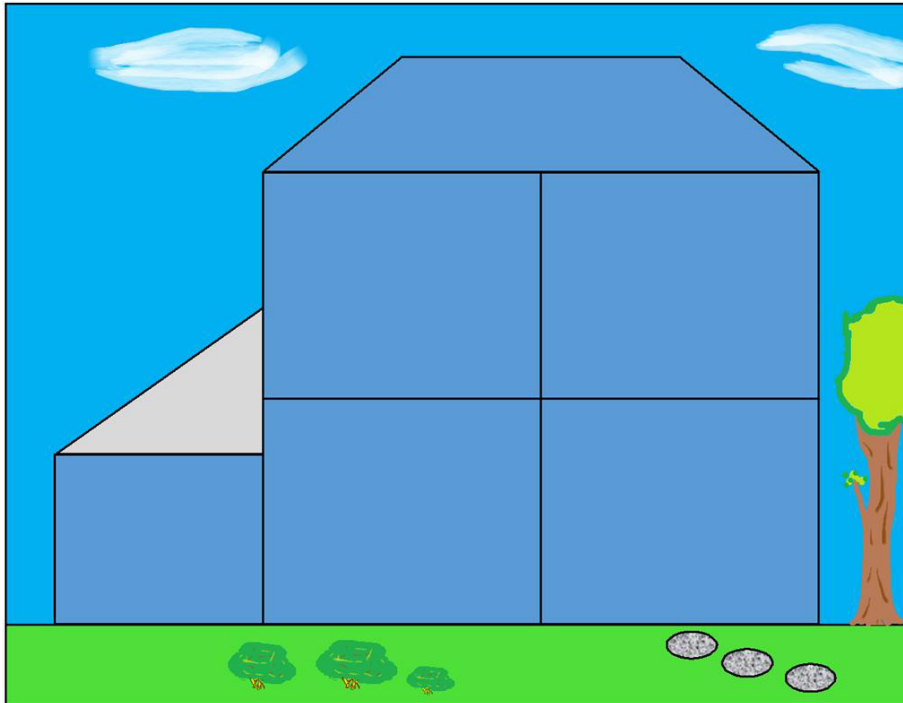
#### 4.5.4 Crime Scene

With these Cases, I planned for it to be very interactive and fun. The students will be taught about what a forensic computer analyst does and what they do when they go to crime scenes. The aspects of what they do at the crime scenes and how they transport data safely will also be described to the student. This concept is to give the students an understand of the types of jobs involved in cyber and how data they would usually protect in progression 1, is important during police investigations. This use of the concept is again a way to help the student relate things to the real world.

My initial design was to have a room and there would be things hidden which the user would have to find. I expanded on this and developed the building ideas. My final design for this concept is for there to be a zoomed out view of a building, with different boxed rooms. The user will need to click on a room which will result in them being taken there instantly, changing from the building view to being in the room just they clicked. Within that room, the user will able to look around and try to spot any items that a forensic examiner might want to take from the scene. For every item a student clicks, they will have a description for the type of information that could be of importance stored inside. For Case 1, I have designed a house with different rooms you would typically find in an average home. For Case 2, the setting of the crime scene will be at a business instead, where everything will be the same but the environment, such as the room layout, which will be different. These Cases will have many aspects of interactivity where the controls will be all mouse and require the students to click on items and rooms.

Below in Figure 15 is the final design for how the house view will look in Case 1. The house will contain main rooms such as bedrooms, a kitchen and a lounge, and the squares seen on the house in Figure 15 will be the zoomed out squares of the room. These rooms shown in the house view will be a zoomed out versions of what they would look like if the user was inside them. For each room, I plan on having at least one item of interest for students to click on and collect. During this design stage, the rooms themselves did not have any graphics developed. This happened during the implementation which is

when I knew the type of interaction was codable and did the designing as I went along. As mentioned earlier, Scratch has a limited animation window so these rooms would have to be developed on Scratch to ensure everything fits.



**FIGURE 12 - THE LAYOUT OF THE HOUSE THAT WILL BE SEEN IN THE HOUSE VIEW FOR THE CRIME SCENE CASE 1**

During this stage of the project, my supervisor organised a show and tell for myself and her other students to share what we were working on. This was early on and I showed my very first design for the game which people liked and I also got feedback. At this point there was only four rooms in the house and I had mentioned I would like more. I received feedback to add a loft and a garage which made it into the final design as seen above, with the loft at the top and the garage to the left.

## 4.5 Time Challenge

A main aspect of this game will be the time challenge. A key point in game-based learning is challenging and rewarding the player. In this game, once the user has reached the main menu, a timer in the background will begin. I will be hiding the timer during the game as it may be off putting or stressful to the users while playing which could cause them to concentrate less when reading through information. Once the user has completed the game, the timer will stop and their time will be shown. Their time will decide what officer badge they get: Gold, Silver or Bronze. The design for the badges can be seen below in Figure 16. Each badge will represent a different amount of time and these timings will be decided once the game has been created as run throughs and testing will be crucial in selecting accurate time frames for each badge. As well as a constantly increasing time, each Case will contain different elements which give time penalties. These time penalties will add a few seconds onto the timer for things such as incorrect guesses or collisions in the mazes. I plan to explain this during the

introduction and again during the information for each concept where the user will be made aware what causes a time penalty.



FIGURE 13 - THE DESIGN FOR THE THREE BADGES FOR USE IN THE GAME

## 4.6 Game Completion

How the game will end is very important. To end the game, all Cases must have been completed successfully in order for the conditions to be met for the game to come to an end. Once the conditions have been met, the user will be able to go to the ending screen. While here, there will be no more challenges, it will be a type of congratulations and well done ending with some text. It is at this point that the users time will be displayed, as well as the badge depending on the time they completed the game in. It is important that the user feels like they have accomplished something so words of congratulations will be used to make them feel good about their achievement. While in the end game screen, there will be no option to go back to the main menu as this may confuse them into thinking the game is still going.

## 4.7 Constraints

As stated in the research, Scratch offers a great interface to be able to code but the development of graphics to be used as backdrops and Sprites is very poor. With this issue faced during the design stage, I was able to overcome it by using a range of other programs. The majority of designs I created for this game were done in either Microsoft Publisher or Paint due to their high number of features.

## 4.8 Classroom Resources

For this game to be used in a classroom, there will need to be supportive material which a student can further benefit from. The point of these classroom resources are to aid in the development of the students understanding of the concepts that will be in the game. Each of these resource will be supportive and not strictly necessary in order to play the game. If I teacher wants to use the game in a lesson but use their own resources or none at all, students will not be disadvantaged from this.

A PowerPoint presentation is a useful way to grab attention, introduce the game and present the concepts to pupils before playing the game. The game itself will have enough information for pupils to play without having looked at any of the concepts before, but this PowerPoint will dig deeper into the concepts and provide additional information not in the game. It is import in the design of the PowerPoint that the concepts are explained clearly and relevant examples are given for students to relate the knowledge to. It is also a key point to have some interaction during the presentation, to further ensure students are alert and are taking in what is being presented. I plan for the presentation to go through each of the four concepts mentioned in the game and contain interactive questions for leaners to give answers to. I will also be using the notes section in this PowerPoint to give information to a teacher using it and directions for how to put the information across. The teacher may not have as deep an understand of these areas so these notes are useful in guiding them.

In addition to this PowerPoint, a case booklet will be used by the students in class during game play. This booklet will be referred to as the 'Case Booklet' and the pupils will fill in information as they complete the cases to reinforce their learning. The questions inside the booklet will be near identical to the Cases, but some layout changes may be needed as it will be paper based. For a teacher, they may use this booklet as a way to check students learning progress and motivate them to perform well with the knowledge some may present their answers from their booklets to the class. This booklet can be used to monitor leaners during their gameplay and kept by teachers as a way to show progress or for keeping track of how a student is performing in their progressions. During my time at school, everyone in the class had a red folder which the teacher would put our achievements in and other things that were important that we had done during our education year, which showed our development and could be looked back on.

The final resource will be an answer sheet. If a teacher wants to use the game, they will need the answers in case they have to help during gameplay.

Each of these resources have been brainstormed during the design stage and ideas thought up but it is after the implementation stage where the game has been developed that these resources will be developed. This is because I am unable to create resources to support the game without the game first being made and the exact contents and information known.

## 5. Implementation

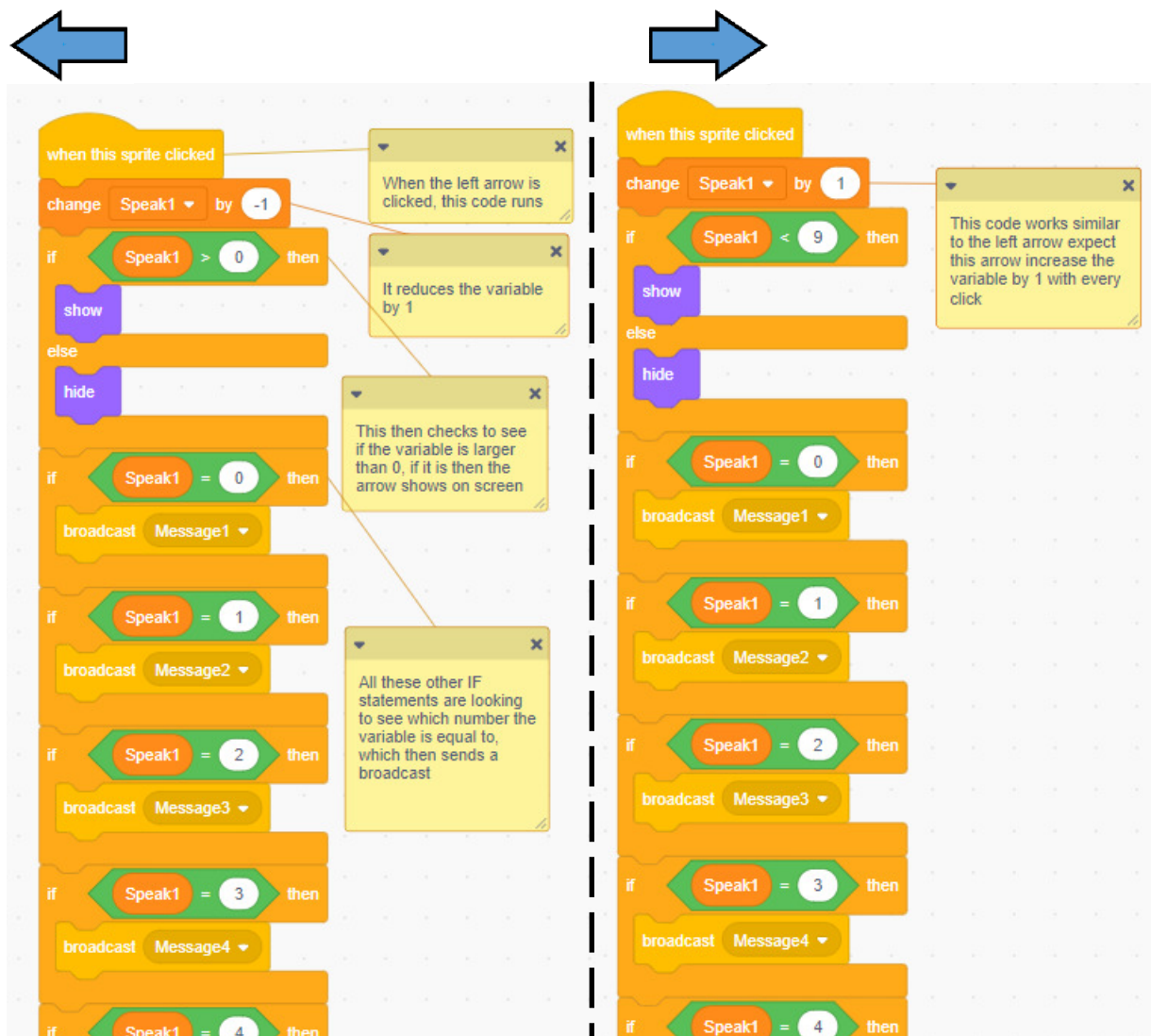
This section will go through each stage of the development of the game, in a similar order to the design stage to make it easier to follow. I will walk you through how I conducted the implementation for the main parts of the game, providing screenshots of code and other visuals to better backup my points and for easier understanding. I will also discuss problems within the functionality of the game and what I did to overcome these issues. The Implementation will go through the different sections of the game in a similar order to the design section of this report for consistency.

### 5.1 Information

As mentioned in the design stage, the information and how it was put across was an important part I needed to address. With the police officer I designed, I was able to put this into Scratch as a Sprite and use it as a type of talking character. The information is very important in this game and I wanted it to stand out and be interactive in a unique way, not just a page full of information. To be able to cycle through different bits of information the police officer would say, I created two Sprites for the arrows and also broke up the information into smaller sentences, which I used to create individual Sprites and set the text as the costume for each. The individual Sprites for the introduction text can be seen at Appendix 1 for example purposes. By putting them in as Sprites, it made coding them individually a lot easier and the interaction between them could be better tailored to how I wanted it.

The code to the below in Figure 17 shows how I created the ability to cycle through the information. Due to the size of the code, Figure 17 is only a small section but the code carries on at the bottom all the way up to `Speak1=9`. This is the code for the left and right arrows to move through the information, the code to the left is the left arrow and the other is the right arrow, with the images of arrows above them for reference. I have put the code here side by side for better understanding of explanations. It makes use of a single variable, which is unique to this section of information, and has a number set to it. Each number corresponds to a piece of text and the arrows increase and decrease this number, causing different pieces of text to show. For example, the first sentence is equal to `Speak1 = 0` and the second sentence is equal to `Speak1 = 1`, and so on. The visibility of the arrows is an important aspect which will be discussed after this. Every time the game starts, the variable is set to 0.





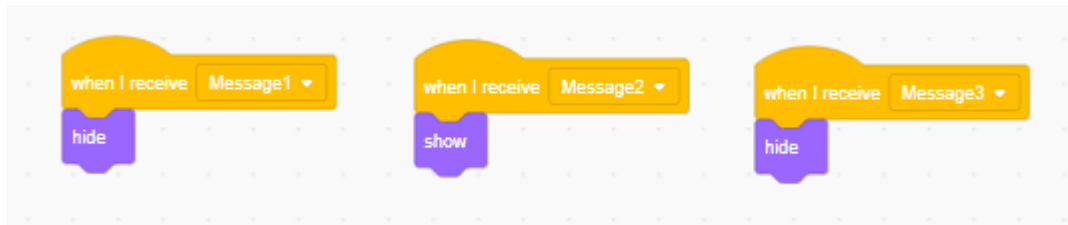
**FIGURE 14 - THE LEFT AND RIGHT CODE IS INSIDE OF THE LEFT AND RIGHT ARROWS FOR THE INTRODUCTION SECTIONS WITH THE ARROWS ABOVE EACH FOR REFERENCE**

As seen in the code, a variable called 'Speak1', is set at the head of a large IF/else statement. This statement runs when the Sprite it is in is clicked as seen at the top of the code, so in this instance when either the left or right arrow is clicked, the corresponding code will run once with every click. When the IF statement runs, which ever number the variable is equal to is picked up by the code, and a broadcast for the corresponding variable is sent.

A broadcast is a specific message sent to everything within the game. These messages are created and named by me and cannot be seen or read by any user of the game while playing but every backdrop and Sprite within the game receives this broadcast. Within the text Sprites is code, which listens for broadcasts and when it receives the exact broadcast its listening for, it runs its code. In this way, I am able to trigger events within the game based on broadcasts from user input.

Below in Figure 18, you can see how I have set up the code for the different text Sprites. This example is for the second piece of information in a series of ten relating to the code above in Figure 17. Each Sprite has code for it to listen for several specific broadcasts. One piece of that code is listening for the broadcast for that specific piece of information to be shown. In the below example, it is waiting

for the broadcast 'Message2'. As you can see, either side of this piece of code is two other pieces that are also listening for broadcasts. These two are very important, they tell the Sprite when to hide and not show on the screen. Here the Sprite will hide when the message before it is showing and when the message after it is showing. This way, it will always be hidden from sight, only showing when its time for it to be read at its turn in the sequence of pieces of information. The message before it is there in case a users wants to go backwards through the information.



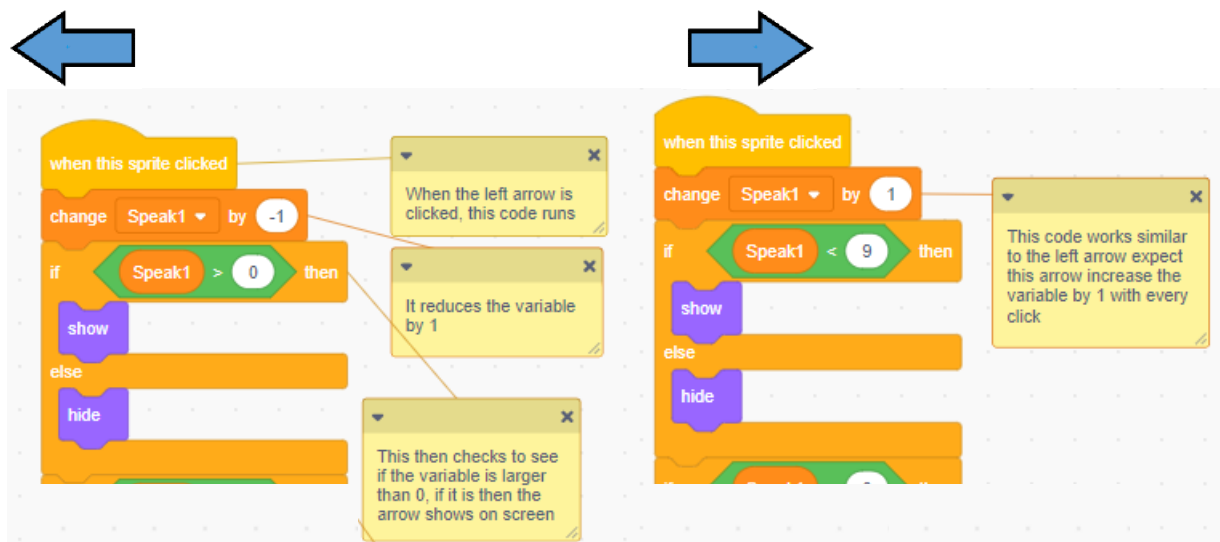
**FIGURE 15 - THIS CODE IS FOR THE SECOND MESSAGE DURING THE INTRODUCTION SECTION OF THE GAME**

### 5.1.1 Issues and Solutions

There are two issues with the arrows which both involve hiding and showing. Both these issues have a solution but it is worth explaining as these problems and solutions are found in each of the Information sections throughout the game.

The first issue is with every click of either arrow, the variable will change. A worry is that someone will click either of the arrows too many times and it will take it out of the range for the information to be displayed. For example, the variable only uses numbers 0 to 9 but if a user keeps pressing the back arrow, the variable could go too far back to a number such as -10. As the user is not able to see these numbers, they could go too far back or forwards and not know how to get back to the correct number range which affects the gameplay.

To ensure the numbers didn't get too big or small, the left arrow would not show for the very first piece of information as there was no information before it to go to and so the variable number would not be able to go less than 0. This is the same with the right arrow but when the user gets to the end of the information, where the variable is 9, the arrow will disappear as there is no more information to go to. Below in Figure 18 you can see the IF/Else statements which hide either arrow before they go out of range. This code can be seen in its full form in the figures at the start of this section.



**FIGURE 16 - THIS IS A SECTION OF THE CODE SEEN EARLIER TO HIGHLIGHT HOW THE CODE HIDES EACH ARROW**

The second issue relates to the previous issue and also has a solution to other functionality. This code within the Sprites works well but it is not able to re-show the arrows as to re-show them the code would have to run to check they're satisfying the criteria to show. As the arrows are hidden and the code to check the variable only activates when it is clicked, this will not happen. To solve this, I have implemented listening blocks for broadcasts within the arrows. If the left arrow is hidden, it means the information is at the beginning and the only arrow showing is the right arrow. When this right arrow is clicked like in the example before, the variable will change from Speak1 = 0 to Speak1 = 1 and broadcast 'Message2' is sent to trigger the next Sprite to show the information next in the sequence. This also triggers the back arrow to show as that too is listen for 'Message2'. This way, the arrow will be hidden for the first message as there is no other message before it, and it will show when the second piece of info is showing as there is now a message to be able to go back to.

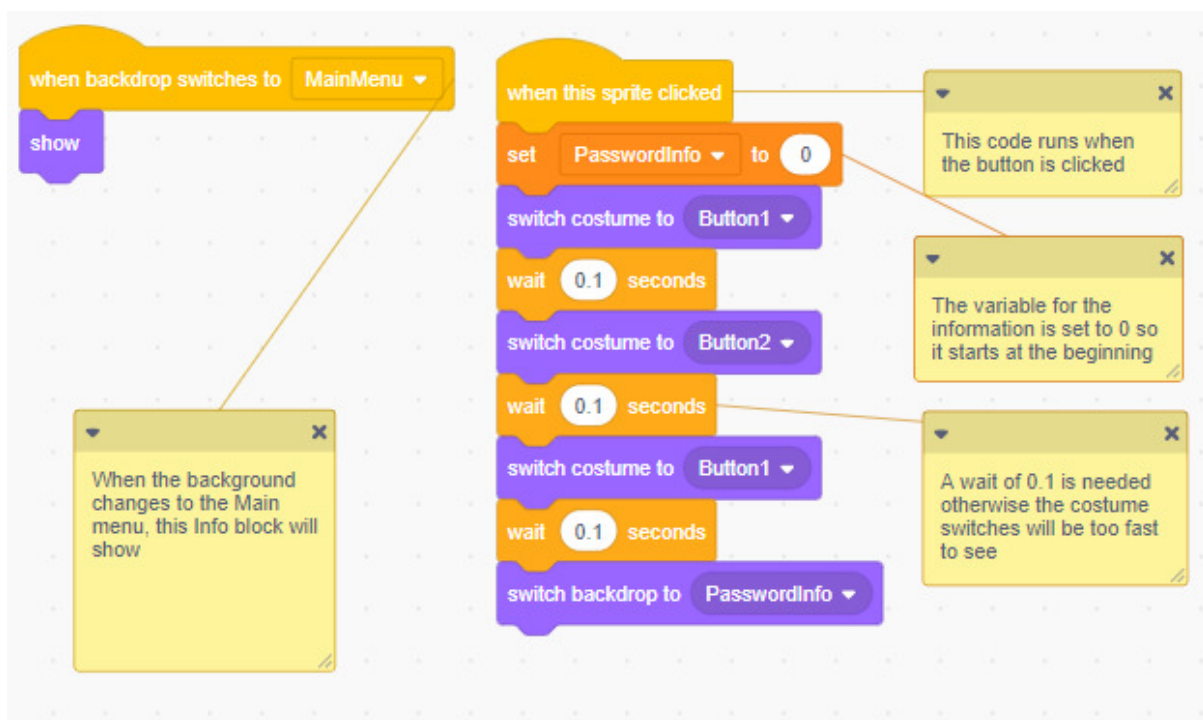
This issue was the same for the right arrow. When it gets to the end of the information it hides as there is no more information to go to but if a user is to go back, the right arrow will not reappear. The same solution with code listen for a broadcast of the message before it, works to reshown the right arrow should the user go back to re-read the information.

## 5.2 Main Menu

The main menu is the most important area of the game. It connects the user to all the concept information and the associated Cases. It was crucial here that the functionality works perfectly, otherwise a user may be unable to progress through the game. The look of the main menu uses a design created during the design stage and was uploaded to Scratch to be set as a backdrop. The main focus here is the buttons themselves and their main functionality will be explained in this section.

### 5.2.1 Info Buttons

Although it is the main menu, the code here is not very complex and the majority relies on each of the buttons to take the users to the selected area. In Figure 19 below, you can see how the buttons for the Info sections work. Figure 19 shows the Password Info button and how it takes the user to that section of the game. To the left you see how the button shows when the backdrop changes to the main menu. On the right, this code is what happens when the button is clicked. It sets the variable 'PasswordInfo' to 0. This is the variable which is used during the Info section for the Password concept and is unique to this section. Setting it to 0 means that when it changes to the Password Info section, the information starts from the beginning. No other concept Info sections or Cases can influence this variable. It works just as explained before in the Information Implementation section of this report. The code which follows this makes the Sprite switch costumes and this is done to give it a look of a button being pressed. Additional information on these costumes can be found at Appendix 2. The final block in the code changes the backdrop to the area of the game which is for information about the concept Passwords and only that concept.

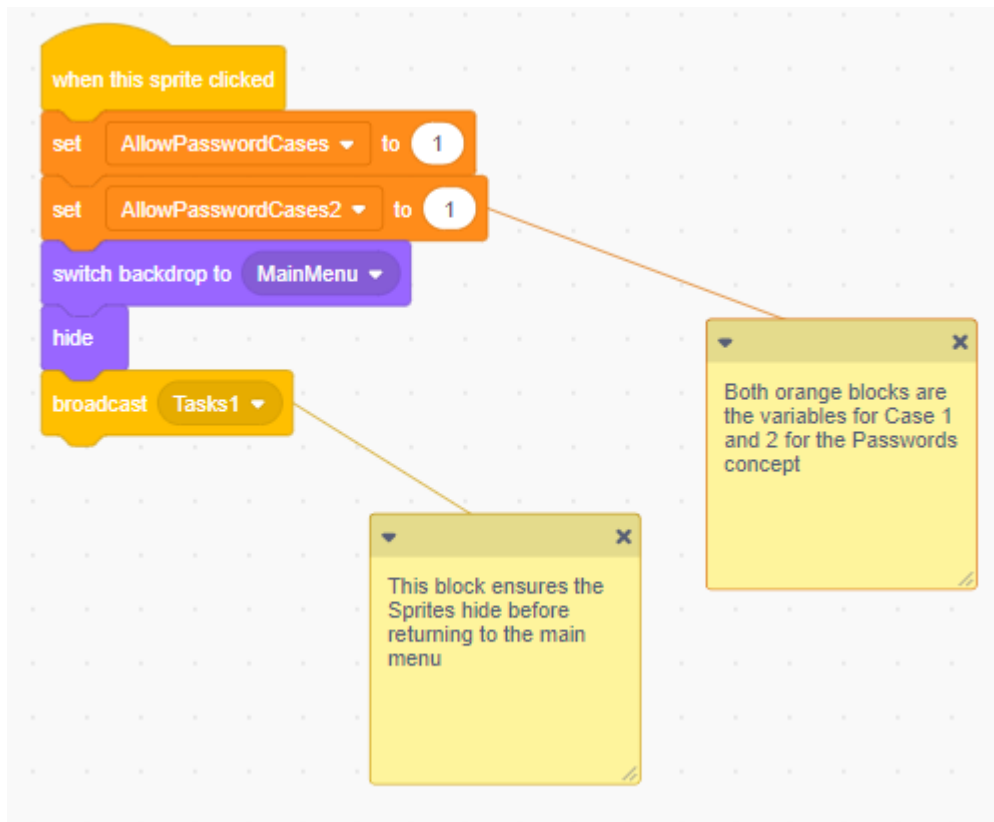


**FIGURE 17 - THIS IS THE CODE FOUND INSIDE THE PASSWORD INFO BUTTON THAT IS LOCATED AT THE MAIN MENU AND TAKES THE USER TO THE PASSWORD INFO SECTION**

### 5.2.2 Unlocking Cases

Each Case has a unique variable which, when the game starts, is set to 0. If a Cases variable is 0, its button appears grey and is unclickable as seen in the design section. As explained before, a user must first go through the concept information associated with each Case to be able to unlock its Cases. When a user finishes the information section, the button they press to return them to the desk

changes the variables from 0 to 1. With this variable now set to 1, the Cases buttons will have changed to red clickable buttons which makes them playable. Below in Figure 20, you can see the code for the button which brings the user back to the main menu from the password concept information section.



**FIGURE 18 - THIS IS CODE FROM INSIDE THE BUTTON AT THE END OF THE PASSWORD INFO SECTION THAT WHEN CLICKED, TAKES THE USER BACK TO THE MAIN MENU**

It is important to note here that the variables also increase to 2 but not at this point in the game. This is important to the end game criteria and will be explained later in the Implementation section.

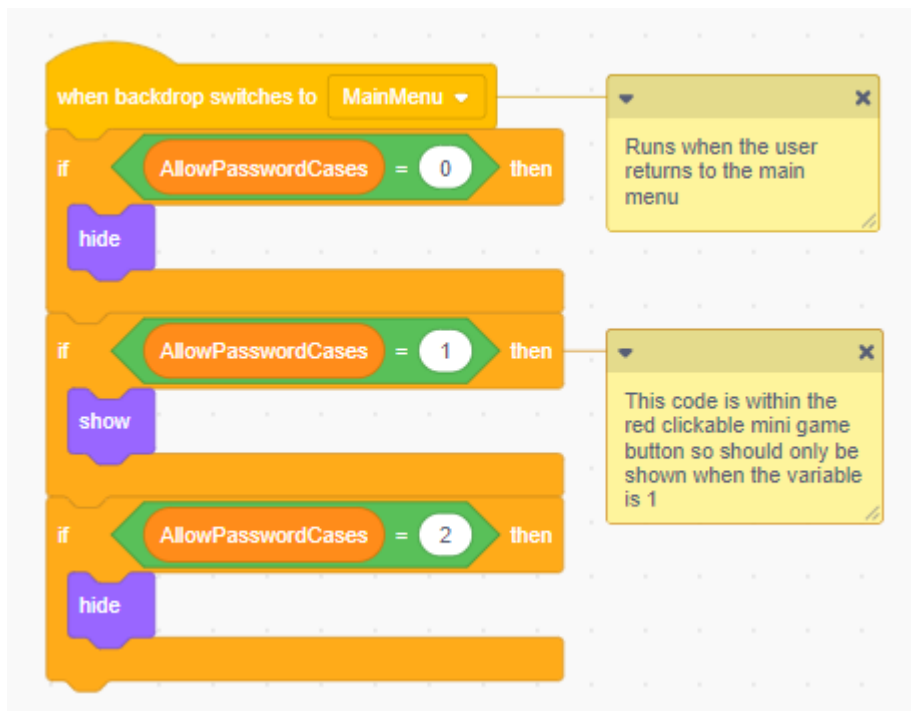
### 5.2.3 Case Buttons

The Case buttons work similar to Info buttons but have addition looks as seen in the design section. I will explain how they work as it is an important feature which affects game play.

It is very important the Case buttons have different looks and perform as intended. The greyed-out buttons are not clickable as they indicate the Case has not been unlocked and the user must go through the concept info associated with those Cases first in order to unlock them. A red button means the Case is playable and has not been completed yet. A red button with a green tick stamp on it is not clickable and means the Case has been completed. These buttons designs were shown during the Design section and can be seen in full there.

Within each button is a very important piece of code which decides which buttons are showing, in relation to the buttons mentioned before, as well as impacts the end game criteria. The code for the red clickable Password Case 1 button can be seen below in Figure 21. This code makes use of a variable which featured in Figure 20 on the page above. On that page in the Figure, you can see two variables,

each relating to either Case 1 and Case 2. As each Case is played separately, they both need separate variables to register when each is completed. The variable seen below in Figure 21 is unique to Password Case 1. In the code below, it executes every time the user is brought back to the main menu. The first time the student arrives at the main menu, the variable is 0 meaning that this red button is hidden as they haven't gone through the Password Info section yet. When they do, the variable is changed to 1 and this red button shows meaning they can play the Case. Later on it will be explained but when they complete the Case, the variable is set to 2 and this means the Case has been completed and the red clickable button should hide so it cannot be played again.



**FIGURE 19 - THIS CODE IS FROM INSIDE THE RED CLICKABLE PASSWORD CASE 1 BUTTON WHICH SHOWS HOW THIS BUTTON IS SHOWN IN RELATION TO THE VARIABLE**

#### 5.2.4 Issues and Solutions

An issue that was occurring was with the buttons being clickable even when showing as grey or completed. I quickly realised it was because the code to make the button clickable was always active. To solve this issue, I had to use three separate Sprites. One Sprite would be the grey button which would show up and have no code that activates when clicked, one Sprite for the red button which could be clicked and one Sprite to act as the button with a tick on which has no code that activates when clicked. Separating these made coding them to work with the variables a lot easier.

### 5.3 Case Mini Games

Each concept has Case mini game associated which are unique from the other concepts. With the variety of Cases, each has its own play style and so they need their own unique coding and error handling. Following here, I will go through each of the four concepts detailing their associated Cases

and how I implemented their functionality and gameplay, including any important code I used to ensure smooth gameplay without errors or glitches.

It should be noted, there is no specific order the player should go through with the information sections or playing the games. As long as they have to go through the concept information first to then be able to play the associated Cases, the game as a whole will run smoothly. The order the games will be discussed in is the same order they were discussed in the design stage and will appear top to bottom in the main menu within the game.

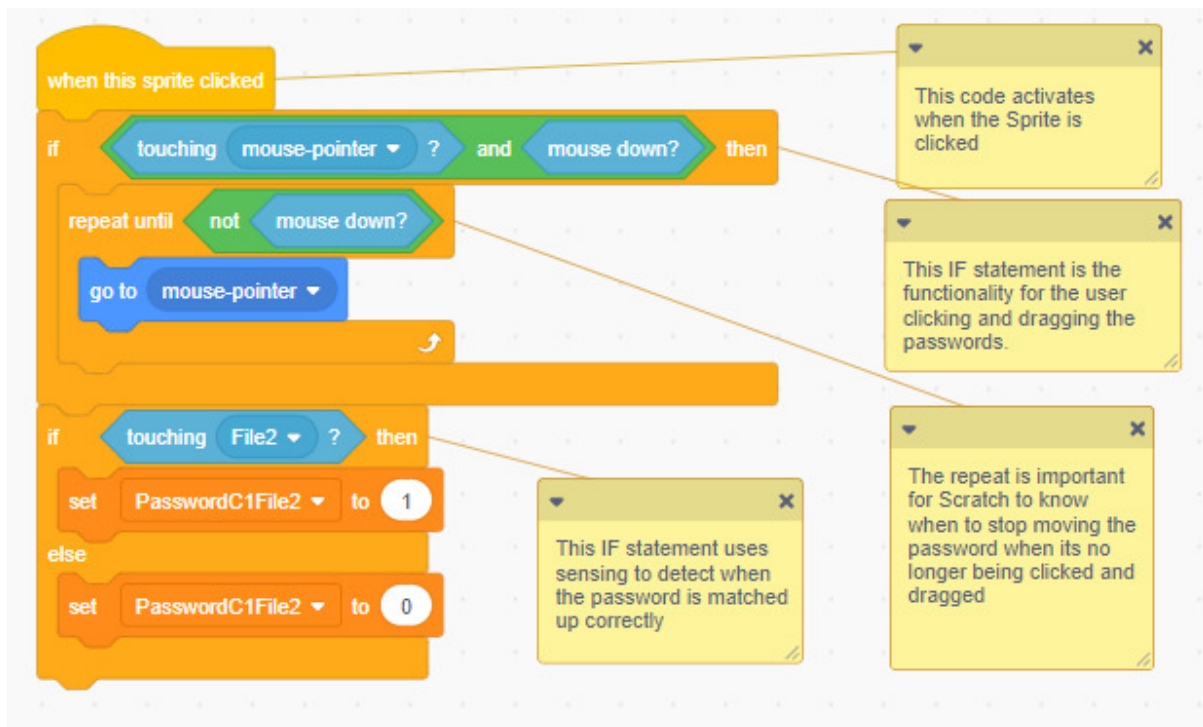
### 5.3.1 Passwords

Passwords was challenging to implement but very rewarding. The Cases focus heavily on problem solving with the need for trial and error when issues arise. From the design and after the final implementation, the player is required to open each criminals file and read the contents. The open case file should be in front of all other Sprites, meaning nothing is blocking its view. Once the user has read through file, they must then look at the passwords and try to draw similarities with the files to match up each password with the correct file. To match up passwords and files, the user clicks and drags a password and then places it on top of a file. The user then clicks the 'Check' button to see if their selection is correct. If it is wrong, the button flashes red and if it is correct, the button disappears and a green 'Return to Desk' button appears signally the users to click it and end the game taking them back to the main menu. A full view of how the game looks when first starting can be seen at Appendix 3.

The following will describe two aspects of the game, how the user is able to click and drag the passwords and also how the user checks if they are correct or not.

The first aspect is what allows the user to interact with the game and move the passwords around with their mouse and also how the game registers if the right password is on top of the right file. Below in Figure 22 you are able to see how each of these is done. The code itself works when the user presses on it and the first IF statement allows the user to move the passwords around. It does this by using a repeat block to allow the user to continue moving the passwords for an extended period of time. The code checks to see if the users mouse is touching the password and also if the user is holding down the left button on the mouse. If so, the user can move the password until they are no longer holding down the mouse left button. At this point the password is released and stays where it was dropped.





**FIGURE 20 - THE CODE IS FROM WITHIN THE FIRST PASSWORD IN CASE 1, HIGHLIGHTING HOW IT ALLOWS THE USER TO CLICK AND DRAG IT**

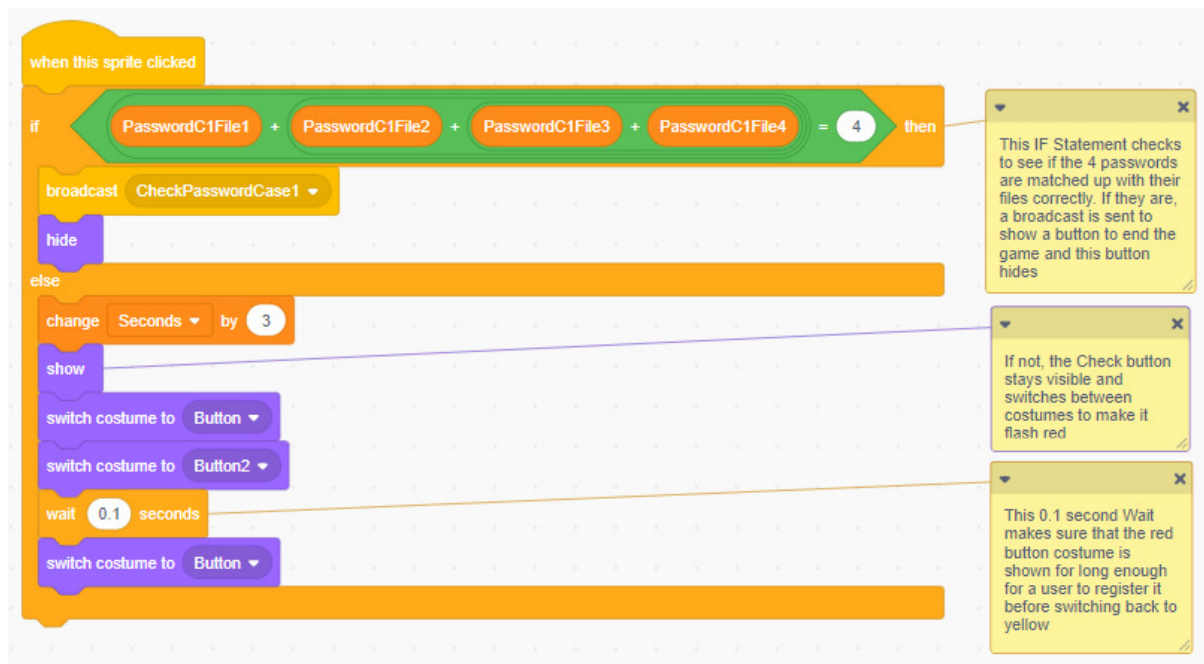
The second IF statement in this code is what registers the matching. It is important to note, this just registers if the Password is touching its matching file, how the game ends is mentioned in the next part of this section. For each password within the game, it has its own unique variable. The password this code belongs to is the very first password, which is at the top of the list of four you can see at Appendix 3. It uses an IF statement to see if it is touching its matching file which is file2. The files are numbered 1 to 4 and arranged on screen as you would read, top left to bottom right. If the Password is touching its matching file, it sets its variable to 1, otherwise the variable is set to 0.

The second aspect is how the user checks to see if their selection is correct and how they complete the Case. Each password has code, which when placed on top and touching a file it matches with, it sets its variable to 1 as seen above. Below in Figure 23 you can see the four orange variables within the IF statement and each variable matches with code inside a password as seen above in Figure 22. The names are not important to the user, they are just set by me to remember which file the password which the code is inside, matches with. To explain, the variable 'PasswordC1F2' in the code above means its in the password concept mini games, Case 1, and this password matches with File 2 so if I need to check its working I know where to go.

The Check button when clicked, runs the code and looks to see if the sum of these variables is equal to 4 as seen below. If it is, it sends the broadcast below it called 'CheckPasswordCase1' and hides so its no longer visible on screen. The broadcast is picked up by the button to finish the case and this button shows to allow the user to click it and return to the main menu. If the variables are not equal



to 4, the else runs which switches its costume to a red version of itself and then back again which gives it the look of flashing red. These costumes can be seen in the Appendix 4.



**FIGURE 21 - THE CODE IS FROM INSIDE THE CHECK BUTTON WHICH SHOWS HOW IT CHECKS TO SEE IF THE PASSWORDS ALL MATCH THE CORRECT FILE**

### 5.3.2 Email Safety

During the design stage, I was able to develop a backdrop which I have implemented into the game. The backdrop sets the scene and loosely resembles an email platform and in relation to this, I have tried implementing code to mirror similar functionality with viewing emails during the implementation and this will be discussed shortly. There are two crucial elements in play during these Cases: broadcasts and a single variable.

The mini game is mouse and click only, there is no other interaction needed or possible. An image of how the screen looks when you start Case 1 can be seen at Appendix 5. To open up each email, the user clicks the email thumbnails in the column to the left of the screen. When clicked, these emails send a broadcast which triggers the associated Sprites, which are the email content page and interactive buttons, to show. They also change to a second costume which is a lighter shade of blue, showing the thumbnail is currently selected. This code can be seen below in Figure 24.

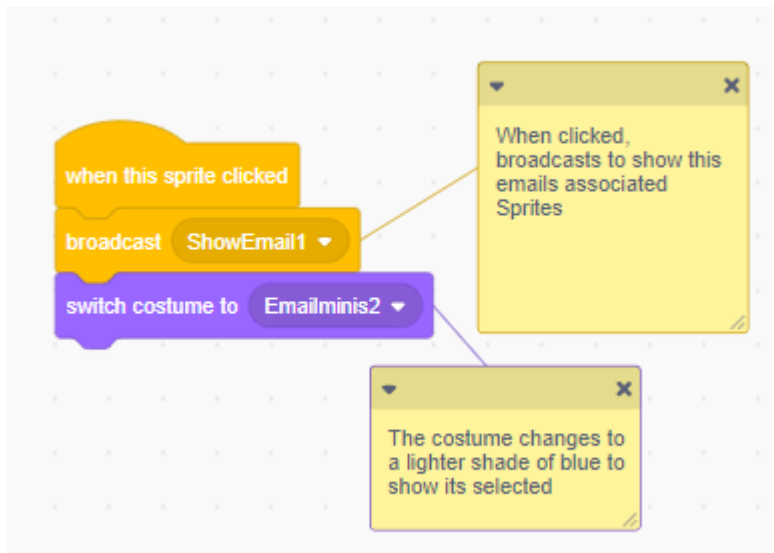


FIGURE 22 – THE CODE BELONGS TO THE FIRST EMAIL THUMBNAIL IN CASE 1

Each email thumbnail has a unique broadcast message so only the Sprites associated with that email will show up. It is here that I have tried to mirror the interaction of opening an email and viewing its contents, so students can relate to the real world usage of these programs. In real world email applications, you are able to click through and view emails in any order and this is what I have been able to achieve. Below in Figure 25. Is code for the first email in the list. This code is for the email contents Sprite so there is no interactivity, it just needs to show and be viewable when its matching thumbnail is selected. The Sprite shows when the first email is clicked and hides or stays hidden when any of the other three are clicked. Each of the other email content Sprites have a different combination of show and hide, relating to broadcasts they receive from their associated email thumbnails. This code allows the users to click on different thumbnails, showing its associated contents and making sure the others stay hidden.

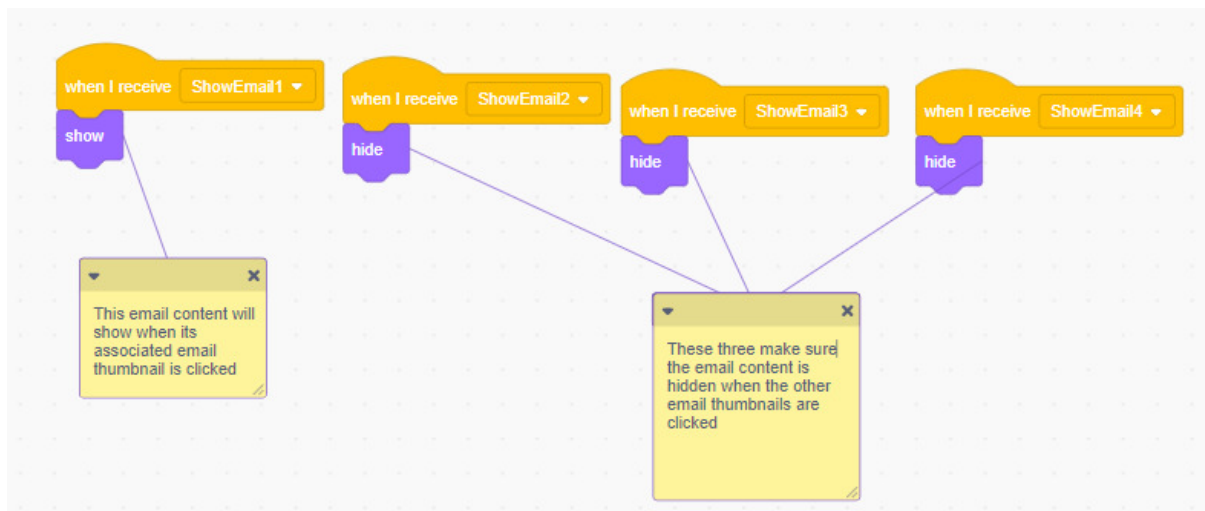
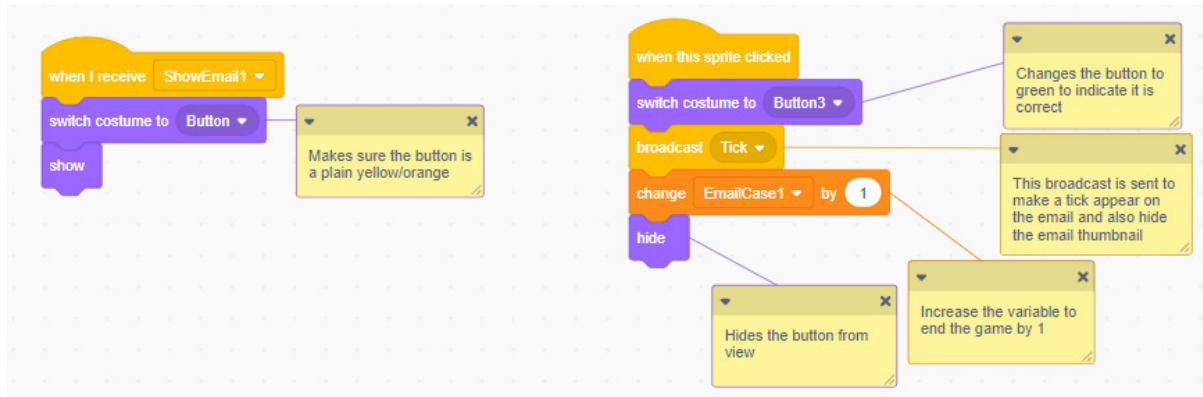


FIGURE 23 - THIS CODE IS USED TO TELL THE FIRST EMAIL CONTENT SPRITE WHEN TO SHOW AND WHEN TO HIDE IN RELATION TO BROADCASTS RECEIVED AS SEEN IN THE FIGURE BEFORE

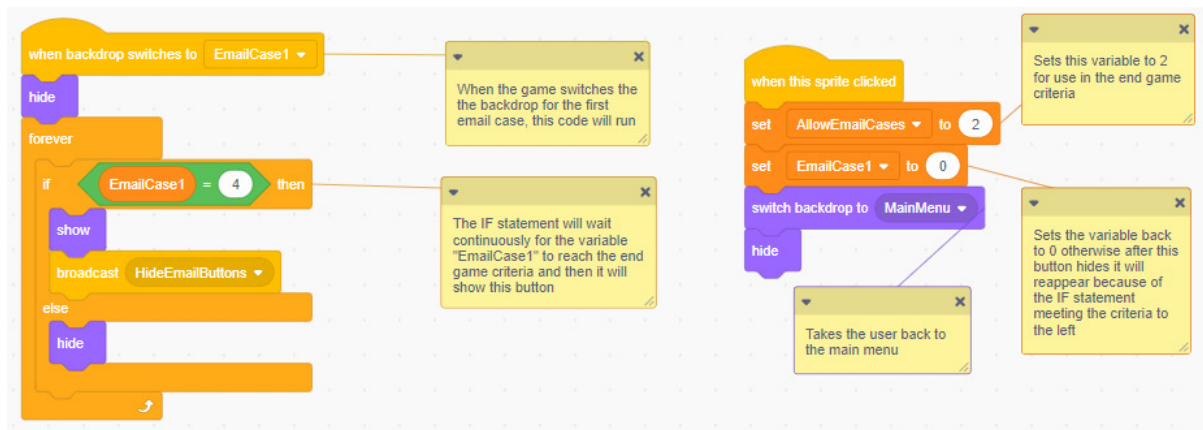
When an email thumbnail is clicked and the email content is shown and so are two buttons as stated before. The buttons have very similar code to what is seen above but these buttons are interactable. The choices of buttons are either 'Safe' or 'Unsafe', to give the user a clear choice. Below is Figure 26 which shows the code inside the correct button for the first email and how the correct button influences the game completion criteria.



**FIGURE 24 - THIS CODE IS INSIDE THE BUTTON WHICH IS THE CORRECT OPTION FOR THE FIRST EMAIL IN CASE 1**

When the button first appears, as seen in the code to the left, it appears as a neutral colour. When the correct button is clicked, which is the code to the right, the button switches costumes to a green which indicates it is correct. To further inform the user they are correct, a broadcast 'Tick' is sent which shows a large tick over the email and also removes the other button and the associated email thumbnail. The email thumbnail is removed as the email has been completed and the user should not be able to reopen it.

The important part here is the variable. This variable starts the Case at 0 and with every correct option, it increases by 1. There are four correct options, meaning after the last correct option has been selected, the game should offer the student a button to end the Case. This code to end the game can be seen below in Figure 27. The code below is inside a button to end the Case and return the user to the main menu. The code to the left starts when the Case begins and forever waits for the completion criteria to be met. While it's not met, the button stays hidden, but once it is met the button will show and send a broadcast to hide all the buttons and Sprites associated with the Case. This broadcast 'HideEmailButtons' is received by all Sprites in the Case as the user can complete the emails in any order, so there is no way to tell which ones will still be shown at the end. It is a way to be sure that everything gets hidden before returning to the main menu.



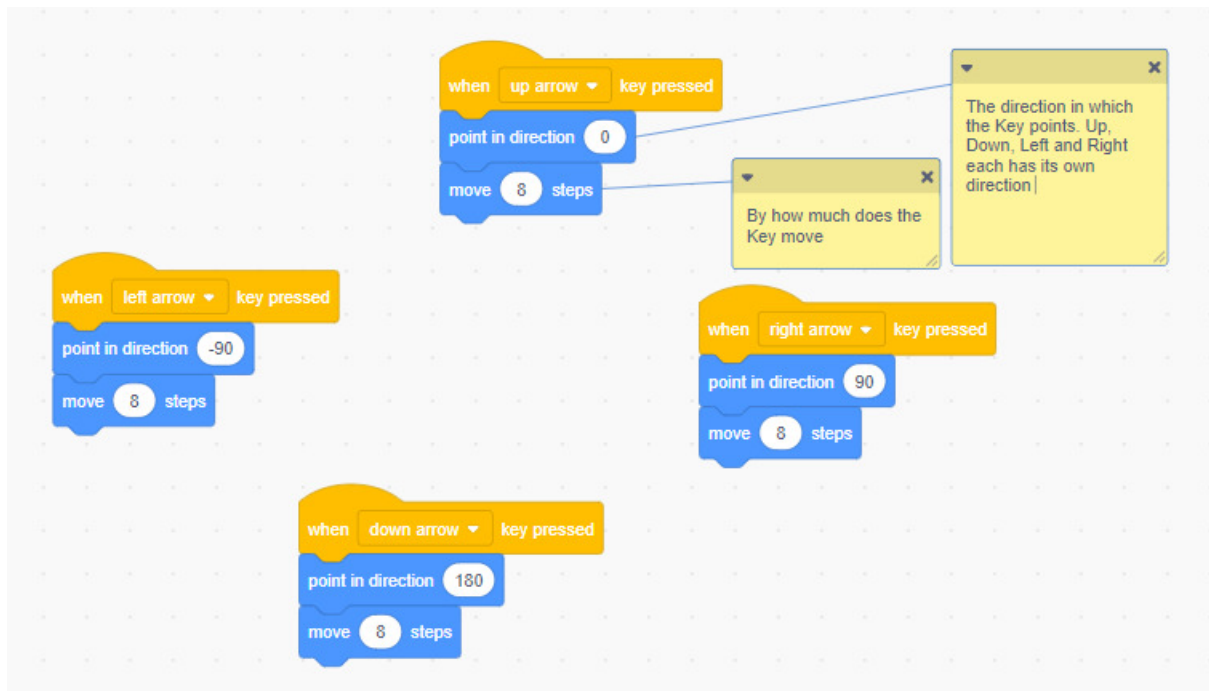
**FIGURE 25 - THE CODE IS INSIDE THE END CASE 1 BUTTON AND IS USED TO DETECT WHEN THE CRITERIA TO END THE CASE HAS BEEN MET**

The code to the right activates when the user clicks the button. It sets the variable 'AllowEmailCases', which is unique to this game, to 2 which will be used in the end game criteria and explained later. The variable code that follows is important as without setting the variable to something other than 4, the forever loop to the left will continue working. If allowed to continue it can show the button while back at the main menu which is an issue.

### 5.3.3 Symmetric Cryptography

The Cases for this concept are the most complex of the four concepts in terms of backdrop changes and code. To move from each of the stages within the concept, a backdrop change is needed to ensure each stage is unique.

With different stages of symmetric cryptography, I tried to make the game as interactive as possible while keeping the complexity of the concept low. After encrypting and sending the Key, the user is sent to a new backdrop with new content. This backdrop is a maze which uses the arrow keys on the keyboard to move the Key Sprite around, with the goal of getting it to the other side of the maze to the computer. There are four mazes which can be seen at Appendix 6. In Figure 28 below, you can see the code used to program the movability into the Key. Any key on the keyboard can be programmed to move the Key in certain ways but I chose to go with the arrow keys as this is the most common method. When a Sprite moves, it moves forward in the direction it is pointing. Each arrow key has code which points it in the correct direction, for example, the up arrow key points the key facing up and the right arrow key makes it point right. The move code is what moves the Key. It is important that the 'move' is not too big, otherwise a click of the arrow key can send the Key too far in that direction and impede the usability. It is important that the direction points correctly as this gives the Key the orientation for the direction it is intended to move in. The order the direction and move code blocks are in is important, as the Sprite should change direction first and face the correct direction before moving so it moves in the intended direction.



**FIGURE 26 -THIS CODE IS HOW USERS INPUT MOVES THE KEYS THROUGH THE MAZES**

The code below in Figure 28 shows the functionality for the key within the third maze game. The Key makes use of sensing, to detect if it comes into contact with either the maze walls or the viruses which are Sprites. It is important that this code works continuously throughout the maze section so to do this it is within a forever loop. Each object within the maze is an individual Sprite and so must have its own IF statement to sense a collision. Each collision adds 5 seconds to the timer. Once the Key touches the computer at the end, a broadcast is sent and picked up by all objects within the maze, causing them to hide. This bit of the code also changes the current maze backdrop to the decryption backdrop which is the next section to decrypt the initial ciphertext that was sent.

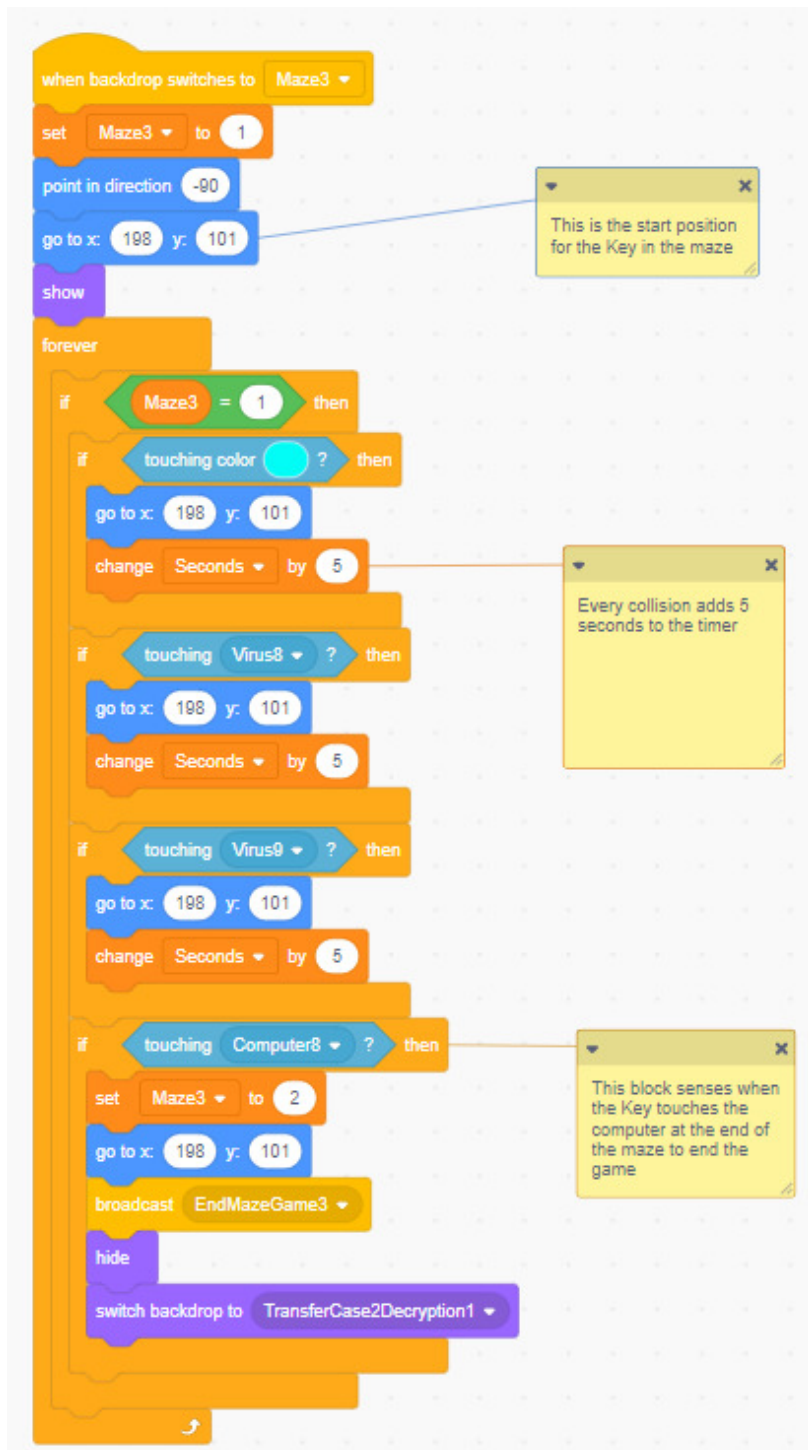
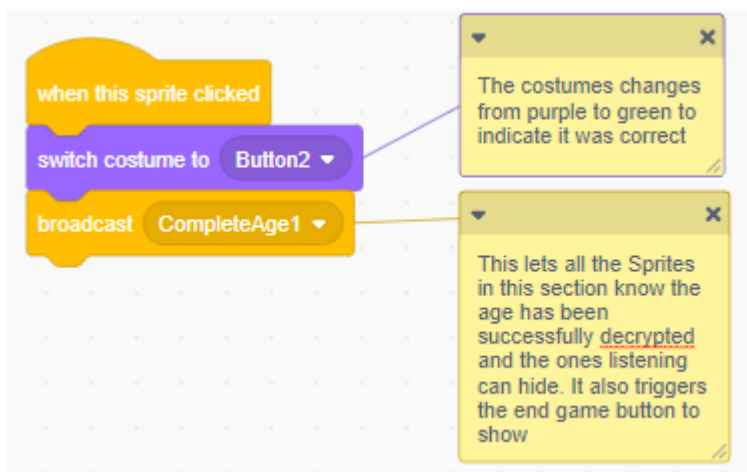


FIGURE 27 - THIS CODE IS WITHIN THE KEYS DURING THE MAZE SECTIONS

At the final stage, there is decryption involved where the user must select the correct option for the Key used. This decryption stage has two endings. If it is the first time the user has come to this stage within a Case and they have decrypted no messages yet, they will be guided back to the start of the Case. The button takes them back to the start screen to do the same sequence of things all over again but with a different message.

For the final run through, the Case end criteria is very simple. When decrypting the ciphertext, the user must select the correct option for the Key. A screenshot of this ending section for the first message in Case 1 can be seen at Appendix 7. If they press the wrong option, the button will flash red and nothing else will happen. Once the user clicks the correct option, the text on the page is shown and a button to take the user back to the main menu appears. When this button is clicked, it changes the background to the main menu and hides all the Sprites which were apart of the Case. Below in Figure 29 is the code which activates when the correct decryption Key option is clicked. The broadcast is picked up by the end game button which causes it to show and allows the user to click it and return to the main menu.



**FIGURE 28 - CODE WITHIN THE BUTTON TO END THE SYMMETRIC CRYPTOGRAPHY CASE 1**

### 5.3.4 Crime Scene

In these Cases, as described in the design section, the user must go between rooms in a building and interact with items. They must go through each room, selecting the items that are of importance to take from a crime scene and ignore the rest. Items that are not correct do nothing, they are not interactable in any way. When a correct item is clicked, information about why that item is important is displayed for the user to read and then they can close that window and continue their search. There is a main building view, where the user can see each room of the building at once and click any to enter that room. A building view of Case 1 can be seen at Appendix 8. When all items are found, the user is presented with a button to take them back to the main menu.

There are two main parts which will be explained: how the building view works and the room images change, and how the items are collected and the game is completed.

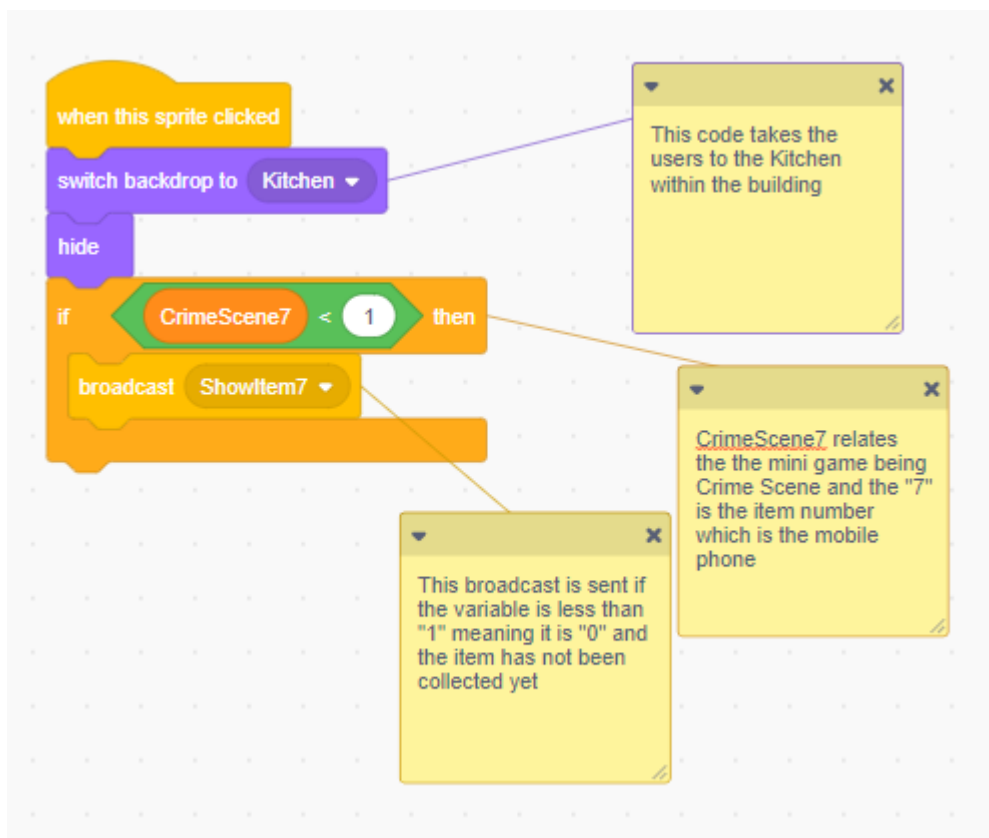
The building view works by setting a screenshot of the individual rooms themselves as Sprites. This means they can be interacted with and coded individually to tailor the experience how I envisioned it. A view of the lounge costume showing its item in the room for Case 1 can be seen at Appendix 9 . These Sprites are also the main deciders to whether an item gets shown in a room. How these room Sprites work in influencing the game will be explained next.



As seen in Appendix 8, each room within the house is a Sprite, which I coded to work independently as each room is different. The code for the kitchen Sprite in the house view can be seen below in Figure 30 . When the kitchen is clicked, it changes the backdrop from the house view to the kitchen and then hides. After this, it runs an IF statement which checks to see if the item within its corresponding room has been collected.

Within the kitchen is item 7, which is a mobile phone. When the Case starts, this item and all the others throughout the house have their variables set to 0. If their variable is 0, it means the item has not been collected yet and when the Case starts, this is the case. When an item is collected, it sets its variable to 1 which I will explain shortly.

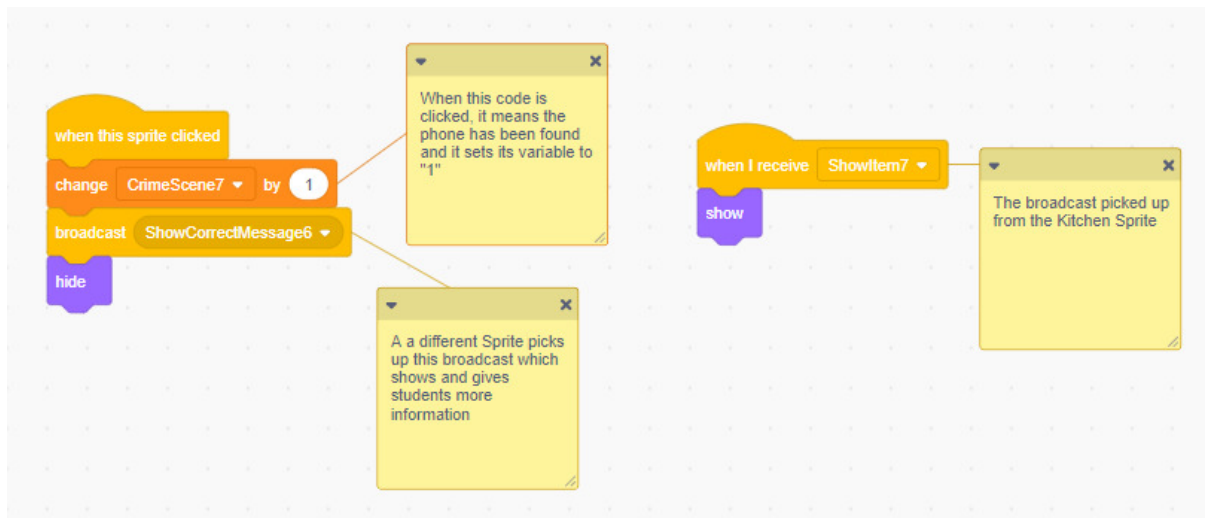
The IF statement that runs is to see if the items within it have not been collected and if they have not, it will need to show them when going to the room. If item 7 has its variable equal to 0, the IF statement will send a broadcast which the item itself has code to pick up. If item 7 has its variable equal to 1, nothing happens.



**FIGURE 29 - CODE WITHIN A ROOM SPRITE WHICH TAKES THE USER TO THAT ROOMS BACKDROP**

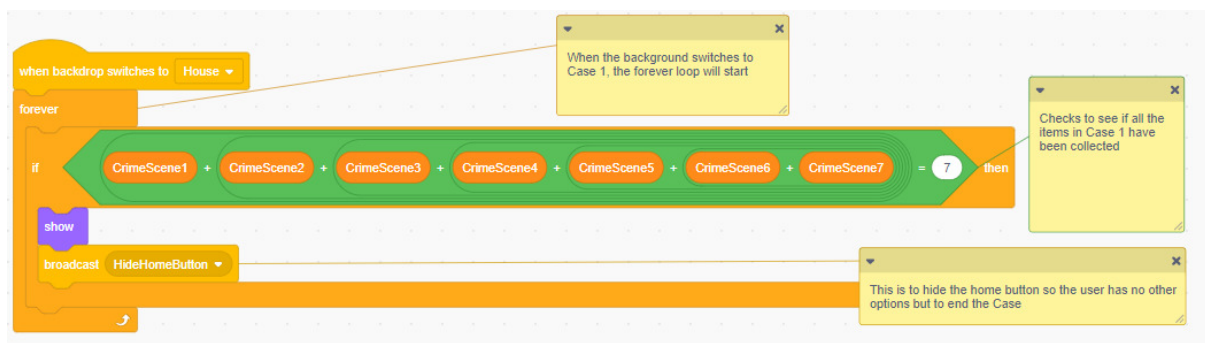
As explained above with the broadcast, 'ShowItem7' is only sent if Item 7 has not been collected yet. In Figure 31 below, it shows the code within this item. To the right is the code which picks up the broadcast and shows the item for when the kitchen is entered by the user. To the left, this code runs when the item is clicked which means it has been collected. It first changes its variable by 1 to equal 1 and ends a broadcast to show the information about Item 7 and why it is an important item.





**FIGURE 30 - CODE WITHIN A MOBILE PHONE FOUND IN THE KITCHEN IN CRIME SCENE CASE 1**

The Case completion criteria is that all collectable items must be collected. When they have been, all the variables for each individual item will equal 1. As seen in the Figure 32 below, for Case 1 the IF statement checks to see if the sum of these variables is equal to 7, which is the total number of items to be found. If it is, the user is presented with a button to end the Case and return to their desk.



**FIGURE 31 – CODE WHICH IS USED TO DETECT WHEN CRIME SCENE CASE 1 MEETS THE CRITERIA TO END**

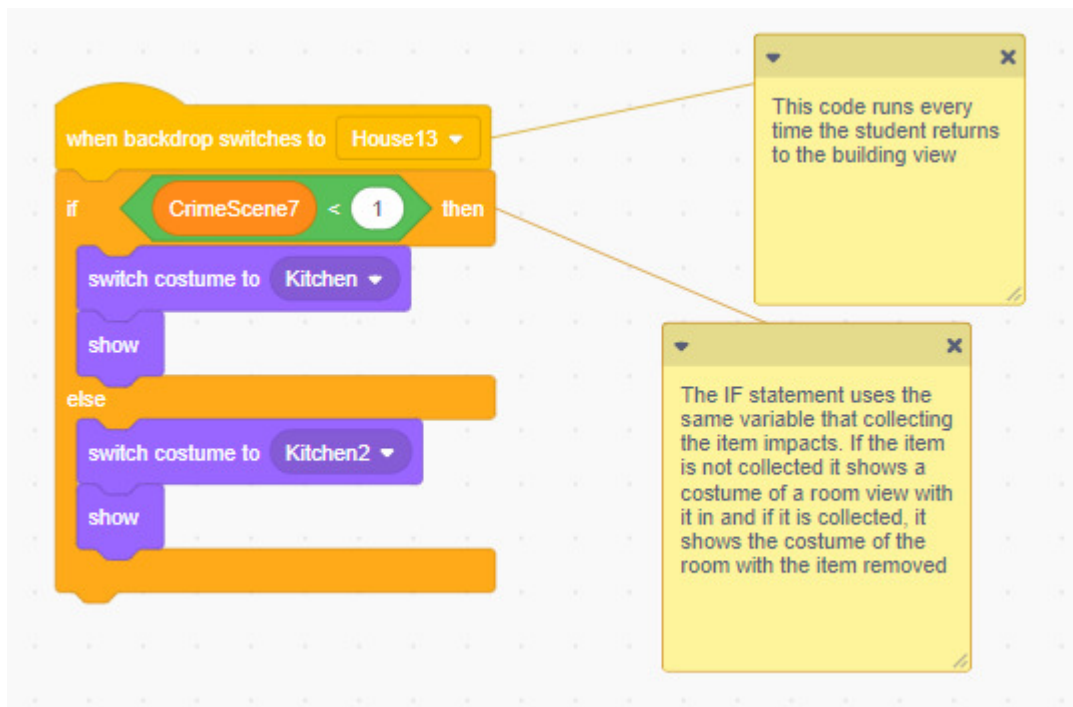
With giving the items their own variables, it means that once an item has been collect it will not show again. This gives the game a feature which allows users to go to rooms they have already visited, even if they have collected the item, and the item will not show up again.

#### 5.3.4.1 Issues and Solutions

An issue I was having was the view of the house and its individual rooms and the items which had been collected. As stated above, the rooms on the house view are individual Sprites. These Sprites have a screenshot of each room as its costume and so act independently of what would happen within those rooms. Initially when playing, the house view shows the rooms and also shows the items which

need to be removed by the user. The issues came when returning back to house view and the rooms with the items that have been removed still showed them in the room in house view. The game had correctly hidden them from the rooms but the house view Sprites were a screenshot and not impacted by the game, so the items being removed had no impact on these.

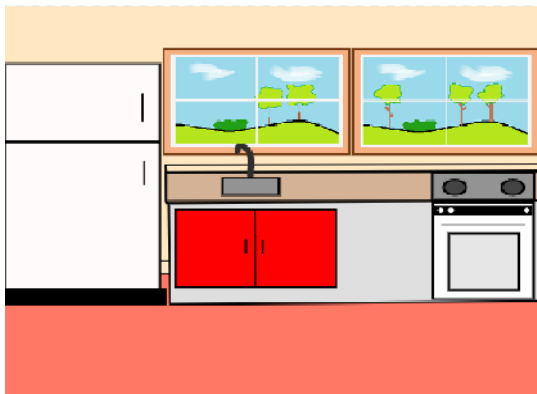
To overcome this issue, I had to screenshot images of the rooms without the items in and set them as a second costume for each of the room Sprites. I implemented code to individually change each room's view in the house view to resemble whether the items were still in the room or not. The code I implemented was complex to work into what was already there but it does work after being implemented and tested. This code can be seen in the Kitchen Sprite in Figure 33 below. To explain the IF statement comment. Just like before with the collected item changing the variable it relates to, to 1 if collected. This Kitchen Sprite checks that variable every time the user returns the building view and shows the costume, either the room with the item or without, based on that variable.



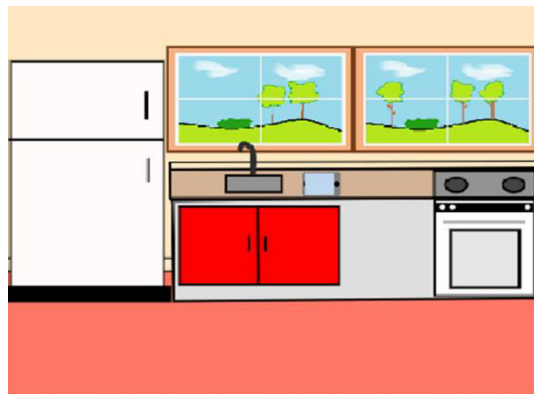
**FIGURE 32 - THIS CODE DECIDES THE LOOK OF THE ROOMS IN HOUSE VIEW IN RELATION TO ITEMS THAT HAVE OR HAVE NOT BEEN COLLECTED**

The costumes 'Kitchen' and 'Kitchen2' can be seen below in Figure 34 to better understand the difference. It would be confusing for students to have collected an item but continue to see it while in building view.

**Costume 'Kitchen':**



**Costume 'Kitchen2':**



**FIGURE 33 - THESE TWO IMAGES SHOW THE TWO COSTUMES THE KITCHEN ROOM SPRITE HAS**

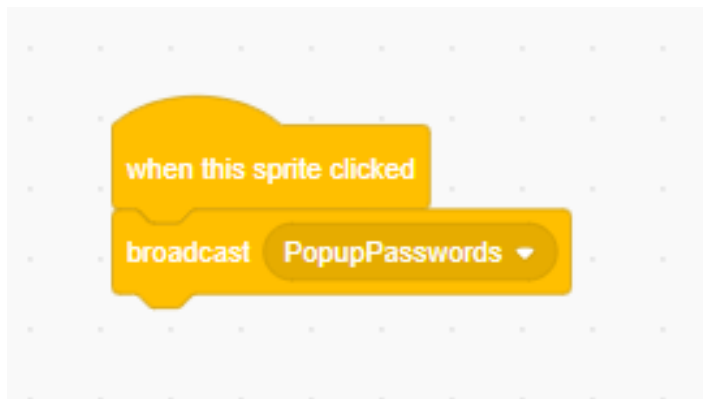
Within Case 2, I have not been able to implement this accurately. The code changes the rooms to show no items when all times in the room have been removed. For Case 2, there are more items in each room and so more complex to implement this feature. This is because there are many combinations to cover in terms of showing some items being removed and not others. If a user only found half the items in a room and then goes to house view, I would have to have code and different costumes which would cover this and which items were left. It is something I will be looking to implement more accurately in the future.

## 5.4 Help and Hints

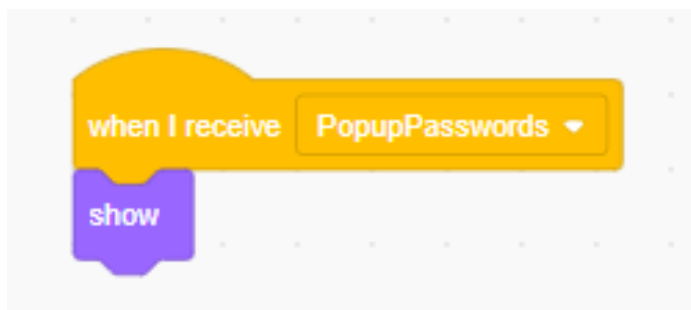
Each part of the game has a help and hints button in the bottom left corner. The button is the face for the police officer giving the information so it is easily recognisable and adds some consistency to the characters and theme. The button stays in the bottom left corner and never changes position for familiarity. The user must click the head for a number of pop up Sprites to appear to offer both information about how to play the associated section and also hints to help them if they are stuck. The pop up Sprites cover a large area of the screen and can be closed with a button in the bottom right of it. The only part of the game that doesn't have any hints is the main menu as there is nothing that is challenging the user in this section but they can still look at the instructions.

For each Case, the help and hints is different which meant I had to create two individual Sprites for the pop up screens and a close button for each individual game. Within the game, there are six of these heads and for each head, there is 1 information and 1 hints pop up as well as 1 button to close the pop ups. There is six as the crime scene Cases have a different hint due to different numbers of items to be found.

These screens and the button make use of the layers within Scratch. It is very important that they are at the front of these layers so they are not hidden by any of Sprites. It is equally important that the close button is at the very front, otherwise it is hidden and the user will never be able to close the screens. At Appendix 10, you can see the screens in action for the passwords Case 1. When the user clicks the police officers head, it sends a broadcast which is picked up by the help and hints Sprites for that section of the game. For the police officers head that appears in the password Cases, its code can be seen below in Figure 35 and below that in Figure 36 is the code in the pop ups which picks up that broadcast.

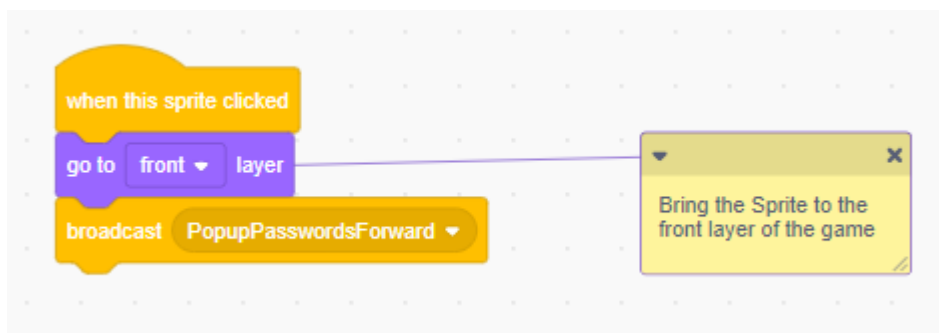


**FIGURE 34 - THIS CODE SHOWS WHAT HAPPENS WHEN THE POLICE OFFICERS HEAD IS CLICKED FOR HELP AND HINTS**



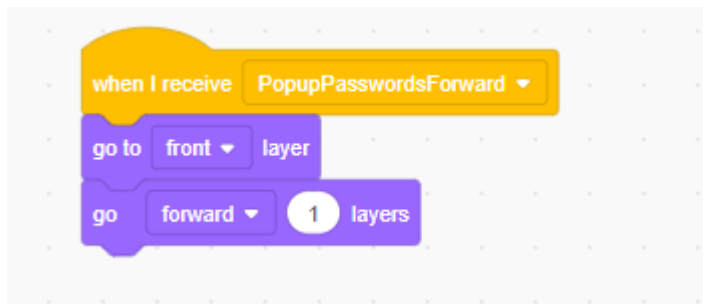
**FIGURE 35 - THE CODE SHOWS THE RECEIVING OF THE BROADCAST AND THE HELP AND HINTS SHOWING**

From reference at Appendix 10, you can see how the help and hints Sprites look. The user can click the top of each to bring the selected one forward to view. Below in Figure 36, you are able to see the code which activates every time someone selects the information sheet of the shown help and hints Sprites. This code is the exact same for the hints Sprite. The code works by sending the selected page to the front, in this case the information page, and moving it in front of the Hints to where it is viewable. Once this is done, it sends a broadcast which is picked up by the Close button. This buttons code can be seen below that in Figure 37 .



**FIGURE 36 - THE CODE SHOWS HOW THE INFORMATION SHEET MOVES TO THE FRONT OF THE SCREEN TO BE SEEN WHEN CLICKED**

The code below moves the close button to the front and then to ensure it is at the front, it moves it forward one more layer for safety. This is a precaution as without the close button, as stated before, the user will be unable to close the Help and Hints pop up and cannot continue to play.

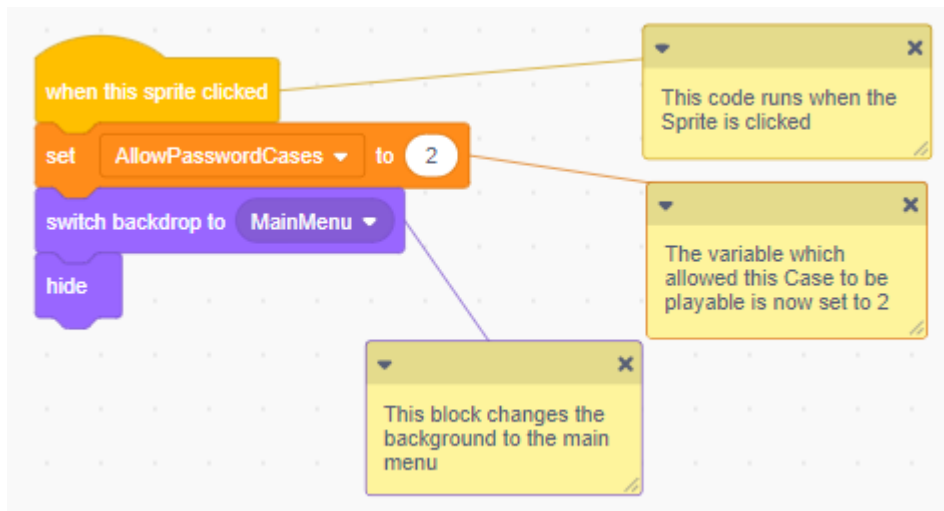


**FIGURE 37 - THIS CODE IS WITHIN THE CLOSE BUTTON AND SHOWS HOW IT STAYS AT THE FRONT OF THE HELP AND HINTS SPRITES**

## 5.5 End Game

In any game, there must be an end. For this game, the end is clear and you are taken to a separate section with a new backdrop. To end the game, certain criteria has to be met, which in this case is all Cases need to have been successfully completed. In order for the game to register when this is true, a number of variables was required. As stated earlier in the Implementation, the variables used to unlock the Cases will play a role in ending the game.

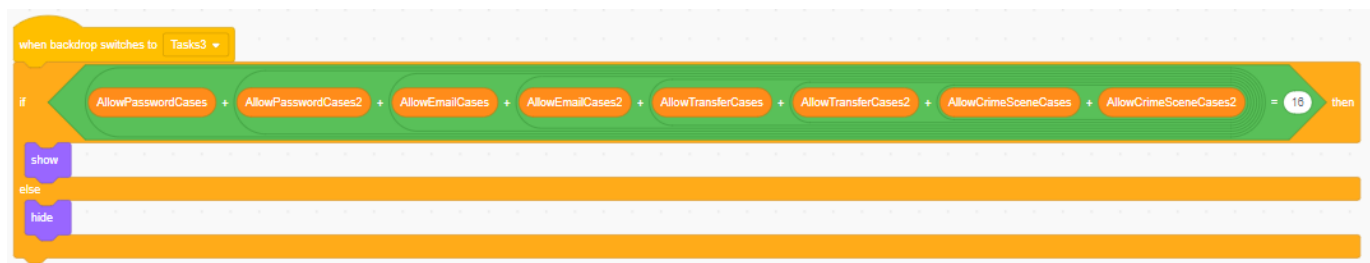
These variables run throughout the game and the numbers associated with each variable have different meanings. The variables to allow a Case to be playable are also used to tell the game when they have been completed. As stated earlier, to allow a game to be playable, the Info sections once completed set the variable to 1 which results in the Case buttons being clickable. To impact these variables for the end game, when a Case is successfully completed, a button appears to take the user back to the main menu. It is when clicking this button that the number the variable is set to is changed from 1 to 2. Below in Figure 38, is code which belongs to the 'Return to Desk' button from password Case 1 which shows when the Case is completed.



**FIGURE 38 - THIS CODE IS WITHIN PASSWORD CASE 1 GAME ENDING BUTTON AND SHOWS HOW IT INCREASE THE VARIABLE IN RELATION TO THE END GAME CRITERIA**

The 2 is important as it also tells the game to change the button to access the Cases from a clickable red button, to a non clickable button with a tick over. The different button looks can be seen at the Figure 5.

In Figure 39 below, the end game criteria can be seen in the button Sprite which the users uses to go to the end game screen. The button is green and is labelled 'Log out' which keeps on theme and will catch the eye of students to click it. An image of this button can be seen at Appendix 11.



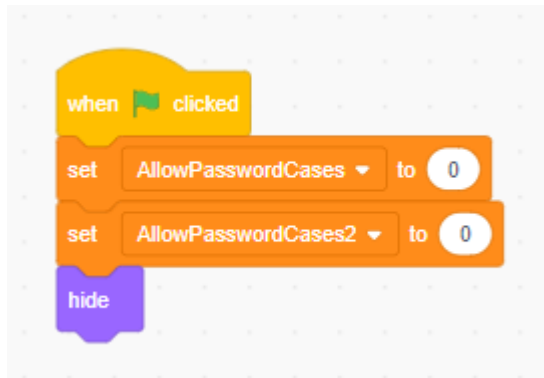
**FIGURE 39 - THIS CODE IS USED TO CHECK WHEN THE END GAME CRITERIA HAS BEEN MET BY CALCULATING THE VARIABLE TOTALS**

In the above screenshot, the code activates every time the backdrop changes and the user arrives at the main menu. This is important as the Cases can be played in any order and the players must return to the main menu after each, which will cause this code to run each time. It is a simple IF statement to check if each game has been completed. As stated earlier, when completing a Case, the Cases variable is set to 2 and so the total for all the completed Cases is 16. This IF statement checks every time to see if the user has completed each Case, if they have it shows the button to log out and if not, the button stays hidden.

It was very important to ensure the game doesn't end prematurely so in this way, there is no issue with ending the game too earlier. The code is very strict and there is no way around logging out unless you have completed each Case.

### 5.5.1 Ensuring all variables are reset

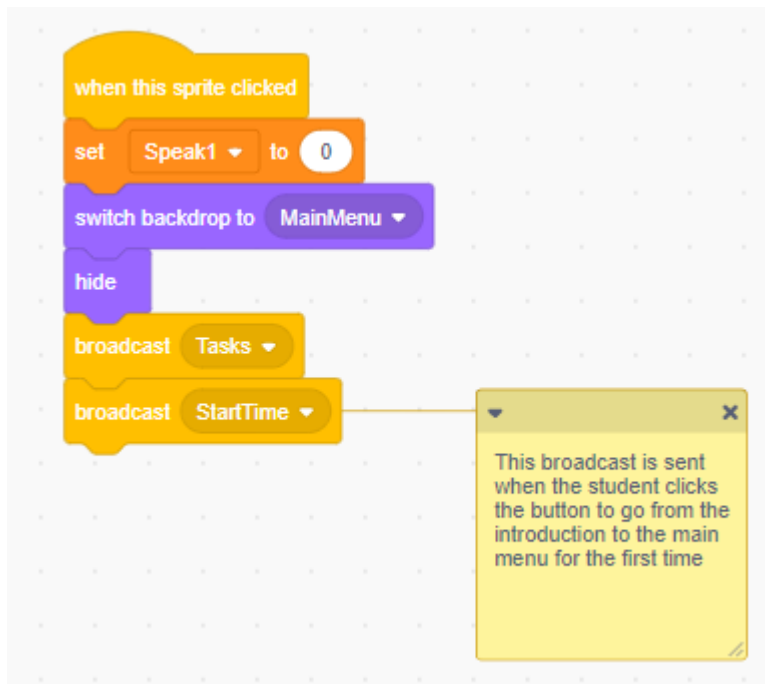
Variables are a key component which ensure the smooth running of the game. It is therefore essential that each variable which changes as the game progresses, is reset to its starting value when the game is started. To ensure this, code is used so that when the green flag to start the game is clicked, all of the variables are reset. An example of this can be seen below in Figure 40. This code is for the Password concept Cases and the hide ensures the variables don't show during the game.



**FIGURE 40 - THIS CODE IS AN EXAMPLE OF HOW THE VARIABLES ARE RESET EACH TIME THE GAME IS PLAYED**

### 5.6 Timer

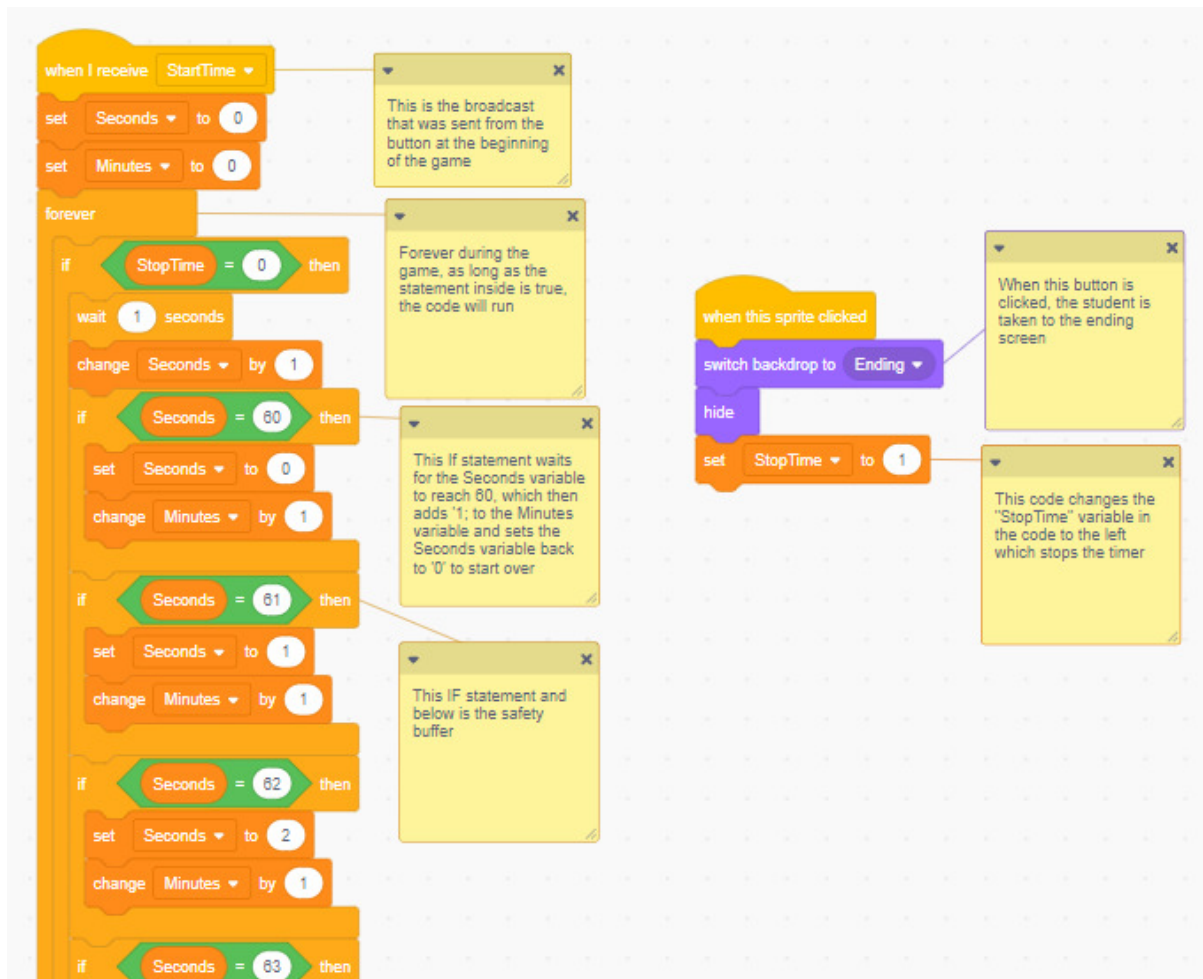
As discussed in the design stage, the game needed some excitement and motivation for students which comes with a reward and praise. For this, I have implemented a timer which runs once the user reaches the main menu for the first time. Below in Figure 41 is code which activates when the user clicks the first button to take them to the desk after going through all the introduction information. Once the user clicks the button, the main things that happen is the backdrop changes to the main menu and a broadcast is sent which is picked up by the log out button, the same button which ends the game. The reason this is sent and only picked up by that specific button is because all the timer code is within the log out button.



**FIGURE 41 - THE CODE SHOWS HOW THE BROADCAST 'STARTTIME' IS SENT TO START THE TIMER**

Once the broadcast is picked up, the timer starts. Figure 42 below shows the top half of the code which starts the timer on the left and stops it on the right. I needed to implement another variable which would act as a stopping mechanism for the timer. The timer itself uses two variables, 'Seconds' and 'Minutes', to simulate a metric clock. All the code which interacts with the timer is within a forever loop as this code will need to work continuously during the game. The first IF statement within this forever loop increases the variable 'Seconds' by 1 every second and this happens as long as the variable 'StopTime' stays equal to '0'. Below this initial IF statement is code which increases the minutes which will be explained below the Figure 42. Other code which acts as a safety buffer which will be explained in the Issues and Solutions at the end of this section.





**FIGURE 42 - THIS CODE IS WITHIN THE END GAME BUTTON AND IS WHAT RUNS THE TIMER**

The code on the left starts once it receives the broadcast and continues forever until stopped. The second IF statement within the forever loop, checks continuously to see if the 'Seconds' variable is equal to '60'. As soon as this is the case, it sets the variable 'Seconds' back to 0 to start over and increases the variable 'Minutes' by 1. This is how it simulates the metric clock and the final Minutes and Seconds values will be shown to the user at the end of the game. The rest of the code will be explained in the issues and solutions section next.

This forever loop is a repeated IF statement that for as long as the variable 'StopTime' is equal to 0, the code will wait 1 second, increase the variable 'Seconds' by 1 and then repeat again by checking that 'StopTime' is equal to 0. Once the log out button is clicked meaning the user has completed all the Cases, 'StopTime' is set to equal 1 which results in the forever loop stopping.

A positive with this is that the timer is stopped and not reset. With this, I have implemented code to show the timer when the student receives their badge at the end so they can visually see their time. The code below in Figure 43 shows how the timer is reset every time the game is restarted. Every time the green flag is clicked to start the game, the variables 'Time' and 'StopTime' are reset to 0.

## 5.6 Time Penalties

One important aspect of the game, as explained in the Design section, is time penalties. The user is informed at the start of the game that some wrong actions can cause them to have time added onto their time. An example of a time penalty was show during the Symmetric Cryptography code and I will show it again below in Figure 43. Each time the Key collides with a virus or the maze walls, a time penalty of 5 seconds is added to the timer. Within the IF statements in the code, every time there is a collision with the Key and either the maze walls or the viruses, the Key is sent back to the starting position and a time penalty is applied. These time penalties will happen every time there is a collision and there is no cap on the number a user can receive.

There is only one concept whose Cases do not have any time penalties and that's Crime Scene Analysis. Here, I have decided it is too harsh to put penalties on wrong clicks so within the information section associated, I have put text to inform the user of this. I had a thought to add a penalty for requesting hints but this too I thought would not be fair in the current game.

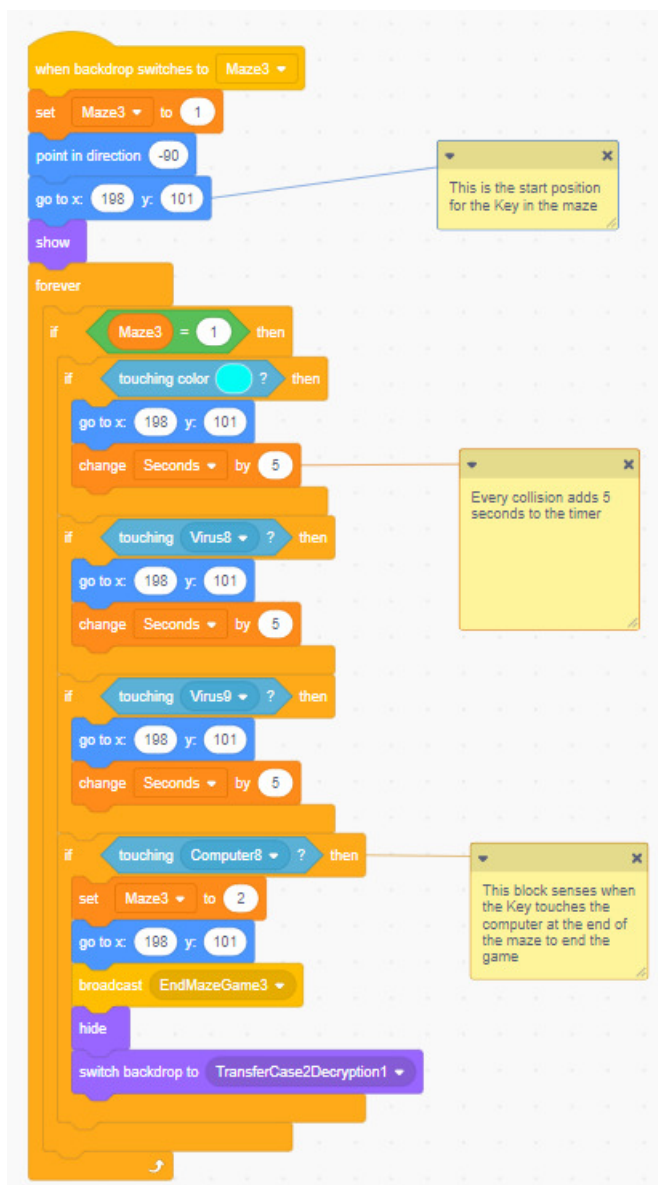
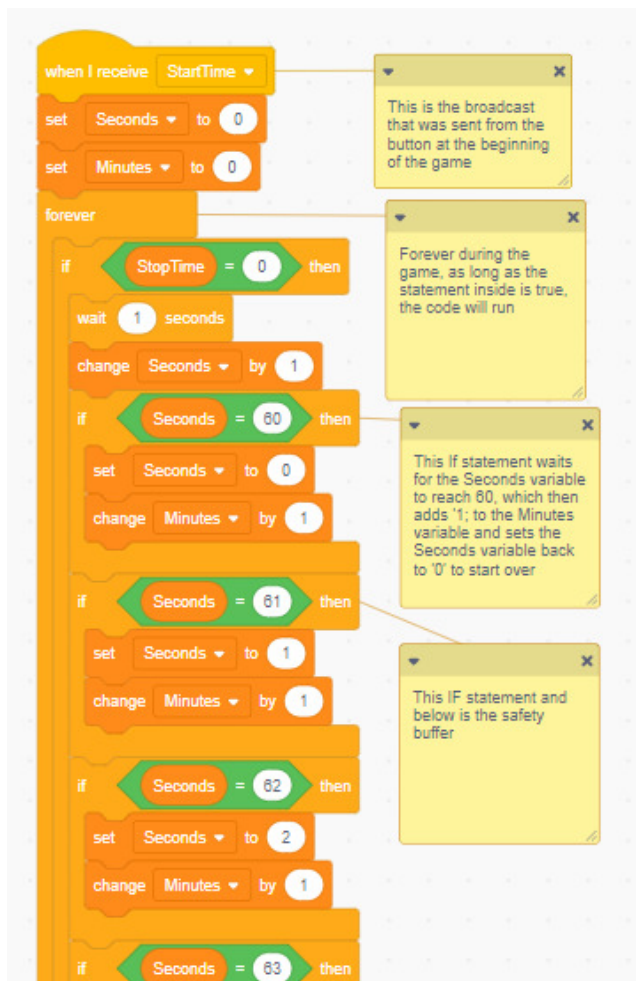


FIGURE 43 - THE CODE HERE IS FROM THE KEY USED DURING THE THIRD MAZE AND SHOWS THE TIME PENALTIES ASSOCIATED WITH COLLISIONS

### 5.6.1 Issues and Solutions

Below is Figure 42 seen earlier.



The initial IF statement contains a series of IF statements and starting there the bottom comment is, the IF statements below that act as a safety buffer. For a user playing the game, some wrong answers cause time penalties of 3 or 5 seconds. These seconds get added on to the 'Seconds' variable at whatever point they occur. The issue I found is that a user may make a mistake and cause the time to jump by 5 when the 'Seconds' variable is equal to a number such as 58 or 59. As the IF statement is looking for exactly Seconds=60, the jump will miss this and so the IF statement will never run and the code will cause the Seconds to continue growing past 60. My thought was to switch the code Seconds=60 to Seconds>60 but I found an issue with this too. If a user made a mistake at 58 and they caused the 'Seconds' variable to increase by 5, it would jump to 63 and then the code would increase the 'Minutes' variable by 1 and the 'Seconds' would go to 0. This would result in the code missing the extra 3 seconds. The way I have done it, it covers all possible extra seconds which could be caused and sets the 'Seconds' variable back to the start, adding on the extra seconds. In the Figure above, if someone makes a mistake and gets a penalty of 5 seconds while the 'Seconds' variable is at 57, the IF statement for 62 will run and set the Seconds variable to 2 which incorporates the additional time solving the inaccuracy. This code can be seen in full at Appendix 12.

## 5.7 Time Frames

To ensure the code works with different time frames and giving different badges, a rough time was implemented at this stage. During testing, a number of people played the game and their times helped to get a gold, silver and bronze time frame.

## 5.8 Classroom Resources

After the Implementation of the game, I was able to develop the classroom resources. Their design and reasoning for them was explained during the Design section of this report. Within this section, I will explain how I developed them.

The first resource is the answer sheet for a teachers use in aiding pupils. I created this answer sheet on Microsoft Word and it clearly displays the answers for each game for the teacher. The answers relate to the game and also to the Case Booklet, which will be explained shortly. This answer sheet can be seen at Appendix 13.

The second resource is a PowerPoint presentation. I used a premade template which gives really nice visuals and complements the theme of the presentation. Each concept within this presentation has between two and four slides, with the ending of the presentation have a recap slide for each. It was important that the presentation was pleasing to look at, otherwise students can easily disengage with what is being presented. This presentation can be seen at Appendix 14.

The final resource is a 'Case Booklet'. This is a paper based booklet designed for use alongside the game by the students. Within the booklet, there are questions that match those within the game and additional ones about the information. On the back is two boxes for the student to put their minutes and seconds from playing the game, as well as a fun activity of colouring their badge which can be used as a time filler by teachers for those who finish before everyone else. It keeps to the theme of the game, using similar colours of graphics for better familiarity. I created this booklet on Microsoft Publisher using its features and the design ability. The booklet is very bright and if printed, would use a lot of colourful ink. The booklet can be printed out in black and white and it would still be useful to students. This booklet can be seen at Appendix 15.

## 5.9 Unforeseen Issues

### 5.9.1 Scratch Quality

For reasons unknown, sometimes the quality of a Sprite or backdrop graphic will reduce while I am editing it. At times, I have had to edit the look or size of objects within a Sprites costume and while doing this, some times the object will become very pixelated. At first I assumed it was because I was making the objects too small for them to be shown in the best quality but I found this was likely not the case. At times I would only move an object, not altering it in any way, from one place to another within a costume and it would become very blurred. The only way around this I found is to delete the object that has become blurred and remake it or re insert it and hope it doesn't happen again.

## 6. Testing and Results

It was very important that other people apart from myself tested the game. As I have been working on it, my judgement and eye for detail may miss out crucial things that can impede the games usability. In this section, I will discuss how I tested the game during the final stages of the implementation and also how I used this game in a focus group for their feedback.

During the implementation, it can be very easy to miss things out or not notice something is not working as it should be. When it comes to this, its very useful to be able to have someone, other than myself, play through the game and give their thoughts. My supervisor and friends played through the game as I was nearing completion and this allowed me to gain some feedback on issues. One issue I had missed was in the first password Case, where the passwords when matched up correctly weren't being accepted as correct. Upon inspection of this, I had realised I had matched them up wrong in the code and when I was bug testing, I placed them from memory and not based on the information so I had being doing it wrong. This is a very good example of why it was important I had others test the game before using it in a focus group.

When it came to the focus group, I was fortunate enough to be able to test my project at the Cardiff Technocamps Code Club. Here I was able to have participants of mixed ability, both beginner and advanced, play the game see if they benefit from it. Before attending the Code Club, I developed the PowerPoint presentation and was able to use this as well as the game. This focus group took place over zoom, so every aspect had no in person interaction. The PowerPoint went down well, the students gave input when prompted and showed they understood what was being explained. Following on from this, I posted a link to the game which they were able to follow and play. Relating back to what I said during the research stage about Scratch, its very easy for anyone to access the game due to its shareability. The focus group was online and so this feature was of huge significance when it came to testing.

I presented the focus group with a questionnaire before they had listened to the presentation and played the game, and then again after. This was so I could better understand if the information had any impact from on them during what they experienced.. The after question contained a few extra questions about the game itself which could help me to improve it further.

Below is Figure 44, which shows the age of participants within the focus group.

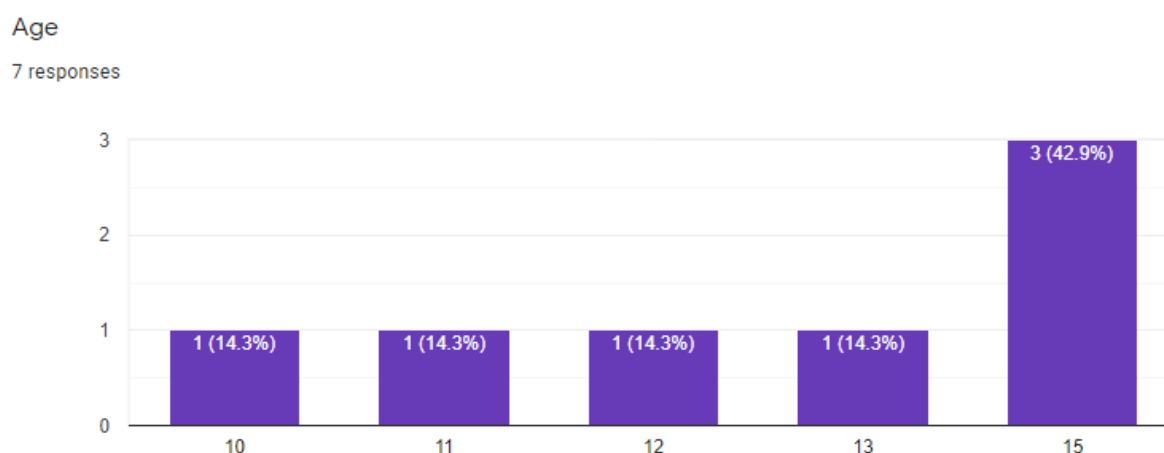
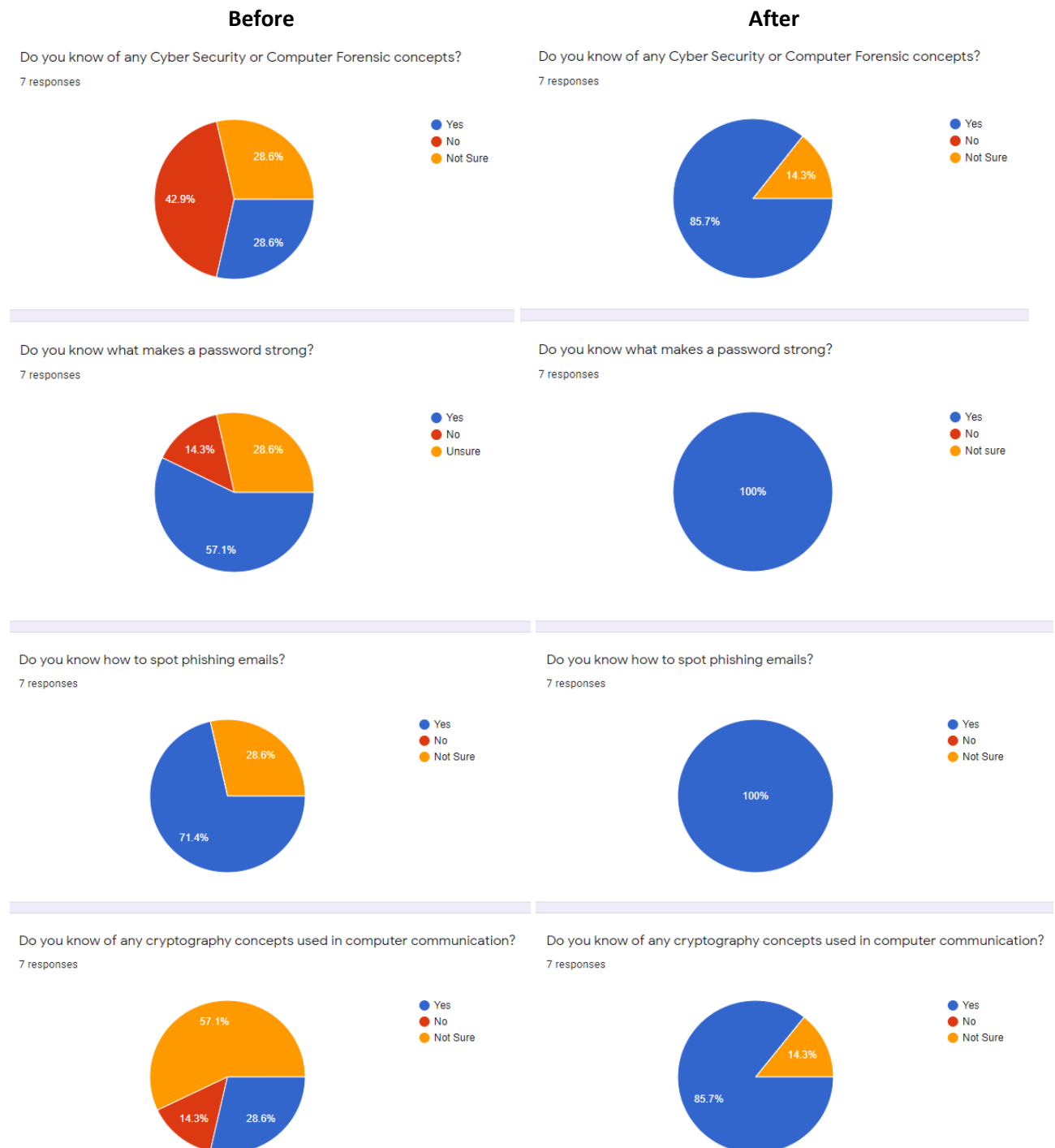
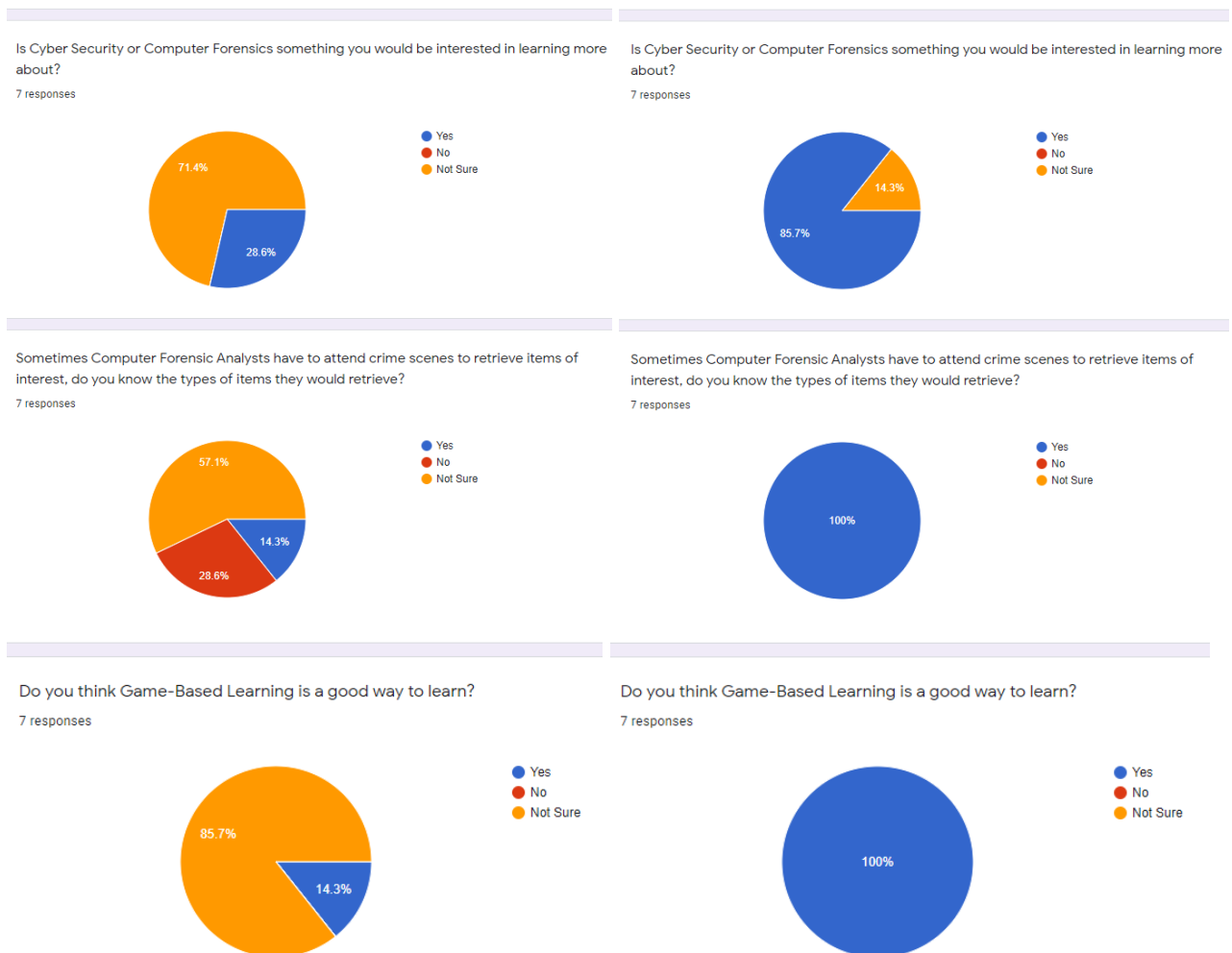


FIGURE 44 - THIS CHART SHOWS THE AGE FOR THE PARTICIPANTS OF THE FOCUS GROUP

I was only able to get 7 people to take part and only three people within the age group. This was not too much of an issue as all the feedback was valuable and gave me insights into what younger learners took away from the game. Below I will give a summary of the feedback in relation to what the participants learnt.

Below in Figure 45 is the results from the before and after questionnaires which will be side by side for better comparison. Following on from this, I will give comments to what can be seen.





**FIGURE 45** -THESE PIE CHARTS SHOW THE DIFFERENCE, FROM LEFT TO RIGHT, ON WHAT PARTICIPANTS ANSWERED IN THEIR QUESTIONNAIRES

With all the concepts apart from one, the majority of the participants either didn't know or were unsure of the concepts before playing the game. The only one where five out of the seven participants knew the concept was with phishing scams. This was a surprise to me as I had expected most to already know about passwords as passwords are needed to access email accounts.

After taking part, all of the participants said they knew about the concepts and what they involved apart from one participant who said they were unsure if they knew any security or forensic concepts and one persons said they were unsure of the computer communication concept which refers to symmetric cryptography. Look at this symmetric cryptography question, I would have preferred to have asked it a different way but at least the majority of participants were able to relate this computer communication concept to something in the game.

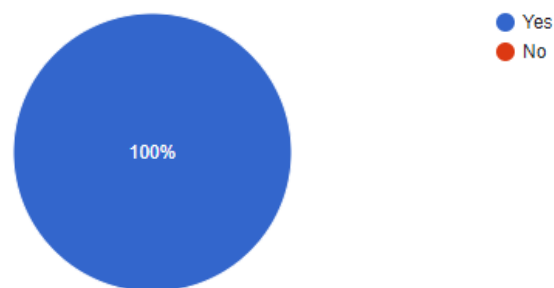
Before taking part, six people said they didn't know if game-based learning was a good way to learn and after taking part, they all said it was. I feel this is a good reflection on the game. If they hadn't

enjoyed it, they may have said game-based learning isn't a good way to learn. As seen in the comments below, with some saying the game is fun and impressive, the game has gone down well.

When looking at the after questionnaire and the questions specific to the game, the feedback has been very positive. Everyone who played the game said they enjoyed it which is very important as it meant the different Cases did not need changing. From asking each person their favourite game, drawing second was Passwords, Emails and Symmetric Cryptography and the one with the most votes was the Crime Scene. The users liked the interaction and being able to move around the scene which made it more enjoyable. Figure 46 below shows the number of people who enjoyed the game and the individual games and their percentage of votes. Figure 47 which follows that shows the feedback comments left by the participants.

Did you enjoy the game?

7 responses



Which case was your favourite?

7 responses

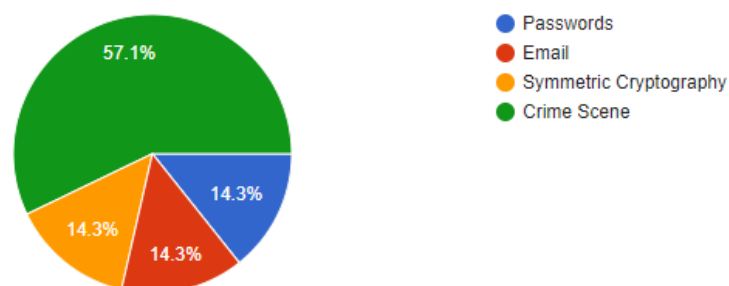


FIGURE 46 - THESE PIE CHARTS SHOW QUESTIONS ASKED SPECIFICALLY ABOUT THE GAME AFTER PLAYING



Do you have any comments or improvements about the game?

7 responses

Impressive the password was very fun

N/A

Loved it, but I would change the movement on the key

I liked the varying game types :)

It was a very fun game, people may be more interested in the text if you were learning through playing, rather than learning then playing. eg for the crime scene, looking through an "easy" house with a detective, with them telling you what to look for, and then looking through a "hard" house by yourself

Really good i liked the crime scene and the two places

The crime scene was fun and something maybe you could add is some opening things

**FIGURE 47 - THESE ARE THE COMMENTS MADE BY PARTICIPANTS AFTER PLAYING THE GAME**

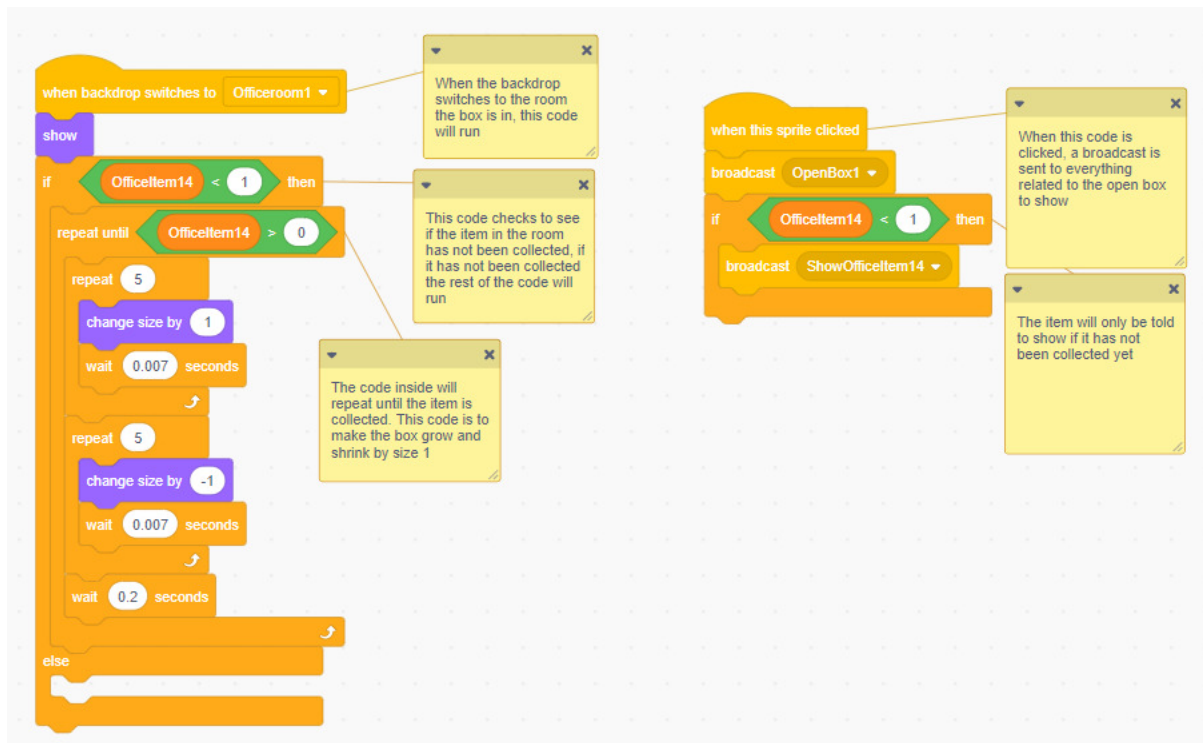
One suggestion in the feedback was to integrate the information into the Cases more, such as with the crime scene, for the first one having the police officer walk you through telling you stuff and then in the second Case you do it yourself. I really liked this idea as it would make learning about the different aspects more visual as you are following the police officers lead. To implement this in, I would have to try it for all concepts otherwise it would be odd within the structure of information and then Cases. Within the project and the time remaining, trying and test this out and implement it would be a lot of work and would not be possible. This idea is mentioned in the next section as a possible future work.

An idea that both my supervisor and a participant had was to add openable objects within the rooms in the crime scene Cases. I really liked this idea and I was able to implement it into the final version. This feature of the game works but there is still a lot of room for improvement.

The feedback from the focus group was very constructive and gave me some points to re-evaluate within the game. One thing that I would do, that will be mentioned in more detail in the next section, is see how that information is retained after a larger period of time has passed.

## 6.1 Feedback Implementation

I was able to implement three boxes into the business crime scene which a user could interact with and open up. To show the boxes are clickable, they continuously get bigger and smaller to stand out from everything else. When clicked, a pop up square appears which an image of the open box on and items inside. If there is an item of importance inside, the users can collect it and close the box. Once the box is closed and the item inside is collected, they cannot open the box again. The code below in Figure 48 shows how I implemented the openable box.



**FIGURE 48 - THIS CODE SHOWS THE IMPLEMENTATION OF THE OPENABLE BOXES IN CRIME SCENE CASE 2**

In the code on the left when the user enters the room that the box is in, it runs an IF statement to see if the item related to the box has been collected. If it hasn't, the box grows and shrinks repeatedly until the item Officeltem17 is collected. To the left, the code runs when the box is clicked and sends a broadcast which is picked up by all the open box pop ups. An if statement checks to see if Officeltem17 has been collected and if it hasn't, it send a broadcast to make it show. Once the item has been collected, every time the user enters the room the box wont grow and shrink. The open box with the item in can be seen at Appendix 16 .

At this point I was able to implement the different time frames that would result in which badge the users would receive. These time are very easy to change but currently, for a gold the should complete the game within 19 minutes, for silver its between 19 and 24 minutes and for bronzes its any time longer than 24 minutes. The code below show the gold badge and its code. When the user reaches the end of the ending screen, their seconds and minutes are displayed. Depending on their time, if its less than 19 minutes this badge will show. This time is not final and can change in the future. At Appendix 17, an example of a Silver Badge and the Seconds and Minutes can be seen.

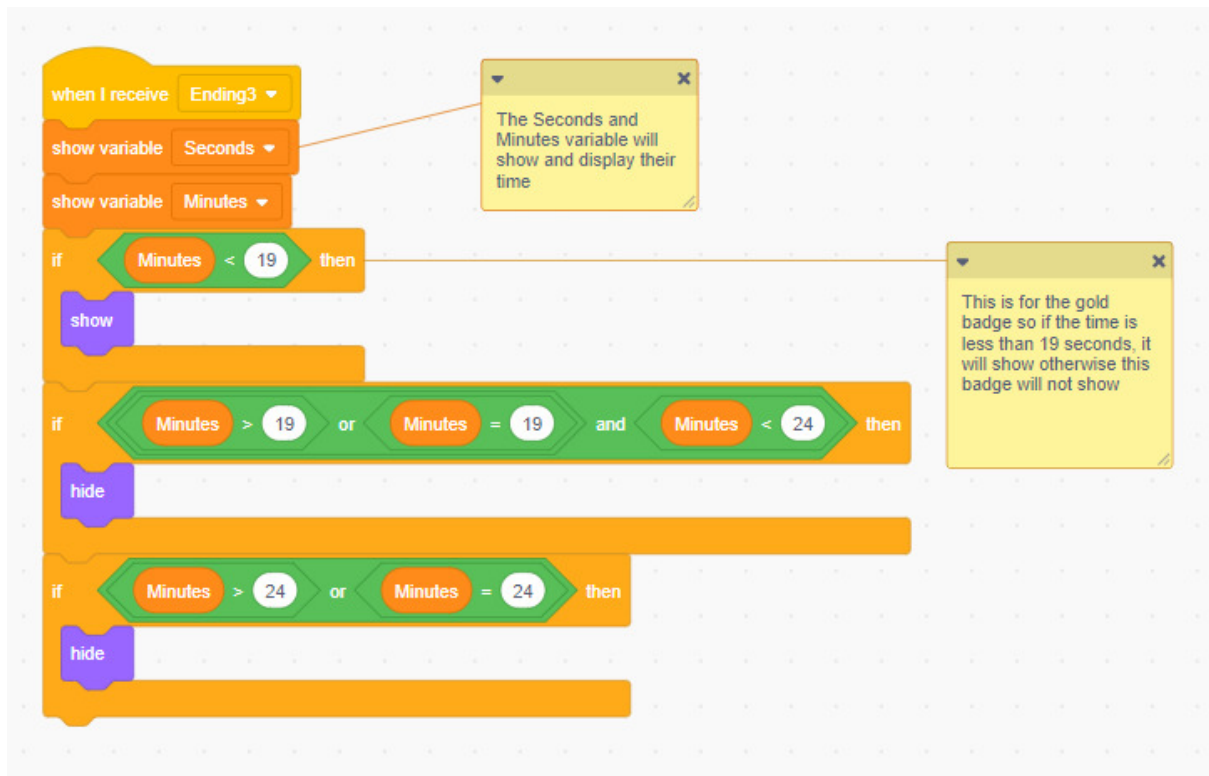


FIGURE 49 - CODE WITHIN THE GOLD BADGE

## 7. Future Work

This section of the report will look at certain parts of the project which I feel, with more time and a better view of everything, I could develop to be better or introduce new elements to improve the game further.

### 7.1 Long term testing

From the use of the game, the aim is that students will have a better understanding of the concepts and will be able to use that knowledge further within their progression. My feedback from them has been shortly after playing when the information is fresh. One thing I would like to see is if they still have an understanding or awareness of the concepts after a longer period of time. A follow up game with less information but the same level of challenge could be a possible idea to see if they can recall some of the information about the concepts. This could show that students retained what they learnt and by using different challenges or ways to apply the knowledge, students would have to adapt what they know to certain scenarios.

### 7.2 Welsh Language

The game is aimed at use for students in Wales. For this to be fully inclusive for both Welsh and English speakers it would need to have a Welsh language version for students who prefer to learn through the medium of Welsh. It would take some work but the functionality of the game would stay the same. The main work would be translating all the existing text into Welsh and re-shaping Sprites and headings to better fit any size changes as well as the PowerPoint and Case Booklet.

### 7.3 Integrating Information into the Cases

Currently the Info and Cases are separated but in the future I would like to look into a more integrated approach. Having the Info flow into game in a smoother way may help with the students applying the information better. This would involve having to edit the backgrounds and variables to allow this to happen but it is achievable and something worth trying.

### 7.4 Improved design of Sprites and Backgrounds

For the majority of the graphics, everything has been drawn by me through different applications and then uploaded those drawings into Scratch. My art and design skills are not the best but for the game as it is they do a good job. In the future, I would prefer the Sprites and backdrops I developed to have a more profession look and the design style to be more consistent. If it means having the game look more profession and sharper graphics, I am will to work through tutorials to achieve this.

### 7.5 Introduce a Point System

At the moment there is no scoring system, the pupils are against the clock and this determines their badge at the end. I think a scoring system would add more excitement and within a classroom environment, a feeling of competition with friends to see who got the best score can be very motivating for a student. I would like to look into a scoring system, one which would better improve the students motivation to perform well and also give feedback or motivation to go over certain

concepts or aspects again. One idea I had was that users would get points for completing mini games and these points can be saved or used for hints. Possible powerups could be used which give users advantages if they spend their points within an in game shop.

## 7.6 Sounds

At the moment, the game is very quiet as there is no sound. I debated this for a while as sound could make the game more enjoyable and interesting . The main issue I have with this is the use of the game in a classroom with several others, the sound of multiple laptops may be an issue. It would be nice to play around in the future with sound and see what it's like.

## 8. Conclusions

The aim for this project was to develop a game which informed and educated students on security and forensic concepts through game-based learning, focusing on the concepts: Passwords, Email Safety, Symmetric Cryptography and Crime Scene Analysis. Within the game, the different mini game Cases would give students different scenarios and challenges to use problem solving to complete. This aim was to solve the problem that some students lack interest and cannot concentrate to take information in. I believe I have achieved this, in developing Cyber Officer. The game contained important information about the concepts which was used in real life simulations that grabbed the users attention and challenged them.

The theme and story gives the user a purpose and their reward for a badge based on time motivates them to complete the game. The game uses different levels of challenge to test the user and inform them using real life scenarios, which they should be able apply outside the classroom. The concepts have been used in a relatable and interesting way that relates the concepts to real world scenarios and aids with meeting curriculum goals, just like with email safety within digital competency. In the specification, I lay out some requirements for game based on the different features of serious games and game-based learning. Each of these features has been successfully incorporated into the game, adding to its informative ability.

The use of the focus group was helpful in seeing if the game was able to inform students and also if it was enjoyable. Even though not all the participants were in the age group the game was aimed at, they all gave useful feedback which helped improve the game further. One thing I didn't do but would like to, is getting an opinion from a teacher. Even though the new curriculum is not in use at the moment and schools will not have designed their curriculum content, I feel a teacher of the targeted age group would be able to give a valuable view of the game which could produce further valuable feedback.

I am very happy with my choice of using Scratch to develop this game. It's hosting and sharing ability made testing this online very simple. The use of block based coding made visualising what all the code does a lot easier and straight forward, aiding in sorting any problems that I had. Even though there were let downs with the design interface on Scratch, my use of Microsoft Publisher and Paint was a good choice as alternatives as they gave me more features to develop my graphics. My design skills are very basic so the graphics within the game could be developed further in the future but in the game as it is, they work well.

Cyber Officer has turned out far better than my initial expectations, which couldn't have happened without each stage included in this report. As seen in the Future Works section, there are many different aspect to improve upon and try out which could make this game even better.

## 9. Reflection

I have found this project to be a very enjoyable experience and with which I have learnt a great deal. Spending the last few months working on this game has been both fun and challenging but it has all helped me to develop my skills which will be used after the end of this project. Looking back to when I first started, there were many aspects I did not anticipate but I over came each hurdle to be able to meet targets and the aim for this project.

Problem solving played a major role throughout this project and has been a skill in constant use. As I had never created a game on Scratch of this size, there were times when I would discover issues for the first time and needed to over come them. Over the last few years, this course has helped me to improve my problem solving skills to a good level which I was able to apply to the problems faced in the project. Through methods such as trial and error which the game covers, I was able apply these concepts to aid in my own progress and overcoming of obstacles in the games development. This skill I will continue to use past education and this project, further developing it as I move into the world of work. Learning through repetition helped me to become more efficient with block coding. When starting this project, I had never developed a game like this and so there were ways in which the code blocks worked that I didn't fully grasp until later. Over time and dealing with the issues, I become more efficient at implementing correct code with fewer errors. My understanding of how Scratch and the code worked helped me to catch potential problems, leading to less time focused on problem solving and more time to focus on implementing the rest of the game.

There were definitely points during this project where motivation became very lower and the progress began to slow. For extended periods of time doing the same task, such as the research, this is inevitably going to happen. It's important in these moments to take a step back and take break to then come back to it with a fresh mind and renewed focus. This is an important thing I learnt and it is something which will be used again during future work or studies. Sometimes spending long periods of time doing the same task can have results and get the job done but at some point you will burn out and need to recuperate.

## 10. Appendices

[1]

Below is example text for the first three information Sprites in the introduction section. Each block of the red text is used as a Sprites costume.

Text Sprite 1:

Welcome to the team!

Text Sprite 2:

I am the lead cyber specialist here at the  
cyber crime department and I need  
your help!

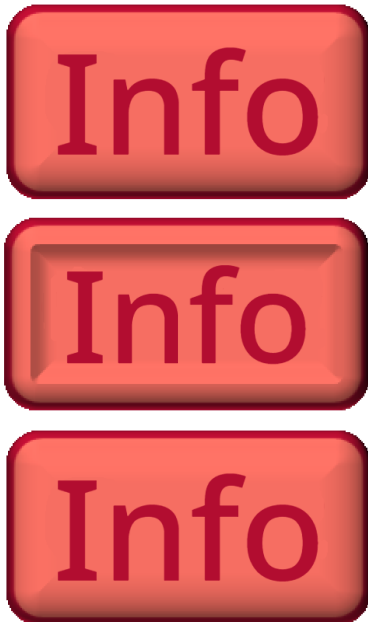
Text Sprite 3:

We have become over run with cases  
and need you to take on the extra work



[2]

When the button is clicked, it switches between two costumes in a sequence to make it look like a button being pressed. The image below shows the button from top to bottom, how it would look when clicked.



[3]

This is how password Case 1 looks when it first starts.

MJ!97!

Wales1998

!h0lm3s!

eNg!22!js

Mark Jones

Jane Smith

Jess Holmes

Will Curtis

Check

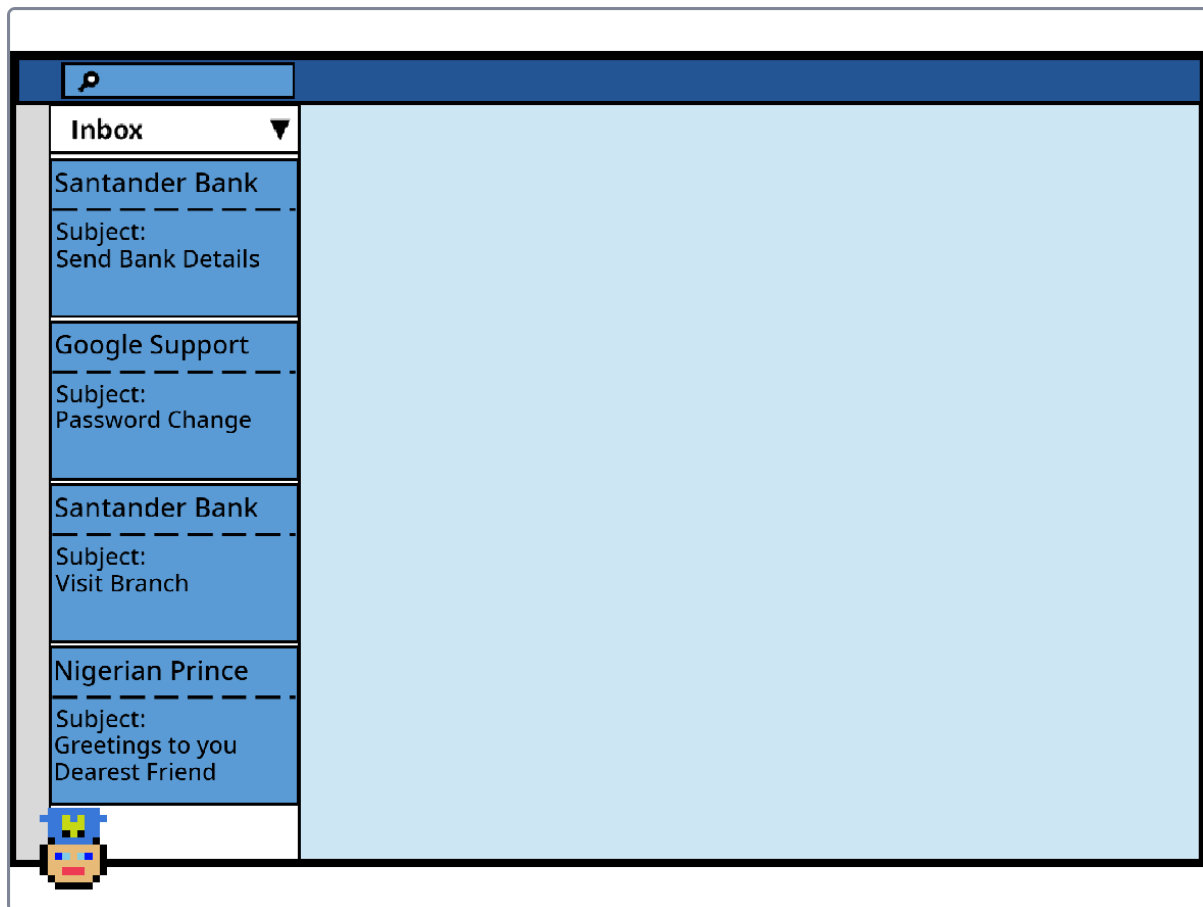
[4]

These buttons show from top to bottom, the sequence the password Case 1 check button goes through to give a look of flashing red.



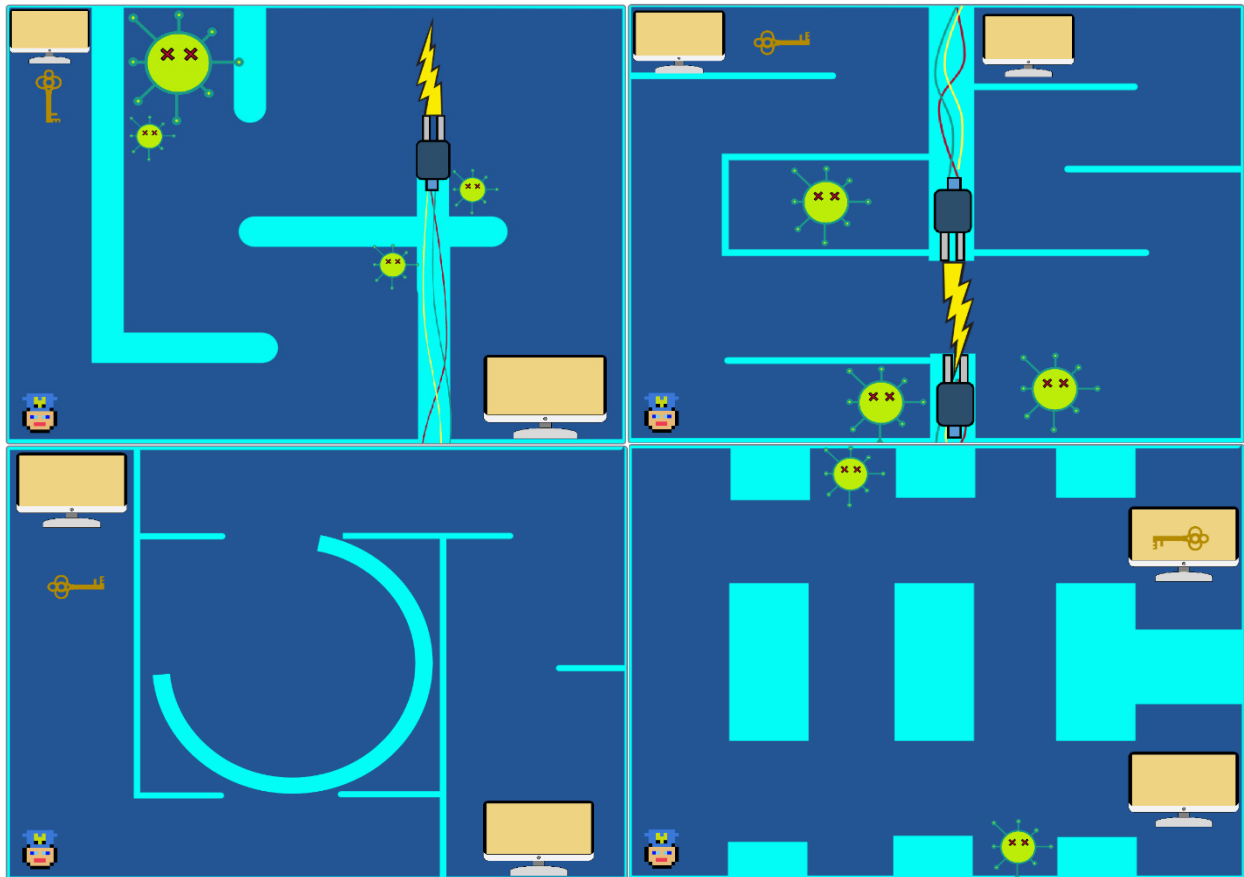
[5]

When first taken to Email Case 1, you are presented with the screen below.



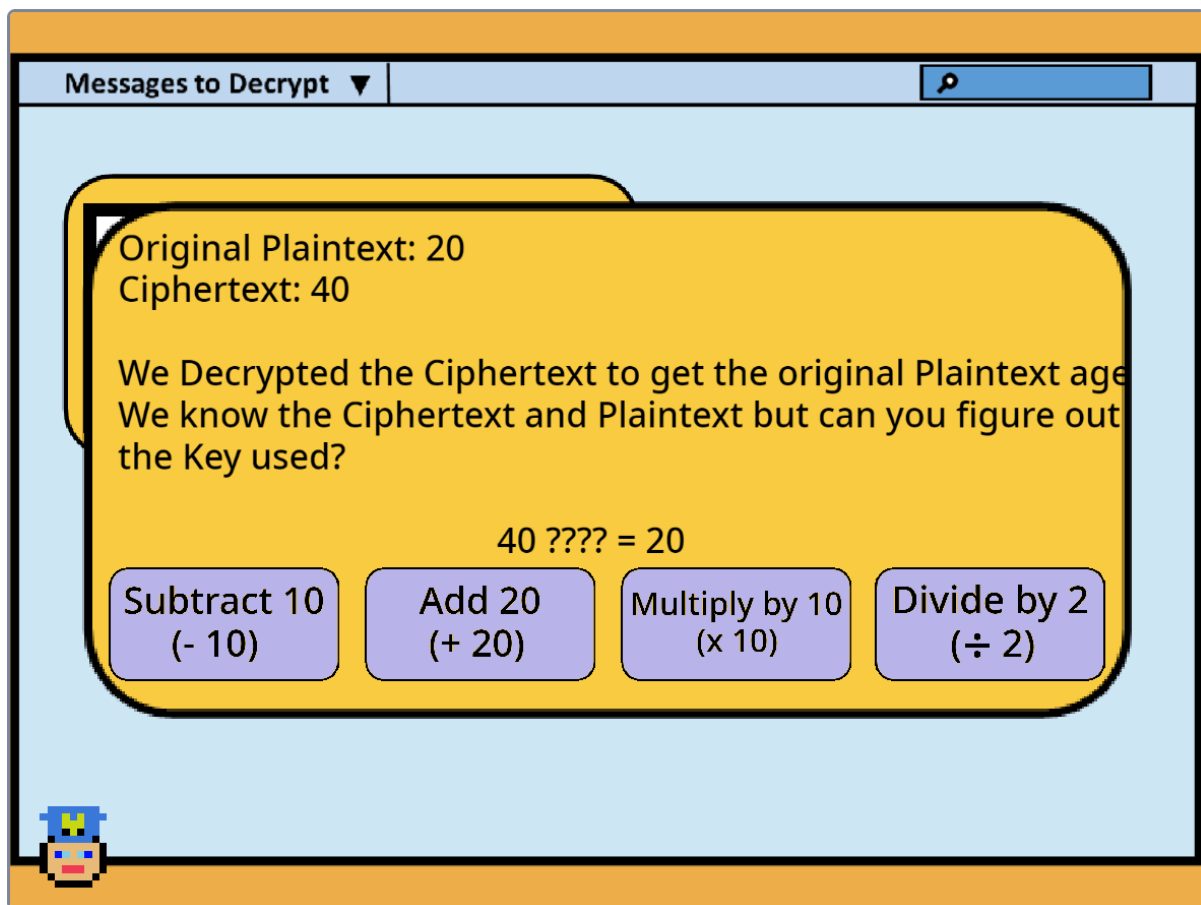
[6]

The four mazes have different layouts, Key starting points and moving obstacles such as the viruses and the electricity which flashes on and off.



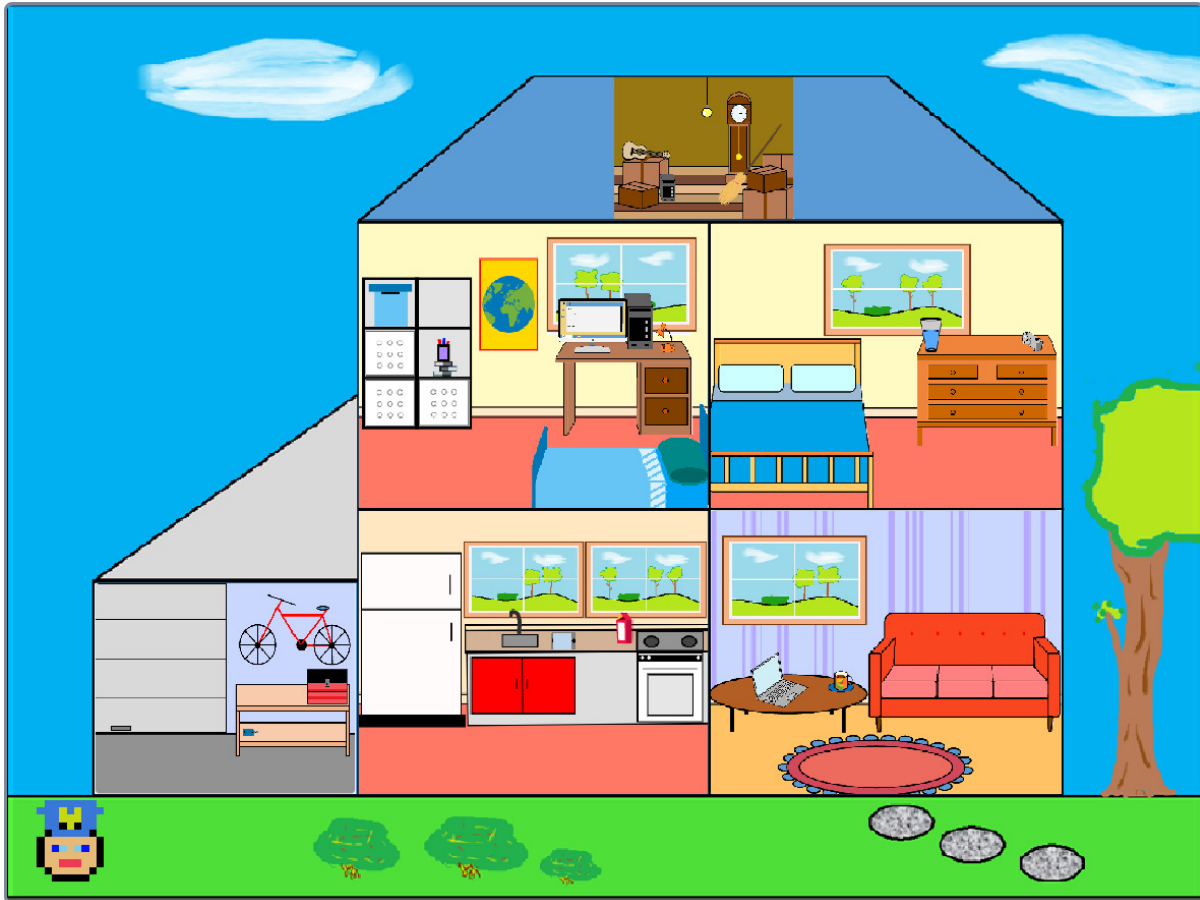
[7]

The final section of Symmetric Cryptography is the decryption stage which can be seen in the image below.



[8]

Below is the house view in Case 1 of the crime scene concept. Each room can be seen in this view.



[9]

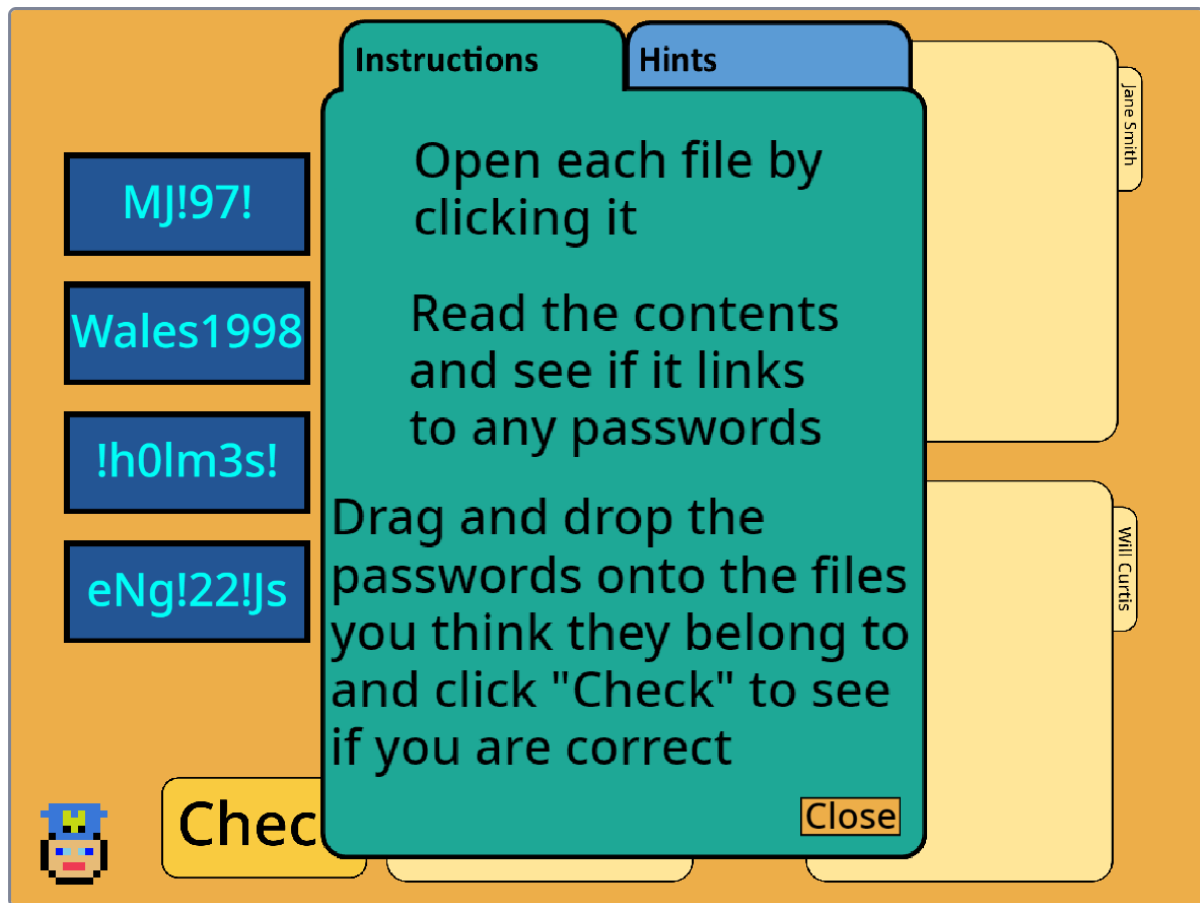
Below is the costume of the lounge Sprite which is seen during house view.

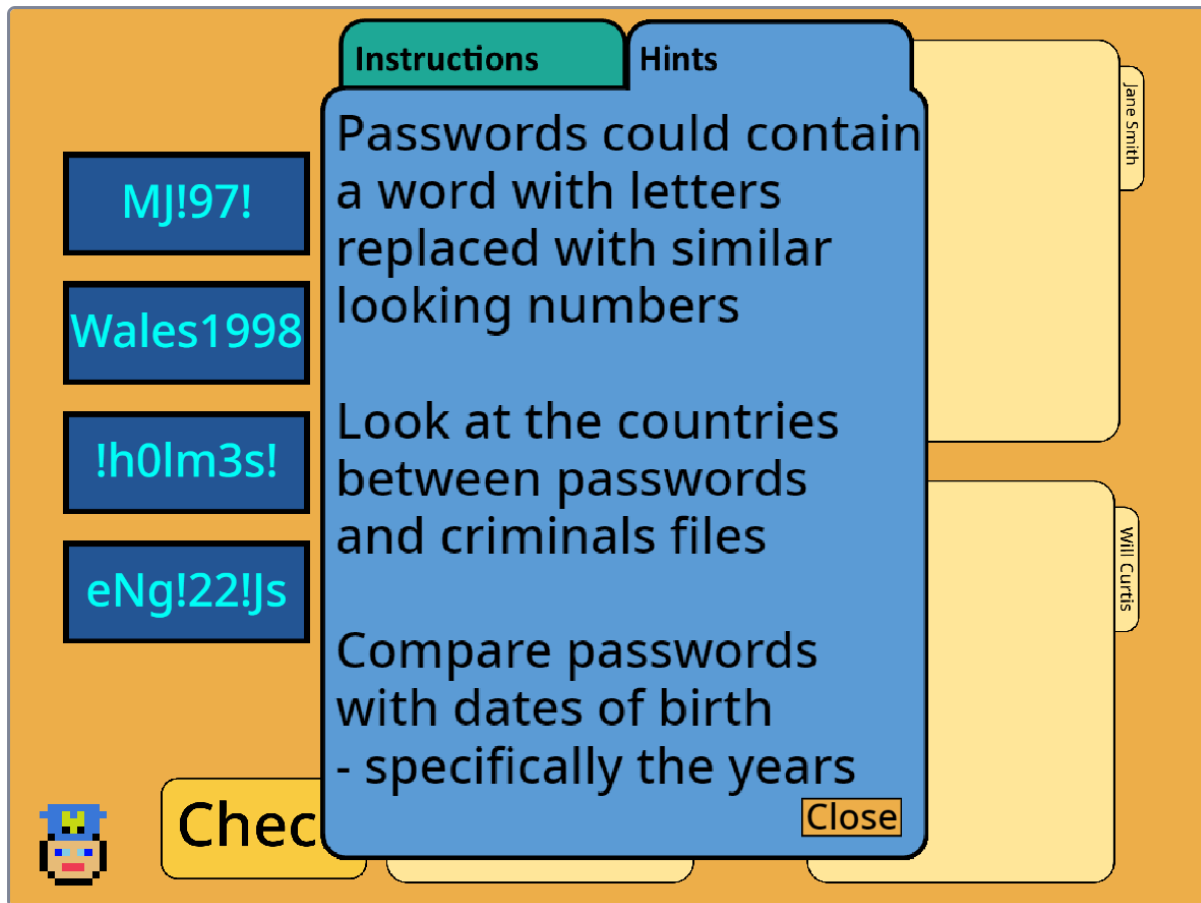




[10]

The image below shows the pop up help and hints with the instructions being on the green pop up and the hints on the blue in the image below that.





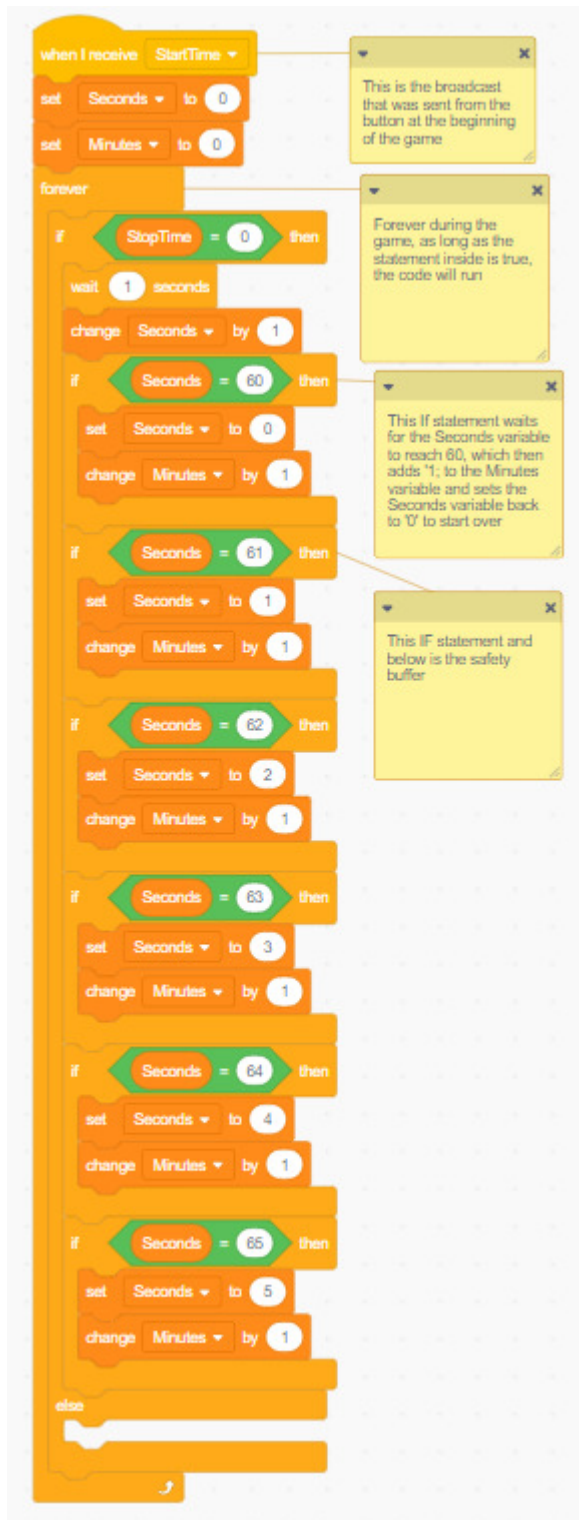
[11]

This button is button is used to send the user to the end game screen.



[12]

Below is the full code for the timer and its safety IF statements

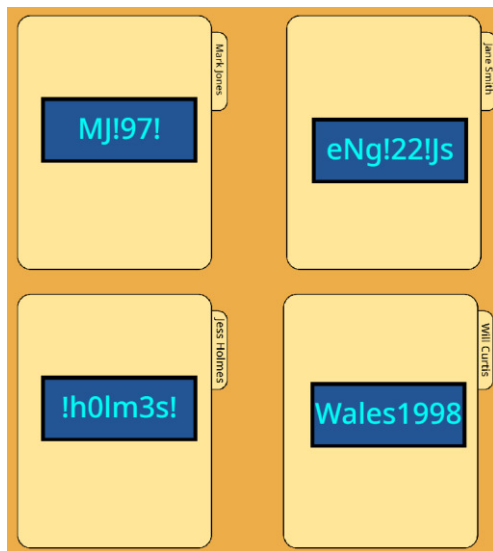


[13]

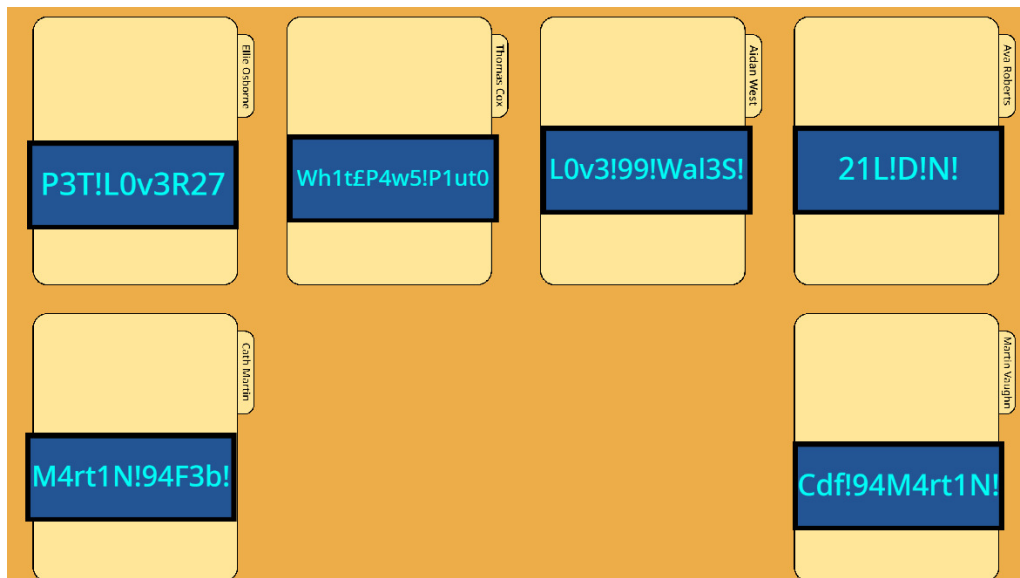
Below are the answers from the answer sheet in relation to the game.

## Cyber Officer Answer Sheet

### Passwords Case 1



### Passwords Case 2



### Email Safety Case 1

Santander Bank	Subject: Send Bank Details	Unsafe
Google Support	Subject: Password Change	Unsafe
Santander Bank	Subject: Visit Branch	Safe
Nigerian Prince	Subject: Greetings to you Dearest Friend	Unsafe

### Email Safety Case 2

Boots Pharmacy	Subject: Prescription Ready	Safe
Amazon	Subject: Thank you for ordering	Unsafe
Outlook	Subject: outlook	Unsafe
Dropbox	Subject: Important documents	Unsafe

### **Symmetric Cryptography Case 1**

Decrypt Message 1 answer =  $\div 2$

Decrypt Message 2 answer =  $+ 20$

### **Symmetric Cryptography Case 2**

Decrypt Message 1 answer =  $\times 8$

Decrypt Message 2 answer =  $- 66$

### **Crime Scene Case 1**

Loft – Desktop

Bedroom Top Left – Monitor and Desktop

Bedroom Top Right – Camera

Garage – USB

Kitchen – Mobile Phone

Lounge – Laptop

### **Crime Scene Case 2**

Reception – Laptop and Mobile Phone

Kitchen – Laptop and Mobile Phone

Warehouse – Laptop and Desktop

Inside the Box – Mobile and USB

Store Room above Kitchen – Monitor, Desktop and Camera

Office Room – Laptop, Monitor, Desktop and Camera

Inside the Left Box – Mobile Phone

Inside the Right Box – USB

[14]

Below is the overview for the PowerPoint presentation.

CYBER SECURITY AND FORENSIC CONCEPTS

GAME - BASED LEARNING

07/05/2021

TODAY'S LEARNING CONCEPTS

- Passwords
- Email Safety
- Symmetric Cryptography
- Crime Scene Analysis

PASSWORDS

What makes a strong password?

Passwords are an important way of keeping information protected! For better protection, strong passwords are essential!

Can you think of anything that requires a password?

PASSWORDS

Passwords are used for:

- Computers
- Phones
- Email Accounts
- Social Media Accounts

Without a password anyone can access these things and that's why it is important to create strong password! Keep them private and don't share them!

A password restricts access to only the people who know the password!

CREATING STRONG PASSWORDS

A password is strong if:

- It contains more than 8 characters
- It is a mix of numbers, letters and symbols
- It is not based on personal information such as name or date of birth

Can you decide which password is strong and which password is weak?

123password      52a!9GhB!76

EMAIL SAFETY

You should always have some caution when opening emails!

A phishing email is an email that tries to present itself as someone else to try and obtain your personal and sensitive information!

If you suspect an email is dangerous you are probably right!

Always be cautious!

WHAT ARE THE SIGNS OF A DANGEROUS EMAIL

- Does the sender's name and email address match?
- Be cautious when clicking links!
- Don't open attachments from unknown people – it could be a dangerous document!
- Never give bank or personal information to suspicious email!
- Phishing emails usually seem urgent – they want you to panic and give them your info without thinking!
- A sign an email is dangerous is bad spelling – if an email contains spelling mistakes or bad grammar you should be very careful!

SYMMETRIC CRYPTOGRAPHY

How do we secure messages?

This cryptography involves Encrypting and Decrypting messages using a key.

We Encrypt messages to ensure no one can read them during transmission.

The key is very important and must be kept safe!

IMPORTANT TERMINOLOGY

Plaintext – The original message we want to send

Ciphertext – The message after we've encrypted it

Encryption – Turning the Plaintext into Ciphertext

Decryption – Turning the Ciphertext into Plaintext

Key – What we apply to Encrypt and Decrypt

Encryption and Decryption are inverse operations so what we do for one we do the opposite for the other!

We call it Symmetric Cryptography because the same key is used for both Encryption and Decryption!

HOW DOES IT WORK?

First, we have a Plaintext message we want to send: 10

We now need to Encrypt that message and change it from Plaintext to Ciphertext – We do this by applying the key to the Plaintext!

Key: 5

Our encryption method is addition, so when we apply the key to the Plaintext we will be adding them together!

10 + 5 = 15

Plaintext      Key      Ciphertext

HOW DOES IT WORK?

We now have our Ciphertext message: 15

We send this through the Internet to our friend Bob!

The key is sent separately through a secure channel!

Once Bob has both the key and the Ciphertext, they can decrypt the message back to the original!

HOW DOES IT WORK?

Remember – Encryption and Decryption are inverse operations so what we do for one we do the opposite for the other!

Bob now has: Ciphertext: 15      Key: 5

To work out the original Plaintext message, Bob must Decrypt the Ciphertext!

To encrypt we used addition so we must use the opposite to Decrypt which is Subtraction:

15 - 5 = 10

Ciphertext      Key      Plaintext

Bob now has the original message

CRIME SCENE

What items are of interest at a crime scene?

A computer forensic examiner can sometimes be required to attend crime scenes to recover items of interest.

The items they look for are devices that may contain data or information relevant to investigations.

Can you think of any items of interest that could contain data or information?

ITEMS OF INTEREST

Mobile phones, Computers, cameras, USB storage devices, etc.

These are all items of interest as they could contain documents or images that need to be examined!

The majority of the forensic examination will happen back at the investigator's lab, so it is important all these items are reviewed and transported carefully.

A Faraday Bag is used to put items in to stop signals reach them and possibly destroying data.

RECAP

- Passwords
- Email Safety
- Symmetric Cryptography
- Crime Scene Analysis

PASSWORDS

Always make sure you have strong password!

A strong password will have these features:

- 8 or more characters
- Mix of letters, numbers and symbols
- Will not be based on personal info such as name or DOB

Never share your passwords!

EMAIL SAFETY

You should always have some caution when opening emails!

Look out for the signs on email is unsafe:

- Name and email address don't match
- Bad Spelling and grammar
- The email is asking you to give personal information

Always be cautious!

SYMMETRIC CRYPTOGRAPHY

Encryption and Decryption are inverse operations – what we do for one we do the opposite for the other!

Plaintext is the original message and Ciphertext is the message that has been encrypted with a key.

The key is sent through a different channel than the Ciphertext which is more secure.

Same Key for Encryption and Decryption!



19

### CRIME SCENE

The items at a crime scene that are of importance to a computer forensic examiner are ones that contain data and information!

Most of the examining is done back at the lab.

All items need to be transport back to the lab securely to ensure no data is altered or destroyed!

**Most items are electric!**

20

FOLLOW THIS LINK TO PLAY THE GAME

<https://scratch.mit.edu/projects/516640329>



[15]

Below is the Case Booklet overview. The first image is the front page and the last is the back page, with the ones in between opening like a book.



# 

### Case 1

Circle the answer:

A **Strong** / **Weak** password offers more protection

Draw lines and connect the passwords to the files like you did in the game!

MJ!97!

Wales1998

!h0lm3s!

eNg!22!js

### Case 2

Ellie  
Osborne

Thomas  
Cox

Aidan  
West

L0v3!99!Wal3S!

21!D!N!

Cdf!94M4rt1N!

M4rt1N!94F3b!

P3T!L0v3R27

Wh1tEP4w5!P1ut0

Ava  
Roberts

Cath  
Martin

Martin  
Vaughn



A password should be more than 8 characters long, consist of a mix of numbers, letters and symbols and don't use personal information!

# 

### Case 1

Circle the answer:

You should always be **Care Free** / **Cautious** with suspicious emails

Circle the answer for this email like in the game:

FROM Santander Bank <Noreply@ScamU.com>

Subject: Send bank details

Dear Customer

Your bank has lost your details and we need you to send them to us.

There is no need to contact us juts [Click Here](#) and fill in the form.

Regards  
Your Bank

**Safe / Unsafe**



If you feel an email is unsafe or could be dangerous, you are usually right!

### Case 2

FROM Boots Pharmacy <Pharmacy@Boots.com>

Subject: Prescription Ready

Your prescription is ready!

Thank you for choosing Boots Pharmacy.

Please visit your regular Boots Pharmacy to collect your prescription, where a member of staff will be happy to help.

Regards  
The Boots Pharmacy Team

**Safe / Unsafe**

Circle the answer:

A sign an email is unsafe is if it has bad spelling

**True / Not True**

# Symmetric Cryptography

## Case 1

Circle the answer:

The Key used for encryption is **The Same** / **Different** for decryption

Circle the answer:

Original Plaintext: 25

Ciphertext: 5

We Decrypted the Ciphertext to get the original Plaintext age  
We know the Ciphertext and Plaintext but can you figure out  
the Key used?

$$5 \text{ ???} = 25$$

**- 10** / **+ 20** / **x 10** / **÷ 2**

## Case 2

Original Plaintext: 48

Ciphertext: 6

We Decrypted the Ciphertext to get the original Plaintext age  
We know the Ciphertext and Plaintext but can you figure out  
the Key used?

$$6 \text{ ???} = 48$$

**- 10** / **+ 36** / **÷ 3** / **x 8**

Circle the answer:

We encrypt messages in case someone  
reads it while its being sent

**True** / **Not True**



Encryption and Decryption are inverse operations so  
what you do for one, you do the opposite for the other

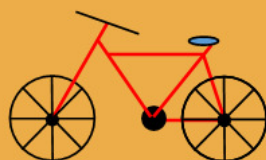
# Crime Scene Analysis

## Case 1

Circle the answer:

Items of interest are usually  
**Electric** / **Not Electric**

Circle the item of interest:



If an item can store data and information, it is  
of value to a computer forensic analyst

## Case 2



Circle the answer:

A Faraday Bag stops signals getting to the  
items inside

**True** / **Not True**



Well done for completing all those Cases! Fill in your game time and colour the badge however you like!

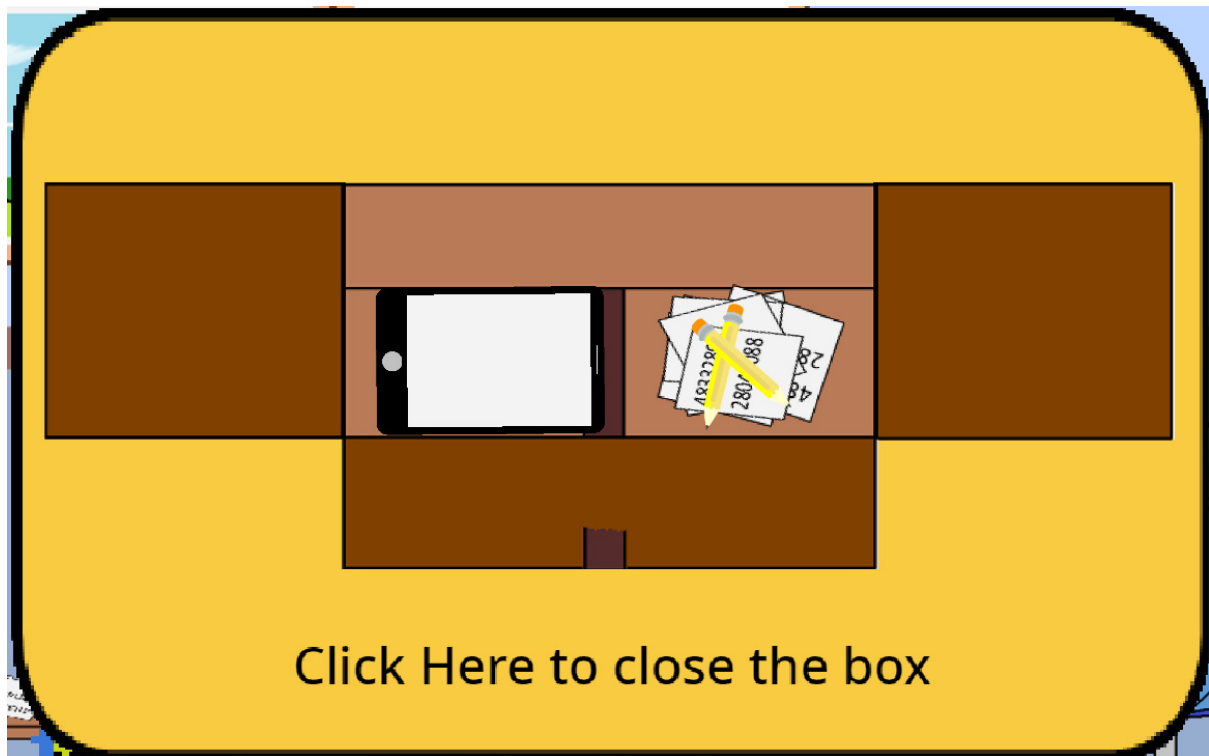
**Minutes:**

**Seconds:**



[16]

The open box with the item inside can be seen below.



[17]

Below is an image of the ending showing a Silver Badge and the time the game took.



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