“Toll and Error”

CS39440 Web Based Gamification Project Report

Author: Damien Xavier Phillips ([bep36@aber.ac.uk](mailto:bep36@aber.ac.uk))

Supervisor: Dr Edore Akpokodje (eta@aber.ac.uk)

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Department of Computer Science

Aberystwyth University

Aberystwyth

Ceredigion

SY23 3DB

Wales, UK

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Name: Damien Xavier Phillips

Date: 25/04/2023

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Abstract

“Toll and Error” is an application that aims to educate visitors to the Ceredigion Museum, and visitors on the website, about the historical events of the Rebecca Riots in a fun and engaging way. The Rebecca Riots, which were a series of riots that took place in Wales in the 19th century, specifically in 1839-1845. These riots were in response to the toll fees that were charged to residents for use of their own local roads. These riots involved the rioters all dressing in traditional Welsh women’s wear and refusing to pay the tolls at the gates, and in some cases tearing them down. These rioters, who were predominantly men, called themselves “Rebecca”, or, more commonly, the “Daughters of Rebecca.” These riots were an important moment in Welsh history, and their story is still told to this day.

Interactive museum displays have become very popular, as they are, in the experiences of many, an excellent way to display information and convey it in a manner that is engaging, memorable, and that makes the museum experience fun and accessible to all. “Toll and Error” is an excellent example of such an exhibit, as it allows visitors to “step in to the story,” so to speak, and take on the role of a toll booth operator in an exaggerated, over the top, “Horrible Histories” style universe.

The game itself was made in GameMaker2 using the GML and GML Visual programming language. The sprites were drawn using the pixel art tool Piskel, and both them and the mock-up design sprites were put together in GIMP. The user interface was made to immerse the player in the game’s world while also being intuitive, accessible and user-friendly.

Once fully implemented, the “Toll and Error” game will be available on the museum’s website, allowing visitors to play and learn about the Rebecca Riots from the comfort of their own homes. In addition, the game may also be displayed in the museum itself, allowing visitors to engage with the exhibit in a more immersive way, as they will be able to see the toll board in question standing in front of them as they play.

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# Background, Analysis & Process

## Background

To prepare for the project, research was done in the following areas:

* The Ceredigion Museum
* Interactive Museum Displays
* The History of the Rebecca Riots
* GameMaker 2

Similar systems were also researched, such as other interactive museum displays in the Eureka! Science and Discovery Centre [1] as well as the Xplore! Science Discovery Centre [2], as well as games and shows of similar styles. “Horrible Histories” [3] was researched to assist with the playful, silly tone of the game, while “Papers, Please” [4] was researched to help with gameplay, as it is a critically acclaimed example of the gameplay features of the type of game that was to be created.

### The Ceredigion Museum

In their words, the Ceredigion Museum is “housed in a beautifully preserved Edwardian theatre. (They) are situated in the heart of Aberystwyth, near the seafront. The museum is home to both permanent and temporary displays that explore Ceredigion’s heritage, culture and art. The museum is open to everyone; young, old and everyone in between.” [5] The building itself is situated in the Coliseum building, which used to house a theatre. The museum is built around the theatre’s auditorium, with exhibits around where the seating used to be. The Ceredigion Museum also hosts events, most commonly weddings, on their premises. The museum also provides tours to assist Welsh learners in their learning of the language, including some basic conversational Welsh language phrases to reinforce the learning of the visitors. The museum focuses on local history and local connections with other cultures, such as the connections between Ireland and Wales. Most of the museums artefacts are from Ceredigion, and those that aren’t specifically from Ceredigion are relevant to Welsh history as a whole.

#### First visit to the Ceredigion Museum

At the beginning of this project, it was essential to research thoroughly and gather as much information as possible. It was important for those involved to visit the Ceredigion Museum and view their displays in person. This allowed us to gain a more thorough understanding of the exhibits there, and provided a lot of inspiration for the final project.

During the visit to the museum, the developer first looked around the museum exhibits alone to get a feel for what topics may be brought up in talks with museum staff. During the meeting, the developer, supervisor and a member of museum staff went through the museum and many “star exhibits” were shown as options for the project. This provided a wide variety of ideas to consider. After much discussion, it was decided that the final game would be a narrative-heavy game that took after the gameplay of “Papers, Please” and the tone of “Horrible Histories” called “Toll and Error” that focused on two star exhibits: The traditional Welsh attire and the toll board.

The decision was made to focus on these two exhibits was based on their local significance, due to the fact that the board is from nearby, and the fact that the story of the Rebecca riots piqued the interest of the team. The Welsh clothing exhibit showed beautiful traditional attire worn by women in Wales during the time period, and the toll board shows the toll fees charged during the 19th century, prompting the Rebecca Riots, which were a very significant event for local people and are remembered as an example of creativity and resilience of the local working class people when standing up for themselves against unfair practices.

#### Second visit to the Ceredigion Museum

A second visit to the museum was then made to showcase the progress made on the games concept and storyline. A presentation was made by the team and developer to the museum staff regarding the games concept, design and plotline, which was very well received by the museum staff.

Following this presentation, discussion begun regarding some of the games details. Issues raised included discussion about some of the games graphics, such as the lever to open and close the toll gates being replaced with a crank handle in the final game for accuracy, and the font being used for the project. The font used for the project is Calibri, which is due to the font being easy to read for those with visual impairments. This also allowed discussion regarding a bilingual script, which then led to the English script being pushed forward in the to-do list so that it could be sent to the museum staff for translation and returned well before the project was due to be handed in.

This second visit to the museum was crucial in finding out the smaller details of what was needed from the project. For example, if this second meeting had not taken place, the developer would have had no idea that the font was required to be a certain one, or that the game had to be translated into Welsh as a requirement (although, the developer did wish for this to be done eventually, but it was not as high priority as it should have been as a task until the meeting took place.)

Aside from these two meetings, several queries were made to museum staff via emails. Any queries regarding the history of the Rebecca Riots and toll board, as well as these queries, requests for images of the toll board were made. Unfortunately, some detail was lost to time, so some short conversations were had regarding making educated guesses on what the lost detail may have said.

### Interactive Museum Displays and Gamification

In order to find out more about what museum visitors would want out of an interactive museum display, multiple examples were researched to provide a greater understanding of the medium of web based gamification. The concept of gamification stems from the need to enhance experiences by bringing them closer to the experience of playing games by using game design elements in other contexts. This helps to keep users engaged, improve learning, improve knowledge retention, among many other valuable improvements to the experience. These principles can be applied from everything to a workplace environment, to marketing, to education. Education will be the focus of this project. [6] According to Valamis.com [7], gamification refers to “the process of using game mechanics, elements, and principles and applying them to non-game contexts to engage users better”. To be successful in this project, the developer will need to use these concepts to motivate the user to learn more about the topic at hand, and make learning engaging by making it fun.

An excellent example of educational gamification comes from the language learning app Duolingo [8], which uses game design concepts such as points, levels and characters to teach users words and phrases in their target language that they can use in the real world. The learning is also personalised to each user to help them learn at a pace and level tailored specifically to them. In my research, the application was discussed with others who I know had used the application, and they had told me that the app was “useful for brushing up on what you already know, with a website that is useful for actually learning the language. The gamification aspects are word scrambles, typing words, phrases, all there to reinforce learning in your brain. It is useful for actually getting you to type out the words and phrases.” Other educational applications that were looked into included the quiz creation apps Kahoot [9] and Quizlet [10] which utilise a format almost similar to that of a quiz based game show to keep learners engaged and bring an element of fun to educational settings. The developer chose to look into these examples as demonstrations of a strange phenomenon observed in their daily life. Namely, the fact that people do not like to take tests but will happily put on a quiz show and participate in it for no reason other than entertainment. The developer believes that applications like Quizlet and Kahoot, Kahoot especially, as it has “count down music”, game show-esque sound effects and other features that make it feel far closer to a quiz show that you might see on the television than a learning tool commonly used in classrooms, use this phenomenon to incentivise learning. Some may call this “tricking” individuals into learning, but the developer disagrees, as the user is fully aware that they are learning, but finds the act of participating in this classroom game show fun enough that the aversion to taking tests and other assessments of skill are nullified.

Researching examples from the Eureka! and Xplore! centres provided some very valuable insight into what museums want, what museum visitors of all ages and abilities want, and, importantly, what they don’t want. Looking at the displays, a pattern emerged. The displays that made it to the centres themselves, thus passing many checks and tests, were either ones that required a lot of interaction from the user, or ones that told a story.

One display of two that stuck out were a display in the Xplore! centre that a member of the team had visited as a child. This display involved two buttons, which were a button to zoom in and a button to zoom out. This enabled the user to press a button, zooming into “their own hand” (a still image of someone else pressing the same buttons at the same display in the centre) past the molecular level and to the level of quarks, or out, past the building and out to the solar system, then the universe as a whole. This example is one of the latter. The zooming in and out feature is simple, yet very effective. So much so that the user remembered their experiences with the exhibit many years. The story that was told by this exhibit was not a narrative one, but one that told the user a lot about the scale of the universe, and just how small the building blocks of life actually are.

The second of the displays that stuck out was one from the Eureka! centre that the project supervisor, Edore, informed the developer about. The display involved showing the user the science behind brewing a cup of tea, and had a giant mug of tea that the user could crank a handle to lift out of the mug. This stuck out as a very good example of an interactive display, as the concept itself was very simple, as the story it told wasn’t a grandiose story about the scale of the universe. However, this exhibit showed the former point raised earlier, that of a display that required a lot of interaction. The crank handle was something users had to physically work to achieve, and it resulted in lifting the giant teabag out of the comically oversized mug. This display may have put forward an everyday concept, but it did so in an engaging way.

“Toll and Error” takes more inspiration from the types of displays that tell stories, as the team believes that the story alone is enough to keep museum visitors engaged. They also realise that a bigger project with more interaction, such as the tea brewing display, would be far too complex of a build for this project.

### The History of the Rebecca Riots, and other miscellaneous research.

After a decision was made regarding the game’s topic, research then had to be done on the history of the riots. A lot of time was spent researching the event via articles online, podcasts, and discussion with the museum staff. This was quite an enjoyable part of the project due to the very interesting nature of the event and its prevalence in Welsh history.

In addition to researching the history of the riots, this phase also involved looking at the social and cultural context of the time. Learning about this allowed moving forward to look into how to make the tone of the script fun for all audiences. This led to looking into specific sketches from the BBC’s educational sketch comedy “Horrible Histories”. The specific sketch that inspired many parts of the script was the “Measly Middle Ages – Pay Rise” sketch that involved a medieval peasant approaching the knight he worked for to ask for a pay rise due to the plague wiping out many of them.

The team also worked closely with museum staff to ensure that the game accurately represented the exhibits and historical events depicted in the game. The staff provided valuable insight and expertise, as well as the aforementioned Welsh translation of the script.

### GameMaker2

When developing a game, one of the critical decisions that need to be made is selecting the right game engine. For the “Toll and Error” game, the team researched different game engines to determine which one would be the best fit for the project. After careful consideration, the team decided to use GameMaker, as it looked easy to use and had the features that would allow them to create an engaging and interactive game.

In the projects early phases, several different pieces of game development software were considered:

#### Unreal Engine

Unreal is a widely used game engine that is popular for its advanced graphics, high performance and versatility across a wide range of applications ranging from mobile games to virtual reality. The team, despite these advantages, determined that Unreal engine may not be the most suitable choice for the project given its emphasis on 3D game development, while the project is focused on 2D point-and-click gameplay. Additionally, Unreal requires more powerful computing resources than some other game engines, which could have caused a lot of problems down the line for the team working on the project for extended periods of time due to the fact that the hardware on the developer’s device is not suited to run something as labour intensive as Unreal for long periods of time. As a result, alternatives needed to be explored that would be better suited to both the projects needs and the team’s resources.

#### Unity

Unity is another well-known and widely used game engine that has been used extensively in the game industry. While the developer has experience using Unity for previous projects, the team acknowledges that there may be limitations for its use in this particular project. One potential drawback is that the Unity game engine is known to require a significant amount of coding, particularly in C#, which may pose challenges due to the developer being relatively unfamiliar with the C# programming language. However, despite these challenges, the flexibility and wide range of applications of Unity allowed it to be strongly considered for its suitability for this project, and for it to be thoroughly researched and compared to other options.

#### GameMaker2

GameMaker2 is widely recognised as one of the most user-friendly game engines with its drag-and-drop visual scripting language, GML Visual. The team considered it as an option for this project because of its ease of use for a beginner programmer. Given that the developer has only been programming since the beginning of the course in 2019, it would be easier to create a game that is fit for purpose using GML Visual. GameMaker 2 is also suited for a wide variety of 2D applications, meaning that the design could change if needed while still using the same piece of software. Several games that were made in GameMaker have also gone on to become widely loved, from cult classics such as the action RPG, Hyper Light Drifter [7] to critically acclaimed pop-culture phenomena such as the narrative and character heavy, “RPG where no-one has to die”, Undertale [8], from which a lot of inspiration was also taken due to the fact that the developer of Undertale also did not have much programming experience before developing the game. While concerns were raised regarding the method of publishing the game without a subscription, but these were dismissed, and GameMaker2 was selected as the game development software of choice for this project. This turned out to be a good decision, as features such as the workspaces allowed the development to be tailored and streamlined without clutter from other parts of the project interrupting the flow of work, and the object editor was more user-friendly than editing objects in Unity was.

To fully test that the software was fit for purpose, a tester game was made. This enabled full exploration of the games features in an actual game development setting and finalised the decision to use GameMaker2 over Unity to create the game.

There were challenges encountered in the process of the game, such as the more advanced features of GameMaker, and trying to code things in GML, GameMaker’s text-based programming language, that weren’t possible with GML Visual, GameMaker’s “code block” style programming language.

Deciding on, and subsequently learning to use GameMaker was critical in the development of the game.

## Analysis

The issue presented was that of a museum looking for a web-based gamification of their exhibits. To solve this problem, the task had to be broken down into smaller parts to make the whole thing more manageable. There was only one proposed approach to this, which was to first visit the museum, gain knowledge on the exhibits, decide on a topic for the project, research the topic extensively to provide historical accuracy and a compelling, entertaining game that’s tonally appropriate for all ages and abilities. The next step was to research how the game was actually going to be created. The game engine had to be decided, and then had to be researched, as despite being somewhat familiar with the game engine Unity from the “Computer Graphics and Games” module from the previous semester, prior experience with the software was still very limited, as before September 2022, the user had not been exposed to any game development software whatsoever, so was still very much a beginner in that regard.

Security is a very important issue when faced with a computing project, especially one that interfaces with the public and works with people directly, such as in the case of “Toll and Error”. However, “Toll and Error” does not take any data from users whatsoever, nor does it save anything between playthroughs of the game. Each run is completely independent from the last, with the only differences coming from decisions made within the game itself, such as language choice and decisions made by the player character. So, while still very important, security wasn’t much of a concern for this project.

The goal of this project was to present an original script written by the team via the means of a narrative game published via GameMaker’s own hosting service, GX.games. The smaller goals of this project to reach the final, ultimate end goal are:

* To gain an understanding of the Rebecca Riots for the purpose of writing a sensible script.
* To create a simple, mock-up framework for the game, for the purposes of showing both developers and museum staff how the game will look at the end of development.
* To create original graphics for the game based on the mock-up design.
* To write an original script for the game, that will then be approved and subsequently translated into Welsh by museum staff.
* To create a first, beta version of the game where there are no user decisions, and only one ending.
* To create a final version of the game where there are user decisions and two endings.

## Process

An Agile development methodology was utilised for this project. There wasn’t a rigid plan followed for this project which aligned very well with the flexible nature of Agile.

Basic principles of Agile were followed throughout the project, such as frequent communication with stakeholders (in this case, museum staff) to ensure that the project was meeting their needs, as well as adapting to changes as and when they arose. Tasks were also prioritised based on efficiency, which also aligns with the principles of Agile development, as does the clear idea of what features were needed.

An agile framework, such as Scrum or Kanban, was not used, as the development of this project was adapted very specifically to suit the work style of the developer. Choosing and then sticking strictly to a specific framework was not possible, not only due to the unknowns presented by the project, but the changing needs of the developer.

# Design

As previously mentioned, “Toll and Error” is a historical comedy game in the point-and-click adventure style of “Papers, Please”. The game follows the story of a toll collector from the 1830s-40s watching the Rebecca Riots play out in real time. The player is encouraged to make their own decisions regarding what to do about the rioters.

The game mechanics include dialogue options, and a point and click interactable objects within the world. The UI design had to facilitate this, and such, a significant amount of time was dedicated to creating a user interface that facilitates this. The user interface had to be both immersive and intuitive, and one that complemented both the game’s theme and setting.

In terms of the programming language, the programming language that was built into GameMaker2, GML, was used. GML visual was also used as it is very intuitive and beginner friendly. Many tutorials are available for both, enabling quick learning, and easy exploration of the software, especially during early phases of development.

Throughout the design process, multiple alternative designs and plot lines for the game were considered and rejected. These alternate designs included a cooking simulator style game based on the mining and processing of lead, A “What is that thing?” style of game using stone age artefacts, and a talent show rhythm game based on the Eisteddfod. While all of these ideas had merit, the team chose to focus on “Toll and Error” due to its story and local relevance.

## Detailed Design

Due to the narrative nature of the game, there was never many coded features. However, Coding has been required to implement those few features. Firstly, the game has multiple endings, and which ending the player is going to get is decided based on a score system. Certain decisions will raise the score, and certain decisions will lower it. Depending on the players score at the end of the game, the player will be shown one of two endings. This score is not visible to the player and is purely behind the scenes. The player would also be able to check different pieces of information, namely the toll price sheet and a chart of pre-decimalisation currency that was proposed to give players a better idea of what the currency of the time looked like. The player could then check whether the money being given by the toll payers was correct. The player could also crank a handle to open and close the toll gate itself to let non-player characters go through.

Another feature that had to be coded into the game was that of making the game bilingual and available in both English and Welsh. At the beginning of the game, there is a decision regarding language. Depending on which button the player presses, English or Cymraeg, that corresponding script is then loaded into the game using a Boolean variable that is altered depending on the button pressed. This decision regarding how to implement the language system was created to avoid having to hard code the dialogue, as this would have made making any edits very tedious and require sifting through code to do so. This could, in the future, also enable for further translations of the game in the future, as all that would have to be done is change the Boolean into another type of variable, and use that to load up more scripts in other languages.

## User Interface Design

The goal of the user interface design was to emulate the desk of a toll booth worker, and give various windows to show different areas of the booth, and a window for dialogue bubbles to appear inside. Everything on-screen is point-and-click, and is activated by the left mouse button. The layout is heavily inspired by that of “Papers, Please”.



Figure . The User interface of "Papers, Please"

Diagram

Description automatically generated

Figure . The User Interface of "Toll and Error"

Diagram, schematic

Description automatically generated

Figure . The User Interface of "Toll and Error", showing a customer as well as the dialogue.

The colour scheme of the user interface was based on several reference images of toll booths from Wales that existed in the 19th century. Muted, realistic colours were used to match the images found. A key image from the organisation History Daily [9] is shown below, alongside a mock-up of the final user interface design made with royalty free stock images. The sources of these images are credited in the appendices.

A small white building

Description automatically generated with low confidence

Figure . Aberystwyth Southgate Tollhouse



Figure . The mock-up of the final games User Interface

The font used for the project is Calibri. This is because, during talks with museum staff, the team were told that it is one of the best fonts for accessibility, and that the museum is required to use it for signage in order to make the museum as accessible as possible. The team also wanted to make the user interface as intuitive as possible for users who are, perhaps, visually impaired, young, or otherwise have trouble understanding user interfaces where too much is going on at once. Accessibility was a top priority of the team, as the developer has a lot of personal experience, both with themselves and their friends and family, with inaccessible software.

The user interface overall supports the design of the game, as, with the aid of the tutorial, it provides an intuitive and immersive experience when playing.

## Script Writing

As a narrative-heavy game, the script was very important to get right, and one of the projects greatest strengths. As previously mentioned, much inspiration was taken for the story from other age-appropriate historical comedy media. A lot of time and consideration was taken to ensure that the script would be entertaining for all ages, appropriate for all ages, and understandable for all ages as well. While writing the script, the developer took a lot of care to ensure that the script was appropriate for all ages, using language that is child friendly as well as understandable by younger players. A careful balance had to be made between making the script child-friendly and appropriate for all ages, making the script memorable and educational to support the telling of the story of the riots, and making the script entertaining for older audiences. This is known by the developer to be very much possible by the aforementioned Horrible Histories.

Writing the script took several days, and several iterations to get the script up to a good standard. The script also had to be translated to Welsh by museum staff. Due to the museum staff’s understandably busy schedule, translation of the script took over a week to complete, so once the script was finalised, it could not be changed. This added quite a bit of pressure to the script writing process due to the lack of ability to change the script once it was sent off for translation. However, this would have been less of a problem if there was less of a time constraint. Both the English and Welsh scripts are included in the final project file.

The development of the game relied heavily on writing and implementing the script, as the dialogue system was the games defining feature. The script served as the backbone of the game, defining the storyline and allowing the game to progress. Adding the script to the game proved difficult, but development could not continue until it was done.

# Implementation

Implementing this project provided many significant obstacles, and was very challenging to complete, and, despite the best efforts of the team, many of them were unable to overcome within the designated timeframe. No appropriate third-party code or libraries were able to be found to assist with this. However, many important aspects of the game were still complete, and, while there is no completed game, very important groundwork has been done. Due to the amount of work already completed, it could easily be continued by the current developer, or a more experienced developer could easily pick up and continue the project.

Features that have been implemented include the mock-up graphics being functional in the game, and easily replaceable by their final designs. The script is also in the game, although clicking through it is not currently possible. The scripts in both English and Welsh are finalised, and included in the games files for later implementation. Sprites have also been made representing a generic humanoid figure to be modified to become different characters, and this same sprite with a top hat was created to be the player characters boss.

Loading the dialogue was perhaps the most significant hurdle encountered, and it is still not fully implemented. A lot of time had to be dedicated to trying to fix the script failing to load, and this issue was only fixed in the final week of the project. Common bug fixes, such as checking the file path, and utilising the console to check various points in the code were tried, but, unfortunately, nothing ever worked until the last week. This obstacle took a lot of time away from other tasks where time would have been better spent, simply due to the fact that the developer was not stuck on those tasks, such as turning the mock-up User Interface into hand-drawn graphics and character sprites. This, as well as other issues with the GameMaker2 program not opening on the available hardware, caused significant delay and prevented the game from being completed.

In conclusion, the implementation is visibly unfinished, and not all requirements have been met. While an understanding of the Rebecca Riots was gained, a framework for the game and its features was made, scripts were written and some original graphics were created, the beta of the game is unfinished, and, needless to say, the final version of the game was never made within the timeframe of the project.

# Testing

Due to the very limited development of the software, there was no comprehensive testing needed. However, initially, simple tests were conducted. The plan was to have play testing take place, with several colleagues able to play the game through, and report any bugs that they found. There was also plans for the developers to play the game and go through a list of features to check them, such as dialogue progression, dialogue options, correct language, etc.

## Overall Approach to Testing

As previously mentioned, a play-testing method would have been employed for this project as well as testing by developers against a checklist of features.

This form of testing would address the design, as it would put the software into a situation where someone who had never interacted with the game before would play it, and a developer would get to see what these users, who were going in completely blind would do with the information given. This is an excellent testing method for many forms of software, but especially games. Many times, game developers who have not ran user testing as part of their process are confronted upon release with the fact that the users will attempt to do things never before thought of by developers, and often end up breaking or crashing the software.

Due to the interactive nature of the system, it relies heavily on human input. This means that automated testing would not be appropriate given the situation. Unit tests were, and would be in the future, performed manually.

## Integration Testing

Integration testing was, and would have been if the software was complete, done with every new asset or code block that was brought together in the final piece of software. Every new asset or code block added was tested as it was added to ensure the software continued to run smoothly, and so that if it did break the system, it would be easy to narrow down the issue. During integration testing was where the issue with the dialogue was discovered.

The short test table is shown below. Tests were created as the project progressed, and thus, the table includes tests done to determine why the results of previous tests happened.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Test No. | Test Action | Expected Results | Actual Results | Pass/Fail | Comments |
| 1 | Run program after adding all scenery objects. | The screen is displayed, appearing identical to the PNG mock-up. | The screen is displayed, appearing identical to the PNG mock-up.. | Pass |  |
| 2 | Run program after adding boss sprite layered behind the gui, but in front of the background. | See above, but identical to the second mock-up screen. | See above, but identical to the second mock-up screen. | Pass |  |
| 3 | Run program after adding code to load in the script, along with an error message if it fails to load. | No error message displayed. | “Error opening file: dialogue.txt” | Fail | Further tests and investigation needed to determine the exact nature of the problem. |
| 4 | Run program after fixing missing function in code, along with adding an error message showing what exactly was loaded. | Message showing: “[Boss] Ah, hello there! You must be the new toll collector! I suppose I should show you how things work here. You can click anywhere to continue.” | Message showing: “[Boss] Ah, hello there! You must be the new toll collector! I suppose I should show you how things work here. You can click anywhere to continue.” | Pass | Problem fixed. |
| 5 | Run program after adding code to display dialogue box. | “[Boss] Ah, hello there! You must be the new toll collector! I suppose I should show you how things work here. You can click anywhere to continue.” Displayed in pale area in bottom right-hand corner. | “[Boss] Ah, hello there! You must be the new toll collector! I suppose I should show you how things work here. You can click anywhere to continue.” Displayed in top left. | Fail | Text box needs moving into the corner. |
| 6 | Run program after modifying code to display dialogue box to place it in the bottom right-hand corner. | “[Boss] Ah, hello there! You must be the new toll collector! I suppose I should show you how things work here. You can click anywhere to continue.” Displayed in pale area in bottom right-hand corner. | “[Boss] Ah, hello there! You must be the new toll collector! I suppose I should show you how things work here. You can click anywhere to continue.” Displayed in pale area in bottom right-hand corner. | Pass | Problem fixed. |
| 7 | Run program and click after adding code to iterate through the array containing the script once every click. | “[Boss] Good! You can do that to speak to your customers. Next, you’ll need to know how much it costs to use the toll road. You can do that by clicking on the price list down here.” Displayed in pale area in bottom. right hand corner | No change upon left click. | Fail | Code to iterate through the array and update dialogue box needs fixing |
| 8 | Run program and click after adding code to display a message every time the left mouse is pressed. | Message showing “Dialogue Number: 1” | No message shown, no change from previous screen. | Fail | Clicks are not being detected. |
| 9 | Run program after adding additional click detection function to the code. | Message showing “Dialogue Number: 1” | No message shown, no change from previous screen. | Fail | Clicks are still not being detected. |
| 10 | Run program after moving all code relating to progressing dialogue to Step event within Game object | Message showing “Dialogue Number: 1” | Error message: “ ERROR in  action number 1 of Step Event0 for object Game:  DoAdd :: Execution Error  At gml\_Object\_Game\_Step\_0  gml\_Object\_Game\_Step\_0 (line -1)” | Fail | Clicks are still not being detected. |

These tests are as far as integration testing went. The developer is still very unclear on how this issue could be resolved, or what tests could be done to determine the nature of the problem.

## User Testing

As previously mentioned, in order to ensure that the software is user-friendly and could not be broken easily by end users, the software was planned to be tested on a group of users who had no previous interaction with the software behind the scenes. This was planned to be done using friends of the development team, museum staff, and the project supervisor. This would have allowed for a broad range of feedback, from finding criticisms based on historical context to criticisms and help based on technical knowledge. This wide range of individuals with various levels of knowledge on different aspects of the project would have rigorously evaluated the project.

This testing would have provided valuable insights into the software’s performance and usability to ensure that it was the best possible quality. Arguably, this is the best form of testing for games, although it certainly cannot exist in a vacuum.

Some planned tests for “Toll and Error” were to have play testers run through the game once while picking all of the choices that would lead to one specific ending, another time while picking all the choices that would lead to the other, another time while picking a mixture of the two, several other run throughs to ensure that endings are achievable with normal gameplay, and some tests of interactable objects in the scene via clicking on them to see if the correct response was gotten by the game. Another test that was planned was to see if any of the play testers could intentionally break the game. For this, no direction would be given to the play testers aside from “try to break the game”. From this, the team could perhaps see how, for example, anyone trying to break the game in the real world, or very young children, may interact with it, what could be done to prevent the game from breaking, and what would happen in the event of an unresolvable error caused by player actions. This would tell the team what kind of unexpected player action could be taken to cause the game to crash, return errors, or otherwise break, and how to fix the game in the event of unexpected player action so that it can be reset and played again from the beginning.

# Critical Evaluation

The requirements for this project were extensively explored, and correctly identified according to staff at the museum. The design was also very robust and able to be displayed in all contexts in which it was needed, those being on a display in the museum itself, and on the museum’s website.

It is unclear if using Unity for this project would have made it easier to complete. It would have to be remade in Unity for this to be explored fully, as the developers would have to see for themselves if the bugs encountered with GameMaker2 would also appear in Unity.

Unfortunately, the software did not meet the needs of those expecting to use it. As it is not functional at this point, it would need a lot more work done to get it to a functional state. However, it is not for a lack of effort that the software was not finished. A lot of work has been done on the project which could be useful to the museum in other ways. The developers would also be happy to continue working on the project outside of the context of the major project if needed.

While the software is not finished, the process of getting to this current point shows valuable skills when it comes to working collaboratively with others and incorporating their requirements and feedback into the project. Through engagement with museum staff and the project supervisor, important insights were gained into the user needs and expectations.

A strength of the project’s design is its adaptability, and the fact that new parts of the game could be added very easily. If, for example, a new part of the script with a new character were to be added, it could be very easily added to the script with no bugs.

In regards to future projects, the strengths from this project could be applied to any other project, computer science or not. This project shows many desirable skills to have when creating any project that is needed, such as ability to research effectively, the ability to interface with stakeholders and to apply their needs to the project being developed.

If the project was started again from the beginning, prior research on the topic in question, in this instance, the Rebecca Riots, would have been done before the time constraint began would have been ideal. Issues in the developers personal life also delayed the project significantly, some were unavoidable and some were completely unexpected. Unfortunately, it is unclear what could have been done differently in these situations.

# References

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# Appendices

## Royalty Free Image Credits

Pngall.com

Wixmp.com

Myfreetextures.com

Pexels.com

## Non-Royalty Free images used as reference in the mock up

Liveauctiongroup.net

## Sound effect credits (these did not appear in the project, but are included in the game file)

Pixabay.com

Images of the toll board and Welsh translation of the script provided by the Ceredigion Museum.