# Abstract

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# Chapter 1: Introduction

# Chapter 2: Output Summary

# Chapter 3: Literature Review

## 3.1 Application Domain

Between a lack of access to specialist facilities and an increased understanding of the benefits of at home learning, the development of software to facilitate this has become increasingly more essential. An article looking into the equipment found in state-funded schools shows that 30-60% of students are missing out on engaging in practical experiments due to limited resources despite schools recognising that a complete science learning experience is “Vital for future prosperity” (Burns, 2022). Completing science practical’s is a very important part of learning scientific concepts and the process of an investigation (How important is Practical Science in the Classroom? - Innova Design Group, 2022). Therefore, it is crucial that we make the required experiments more accessible, to allow society to flourish.

A good deal of research has taken place into the effectiveness of virtual science practical’s on scientific education. Examination shows that virtual experiments are better at facilitating understanding of complex topics, adapting to specific user requirements, and providing immediate feedback on activity (Heradio et al., 2016).

An investigation into 3D vs 2D experiments shows that 3D realistic environments are far superior at educating the users. With 2D simulations (such as PHET Interactive Simulations) having “weak attractiveness and weak reality”, compared to realistic 3D environments with high-definition graphics which are used very effectively already in military training (Liu et al., 2015).

## 3.2 Similar Software

### 3.2.1 Labster

Labster (https://www.labster.com/) is a platform that contains over 200 science experiments and practical’s that the user can complete to enhance their scientific understanding. Their research and accreditations prove the benefit of virtual experiments to students, something that encouraged my exploration of a similar topic. These practical’s are all first person and take place in a lab, recreating a complete experience. However, this software is run on an expensive subscription basis and does not have the practical I am creating. My software therefore fits this gap in a manner that is much more accessible to the general population.

### 3.2.2 PHET Interactive Simulations

PHET Interactive Simulations (https://phet.colorado.edu/) has a great many science experiments that can be completed online; however, they are not meant to be a realistic practical experience. Instead of a first-person virtual reality experience, they opt for the user moving items in a top down, 2D world. The success and widespread use of this software proves the benefits of completing at home science experiments and has inspired some of the 2D screens that I will be using. However, my project will take a 3D virtual reality approach which should improve the learning experience of the user.

### 3.2.3 Inch by Inch

Inch by Inch (Dare Looks, 2004) is a videogame developed by LevelXProject and Dare Looks that features involve a first-person character completing racing to complete a science experiment. I played this game during my research as many of the features in this game will translate into my own software. One example of this is the mechanic of building the practical set-up. In the game, the user carries an object, that has physics functionality to increase the realism, and then places this object into another one. These two models are then seamlessly replaced with a model of the two objects combined.

## 3.3 Algorithms and Architecture

### 3.3.1 Engine

The three possible game engines I considered using are Unity, Unreal and the City Engine (provided in Advanced Games Technology). Unity is known as the “go-to development environment for indie games” due to its speed and beginner friendly development. Its plan is free to use, there are vast Unity docs to support improvement and a huge asset marketplace, supporting my requirements for 3D models (Dealessandri, 2022). Unity uses C# which meets one of my goals of educating myself with a new coding language. Unreal’s emphasis lies in visual design, and whilst can create far superior environments than Unity, this is not an important consideration in my project (Eldad, 2022). Unreal, like the City Engine, uses C++ which I am familiar with and so this would not be an effective tool for my development. The city engine also requires everything to be hard coded which would introduce so much more work that I would be forced to sacrifice the grading system in my own project. I have also read the ‘Unity Game Development Cookbook’ which details many functions and uses of the editor in creating effective games. (Butterfield-Addison, Manning and Nugent, 2019)

### 3.3.2 Design patterns

Singletons represent a very useful mechanic for my project, creating a single class that can be easily accessed from any other class. This is very useful for keeping track of the current game attributes. Singletons have the benefit of not being able to be reproduced accidentally by other classes so I can also be sure the variables that are being accessed are the ones I intend to. (Butterfield-Addison, Manning and Nugent, 2019)

Using multiple states are also an essential part of my project, with each set stage of my game needing to be clearly defined and recorded. Using states reduces the complexity and can be easily designed using a finite state machine. The ability to switch between states is also far simpler than using alternative methods. (Kushwah, 2022) (Design Patterns and Refactoring, 2022)

### 3.3.3 Raycasting and Layers

Raycasting is a very useful tool that involves firing an invisible ray from one point to another, detecting all collisions it causes. In a first-person game this can help easily figure out where the player is looking and what objects they would like to select. I will use this extensively in my game (Glover, 2017). However, raycasting can cause issues by causing unwanted collisions. To alleviate this, I will organise my game objects into layers. “Layers in Unity help indicate functionalities across GameObjects”. This will allow me to classify what objects will collide with ray’s as well as what objects can interact with users and other objects (Working with the Layer Editor - Unity Learn, 2022).

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# Chapter 4 Methods

## 4.1: Methodology

My project uses an agile methodology, an iterative approach, that allowed me to break down a large software product into smaller, more manageable stages. By iterating over these planned builds, I can produce sets of functions and improvement, regularly testing them. This is a huge benefit of an agile methodology as “faults are detected earlier and can be fixed before it increases in severity” (Kumar and Bhatia, 2022). This also allows me to get feedback on each build, giving me improvements that I can make in my next iteration. “As handling change in requirements is the main feature of agile methodology” (Kumar and Bhatia, 2022) I can consistently add new ideas or adapt requirements based on my feedback. This is the biggest motivation for choosing an agile instead of waterfall methodology, the ability to add and changes ideas during development is important to the project’s success. As well as the lack of flexibility, “Once the end goal is established, Waterfall does not involve the client” (Hoory and Bottoroff, 2022) which goes against my plan of continually testing based on user feedback to provide improvements.

## 4.2 Analysis

### 4.2.1 Research

### 4.2.2 Requirements

After breaking the project down into three builds, the requirements were further broken down into several functional and non-functional requirements, with the functional requirements defined as “what the system should do” (ReQtest, 2012) and the non-functional requirements “how the system performs a certain function” (ReQtest, 2012). These are important to set out as they help guide development and to “keep project team going in the right direction” (ReQtest, 2012).

## 4.3 Design

### 4.3.1 Class Diagram

### 4.3.2 User Interface

## 4.4 Implementation

### 4.4.1 Tools

#### 4.4.1.1 Unity

Unity is a free and easy to use game engine which is perfect for beginners due to its massive online support. Along with a vast number of articles and guides, Unity also includes built in demo’s and tutorials to teach users how to use the UI as well as a very large asset store that I could use for models required in my project. The main alternative to Unity is Unreal, however, Unreal’s focus on art and visual design is not beneficial to my project, who’s visual design is very simple. In addition, Unreal uses C++ which does not then meet my objective of teaching myself a new coding language. Unity however uses C# which does meet this objective.

#### 4.4.1.2 Visual Studio

Unity comes with built in visual studio compatibility when writing C# scripts, providing code completion and simple changes to source files. Furthermore, I have experience using Visual studio which removes the learning required.

#### 4.4.1.3 Blender

Blender is a free, 3d modelling software that was used to create several assets within the project. I chose this due to its ease of use. This was very important as I had no experience using any 3D modelling software. Due to blender’s popularity there are a great deal of online tutorials that I was able to use to teach myself to use the program, which meets my objective of learning to use new pieces of software.

#### 4.4.1.4 Visual Paradigm

I used visual paradigm for the creation of design diagrams due to my previous experience using it during the Object Orientated Analysis and Design module as well as the licenses being supplied by the university.

#### 4.4.1.5 Microsoft PowerPoint

PowerPoint was used to develop the 2D user interface assets primarily due to my experience using it. I had developed 2D assets for previous classes using their simple shapes and found this to be the quickest and easiest method of developing the required assets.

### 4.4.2 Version Control

I used GitHub as a method of version control throughout my project, primarily due to my extensive experience with it in other projects. Using GitHub is easy to understand and use, providing an efficient method of regularly saving work, affording me the ability to go back to previous versions if necessary. This is essential as my project has so many interconnected parts that one small change can have a dramatic effect, something that is easier to remedy with access to previous successful versions. GitHub pushes also allow me an easy way to timetable and track my changes to ensure I am keeping on time with my project plan.

### 4.4.3 Work Plan

My project has been divided into three main builds: Physics, User Data Interaction and Grading and Scientific Knowledge. The second build (User Data Interaction) will see the project in a minimum viable product stage. It will allow the user to run the experiment and analyse the results. After my second build was completed, the software was play tested by several colleagues, who were then issued with a questionnaire. This allowed me to take on user feedback and inspired several changes and additions, detailed in the relevant sections below.

The final build is based on improvements and additions that will add to the overall user experience. Each of these builds, as well as the tasks within them were all designed to be testable with predefined success conditions as “Breaking down projects into*truly* actionable pieces means including a clear definition of done” (Georgieff, 2022). This means that I can ensure each iteration is complete before moving to another task, reducing errors made from overlooking problems early on. The specifics of each build were defined in the Gantt chart found in my PDD (Appendix A) and were kept consistent throughout the project, acting as an overall timeline.

### 4.4.4 Build 1 – Physics

The first build focuses on creating a 3d environment that the player can move around with all objects required for the practical available to be interacted with. Each of the individual pieces should be able to combine into the main apparatus and light gate should be able to measure the time taken for an object to fall through it. This build will complete the objective of recreating the science practical, without the refinement of the user being able to analyse the results.

#### 4.4.4.1 Player Control

For the player to operate in the game world a character must be created with given movement functions. This involved creating a simple object to represent the player as well as adding a camera to it which can be controlled with the mouse. A class was added to control player movement with the WASD keys as this is the most common form of movement in videogames. Both the movement and camera controls were made to be the most intuitive to the player to improve the user experience.

Finally, a class was created to be added to all objects in the game capable of being picked up by the player. This allows the user to carry around relevant items.

#### 4.4.4.2 3d Models

The essential models required in this build are the desks and practical equipment. These were either downloaded (in the case of the desks, ruler, or wires) or created in blender. The involved following online tutorials and producing practice models to teach myself how to use the system before creating the necessary models. Models were created to represent each state of the apparatus and were all loaded into unity.

#### 4.4.4.3 Physics System

All 3d models were given physics functionality and collision detection so the user can correctly interact with them as well as having the objects act realistically. User picks up and creates apparatus. The light gate was given collision detection to record the time taken for objects to fall through it. This data was then output on the timer for the user to see.

### 4.4.5 Build 2 – User Data Interaction

#### 4.4.5.1 Heads Up Display

#### 4.4.5.2 Table View

#### 4.4.5.3 Graph View

### 4.4.6 Build 3 – Grading and Scientific Knowledge

## 4.5 Testing

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# Chapter 5: Results

## 5.1 Analysis

## 5.2 Design

## 5.3 Implementation

### 5.3.1 Build 1 – Physics

#### 5.3.1.1 Player Control

To create the player character, I added a simple cylinder in unity. As the game is played in first person, the player character is not in view, so the appearance doesn’t matter. The cylinder shape was useful for my positioning of other objects. To this player I childed a camera. As the player character is moved or rotated, the same transformations will apply to any childed object, meaning I only have to set controls for the player, with the camera moving accordingly.

To move my character, I added a character controller to the player. This is a built-in unity system for simplifying the movement of a character. “Its function is to move the player according to the environment” and “provides basic collider responses without any physics” (IronEqual, 2022). The benefit of this over a RigidBody (Unity’s physics class) is that I can code the specific movement functions, ensuring that the motion is framerate dependant. I did this by factoring ‘Time.deltaTime’ into my speed calculation. Therefore, I chose to use ‘Move’ in place of ‘SimpleMove’ as the move function allows me the ability to account for framerate and program my own gravity. A second benefit to using this class is that I don’t need to handle inputs, as by default the system will move the character when using WASD.

Text

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I then created a class to control the first-person camera angle. Like the player movement, this needed to be independent of frame rate to ensure the game plays the same on all devices, meeting the non-functional requirement and allowing for maximum accessibility. After testing I found the constant float of 100.f gave the best user experience. To ensure the realism is maintained, I then clamped the rotation meaning that the player cannot look beyond directly up or directly down, matching human motion. I then applied the rotation to the player and camera before locking the mouse cursor to the screen. This ensures the mouse is invisible as having a visible mouse in the screen will remove the realism. In addition to this, by locking the mouse, the cursor is always set to the centre of the screen, meaning I can still use the mouse to select objects that are placed in the screen centre.

Text

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Finally, to create the ability to pick up objects, I added an empty game object called ‘HoldPoint’ that was childed to the player. I then created a class called ‘PickUp’ based on insert youtube. This initial code deactivates the object’s gravity and transforms it’s position to the HoldPoint position when the mouse is pressed over it. When the mouse is released, the gravity is returned, and the object falls. The PickUp script will then be applied to all objects capable of being picked up.

During the game, different functions must take place depending on what the user is holding. As such a script was created to record what item is being held. After research done in my literature review, I found that the best way to do this is to use a singleton. This is a class that exists in one single instance in the project and so can be globally accessed without defining the instance in every class that it is used in. To protect against multiple instances of the class, any new additions are destroyed instantly.

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This class is called ‘HoldPointScript’ and contains getters and setters for the string variable ‘objHolding’. In my pickup script I reference the HoldPointScript and set what item is being held, for the duration that the mouse button is down.

#### 5.3.1.2 3d Models

#### A picture containing scale Description automatically generated5.3.1.3 Physics System

In the game the objects need to be picked up, fall with gravity, and collide with one another. To add this, I used box colliders to act as bounding boxes around my objects. For more complex shapes I created stacked models which add “multiple bounding volumes as needed” – Games tech lecture 7. Having collision detection for every vertex is very computationally expensive and could cause performance issues in game so these stacked models comprised of box colliders are far more efficient.

In addition to the box colliders, many of the objects (namely the apparatus elements) require gravity to act on them. This was added using a RigidBody, unity’s built-in physics system. This means that objects will naturally fall under the effect of gravity, as well as giving the ability for me to vary physics attributes such as mass and drag. In this RigidBody system I locked the rotation for the objects that needed to be picked up to stop them from freely spinning when getting knocked by another object.

### 5.3.2 Build 2 – User Data Interaction

#### 5.3.2.1 Heads Up Display

#### 5.3.2.2 Table View

#### 5.3.2.3 Graph View

### 5.3.3 Build 3 – Grading and Scientific Knowledge

## 5.4 Testing

Results References

IronEqual, 2022. *Unity: CHARACTER CONTROLLER vs RIGIDBODY*. [online] Medium. Available at: <https://medium.com/ironequal/unity-character-controller-vs-rigidbody-a1e243591483> [Accessed 11 April 2022].

# Chapter 6: Conclusions and Discussion

# Chapter 7: References

# Appendix A, Project Definition Document and Ethics Form

**Course:** BSc (Hons) Computer Science with Games Technology

**Title:** Virtual Science Experiment using Unity

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**Proposed by:** Oliver Reekie

**Project Description:**

The goal of this project is to recreate the investigative experience of a science practical virtually, making the experience more accessible to potential users. This project will recreate the experiment ‘Determination of g from free fall’, educating the user on the scientific knowledge they are testing as well as having them design, conduct and analyse the results from their investigation, facilitating knowledge of the scientific method. Following the experiment, the user will be graded and given feedback on their performance, allowing them to repeat and tune their skills. The software developed in this project will also act as a platform for more experiments to be added to.

**Proprietary Interests:**

This project will be created using the Personal Edition of the Unity game engine in accordance with Unity’s licensing policies. I will also being using externally created assets which will all be credited with their individual copyright requirements.

**Word Count:** 1358

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## Problem to be solved

Practical science activities are essential to learning and understanding the process of scientific investigation and concepts (How important is Practical Science in the Classroom? - Innova Design Group, 2022). Therefore, bringing the ability for those studying science to engage in experimentation is an invaluable experience that many miss out on. Without access to science facilities a great many people are unable to take part in such activities, this is what my project attempts to solve. I will be using a game engine to replicate not just a science practical in a realistic virtual environment, but to recreate the entire investigative experience in a more accessible form.

This virtual laboratory experience allows users to interact with experiments in a safe and cost-effective manner, providing specialist equipment (7 Benefits of Using Virtual Labs in K-12 Education, 2022) that can be studied in the comfort of one’s own home. This allows the user to work at their own pace, repeating sections that were difficult to understand and relieving the pressure of an in-person experience (Staff, 2022). These benefits will ensure that the material is learnt in an effective way, providing the best experience to those developing their scientific understanding.

Virtual science laboratories as a method of learning do exist with the most prominent being Labster (http://www.labster.com/). However, most of these platforms are not built to be realistic and are more simple interpretations made to demonstrate concepts, not recreate a genuine experiment (https://phet.colorado.edu/en/simulations/browse).The platforms that do create these experiences such as Labster are run on subscription models and are aimed at use with a VR or AR headset. Whilst I considered producing my project in VR as it would increase the realism of the experience, this would also massively reduce the accessibility of this software, which contradicts one of the primary reasons for my application, to bring practical experiments to everyone.

As this project’s primary goal is to develop the user’s understanding of the scientific method, my software will follow the main stages that it espouses. This will begin with a question that is to be investigated with supporting background research to explain the science behind it and a stating of an initial hypothesis. We will then design the experiment in conjunction with the user, having them assemble the equipment in a 3-dimensional, first-person environment. The user will then perform the experiment, collecting data and then analysing it by graphing the data. Finally, the software will grade the user on their performance and analysis with targeted feedback. This grading, combined with the infinite replayability, means the user can continuously learn and improve their experimentation skills, something that would be impossible in an in-person setting. My software therefore follows the main stages of the scientific method, which is one of the primary subjects that my software is made to educate the user in (ProjectPlace, 2022).

The second goal of the software is to educate the user on the scientific concepts that the experiment directly relates to. For this project I will be re-creating the experiment “Determination of g from free fall”. This is a staple in practical experimentation as it does not require complex scientific understanding to comprehend, whilst still requiring graphing and the rearrangement of equations to fully complete. This experiment also works with gravity which, unlike many other experiments, is relatable and demonstrates a concept that we experience constantly. This relatability is extremely beneficial in facilitating learning (Grafwallner, 2022).

The mechanics of my project will be inspired by games such as ‘Inch by Inch’ (https://store.steampowered.com/app/992120/Inch\_by\_Inch/). This is a first-person game where the player completes science experiments by carrying items in front of them and placing them in set machines, whilst also acting as bodies that can be placed wherever the player wants. These are mechanics that will be used in my software.

## Project Objectives

This project shall use physics to create a virtual simulation of a science practical. This will involve the creation of a 3d environment with 3d models that use physics functionality that allow the user to accurately complete the experiment.

This project shall allow users to store and analyse data using separate screens that can be used to correctly measure the acceleration due to gravity.

The project shall educate users on the scientific method, principles and how to correctly organise and analyse their data.

The project shall grade the users on their ability to record and analyse the results of their work. The software shall also give feedback to allow them to improve.

## Project Beneficiaries

The primary beneficiary for this project is those attempting to learn more about the scientific method and to develop practical ability. This will therefore be useful for anyone learning or using this as a revision tool to supplement their learning.

A secondary beneficiary will be myself as this project will develop my skills and knowledge of C# and the Unity engine. This project will also be used as a portfolio piece, demonstrating my skills for future employers.

The third beneficiary will be societal benefits that come from a greater understanding of science. As science is the driving force for advancement my project, which not only teaches one experiment but acts as a platform to continually improve the use of the scientific method, will create a society that is more capable of creating the processes required to improve the world around us.

Finally, as I plan to create the interface that starts the practical experiment, the software will be able to be built upon by software developers, acting as a base platform for multiple other virtual experiments to be added to.

## Timeline Description automatically generatedWork Plan

## Project Risks

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Objective | Probability /5 | Severity /5 | Risk | Prevention | Mitigation |
| 1.1 Initial Research | 1 | 2 | It takes me longer to understand C# and unity concepts that prevents starting my development | Practise C# and Unity with online courses before the PDD approval to reduce learning time during project | Allocate time in the initial week to work on learning so it doesn’t push back my timetable |
| 1.2 3d Environment | 2 | 2 | Difficulty in finding and creating assets | Find assets before the project begins | Use blender tutorials to practise making my own assets to compensate for the lack of available ones |
| 1.3 Equipment Functionality | 3 | 4 | Issues with physics and light gate detection | Use the same physics system as 1.2 so I should have good experience when creating it | Seek advise from project team to help understand physics issues |
| 1.4 Additional Views | 4 | 5 | Difficulty in creating new views | Use Unity courses and tutorials to prepare | Continue using Unity courses to create the views |
| 2.1 HUD | 2 | 4 | Unable to correlate HUD information | Use materials from Advanced Games Tech to help add HUD display elements | Discuss with project team how best to implement HUD |
| 2.1 Table View | 4 | 5 | I am unable to have user created tables work properly | I will set aside lots of time for this section to allow for lots of practise and testing | Discuss with supervisor how best to store ad work with user input |
| 2.2 Graph View | 5 | 5 | Issues with the user graphing and averaging the results | Conduct lots of prior research into similar applications to take ideas for my own. Dedicate a lot of time to this section | Test multiple types of graphing ability and use user feedback to test simpler applications |
| 3.1 Advanced 3d Environment | 2 | 1 | Unable to find pre-made assets | Research assets before this stage and practise blender | Use blender to make my own assets |
| 3.2 Grading System | 4 | 3 | Difficulty in grading different areas of work | Discuss with supervisor to produce models for comparison | This is a key objective however can be simplified if time is a limitation to remove detailed feedback |
| 3.3 Science Knowledge | 1 | 4 | I am unable to complete this due to time limitations | Consolidate required research materials beforehand to reduce research time | Simplify to the core requirements and prioritise equation solving |
| 3.4 User Interface | 3 | 2 | I am unable to complete this interface with time limitations | The research conducted in 1.4 should prevent issues | This is an extra feature that does not affect the project’s goals so it can be left out if necessary |

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| --- |
| Ethics Review Form **Research Ethics Review Form: BSc, MSc and MA Projects**  **Computer Science Research Ethics Committee (CSREC)**  <http://www.city.ac.uk/department-computer-science/research-ethics> |

Undergraduate and postgraduate students undertaking their final project in the Department of Computer Science are required to consider the ethics of their project work and to ensure that it complies with research ethics guidelines. In some cases, a project will need approval from an ethics committee before it can proceed. Usually, but not always, this will be because the student is involving other people (“participants”) in the project.

In order to ensure that appropriate consideration is given to ethical issues, all students must complete this form and attach it to their project proposal document. There are two parts:

***PART A: Ethics Checklist***. All students must complete this part. The checklist identifies whether the project requires ethical approval and, if so, where to apply for approval.

***PART B: Ethics Proportionate Review Form****.* Students who have answered “no” to all questions in A1, A2 and A3 and “yes” to question 4 in A4 in the ethics checklist must complete this part. The project supervisor has delegated authority to provide approval in such cases that are considered to involve MINIMAL risk. The approval may be ***provisional*** *– identifying the planned research as*likely to involve MINIMAL RISK. In such cases you must additionally seek ***full approval*** from the supervisor as the project progresses and details are established. ***Full approval*** must be acquired in writing, before beginning the planned research.

**Part A: Ethics Checklist**

|  |  |  |
| --- | --- | --- |
| **A.1 If you answer YES to any of the questions in this block, you must apply to an appropriate external ethics committee for approval and log this approval as an External Application through Research Ethics Online - https://ethics.city.ac.uk/** | | *Delete as appropriate* |
| 1.1 | Does your research require approval from the National Research Ethics Service (NRES)?  e.g. because you are recruiting current NHS patients or staff?  If you are unsure try - https://www.hra.nhs.uk/approvals-amendments/what-approvals-do-i-need/ | **NO** |
| 1.2 | Will you recruit participants who fall under the auspices of the Mental Capacity Act?  Such research needs to be approved by an external ethics committee such as NRES or the Social Care Research Ethics Committee - http://www.scie.org.uk/research/ethics-committee/ | **NO** |
| 1.3 | Will you recruit any participants who are currently under the auspices of the Criminal Justice System, for example, but not limited to, people on remand, prisoners and those on probation?  Such research needs to be authorised by the ethics approval system of the National Offender Management Service. | **NO** |
| **A.2 If you answer YES to any of the questions in this block, then unless you are applying to an external ethics committee, you must apply for approval from the Senate Research Ethics Committee (SREC) through Research Ethics Online -**  **https://ethics.city.ac.uk/** | | *Delete as appropriate* |
| 2.1 | Does your research involve participants who are unable to give informed consent?  For example, but not limited to, people who may have a degree of learning disability or mental health problem, that means they are unable to make an informed decision on their own behalf. | **NO** |
| 2.2 | Is there a risk that your research might lead to disclosures from participants concerning their involvement in illegal activities? | **NO** |
| 2.3 | Is there a risk that obscene and or illegal material may need to be accessed for your research study (including online content and other material)? | **NO** |
| 2.4 | Does your project involve participants disclosing information about special category or sensitive subjects?  *For example, but not limited to: racial or ethnic origin; political opinions; religious beliefs; trade union membership; physical or mental health; sexual life; criminal offences and proceedings* | **NO** |
| 2.5 | Does your research involve you travelling to another country outside of the UK, where the Foreign & Commonwealth Office has issued a travel warning that affects the area in which you will study?  *Please check the latest guidance from the FCO -* [*http://www.fco.gov.uk/en/*](http://www.fco.gov.uk/en/) | **NO** |
| 2.6 | Does your research involve invasive or intrusive procedures?  These may include, but are not limited to, electrical stimulation, heat, cold or bruising. | **NO** |
| 2.7 | Does your research involve animals? | **NO** |
| 2.8 | Does your research involve the administration of drugs, placebos or other substances to study participants? | **NO** |
| **A.3 If you answer YES to any of the questions in this block, then unless you are applying to an external ethics committee or the SREC, you must apply for approval from the Computer Science Research Ethics Committee (CSREC) through Research Ethics Online - https://ethics.city.ac.uk/**  **Depending on the level of risk associated with your application, it may be referred to the Senate Research Ethics Committee.** | | *Delete as appropriate* |
| 3.1 | Does your research involve participants who are under the age of 18? | **NO** |
| 3.2 | Does your research involve adults who are vulnerable because of their social, psychological or medical circumstances (vulnerable adults)?  This includes adults with cognitive and / or learning disabilities, adults with physical disabilities and older people. | **NO** |
| 3.3 | Are participants recruited because they are staff or students of City, University of London?  For example, students studying on a particular course or module.  If yes, then approval is also required from the Head of Department or Programme Director. | **NO** |
| 3.4 | Does your research involve intentional deception of participants? | **NO** |
| 3.5 | Does your research involve participants taking part without their informed consent? | **NO** |
| 3.5 | Is the risk posed to participants greater than that in normal working life? | **NO** |
| 3.7 | Is the risk posed to you, the researcher(s), greater than that in normal working life? | **NO** |
| **A.4 If you answer YES to the following question and your answers to all other questions in sections A1, A2 and A3 are NO, then your project is deemed to be of MINIMAL RISK.**  **If this is the case, then you can apply for approval through your supervisor under PROPORTIONATE REVIEW. You do so by completing PART B of this form.**  **If you have answered NO to all questions on this form, then your project does not require ethical approval. You should submit and retain this form as evidence of this.** | | *Delete as appropriate* |
| 4 | Does your project involve human participants or their identifiable personal data?  *For example, as interviewees, respondents to a survey or participants in testing.* | **YES** |

**PART B: Ethics Proportionate Review Form**

If you answered YES to question 4 and NO to all other questions in sections A1, A2 and A3 in PART A of this form, then you may use PART B of this form to submit an application for a proportionate ethics review of your project. Your project supervisor has delegated authority to review and approve this application under proportionate review. You must receive final approval from your supervisor in writing before beginning the planned research.

However, if you cannot provide all the required attachments (see B.3) with your project proposal (e.g. because you have not yet written the consent forms, interview schedules etc), the approval from your supervisor will be ***provisional***. You **must** submit the missing items to your supervisor for approval prior to commencing these parts of your project. Once again, you must receive written confirmation from your supervisor that any provisional approval has been superseded by with ***full approval*** of the planned activity as detailed in the full documents. **Failure to follow this procedure and demonstrate that final approval has been achieved may result in you failing the project module.**

Your supervisor may ask you to submit a full ethics application through Research Ethics Online, for instance if they are unable to approve your application, if the level of risks associated with your project change, or if you need an approval letter from the CSREC for an external organisation.

|  |  |  |
| --- | --- | --- |
| **B.1 The following questions must be answered fully.**  **All grey instructions must be removed.** | | *Delete as appropriate* |
| 1.1. | Will you ensure that participants taking part in your project are fully informed about the purpose of the research? | **YES** |
| 1.2 | Will you ensure that participants taking part in your project are fully informed about the procedures affecting them or affecting any information collected about them, including information about how the data will be used, to whom it will be disclosed, and how long it will be kept? | **YES** |
| 1.3 | When people agree to participate in your project, will it be made clear to them that they may withdraw (i.e. not participate) at any time without any penalty? | **YES** |
| 1.4 | Will consent be obtained from the participants in your project?  Consent from participants will be necessary if you plan to involve them in your project or if you plan to use identifiable personal data from existing records. “Identifiable personal data” means data relating to a living person who might be identifiable if the record includes their name, username, student id, DNA, fingerprint, address, etc. | **YES** |
| 1.5 | Have you made arrangements to ensure that material and/or private information obtained from or about the participating individuals will remain confidential? | **YES** |

|  |  |  |
| --- | --- | --- |
| **B.2 If the answer to the following question (B2) is YES, you must provide details** | | *Delete as appropriate* |
| 2 | Will the research be conducted in the participant’s home or other non-University location?  *If* ***YES****, you must provide details of how your safety will be ensured.* | **NO** |

|  |  |  |  |
| --- | --- | --- | --- |
| **B.3 Attachments**  **ALL of the following documents MUST be provided to supervisors if applicable.**  **All must be considered prior to final approval by supervisors.**  **A written record of final approval must be provided and retained.** | ***YES*** | ***NO*** | ***Not Applicable*** |
| Details on how safety will be assured in any non-University location, including risk assessment if required (see B2) |  |  |  |
| Details of arrangements to ensure that material and/or private information obtained from or about the participating individuals will remain confidential (see B1.5)  *Any personal data must be acquired, stored and made accessible*  *in ways that are GDPR compliant.* |  |  |  |
| Full protocol for any workshops or interviews\*\* |  |  |  |
| Participant information sheet(s)\*\* |  |  |  |
| Consent form(s)\*\* |  |  |  |
| Questionnaire(s)\*\*  *sharing a Qualtrics survey with your supervisor is recommended.* |  |  |  |
| Topic guide(s) for interviews and focus groups\*\* |  |  |  |
| Permission from external organisations or Head of Department\*\*  *e.g. for recruitment of participants* |  |  |  |

*\*\*If these items are not available at the time of submitting your project proposal, then* ***provisional approval*** *can still be given, under the condition that you must submit the final versions of all items to your supervisor for approval at a later date.* ***All*** *such items* ***must*** *be seen and approved by your supervisor before the activity for which they are needed begins. Written evidence of* ***final approval*** *of your planned activity must be acquired from your supervisor before you commence.*

**Changes**

If your plans change and any aspects of your research that are documented in the approval process change as a consequence, then any approval acquired is invalid. If issues addressed in Part A (the checklist) are affected, then you must complete the approval process again and establish the kind of approval that is required. If issues addressed in Part B are affected, then you must forward updated documentation to your supervisor and have received written confirmation of approval of the revised activity before proceeding.

**Templates for Consent and Information**

You must use the templates provided by the University as the basis for your participant information sheets and consent forms. You **must** adapt them according to the needs of your project before you submit them for consideration.

Participant Information Sheets, Consent Forms and Protocols must be consistent. Please ensure that this is the case prior to seeking approval. Failure to do so will slow down the approval process.

We strongly recommend using Qualtrics to produce digital information sheets and consent forms.

**Further Information**

<http://www.city.ac.uk/department-computer-science/research-ethics>

https://www.city.ac.uk/research/ethics/how-to-apply/participant-recruitment

https://www.city.ac.uk/research/ethics

# Appendix B, Reuse Summary

# Appendix C, Questionnaire, Participant Information Sheet and Consent Form

Participant Information Sheet

**What is the purpose of this project?**

The purpose of this project is to create a virtual science experiment to provide the same at-home science learning, to individuals unable to access a laboratory environment. This questionnaire will give important feedback to improve this software to provide the best experience for the user.

**Do I have to take part?**

Participation in this questionnaire is entirely voluntary. You are permitted to withdraw at any point without incurring any penalties. Should you agree to take part you will be asked to sign a participant consent form

**What will happen if I take part?**

If you agree to take part in this questionnaire you will play the game whilst being asked a series of questions based on features that are currently implemented. You will be asked for your opinions and in some cases shown multiple versions of features to allow you to draw a comparison.

**Is my questionnaire confidential?**

Yes, no personal information will be collected, and all responses are entirely anonymous.

**What will happen with the results of the questionnaire?**

All user feedback will be collected and used to improve the current build of the game to ensure the best experience is created for the end user.

Participant Consent Form

**Please tick the following boxes to record consent**

|  |  |  |
| --- | --- | --- |
| 1 | I have had the project explained to me and have read the participant information sheet |  |
| 2 | I understand that participation in this questionnaire is voluntary and anonymous |  |
| 3 | I agree to the recording of my statements for use in project development |  |
| 4 | I consent to take part in this questionnaire |  |

# 

Questionnaire

**Question 1:** Playing the game both with and without crosshairs, which provides a better experience of aiming and realism?

**Question 2:** Is the text that appears when hovering over an object clear and easy to read? How could this be improved e.g., size and colour.

**Question 3:** Is the UI colour easy to read? Is this a pleasing colour? What other colours could provide a better experience?

**Question 4:** The game includes a timer that begins when the game is started, should this be shown to the user? If so, how?

**Question 5:** When dropping the card through the light gate, the value for the time taken for the card to fall is output on the screen (HUD) as well as shown on the light gate, is this a useful feature?

**Question 6:** When adding and removing rows to the table view, what is the best way to achieve this? Playing the game with input fields and sliders, is one of these a better mechanic? Is there another suggested method?

**Question 7:** When using the graph view, what would be a better mechanic for creating the squares on graph paper, a static image, moveable with sliders or scrollable with scroll wheel?

**Question 8:** When using the graph view, what would provide a better experience for labelling axis? A drag and drop input field mechanic or input fields that generate with each graph line?

**Question 9:** Is the game enjoyable?

**Question 10:** Are there any other comments or suggestions you would like to make that could improve the game?

# Appendix D, Questionnaire Results

Questionnaire 1

**Question 1:** Playing the game both with and without crosshairs, which provides a better experience of aiming and realism?

The crosshairs are better as it is easier to see what you are pointing at

**Question 2:** Is the text that appears when hovering over an object clear and easy to read? How could this be improved e.g., size and colour.

The text could be a darker colour, so it stands out more

**Question 3:** Is the UI colour easy to read? Is this a pleasing colour? What other colours could provide a better experience?

Yes, the colours are very easy to read

**Question 4:** The game includes a timer that begins when the game is started, should this be shown to the user? If so, how?

Yes, the timer should be shown the whole time clearly on the screen

**Question 5:** When dropping the card through the light gate, the value for the time taken for the card to fall is output on the screen (HUD) as well as shown on the light gate, is this a useful addition?

Yes, but it takes away from the realism of the experience

**Question 6:** When adding and removing rows to the table view, what is the best way to achieve this? Playing the game with input fields and sliders, is one of these a better mechanic? Is there another suggested method?

The input fields are better as they are more specific

**Question 7:** When using the graph view, what would be a better mechanic for creating the squares on graph paper, a static image, moveable with sliders or scrollable with scroll wheel?

Scroll wheel

**Question 8:** When using the graph view, what would provide a better experience for labelling axis? A drag and drop input field mechanic or input fields that generate with each graph line?

A drag and drop would be better

**Question 9:** Is the game enjoyable?

Yes, it is very enjoyable to play

**Question 10:** Are there any other comments or suggestions you would like to make that could improve the game?

No

Questionnaire 2

**Question 1:** Playing the game both with and without crosshairs, which provides a better experience of aiming and realism?

The crosshairs take away from the realism but improve the aiming experience

**Question 2:** Is the text that appears when hovering over an object clear and easy to read? How could this be improved e.g., size and colour.

The text is clear and easy to read

**Question 3:** Is the UI colour easy to read? Is this a pleasing colour? What other colours could provide a better experience?

The colours work well and are very pleasing

**Question 4:** The game includes a timer that begins when the game is started, should this be shown to the user? If so, how?

I think showing the timer is important to keep people on track

**Question 5:** When dropping the card through the light gate, the value for the time taken for the card to fall is output on the screen (HUD) as well as shown on the light gate, is this a useful addition?

No, I think it is unrealistic and should just be on the light gate

**Question 6:** When adding and removing rows to the table view, what is the best way to achieve this? Playing the game with input fields and sliders, is one of these a better mechanic? Is there another suggested method?

I think sliders are the more user friendly of the two

**Question 7:** When using the graph view, what would be a better mechanic for creating the squares on graph paper, a static image, moveable with sliders or scrollable with scroll wheel?

Using the mouse wheel to scroll is the best option

**Question 8:** When using the graph view, what would provide a better experience for labelling axis? A drag and drop input field mechanic or input fields that generate with each graph line?

Dynamic input fields are more impressive and fits with scrolling

**Question 9:** Is the game enjoyable?

Yes

**Question 10:** Are there any other comments or suggestions you would like to make that could improve the game?

No

Questionnaire 3

**Question 1:** Playing the game both with and without crosshairs, which provides a better experience of aiming and realism?

It is easy to see where you are looking so the crosshairs aren’t important

**Question 2:** Is the text that appears when hovering over an object clear and easy to read? How could this be improved e.g., size and colour.

The text is very small to see, especially if your eyesight is poor

**Question 3:** Is the UI colour easy to read? Is this a pleasing colour? What other colours could provide a better experience?

The white works well but the blue colour could be darker

**Question 4:** The game includes a timer that begins when the game is started, should this be shown to the user? If so, how?

Showing the timer could be daunting but it is useful, perhaps showing it should be optional

**Question 5:** When dropping the card through the light gate, the value for the time taken for the card to fall is output on the screen (HUD) as well as shown on the light gate, is this a useful addition?

This does make the value easier to see

**Question 6:** When adding and removing rows to the table view, what is the best way to achieve this? Playing the game with input fields and sliders, is one of these a better mechanic? Is there another suggested method?

Sliders are a better mechanic

**Question 7:** When using the graph view, what would be a better mechanic for creating the squares on graph paper, a static image, moveable with sliders or scrollable with scroll wheel?

A slider for zooming on each axis is better as the user is used to using them with the table

**Question 8:** When using the graph view, what would provide a better experience for labelling axis? A drag and drop input field mechanic or input fields that generate with each graph line?

Dragging and dropping is better because it forces the user to label the axis rather than being provided a box

**Question 9:** Is the game enjoyable?

It is very fun

**Question 10:** Are there any other comments or suggestions you would like to make that could improve the game?

The last timer value should stay on the screen so that the user doesn’t have to remember it

Questionnaire 4

**Question 1:** Playing the game both with and without crosshairs, which provides a better experience of aiming and realism?

Since the middle of the screen is where you are looking, crosshairs are not necessary

**Question 2:** Is the text that appears when hovering over an object clear and easy to read? How could this be improved e.g., size and colour.

The text should be bigger to make it more clear

**Question 3:** Is the UI colour easy to read? Is this a pleasing colour? What other colours could provide a better experience?

The colours work well but the user could be given options

**Question 4:** The game includes a timer that begins when the game is started, should this be shown to the user? If so, how?

The timer is good but should start from when the user first interacts with the pieces to give people time to get prepare

**Question 5:** When dropping the card through the light gate, the value for the time taken for the card to fall is output on the screen (HUD) as well as shown on the light gate, is this a useful addition?

This is not useful as the timer is clear to read anyway

**Question 6:** When adding and removing rows to the table view, what is the best way to achieve this? Playing the game with input fields and sliders, is one of these a better mechanic? Is there another suggested method?

If the user can press enter to add a new row this could be very intuitive

**Question 7:** When using the graph view, what would be a better mechanic for creating the squares on graph paper, a static image, moveable with sliders or scrollable with scroll wheel?

A scrolling zoom would be a better mechanic

**Question 8:** When using the graph view, what would provide a better experience for labelling axis? A drag and drop input field mechanic or input fields that generate with each graph line?

Dragging and dropping

**Question 9:** Is the game enjoyable?

Yes, it is enjoyable

**Question 10:** Are there any other comments or suggestions you would like to make that could improve the game?

Not really

Questionnaire 5

**Question 1:** Playing the game both with and without crosshairs, which provides a better experience of aiming and realism?

The crosshairs make it easy for the player to see where they are looking, but the realism is affected

**Question 2:** Is the text that appears when hovering over an object clear and easy to read? How could this be improved e.g., size and colour.

A more vibrant colour could make it clearer

**Question 3:** Is the UI colour easy to read? Is this a pleasing colour? What other colours could provide a better experience?

It is very easy to read and clear, the colours now are good as the blue is quite seamless

**Question 4:** The game includes a timer that begins when the game is started, should this be shown to the user? If so, how?

The timer is good and is realistic as a classroom would also have a timer

**Question 5:** When dropping the card through the light gate, the value for the time taken for the card to fall is output on the screen (HUD) as well as shown on the light gate, is this a useful addition?

The output on the screen makes this seem like a game rather than an actual experiment

**Question 6:** When adding and removing rows to the table view, what is the best way to achieve this? Playing the game with input fields and sliders, is one of these a better mechanic? Is there another suggested method?

I think input fields are better as they allow the user to pick an exact number of rows and columns

**Question 7:** When using the graph view, what would be a better mechanic for creating the squares on graph paper, a static image, moveable with sliders or scrollable with scroll wheel?

Sliders would be intuitive but wouldn’t be as good of an experience for the user

**Question 8:** When using the graph view, what would provide a better experience for labelling axis? A drag and drop input field mechanic or input fields that generate with each graph line?

Generating the input fields is easier for the user

**Question 9:** Is the game enjoyable?

Yes, very fun

**Question 10:** Are there any other comments or suggestions you would like to make that could improve the game?

Not at the moment

Questionnaire 6

**Question 1:** Playing the game both with and without crosshairs, which provides a better experience of aiming and realism?

The crosshairs are useful but would be better if they were optional and could be toggled on and off

**Question 2:** Is the text that appears when hovering over an object clear and easy to read? How could this be improved e.g., size and colour.

The text is easy to read so it doesn’t need to be changed

**Question 3:** Is the UI colour easy to read? Is this a pleasing colour? What other colours could provide a better experience?

The colours are nice and calming but a green colour could be good with the white text

**Question 4:** The game includes a timer that begins when the game is started, should this be shown to the user? If so, how?

The timer should be shown optionally, perhaps in a second screen that is opened optionally?

**Question 5:** When dropping the card through the light gate, the value for the time taken for the card to fall is output on the screen (HUD) as well as shown on the light gate, is this a useful addition?

The feature is useful but when considering the effects on how the experience is affected, it is not worth it

**Question 6:** When adding and removing rows to the table view, what is the best way to achieve this? Playing the game with input fields and sliders, is one of these a better mechanic? Is there another suggested method?

Sliders are better than input fields

**Question 7:** When using the graph view, what would be a better mechanic for creating the squares on graph paper, a static image, moveable with sliders or scrollable with scroll wheel?

Scrolling and sliders would be good, but I don’t think a static image would work

**Question 8:** When using the graph view, what would provide a better experience for labelling axis? A drag and drop input field mechanic or input fields that generate with each graph line?

As the game is educational, dragging and dropping is better

**Question 9:** Is the game enjoyable?

It could be more fun

**Question 10:** Are there any other comments or suggestions you would like to make that could improve the game?

A jumping mechanic would make the gameplay more realistic

Questionnaire 7

**Question 1:** Playing the game both with and without crosshairs, which provides a better experience of aiming and realism?

The crosshairs are not needed as the game is intuitive enough

**Question 2:** Is the text that appears when hovering over an object clear and easy to read? How could this be improved e.g., size and colour.

The text would be clearer if it were made larger, the colour is suitable though

**Question 3:** Is the UI colour easy to read? Is this a pleasing colour? What other colours could provide a better experience?

Yes, the background colour is very good but black would be a better text colour

**Question 4:** The game includes a timer that begins when the game is started, should this be shown to the user? If so, how?

Having the timer as an object in the game would be more realistic

**Question 5:** When dropping the card through the light gate, the value for the time taken for the card to fall is output on the screen (HUD) as well as shown on the light gate, is this a useful addition?

I don’t think this is a useful feature, the light gate is sufficient

**Question 6:** When adding and removing rows to the table view, what is the best way to achieve this? Playing the game with input fields and sliders, is one of these a better mechanic? Is there another suggested method?

Sliders are more dynamic which allow the user to adjust more easily

**Question 7:** When using the graph view, what would be a better mechanic for creating the squares on graph paper, a static image, moveable with sliders or scrollable with scroll wheel?

A scrolling mechanic is similar to other programs which means it’s probably easier for the user

**Question 8:** When using the graph view, what would provide a better experience for labelling axis? A drag and drop input field mechanic or input fields that generate with each graph line?

Generating input fields with each line

**Question 9:** Is the game enjoyable?

Yes, it is good

**Question 10:** Are there any other comments or suggestions you would like to make that could improve the game?

No

Questionnaire 8

**Question 1:** Playing the game both with and without crosshairs, which provides a better experience of aiming and realism?

The crosshairs make the experience less realistic, so the game is better without it

**Question 2:** Is the text that appears when hovering over an object clear and easy to read? How could this be improved e.g., size and colour.

The text could be a darker colour, so it stands out more

**Question 3:** Is the UI colour easy to read? Is this a pleasing colour? What other colours could provide a better experience?

The text can be difficult to see but this could be due to the text size or font

**Question 4:** The game includes a timer that begins when the game is started, should this be shown to the user? If so, how?

Having the timer clear on the screen is good

**Question 5:** When dropping the card through the light gate, the value for the time taken for the card to fall is output on the screen (HUD) as well as shown on the light gate, is this a useful addition?

No, this is not a required feature

**Question 6:** When adding and removing rows to the table view, what is the best way to achieve this? Playing the game with input fields and sliders, is one of these a better mechanic? Is there another suggested method?

Sliders are a more visually pleasing method for the user

**Question 7:** When using the graph view, what would be a better mechanic for creating the squares on graph paper, a static image, moveable with sliders or scrollable with scroll wheel?

Scroll wheel is the best

**Question 8:** When using the graph view, what would provide a better experience for labelling axis? A drag and drop input field mechanic or input fields that generate with each graph line?

Drag and drop

**Question 9:** Is the game enjoyable?

Yes

**Question 10:** Are there any other comments or suggestions you would like to make that could improve the game?

Could the table view stay open whilst doing the experiment, so the user doesn’t have to remember the values from the timer

Questionnaire 9

**Question 1:** Playing the game both with and without crosshairs, which provides a better experience of aiming and realism?

The crosshairs are not required as the game is easy to use

**Question 2:** Is the text that appears when hovering over an object clear and easy to read? How could this be improved e.g., size and colour.

The size is good but the text could be a darker colour that stands out more

**Question 3:** Is the UI colour easy to read? Is this a pleasing colour? What other colours could provide a better experience?

The colour scheme seems very natural and isn’t in the way

**Question 4:** The game includes a timer that begins when the game is started, should this be shown to the user? If so, how?

Yes, it should be, the middle of the screen is a good place

**Question 5:** When dropping the card through the light gate, the value for the time taken for the card to fall is output on the screen (HUD) as well as shown on the light gate, is this a useful addition?

No, this is not very useful

**Question 6:** When adding and removing rows to the table view, what is the best way to achieve this? Playing the game with input fields and sliders, is one of these a better mechanic? Is there another suggested method?

Input fields are a better mechanic

**Question 7:** When using the graph view, what would be a better mechanic for creating the squares on graph paper, a static image, moveable with sliders or scrollable with scroll wheel?

Sliders

**Question 8:** When using the graph view, what would provide a better experience for labelling axis? A drag and drop input field mechanic or input fields that generate with each graph line?

Drag and drop is better for teaching the user how to make a proper graph

**Question 9:** Is the game enjoyable?

Since the game is educational, it doesn’t need to be fun

**Question 10:** Are there any other comments or suggestions you would like to make that could improve the game?

The labels for the axis names and graph title should be drag and drop too. This forces the user to choose what to label

Questionnaire 10

**Question 1:** Playing the game both with and without crosshairs, which provides a better experience of aiming and realism?

The game does not require crosshairs, it is easy enough to use anyway

**Question 2:** Is the text that appears when hovering over an object clear and easy to read? How could this be improved e.g., size and colour.

The text size could be variable based on eyesight. But the colour works well

**Question 3:** Is the UI colour easy to read? Is this a pleasing colour? What other colours could provide a better experience?

A good colour scheme blends in but looks good, I think the blue and white fits this

**Question 4:** The game includes a timer that begins when the game is started, should this be shown to the user? If so, how?

I don’t think the timer should be shown as it is an extra pressure on the player

**Question 5:** When dropping the card through the light gate, the value for the time taken for the card to fall is output on the screen (HUD) as well as shown on the light gate, is this a useful addition?

Outputting on the screen feels like cheating and taking away step so I don’t think it should be included

**Question 6:** When adding and removing rows to the table view, what is the best way to achieve this? Playing the game with input fields and sliders, is one of these a better mechanic? Is there another suggested method?

Scroll wheels are the best over the others

**Question 7:** When using the graph view, what would be a better mechanic for creating the squares on graph paper, a static image, moveable with sliders or scrollable with scroll wheel?

Scrolling to zoom in and out is the most intuitive for the player

**Question 8:** When using the graph view, what would provide a better experience for labelling axis? A drag and drop input field mechanic or input fields that generate with each graph line?

Drag and drop

**Question 9:** Is the game enjoyable?

Yes

**Question 10:** Are there any other comments or suggestions you would like to make that could improve the game?

No