

# DataDestruct: The Capabilities of Education through Games

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in

The Queen's University Belfast

by

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15/04/24

## SCHOOL OF ELECTRONICS, ELECTRICAL ENGINEERING and COMPUTER SCIENCE

### CSC3002 – COMPUTER SCIENCE PROJECT

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Project Title: DataDestruct: The Capabilities of A.I in Education through Games

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### Abstract

This dissertation presents the development and the elevation of “DataDestruct”, an educational 3D Platformer game utilising the GPT-3.5 Turbo API to merge gameplay with education. The game is designed to be a tool in the classroom for understanding data structures among GCSE and A-level students. The majority of students dislike programming and data structures in the classroom, DataDestruct is a game that I have designed to help assist with overcoming these difficult topics by making learning fun and engaging. Surveys and playtest carried out in an all-female high school setting indicate the enhanced engagement and comprehension, demonstrating the potential of Game-based learning in the class.

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## **1.0 Introduction and Problem Area**

Students focus and attention span has steadily decreased over the past decade inside and outside of the class. This is heavily linked to the creation of Social Media platforms and with their dopamine activated targeted content along with the impact of COVID 19 on education. This has caused students to become more unfocused and unsettled in class, with an average attention span of between 3-35 minutes and is between 10-12 minutes in younger children [1]. It is understandable why teaching students has become more difficult. I believe that the use of AI (Artificial Intelligence) with games can help in assisting students to learn by doing. Coupled with the usage of AI platforms that has propelled into almost every industry, (such as OpenAI [32] for an example) with these two technologies working together the possibilities of learning can be engaging for the student and yet capable of giving catered responses to questions asked by the student and is ever evolving as AI can adapt.

### **1.1 Personal Context and Background**

Through studying my Computer Science degree, I have struggled with staying focused especially in particularly difficult modules like Data Structures and Algorithms. It has occurred to me that learning through the unconventional methods, the subject's material came to me much easier and in what I would consider a more enjoyable format compared to reading textbooks and scanning through blogs from people explaining these concepts. What I did find that kept my focus for a longer period was interactive animations of how data structures worked, it allowed me to understand how these concepts work, such as the Log2Base [2] platform which assisted me with learning data structures. It made me think about what if we gamified education, would this extend the focus and understanding of students. From my time working as an I.T. Technician at an all-girls' grammar school, I observed that they are very distracted in classes and have a lack of interest in terms of their subjects but specifically in their I.T. classes. My understanding from speaking with the students is that they do not like the subject because of it being difficult to understand.

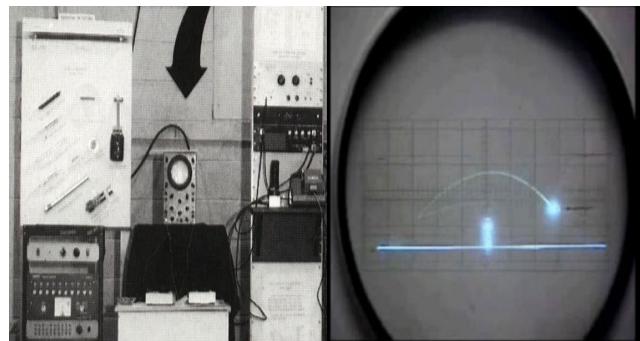
### **History of Video Games and Usage in Education**

There is no doubt about games being around for a very long time, we can look all the way back to the Century 3500 BCE (Before Common Era), where we have the first known board game created in Ancient Egypt called Senet [3] which involves the 2 players casting sticks and moving game pieces in an S-shaped path. You can see in Figure 1 the senet board and playing pieces.



*Figure 1-Image of a Senet board [4]*

Now if we leap forward many of century, we come to October 18<sup>th</sup>, 1958. The year of “Tennis for Two”, designed by the American Physicist William Higinbotham [5]; this was the first form of an electronic game where two players can use a controller, each along with an analogue computer and an oscilloscope screen (Figure 2). This allowed the players to hit a ball backwards and forwards to play a simulated 2D (two dimensional) tennis game.



*Figure 2-Image of Tennis for Two on Oscilloscope Screen [6]*

Few people know about “Tennis for Two” and may not have realised that the game Pong was not the first electronic game to be made, although albeit it is the more well-known game that was created a bit more on down the line in 1972 by Atari [7]. Pong is said to be the game that helped to kick start the launch of the gaming industry that we have today. Now we have games with realistic graphics (Figure 3) that at times can be hard to distinguish between reality or not.



Figure 3- Image from the First-Person Shooter (FPS) game called Unrecord [8]

Virtual Reality (VR) and Augmented Reality (AR) are rapidly advancing with numerous companies competing in this space to create the best VR headsets not only for the use of gaming and simulations (such as training simulations) but for common day usage in the workplace for example, Meta's (formerly known as Facebook) new Quest 3 and Apple's Vision Pro are making VR and AR more accessible to everyone and are pushing the boundaries of these technologies (Figure 4), but the first hurdle we need to get over is making any form of educational game. This brings me to the accessibility of game Engines such as Unreal Engine 5 [33] and Unity [34] are available for anyone to use now, you don't need to be a part of a games company anymore to make games, you develop them from virtually anywhere now.

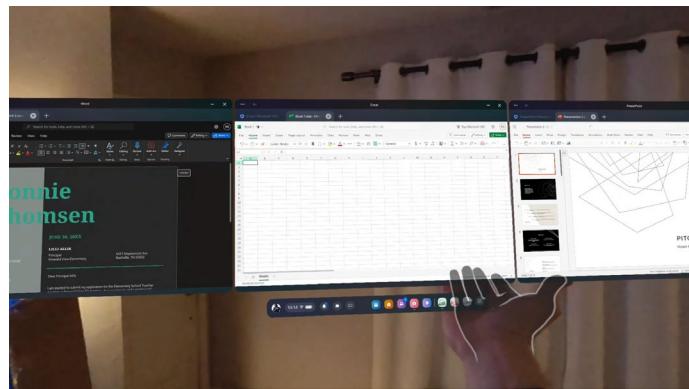


Figure 4- Image of user working in Office 365 apps on the Meta Quest 3 [9]

You are looking at an industry that is sitting at an estimated revenue worldwide of 282.30 billion US dollars in 2024 [10] and is only growing with each year. This is important at demonstrating the popularity and opportunities there is. While the history of educational games is not as extensive compared to other genres, there is some notable ones such as The Sumerian Game created in 1964 by the first female video game designer Mabel Addis (Addis was also a teacher and writer) [11]. we have very few games that are designed for educational purposes compared to other genres of games which dominate the market. One of the best examples of a modern educational game we have to date would

be Minecraft Educational Edition that acts as an interactive teaching tool in the classroom allowing students to learn about different topics through playing special version of Minecraft (Figure 5).

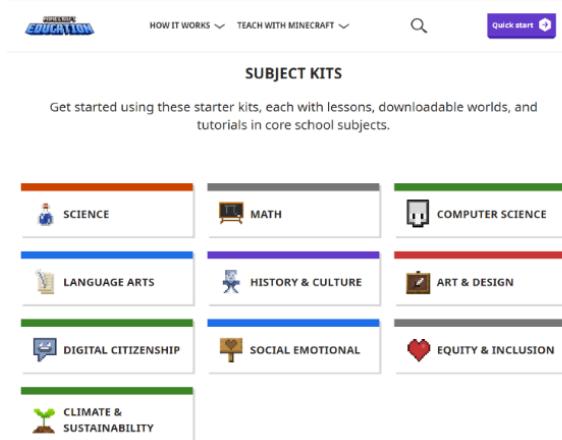


Figure 5- A screenshot of the Subject Kits from  
The Minecraft Education Website [12]

Reflecting on the history of where games started out in ancient times to where we are today with reality breaking graphics and simulations, it's clear that games have had a unique place in culture throughout the centuries by blending learning, strategy, and social aspects together. The need for more educational games is important and the likes of Minecraft Educational Edition exemplifies how immersive and interactive games can be when curated for Game-Based Learning (GBL). There is plenty of opportunity and possibilities for this form of teaching.

## 1.2 Identification of the Problem

As highlighted earlier, students often struggle to maintain focus in class, especially a lack of attention when it comes to learning difficult concepts, such as Data Structures, these are a fundamental part of computing and would greatly benefit their studies if they had a format in which they find enjoyable and engaging, as these concepts can be quite tedious in nature making them difficult to learn.

There is a gap between the tools that teachers use when teaching these concepts to students in the classroom. Traditional methods of using PowerPoints to get the subject across to the students due to the time scope of the curriculum from the examination board this is a given. Although this is not the most effective way to teach this topic and other more practical solutions should be looked upon [13]. Because of the rapid advancements of technology and the consumption habits of students with social media platforms, a call for the reassessment for the educational methodologies that are in use today in classes.

Two Surveys were carried out one geared towards the all students of the school (113 responses obtained) and the other for the teachers (15 responses obtained) it has shown a clear lack of interest in IT and that they find it the subject to an extent difficult (Figure 6), the teachers have also pointed out how they have noticed since lockdown the lack of focus students have in class (Figure 7).

**\*See appendices for the full survey questions and results.\***

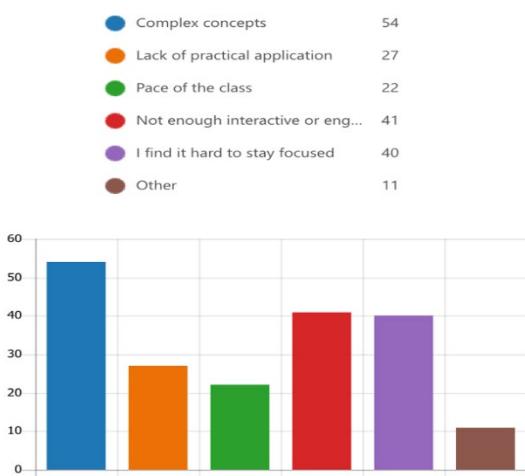


Figure 6 - graph to show "What makes IT classes challenging for you? (Select all that apply)". From Student Survey

1. Since returning to in-person classes post-COVID-19, have you observed any changes in student engagement levels?

[More Details](#)

Yes	15
No	0



2. Please elaborate if so

[More Details](#) [Insights](#)

15  
Responses

Latest Responses

"Lack motivation, gaps in subject knowledge'  
"- higher levels of poor attendance - higher levels of studen...  
"Some students attendance has not improved since returni...

Figure 7- Pie chart showing Since returning to in-person classes post-COVID-19, have you observed any changes in student engagement levels?". From Teachers Survey.

### 1.3 Methodology Description

The focus of the dissertation will revolve around the domain of computing education, specifically teaching, and learning the topic of data structures, a fundamental aspect of computing that students struggle with but will provide a strong backbone to problem solving skills. This will be done through leveraging a 3D platformer game with the GPT-3.5 Turbo Application Programming Interface (API) (Cheapest option for API tokens) [14] as an innovative tool to teach data structures. This approach is rooted in the principles of Game-Based Learning (GBL) by aiming to engage and immerse the students in interactive environments making concepts such as data structures more tangible so that will encourage more exploration experimentation through their learning.

### 1.4 Game-Based Learning Principles

Game based learning follows a range of principles for designing effective learning environments, these principles aren't set in stone and there are a range of different variations of the principles and concepts. For this project and dissertation, I will be following the principles from the research paper "Using the Concept of Game-Based Learning in Education" [15]:

- Interactivity- This is things such as environments that offer a meaningful interaction between the student playing and the game content itself. This interaction needs to engage the student effectively.
- Immersion- The game should immerse the student through multisensory representations such as narrative, visual graphics and sound design as these will help the student enter a flow state mentality enhancing enjoyment of the game as if an award of its own.
- Adaptive Problem solving- GBL should provide the learner with challenges at their level of skills where it pushes them but isn't too above their capabilities to cause annoyance and frustration to the student. By gradually adjusting difficulty of problems to match the students' abilities with help keep them motivated throughout the challenges.
- Feedback- Quality of feedback is important for the student to learn from mistakes and grow, it also helps the student to recognise their strengths too helping reassure them of progress. This can be presented in many different forms in a game such as a point system, level progression or addition of an item to represent progress.
- Exploration- Self-explanatory principle, make the game environment that will encourage the student to explore, experiment and take risk without negatively feeling consequences for trying new things. The purpose of it is to give the student a positive experience that will help in assisting them and encouraging them to learn by making failure feel like a small step to reaching success.

These are the main principles that will be followed through the dissertation and project that will be referenced in the future.

## **1.5 Research and Analysis of the Problem**

Further researching and in exploring why computing education is difficult for students especially the task of algorithmization present a cognitive challenge for learners, as evidenced by research by John Griffin Tupouniuia [16] highlight the complexities students encounter when learning the topic of foundational programming algorithms. It demonstrates the persistence of continually getting incorrect answers after refining and iterating through revisions. Because of this, it shows that the students aren't understanding the problem first which would mean that there is a gap in students' abilities to create solutions beyond the specific problem set that is given to them. This can be taken back as previously mentioned to traditional teaching methods and tools which may not be providing the sufficient skills that will bridge this gap between concepts and practical usage due to these teaching methods heavily being reliant on presentation slides and written exercises.

Furthermore, these difficulties with teach and learning programming concepts is not just due to the abstract nature of algorithms but as put forward by another pivotal study [17] that students are influenced by a much broader range of factors such as engagement, motivation and matching of educational materials to their learning needs/preferences. This research also helps to endorse the notion of traditional academic approaches to these multifaceted challenges, therefor requiring a revaluation of the tools and methods used in computing education.

## **1.6 Scope and Nature of the Problem**

The initial issue at the heart of this dissertation is the engagement gap in computing education, in foundation areas such as data structures and algorithms. Despite how important these concepts are to the field of computing and the beneficial importance of developing critical thinking and problem-solving skills, educators are facing challenges of effectively teaching students.

### **1.6.1 Scope of the research**

This research is specifically scoped to address the traditional teaching challenges associated with data structures at the GCSE and A-Level stages of secondary school students. Focusing on these educational levels the study will aim discover a pivotal moment when students make their decisions about pursing STEM (Science, technology, engineering, and mathematics) subjects into higher education. Within the scope the research will:

- Evaluate the current straits and tools used in the context of data structures within education.
- Design and asses the effectiveness of a 3D Platformer game (DataDestruct), by enhancing the student's engagement and learning outcomes.
- Gather and analyse the data from interacting with the game, quizzes, and feedback from the students to help measure the educational impact.

### **1.6.2 Nature of the problem**

The problem is multifaceted, influenced by a range of factor not limited to just the abstractness of data structures, innovative teaching tools and disengagement/distractions from students. Traditional classroom environments struggle to interest and facilitate learning into the subject because of reliance on lectures and written exercises. Moreover, the issue is augmented by the prescription that students especially in female dominated classrooms (The school that the analysis was carried out in is a cross-

community all-girls' grammar school) that IT is a daunting subject- which is a viewpoint that contributes to there being a gender gap in computing fields. For example women make up 35% of employees in STEM Fields in the U.S [18]. It's also important to look why female students are less likely to study STEM subjects. We can see from a study carried out on behalf of PwC by Opinium in 2017 [19] (Figure 8) that showed that:

- The gender gap in STEM starts early on in school and will persists through to higher education.
- Small percentage of females will consider technology as a career for their first choice with a big contrast with males. This can be due to factors such as lack of information provided to the students, perceived as a male dominated field, and seen as a lack of creativity of technology roles.
- Shortage of female role models in technology that may affect women's aspirations. From inspecting the report females are more committed to making positive differences in the world which is a message not commonly associated with tech careers.
- A-level career plans can heavily influence students to not pick a STEM subject due to high levels of pressure for high performance in these subjects.

With this report this is why it is important to also consider gender disparities through providing engaging education tools.

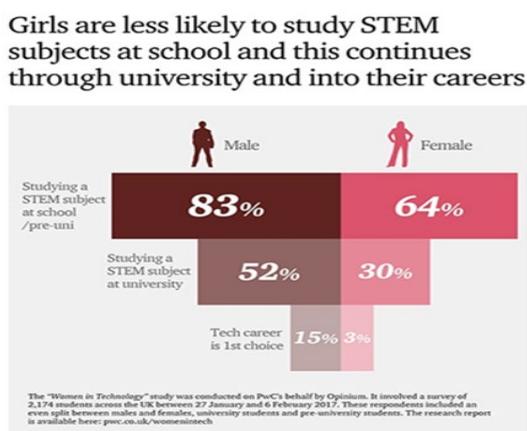


Figure 8- Diagram Showing Gender Disparity in STEM Education and Careers [20]

### 1.6.2 Innovative Solution: DataDestruct

DataDestruct is the attempt to stand as a pioneering approach to redefining the educational process through gamification. By mixing the elements of the 3D platformer with key important computer science concepts, the tool aims to transform these abstract concepts into relatable interactive

journeys. This will be done by aligning the core mechanics of the game with cognitive theories of learning such as advocating for critical thinking and hands on experiences, so that it can help solidify the students understanding of the data structures concepts in adaptive environments.

### **1.6.3 Evaluation and Assessment**

The survey will include quantitative measures such as rating scales of enjoyment and perceived learning in which they will also describe their experience and any new knowledge or perspectives they have gained. This will help provide valuable insights into the benefit as an educational tool. From these surveys and experiences can then be evaluated for the game success in enhancing engagement with computing helping to alleviate the difficulties the students associate with computing.

### **1.6.4 Contribution to Educational Technology**

In terms of contributing to the discourse of education technology, DataDestruct intends to serve as a case study for the practicality of game-based learning. The game will be leveraged to convey digital educational content and spark drive for imagination and enthusiasm within computing.

## **2.0 System Requirements and Specification**

The development of DataDestruct is guided by the comprehensive set of system requirements and specifications that are designed to keep the creation of the game effective, engaging, and accessible for an education tool below outlined is the scope of the projects functional and non-functional requirements to help achieve the projects goals (outlined in 3.3.1).

### **2.1 Functional Requirements**

The list below is what specific functionalities that DataDestruct must provide:

- The game must incorporate interactive elements that will cover the 4 selected topics of data structures such as Arrays, Stacks, Linked List and Binary Trees.
- The player must be able to move around the world with ease while having platforming elements.
- A tutorial must be implemented to teach the player the controls of the game and how it the main mechanic's work.
- The world must be immersive and interesting to explore.
- The player must be able to communicate with the GPT API and it must respond to the player by treating them as a student with a level of explanation set to high school level of education for when concepts need explained.
- The game must feel reactive to the player and allow the player to choose freely in where they want to go in the world.
- An incentive to completing Quizzes must be used so that a sense for completion and satisfaction can be presented to the player.
- Each section of the game (Each Data structure topic) must have a different theme making it feel like its own section of the open world game.
- Each section NPC must provide a basic overview of the concept and section in which the player will be able to ask questions for a deeper understanding of the concept.
- The difficulty of the game will not be too difficult so that no frustration to the player is caused, but it must not be too easy to the extent that the player gets no satisfaction.
- Each section should have its own sense of direction to tell the player were to go without hand holding them the whole way through the game.
- Sound effects and music should be used to increase attention span keeping the player ungauged.

- User feedback is important in helping the player understand why they got a question right in the quizzes or why they got it wrong.

## **2.2 Non-functional Requirements**

The below points are non-functional requirements that DataDestruct must provide:

- Menus and UI should be easily understood and accessible from all parts of the game.
- DataDestruct should be compatible with all major browsers such as Google Chrome, Firefox, Safari, and Edge.
- Code should be constructed so that it supports scalability so that future features can be implemented easier.

## **2.3 Software Requirements Specification**

The software requirements specification (or SRS) for DataDestruct is the blueprint for developing and implementing the features for the educational 3D platformer. The section below is what is required to be implemented into the game so that the prototype can be finished and used in the testing phase of the project.

### **2.3.1 Assumptions and Constraints**

The assumptions for the game are as follows:

- Users have a basic level of experience with navigating a 3D game.
- They have access to a computer with internet access for using the game in browser and for the API calls.
- Users have a basic understanding of ICT related topics and have heard of these four data structures: Arrays, Stacks, Linked List and Binary Trees.

The Constraints for the game are that follows:

- Development time deadline may limit the initial scope of the game and losses in quality in some areas may happen to get the main mechanics of the game complete. Losses may be lack of animations, models, effects, and story.
- Limited experience with Unity may also impact the progress of development as much learning will be required while making the game from the ground up.
- Web browser compatibility needs to be maintained across all the top major browsers.

- Limited amount of time for playtesting DataDestruct with the students in the school due to needing not to take up too much of their class time.
- WebGL (Web Graphics Library) is limited in aspects with rendering as it is built for web browsers.

### 2.3.2 Functional Definitions and Use Cases

<b>Use Case 1</b>	Player Character
<b>Actor</b>	Player/Student
<b>Goal</b>	Allows the player to traverse the world and interact with it while being able to jump up onto platforming elements.
<b>Preconditions</b>	Player understanding of the controls for the character.
<b>Main Flow</b>	The player controls the character by moving with the keyboard keys W, A,S,D while using the mouse to move the 3 <sup>rd</sup> person camera to look in different directions and help with orientation of the character.

<b>Use Case 2</b>	NPC Character and GPT API
<b>Actor</b>	Player/Student
<b>Goal</b>	The NPC is designed to be interacted with by the player, there will be an NPC in each of the sections in which the player can read about what the purpose of the section is and an overview of how the data structure works. Questions can be asked too via the GPT API.
<b>Preconditions</b>	Press E within range of NPC.
<b>Main Flow</b>	Player press E when near the NPC (will be prompted on screen when within range). There will be four buttons to select, Next, Back, okay (close button) and Ask Question (GPT Chat). The next and back button will be to move between the page of dialogue, the okay button is to close the UI and the Ask will bring up the GPT Chat UI allowing the player to ask questions and get a response for the API.

<b>Use Case 3</b>	Quizzes and Final door/Keys
<b>Actor</b>	Player/Student
<b>Goal</b>	To reinforce the topic of that section and get feedback while receiving one key for each of the 4 quizzes key for the final door of the game.
<b>Preconditions</b>	Player must complete a task in one of the sections to unveil the quiz for that topic.
<b>Main Flow</b>	After completing that sections task the quiz will appear for the players to do, by pressing E when in range of the quiz button they will be given the quiz UI with 4 buttons labelled A, B,C and D. These buttons will respond to the questions asked on screen allow the player to click an option then feedback will be presented after each question with a next button. Once completed the key will spawn for the player to pick up. Once all 4 keys are collected the End game door in the Hub will be able to open allow the payer to escape and move onto the end game scene.

<b>Use Case 4</b>	Section Doors and Gems
<b>Actor</b>	Player/Student
<b>Goal</b>	Player can collect gems around each of the sections which then can be used to buy the next section door. Gems will also help to guide the player in correct direction.
<b>Preconditions</b>	Specific number of gems required to buy a section door.
<b>Main Flow</b>	The player will explore the world and while doing the task will collect the gems by running into them to pick them up. The Gem count will be displayed on the UI on the left side of the screen. By following the gems, it helps to provide the user with more of a sense in direction.

<b>Use Case 5</b>	Main Menu (Starting Menu)
<b>Actor</b>	Player/Student
<b>Goal</b>	To let the player select what way they want to proceed, such as starting the game, quitting out of the game, or first choosing the option of playing the tutorial which will prompt after pressing the start button.
<b>Preconditions</b>	Game must be launched/loaded on a web browser.

<b>Main Flow</b>	The player will use this mouse to select which of the on-screen buttons so that they can progress onto their desired decision.
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<b>Use Case 6</b>	Tutorial Scene
<b>Actor</b>	Player/Student
<b>Goal</b>	Scene to help guide the player through the mechanics of the game such as controls. Collecting coins to buy doors and doing quizzes to collect keys for the final door.
<b>Preconditions</b>	Tutorial must be selected in main menu.
<b>Main Flow</b>	Player will go through the guided tutorial in which as they progress, they will be shown important information explaining what each component of the game is for etc.

<b>Use Case 7</b>	The Hub Section
<b>Actor</b>	Player/Student
<b>Goal</b>	The initial starting area in which the player will return to multiple times to reach another section of the game.
<b>Preconditions</b>	Must either complete the tutorial or progressed from the main menu.
<b>Main Flow</b>	User will first speak with the NPC and collect some coins in the hub area so they can progress through the door to the first section.

<b>Use Case 8</b>	Array Alleyway Section
<b>Actor</b>	Player/Student
<b>Goal</b>	To teach the player how to learn about the data structure arrays.
<b>Preconditions</b>	Must progress through from The Hub.
<b>Main Flow</b>	The player will speak with the NPC to find out a bit about the data structure, they will carry out the task to help understand the data structure. Once the task is completed the user can then access the quiz and receive their first key for the final door.

<b>Use Case 9</b>	Stack Overflow Section
<b>Actor</b>	Player/Student
<b>Goal</b>	To teach the player how to learn about the data structure stacks.
<b>Preconditions</b>	Progressed from the previous section (Array Alleyway) which requires several gems to buy that section door.
<b>Main Flow</b>	The player will speak with the NPC to find out information about stacks, they will carry out the task to help understand the data structure. Once the task is completed the user can then access the quiz and receive their second key for the final door of the game.

<b>Use Case 10</b>	Linked List Labyrinth Section
<b>Actor</b>	Player/Student
<b>Goal</b>	To teach the player how to learn about the data structure Linked List.
<b>Preconditions</b>	Progressed from the previous section (Stack Overflow) which requires several gems to buy that section door.
<b>Main Flow</b>	The player will talk with the NPC to find out information about linked list, they will carry out the task to help understand this data structure. Once the task is completed the user can then access the quiz and receive their third key for the final door of the game.

<b>Use Case 11</b>	Tree Top Traversal
<b>Actor</b>	Player/Student
<b>Goal</b>	The last section to teach the player about the data structure and traversal methods of binary trees.
<b>Preconditions</b>	Progressed from the previous section (Linked List) which requires several gems to buy that section door.
<b>Main Flow</b>	The player will talk with the NPC to find out information about linked list, they will carry out the task to help understand the data structure. Once the task is completed the user can then access the final quiz and receive their last key for the final door of the game.

<b>Use Case 12</b>	End Game Scene
<b>Actor</b>	Player/Student
<b>Goal</b>	The end scene to allow the user to return to the main menu or quit the game.
<b>Preconditions</b>	Must have collected all four of the keys from each of the sections and have passed through the Exit door (final game door) in the hub.
<b>Main Flow</b>	Once the user has all the keys and has entered through the exit door, they will be given two option buttons to either click return to main menu or to quit the game.

### 2.3.3 Interface Requirements

- **Player-NPC Interactions:** The interface for the communication between the NPC (Nonplayable Character) and the GPT API functionality must be simplistic and consistent across all the NPCs in the game.
- **Menu Navigation:** Using the games Menus also need to be simple to use and consistently across all the menus in the game.
- **Feedback Mechanic:** The quizzes must be revealed to the player in the world making it easier to locate and so that they know now they can progress to the next part of the game. Along with this during the quiz when a user selects an answer, they must receive feedback to show where they went wrong with their selection or where they went right by providing additional information on the options they could've selected.

### 2.3.4 User Characteristics

- **Primary users:** GCSE and A-level students with an interest or studying ICT, possessing different levels of knowledge of the subject of data structures.
- **Secondary users:** Educators who are looking for additional tools to help aid in reinforcing topics that will also keep students engaged during classes.

## 3.0 Design

### 3.1 Conceptual Framework

This design phase was to help plan DataDestruct so that when it came to adding the features and sections it helped to know what exactly to aim for in the finished prototype, through the development of game features were changed and added when discovering they didn't work quite well with other parts of the game. But with the theme and ideas for the section they mostly stayed the same through the development phase in below in section 4.0 of this dissertation.

#### 3.1.1 Project Design Vision and Goals

Following the principles of game-based learning (Section 1.4) the goal and vision for the game will to be an open world 3D platformer taking inspiration from other platformers such as Ratchet and Clank (Figure 9), Banjo-Kazooie and Spyro to keep with a cartoony look while still being detailed enough to not look too childish for the target age of the students. As previously mentioned, the world of the game needs to be immersive, interactive, educational, and most importantly fun to play, otherwise it will defeat the purpose of introducing games as engaging educational tools.



Figure 9 - Screenshot from Ratchet and Clank.

### 3.1.2 Game Loop

The game loop revolves around collecting gems, doing a task, then unlocking the quiz, collecting the key after the quiz is completed, then buying a door to the next section then it repeats in this way until 4 keys have been collected and then finally the player can proceed to the end game scene as seen in Figure 10. Whenever the user wants more detail on the topic they can ask the chat feature of the NPC. It is important to have a game loop so that the game has a sense of familiarity as you progress because if it was completely different each time then the player would feel like they are not.

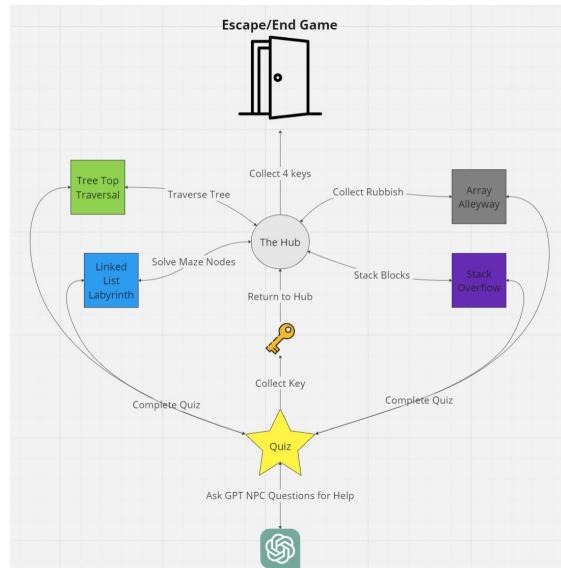


Figure 10- Flow Diagram of Game Loop

### 3.1.3 Assets

Making assets for the game is a very time-consuming task as it requires a lot of experience and knowledge for 3D modelling, texturing, rigging, animation, lighting, sound/FX production and so on. Each using their own specified software with a steep learning curve. For this project. For the scope of this project and the time span for completing its third-party assets will be used to speed up development of the game and to focus on coding the mechanics from scratch.

The main assets below are what have been chosen that best fit the vision for the game best:

**3D Models-** For 3D models a variety of the Synty POLYGON [22] Series asset packs will be used as these have are low poly (small number of polygons on the 3D models mesh, ideal for WebGL browser games) cartoony look but still a nice amount of detail, these will be perfect for the game as they are already textured and have a large number of models to choose from. Many of these packs' licenses have accumulated into possession of the developer over the past year already due to having a large interest

in game development prior to the project by getting these charity supporting bundles off the website Humble Bundle [23].

**Sound Effects-** For the sound effects another asset pack will be used from the Unity Asset Store called Universal Sound FX, this asset has over 7000 sound effects that can be used for all parts of the game. This will save a lot of time searching for copy right free effects. Sound will make the game more engaging by adding an effect to anything the player can interact with.

**Text Animation-** To save time and make the text from the NPC less daunting to read the asset Text Animator [24] will be used to give the text more character and personality. This asset is used by many large successful games for animating their text so the asset will be very beneficial for DataDestruct.

### 3.1.4 Section/Scene theme

Each section will have its own theme to help differentiate them from each other and to also help to link that environment in with the specific data structure being taught in that section. For now, the initial 5 (excluding tutorial) sections are based and themed as such:

1. The Hub - This will be the first section of the game if not coming from the Tutorial Scene. This area will be essentially just the zone that links between all the other areas. The theme will be like an experimental lab with doors to each of the other sections. The lab will be messy as if a crazy scientist has been experimenting and there will be some gems about to purchase the first door to Array Alleyway. The reason the lab setting was picked was to help symbolise the experimental nature of learning. The NPC will be directly in front of the user to introduce them to the game and give them a sense of direction to go. These assets will mostly be taken from the POLYGON Sci-Fi City Pack [24].
2. Array Alleyway (City Themed)- Will be a busy city like New York where there are crazy yellow taxis' speeding up and down the two roads that sit on each side of the alleyway. The zone will have large, towering skyscrapers making the player feel small in a large city. Some of the buildings in the alleyway will be able to be scaled by moving platforms. There will also be a park area at one of the ends of the city too. These assets will be taken from the POLYGON City Pack [25]. My reasoning for picking this theme of a city came down to the aspect of the fast-paced city and keeping cities clean by picking up litter left behind by people.

3. Stack Overflow (Viking Themed)- This section will be using the POLYGON Adventure Pack and Vikings Pack [26] to create a Viking era zone that is a small Viking village with wooden huts and wooden bridges that the player traverses to get to the different statue parts for the task. The Viking themes was picked to show an essence of an historical era.
4. Linked Labyrinth (Giant Labyrinth Themed)- This zone is self-explanatory as it will consist of a large hedge that make up the maze will path textures through the Labyrinth. The theming was picked to show that nodes of information can be scattered through memory but still be linked together. In the middle will be a giant door which is where the quiz button will be hidden in until the task is completed then they will animate to open when the user is near. While the play goes through the labyrinth a giant minotaur will patrol the maze which the player must avoid. The map boards will be made from basic shapes and textured with a wooden texture from one of the asset packs. There two main packs used here will be the POLYGON Horror Mansion pack [27] of the demon character to play the minotaur and the Poly Universal Pack [28] which is like the Synty asset packs as this pack contains a lot of hedges in it to make a labyrinth out of it while still fitting the same low poly cartoon style of the Synty POLYGON packs.
5. Tree Top Traversal (Nature Themed)- This section will involve a large, old, downed tree across a canyon with water at the bottom of it that will cause the player to respawn if they touch it. The tree will connect to the other side that the play can traverse, each side will have lots of trees and will be surrounded by mountains. The reasoning for this theme is because trees are a vital part of nature and there is no better choice than using an actual tree to help show traversal methods of the Binary tree.
6. Tutorial Scene (Traditional Platformer Themed)-The tutorial will be its own scene separate from the rest of the game and sections, here it will be floating islands in a linear format, using the Toon Environment World creator pack Lite [29] meant it will be a vibrant but short part of the game to introduce the mechanics and to show that it is not related to the main part/sections of the game. I picked a natural theming for this part of the game so that the player would focus solely on the tutorial aspect for learning how the game will work than them getting distracted by the environment.

### **3.1.5 Learning Objectives (Game Area Task)**

The learning objectives of each section (area/zone) also revolves around the theme of that environment. The data structure links into the mechanic and theming of that area to best represent and enforce the learning experience for the player:

1. Arrays – in Array Alleyway the objective and previously mentioned is to pick up trash items off the ground and place them into the corresponding array slot on the UI representation of the Array. This is to demonstrate to the student how data (or objects) can be placed into the array.
2. Stacks- In Stack Overflow the player will push parts a Viking statue into place, starting with pushing the head of the statue onto the shown location first etc. This is to demonstrate to the students that the stack data structure works by “first in last out” movements of data.
3. Linked List- The section Linked List Labyrinth will teach the student about the concept of linked list being a linear data structure as each node can be spread about wherever in memory (or in this case spread out in the labyrinth) in which they must pick a node then follow the map boards to direct them to whatever next node has been randomly selected so they may activate all 3 to open the door in the middle of the labyrinth.
4. Binary Trees- Tree Top Traversal will let the player pick a traversal method (randomly gets picked if they try and cross without picking first) which then must traverse in the correct order, if they jump on the wrong node then the tree branches will fall causing the player to fall into the water, respawning them and resetting the branches of the tree. This therefore will help them to understand how each of the nodes of a binary tree can be traversed.

## **4.0 Development**

The Development phase of the game is when the project properly started with implanting each of the features that from the initial plan and expanding on any new ones that came up while developing the game. This was the first time developing a 3D game to this scale, so everything was a new learning experience.

### **4.1 Development Environment and Tools**

#### **4.1.1 Choice of Engine and Frameworks/Libraries**

For the development environment (Or SDK for Software Development Kit) of this game Unity version 2022.3.18f1 which is a long-term support version (LTS) of Unity. The target build target for the game will be using Unity's WebGL export option to allow the game to be run in a web browser without any need to use web-specific programming languages such as JavaScript and HTML5. Unity uses the programming language C# which is a powerful language and is used by many applications but now more commonly used for games development.

Text Mesh Pro is a library that will be used for any of the text components of the game due to it being a powerful asset over Unity's own (now outdated) text objects. Cinemachine is a framework that will also be used to control the 3<sup>rd</sup> person camera as it allows for a lot more customise say and control over how the 3<sup>rd</sup> person camera should work for the player.

#### **4.1.2 Development Tools**

The Development tools that will be used to assist in creating different aspects of the game in unity and to keep track of time are:

- Visual Studio- This will be the integrated development environment (IDE) that will be used for coding with C# in with, this is the recommended IDE to use with Unity as it gives you the option to install it the same time you are installing the Unity Editor. Visual studio has useful such as auto completion and intelligence allowing for coding to be much smoother.

- Blender- A very powerful tool used for animating, 3D modelling, texturing and so much more, for data destruct blender has been used to edit 3D models such as slicing the statue into 3 sections for stack overflow (Figure 11).
- GitLab- used to keep the project in a repository so that if any issues occur the changes can be rolled back (many rollbacks occurred). Allowed for working across multiple devices too.
- Clickup.com- This website is a great tool that allowed for the project to be tracked easily, this eventually replaced the use of the Trello board as it has more features and better for monitoring the progress of the game (Figure 12).



Figure 11 - Image of 3D model getting cut into 3 using blender for the Stack Overflow section.

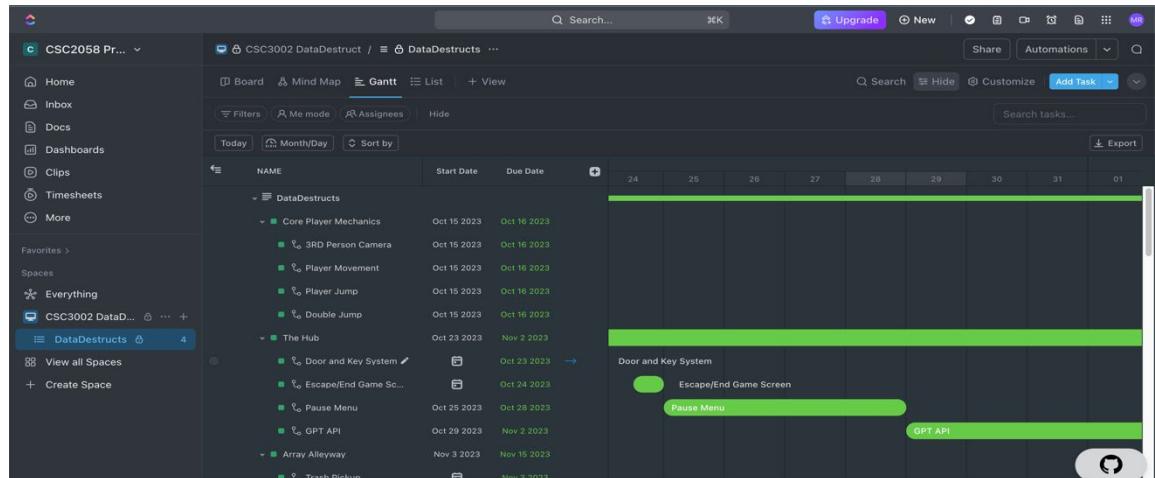


Figure 12- Screenshot of Gantt chart tracking of DataDestruct in Clickup.com

- Mixamo- This website saved a lot of time animating the characters as it provides really good quality animations for humanoid characters by downloading the ANIM file, you can apply this to the characters animator component in unity. You are also able to upload the character to the website so you can see the animation play out on the actual model.
- Miro- Another website that is a great tool for drawing out diagrams, mind mapping, flow diagrams and just conceiving areas of the game, it is a diverse and useful tool.
- Docs.unity.com- This website has been a vital tool to understand a lot of the Unity's built-in functions and libraries as it would be very difficult to program in C# without it.

- Photoshop- Used to edit images and create images such as the key UI symbol which is an image of a standard key icon spliced together with the end of a USB key. The health hearts were also quickly drawn in photoshop which are a heart mixed with a cog wheel (Figure 13).
- Itch.io [35] will be used to host the game on a web browser as this platform is simple to use and free for everyone to use allow for the game to be easily accessed. For the purpose of this project the Itch.io project page will be made private and only accessible through a link (**see appendices for link and details**) and password due to the GPT API key not being encrypted.

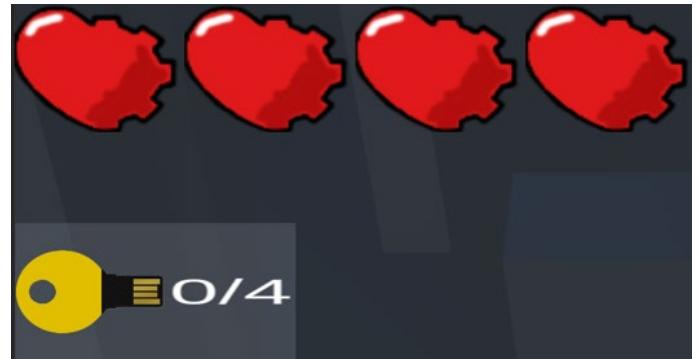


Figure 13- Player health and Key UI Icons made with photoshop.

## 4.2 Implementation Process

### 4.2.1 Player Controller Mechanics

The players mechanics consist of a few different components and scripts to build the players character, the player controllers' movement is probably the largest script of the game as it connects so many parts (Figure 14). It uses physics and forces to push the object in the direction of where the camera is facing, in the future for a game like this movement through manipulating transforms would be more suited as physics based moved had a lot of issues. Double was implemented to allow the player to platform more easily and was more enjoyable to use than a single jump. Detection of double jump was quite troubling so to detect when the play had landed again to reset the jumps a ray cast was used straight down through the player model so that the player couldn't infinitely jump.

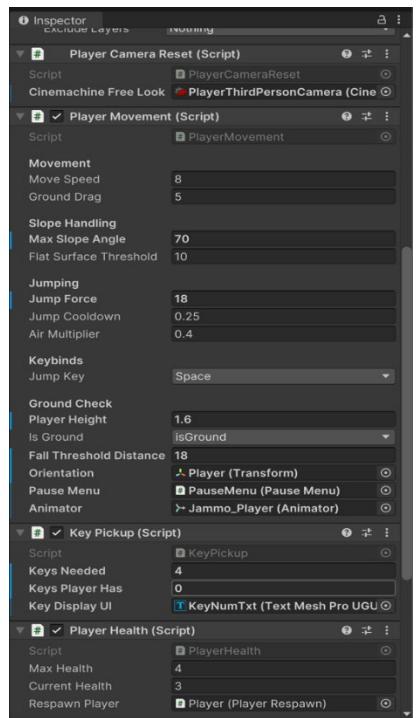


Figure 14- Image of scripts attached to the player.

Another important part of the player controller is the Cinemachine 3<sup>rd</sup> Person Free Look Camera (Figure 15) to allow the player to turn and see themselves in the world and to look around them, as mentioned the direction of camera was used to move the player in the direction of the camera. Cinemachine was difficult to get the 3rd person camera setup correctly so that it worked as intended such as no allowing the camera to be turned through walls and when respawning the player to not quickly jump back across the map to follow the player but instead respawn with them. Lots of small issues like this caused getting the 3rd person camera to act and feel right a long period of time and up until the final version of the prototype, this Cinemachine was still getting tweaked.

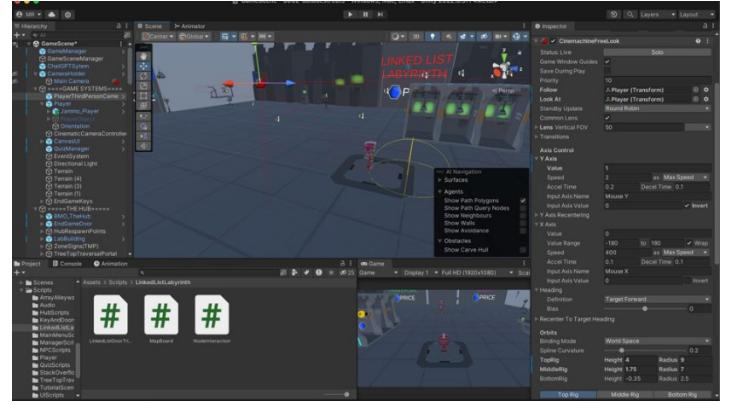


Figure 15- Image of the editor view showing the Cinemachine free look camera.

#### 4.2.2 Implementation of ChatGPT API and the NPC (B.M.O)

The NPC the user interacts with through the world is called B.M.O (short for Binary Machine Online), this NPC is interacted with using 'E' which will bring up the NPC UI, this will give the user 4 options to choose from while providing them with information on that particular section the player is in (Figure 16), B.M.O currently uses the same model as the players character [30 ]due to time constraints and is using Mixamo animations to give an happy idle animation.



Figure 16- Image of player interacting with the NPC (B.M.O).

Setting up the ChatGPT API involved purchasing tokens so that you can access an API key to use in the project so that it can be called when needed, for this the cheapest option was selected so the model used is GPT 3.5 Turbo which will be more than sufficient for the purpose of the game (Figure 17).

```
private const string API_URL = "https://api.openai.com/v1/chat/completions";
private const string API_KEY = "sk-..."; // Replace with a GPT API Key
private const string MODEL_NAME = "gpt-3.5-turbo"; // GPT model name (ChatGPT 3.5 is the current API I can get for low price)
```

Figure 17 - Image of a snippet of code from the ChatGPT script.

This was the first time working with API's and Unity's Networking API for web request with json. So, to send request and receive request was quite a messy experience (Figure 18), using this website jsonlint.com [31] helped to make sure that the json was formatted and validated correctly as visual studio will not inform you if the json is correct. This took a long time to get working due to many issues with the json formatting and Avast Antivirus was blocking web request for days before realising that the issues were not with the code and with this antivirus software discovered through testing with curl commands. The GPT API does not remember previous questions that have been asked, it is essentially send and receive one question at a time, so by prefixing a message onto the front of what the player has asked allows for the API to keep the student on track and for the API to know what its role is.

```

& frequently called -> usage -> Mark Roberts
IEnumerator CallChatGPTAPI(string message, System.Action<string> callback)
{
    // Constructs JSON request body with the provided message and a model name.
    string requestBody = "{\"model\": \"" + MODEL_NAME + "\", \"messages\": [{"role": "user", "content": ""}]}";
    Debug.Log("Sending request with body: " + requestBody);

    var request = new UnityWebRequest(API_URL, method: "POST");

    // Converts body into a byte array
    byte[] bodyRaw = Encoding.UTF8.GetBytes(requestBody);
    request.uploadHandler = (UploadHandler)new UploadHandlerRaw(bodyRaw);

    // handles response
    request.downloadHandler = (DownloadHandler)new DownloadHandlerBuffer();
    request.SetRequestHeader("Content-Type", value: "application/json");
    request.SetRequestHeader("Authorization", value: "Bearer " + API_KEY);

    // Starts request and waits for it to complete.
    yield return request.SendWebRequest();

    // Checks result of the request for errors.
    if (request.result != UnityWebRequest.Result.Success)
    {
        Debug.LogError(request.error);
        callback(0, "Error contacting API");
    }
    else
    {
        // Extracts text response from the request
        string response = request.downloadHandler.text;
        OpenAIResponse jsonResponse = JsonUtility.FromJson<OpenAIResponse>(response);
        string chatGPTMessage = jsonResponse.choices[0].message.content;
        callback(chatGPTMessage);
    }
}

```

Figure 18 - Image of the call function for the API from the C# ChatGPT script.

With the ChatGPT script attached to the NPC (B.M.O) it allows the player to open the UI so that the player can ask questions, it is a bit slow at sending and receiving, so a message to show the player saying their message has been sent and is waiting for the response (Figure 19) so that the player knows that there is a response incoming and that the chat isn't bugged.



Figure 19- Image to show awaiting message.

#### 4.2.3 Implementation of the Quiz

The quiz is another UI component that the player will prompt on screen through interaction with the quiz button that appears once a section task is done. A Cinemachine camera is animated for each button so when the task is completed the camera will switch for 3 seconds to a zooming camera on the button to show the player that it has been unlocked and where it is in that section to do the quiz. The quiz itself is easy to use by using clickable buttons (Figure 20) which would show a screen for If they got that correct or not before transitioning to give feedback with more information on each of the options is correct or false. (Figure 21). For the questions a scriptable object of a set of 3 questions and their responses was used for each section which meant the quiz script could be used multiple times as the scriptable object of questions would be swapped out for those sections. Once the quiz is complete then the player receives a key for the final door.

#### 4.2.4 Implementation of sections Mechanics

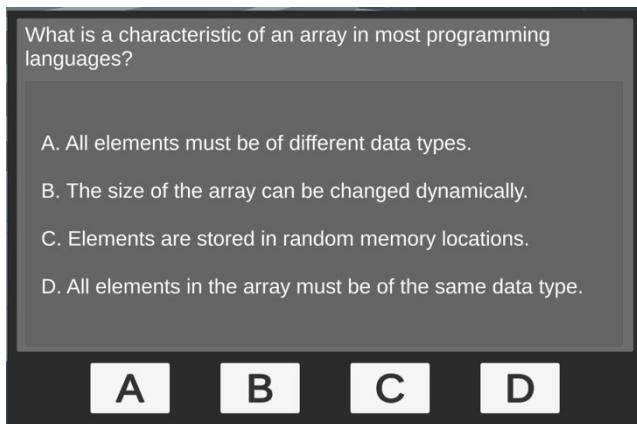


Figure 20- Image of quiz question UI.

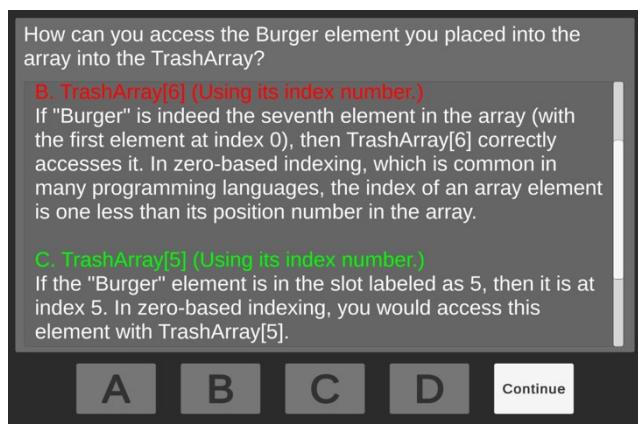


Figure 21- Image of quiz feedback UI.

Implementing these parts of DataDestruct was very time consuming as each section has its own mechanics for completion of the task, therefore most of the code from one section task was unique from the others meaning they had to be built from scratch and consisted of many different components. Below is the mechanics for each section:

#### 4.2.5 The Hub

The Hub (Figure 22) was essentially the first section of the game that was built after the testing scene (where the mechanics for the player and doors etc. were made) as this is the central part of the game world where all other parts of the world will be built around. The main mechanics for this area was to create these animated doors where the user can pick up gems to open their first door to Array Alleyway, once a door

I bought it will use a collider to detect when the player is near to quickly drop the door down and close it once they have exited the collider, the door will not allow the player to buy it if they do not have the required amount of gems. From the Hub the player can see each of the doors to the different areas that they will eventually be able to unlock. Since the section Tree Top Traversal is quite large the entrance didn't fit behind its door so instead as a work around a portal sits behind it which involves using a live texture and two cameras at each end of the portal to show a live view of the other side to create a portal effect like in Figure 23.



Figure 22- Completed section The Hub.



Figure 23- Showing live portal to Tree Top Traversal

#### 4.2.6 Array Alleyway

This section is the first section that involves doing a task and learning about the first data structure in the game which is arrays. This section starts off with the user crossing the road avoiding the crazy taxis (Figure 24), if they get hit the player will either be pushed to the side reducing their health hearts or it will instant kill their character depending on if the player got hit by the crazy taxis in the centre of its bonnet causing them to respawn back at the previous respawn point which is just outside the door to the section (there is infinite respawns, these are triggered by the player passing through their colliders). The taxis spawn randomly and will be deleted once they reach the destroy collider to prevent the game from stuttering with many taxis' objects spawning.



Figure 24- 'Crazy taxis' in the Array Alleyway city

Whenever the player speaks with BMO and clicks the “okay sure” button the array UI will appear on screen while they are within the collider for the city skybox of that section, the player will pickup trash items around the city by pressing E on them to place the item in the corresponding array (Figure 25) . Each trash object that is placed in the array will show a message on screen telling the player how many objects have been picked up so far.



Figure 25- Array UI and trash object array.

#### 4.2.7 Stack Overflow

This section has the most platforming elements of the game where the player will jump along the wooden scaffolding to get to different parts of the statue that the player must push into location to push that part on onto the stack. Guided arrows were added to show where each part is to be pushed, they appear after speaking with B.M.O (Figure 26).

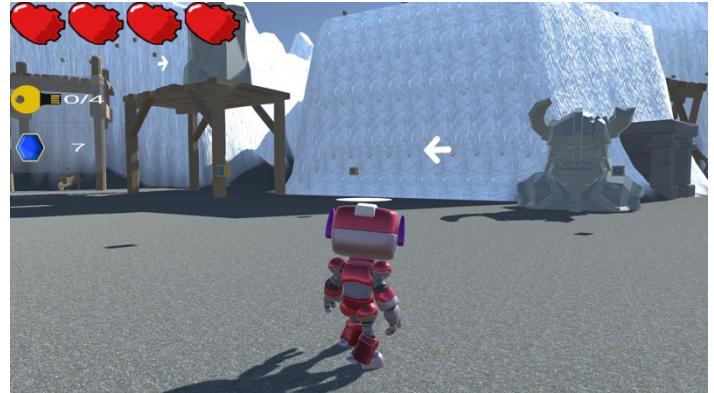


Figure 26 - Guided Arrows for pushing statue parts.

The Statue Snap script went through many iterations of how the statue can snap to a location then act the same way as a stack (first on last off), after many attempts the script that worked best was by using a quaternion (represents rotations from two dimensions to three) and transform to snap the pieces to a location then lock that object (acts like a magnet), although initially whenever the pieces snapped one on top of each other there was a big gap between the parts, so to fix this a manual height adjustment was added as it was really difficult to successfully calculate the height from each of the parts renderer bounds, so with trial and error the statue parts were able to snap on top of each other and look like one statue (Figure 27).



Figure 27-Complete statue and quiz button.

#### 4.2.8 Linked List Labyrinth

This section involves the player making their way through labyrinth to activate 3 nodes to demonstrate scattered data in memory being linked together. The player first picks one then the next node will randomly be picked with a path through the maze represented on a maze board (Figure 28), the player will activate all the nodes then once activated a collider will be set to active so that whenever they reach the doors in the middle of the labyrinth then they animate and open for the player to access the quiz button inside. Each of the node have a red light on top once activated it turns green, this is the same on the map board so if the player gets lost, they know that it has been activated already.



Figure 28 – 1 of the 4 map boards located in linked List Labyrinth.

The player will also have to avoid the centaur that patrols the maze, if they get within its collider it will squash the player respawning them at the last active respawn point (each node has a respawn point collider and the centaur cannot reach these nodes due to blocking off this in its patrolling navmesh), this is the first time programming an AI that uses Unity's navmesh that allows the AI to see where it can and can't walk (Figure 29). It's

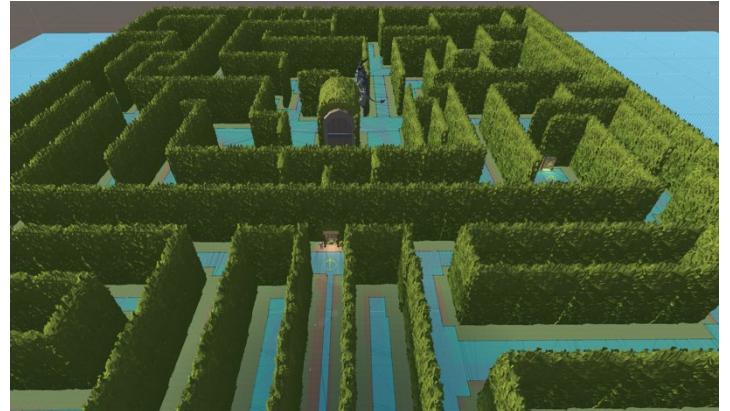


Figure 29 – Navmesh for the AI centaur to traverse.

AI is a simple patrolling one that randomises set waypoints it will patrol the labyrinth between.

#### 4.2.9 Tree Top Traversal

This is the last section of the game where the player traverses a binary tree by jumping on their nodes in the correct order. This was the most complicated part to implement as it consists of multiple scripts just to get the traversal and traversal method selection working together. Like the Linked List Labyrinth section there is a board representation that when a traversal method is selected from one of the 3 buttons in front of the board it will loop through the nodes going from white (not activated) to yellow (yellow for the next node to jump on) to green (green being an activated node), such as in Figure 30. The tree itself will also show these colours to help guide the player a bit more. However, when they jump on wrong nodes all the branches drop (Figure 31) off the tree by giving them a rigibody component to each and activating gravity on them after about 3 seconds they will revert to their initial position.



Figure 30 – Traversal method selection board.

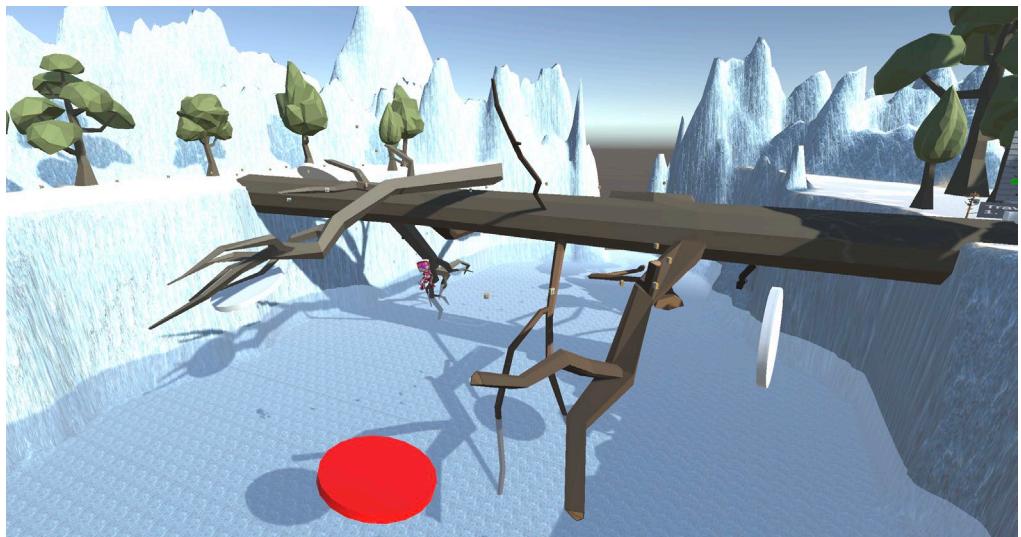


Figure 31 – False node had been jumped on causing it to go red and all branched drop off throwing the player into the water.

#### 4.2.10 Tutorial Scene

This scene was the last section to be worked on as it is a separate scene from the main part of the game. The tutorial scene is a very short part which consist mostly of colliders that the player triggers at different sections of the scene which reveal a UI component (Figure 32) on screen while pausing the game until the continue button has been pressed. Each prompt contains images of controls etc and information to help explain that mechanic of that particular section. This section was also one of the easier ones to do as the skills needed to implement these UI components had already been learnt from battling with the Unity's UI components previously from the other sections of DataDestruct.

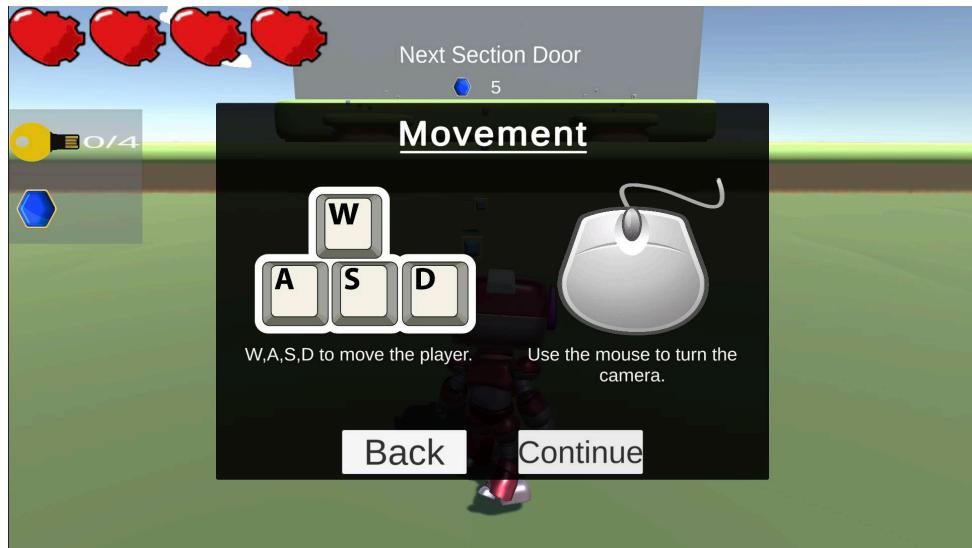


Figure 32- Tutorial Area UI prompt for player movement guidance.

#### 4.2.11 Main Menu, Pause Menu and End Game Scene

The main menu serves to transition the player into the tutorial if selected or to start straight into the game, they also have the option to quit out of the game. This is done just with UI buttons can calls to the Game Manager and Scene Manager Scripts that contains many functions that have been coded to help make the game run smoother and manager certain aspects of the game. This is when the DontDestoryOnLoad function was discovered so that that the two previously mentioned manager scripts can be carried over to the next scene and retain all their components rather than that instance being destroyed and causing issues.

The pause menu can be accessed at any point during the tutorial scene and Main Game Scene, this gives the player the option to pause the game and select if they want to quit the game, respawn, or return them to the main menu, they can resume/close the menu by clicking the X icon on the top right corner.

The final game scene will appear once the user passes through the collider it will then transition to the scene which is just a splash screen with the option to return to the main menu or to exit the game.

## 5.0 Testing and Feedback

Testing the prototype of DataDestruct with a range of 6 students from year 11 to year 13 some studying ICT and some not for GCSE or A-Level (Figure 33) allowed for useful feedback on if the game could be successful and what needs to change to accommodate the feedback to make it a useful tool in the classroom. How the testing was carried out was by letting the students play the game for 15 minutes then after they filled in a survey to give their feedback and experience. Unfortunately due to not taking up too much of the students time from classes about 20-30 minutes was all the I was willing to keep them back from their studies so therefore most did not get through the whole game, the furthest a few students got was through to linked List labyrinth, due to the nature of the game, a lot of time is taken up walking about the world and exploring, in the future for testing, a skip button tool would be beneficial so that the player can quickly move onto the next section to test. Below is the typed feedback provided by students from playing the DataDestruct (**For the full results from the test and to see response for students see Appendices section**):

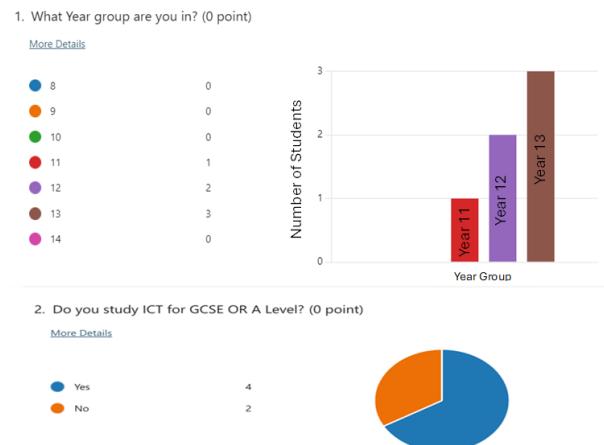


Figure 33- Year group of students and if they are studying ICT for GCSE or A-level who are testing the game.

### 5.1 Updated System Requirements based on Feedback.

Based on the Students feedback from the survey (figure 34) (**Please see Appendices for full text of student responses**) I have gone and update the UI throughout the game making it more clear and nicer to look at. I have also added more sound effects due to lack of them at the time of getting the students to test the game. They have also requested that there should be a bit more guidance in the game so more implementation into helping guide the player has been added such as numbering the Tree Nodes in Tree Top Traversal.

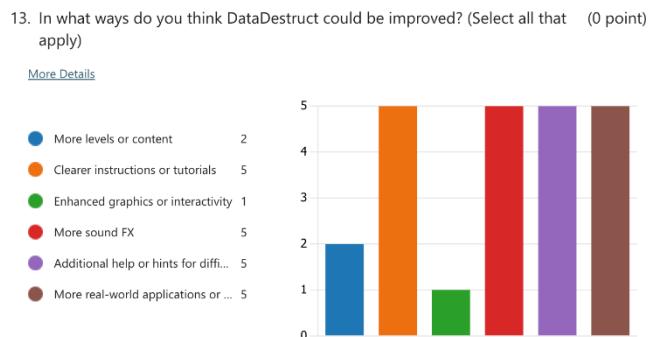


Figure 34 – Graph to show areas that need improved. From DataDestruct Playtest Survey.

## 6.0 Evaluation and Analysis

From the results of the player test and after analysing the data from all the surveys carried out this form of educational tool is wanted by the students and teachers to help enhance teaching and to break it up from the traditional methods of teaching. Out of the 6 students who played DataDestruct their response was mostly positive, they claimed that the game kept them engaged and, in some way, effective at helping them understand data structures a bit better see Figure 36 below.

11. How effective was DataDestruct in improving your understanding of data structures?

[More Details](#)

● Very effective	2
● Somewhat effective	3
● Neither effective nor ineffective	1
● Somewhat ineffective	0
● Very ineffective	0

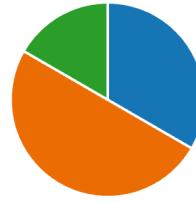


Figure 36 - Pie chart showing how effective the students thought DataDestruct is at helping them to learn Data Structures.

The most effective parts of the game seemed to be the Quizzes, Interactive puzzles, and A.I. Chat (Figure 37). I believe the reason why visual and sound effects wasn't picked was simply because of the lack of variety of effects in the game as previously stated in the feedback section.

8. Which features of DataDestruct did you find most engaging? (Select all that apply)

[More Details](#)

● Interactive puzzles	5
● Theme	3
● Visual and sound effects	1
● Quizzes	5
● A.I. Chat	5

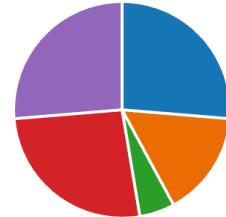


Figure 37- Pie chart showing the most engaging elements of the game.

Whoever, there is still a lot of room for improvement when trying to create an educational game that can be used as a teaching tool. Despite the positive feedback and outcome of the prototype game, as stated by the students who partook in the testing the game lacked a story, this was partially due to time a story wasn't created for the game for the sake of creating one. If a story was implemented. Many of the students pointed out that they had never really played a game on the computer and where more use to playing games on their phones or iPads, therefore the controls to them were quite

intuitive and from my observation during the testing you could see them struggling to control a player as intended at times.

The lack of competitiveness of the game as well is a downfall in its effectiveness, as teachers have stated having a competitive aspect helps students to get involved more and engaged as they compete against their peers, which is why Kahoot is widely used among the teachers (figure 38).

7 respondents (64%) answered **Kahoot** for this question.



Figure 38- Teachers who responded back to the survey about if and what tool game-based tool they have used in class.

## **7.0 Future Work**

In the future when developing an educational game further a multiplayer competitive aspect would be implemented into the game in some form, even it was to track the answers the students got correct in the quiz part of the game. There is much room for improvement, and it is still early days with this form of teaching tool, in the future it is very plausible that educational games will become commonly used in the classroom to assist with teaching subjects in a more enjoyable way. Some technologies are already being developed that would greatly help in creating these tools such as announced recently in the Unity 6 presentation that they will be impacting the WebGPU API [36] that allows the web browser to utilise the GPU of the computer better (Graphical Processing Unit), which means games in a web browser to run much smoother this would in theory replace WebGL because of its better performance. We can also see how fast technology is advancing especially with the help of AI being used everywhere, it will be very interesting to see where AI can be taken in the classroom and how games can be used to assist with teaching.

## References

- [1] J. Lindner, "Student's Attention Span Statistics And Trends in 2024," Gitnux, December 16, 2023. [Online]. Available: <https://gitnux.org/students-attention-span-statistics/>. [14 March, 2024].
- [2] LOG2BASE2. (n.d.). LOG2BASE2 - World's First Visual Learning Platform [Online]. Available: <https://log2base2.com>. [Accessed: March. 9, 2024].
- [3] "8 Oldest Board Games in the World," Oldest.org. [Online]. Available: <https://www.oldest.org/entertainment/board-games/>. [Accessed: March 09, 2024].
- [4] K. Schengili-Roberts, "Faience senet board and playing pieces inscribed with the name of Amunhotep III," September 3, 2023. [Online]. Available: <https://egyptianstreets.com/2023/09/03/senet-the-worlds-oldest-board-game-and-ancient-egypts-favorite-pastime/>. [Accessed: March. 9, 2024].
- [5] Brookhaven National Laboratory, "The First Video Game?" [Online]. Available: <https://www.bnl.gov/about/history/firstvideo.php>. [Accessed: March 09, 2024].
- [6] A. Christie, "Digging into Tennis for Two," Maker Lab in the Humanities, University of Victoria, July 30, 2013. [Online]. Available: <https://maker.uvic.ca/tennis/>. [Accessed: March 09, 2024].
- [7] "Pong," in Encyclopaedia Britannica. [Online]. Available: <https://www.britannica.com/topic/Pong>. [Accessed: March 10, 2024].
- [8] IGN, "Unrecord Official Early Gameplay Trailer still," IGN, [Online]. Available: <https://www.ign.com/videos/the-unrecord-gameplay-looks-unbelievably-realistic-so-we-played-the-ue5-level-it-was-built-on>. [Accessed: Mar. 12, 2024].
- [9] S. Endicott, "Microsoft Office on the Meta Quest 3," Windows Central, December 15, 2023. [Online]. Available: <https://www.windowscentral.com/gaming/virtual-reality/microsoft-office-on-the-meta-quest-3-and-i-dont-even-have-an-o365-subscription-a-vr-expert-shows-how-to-make-the-perfect-virtual-desk>. [Accessed: March 13, 2024].
- [10] Statista, "Video Games - Worldwide," Statista.com. [Online]. Available: <https://www.statista.com/outlook/dmo/digital-media/video-games/worldwide>. [March 10, 2024].

- [11]"Mabel Addis," Women of IxD. [Online]. Available: <https://womenofidx.com/stories/mabel-addis>. [Accessed: Mar. 12, 2024].
- [12]Minecraft Education Edition, "Subject Kits," Minecraft Education Edition, [Online]. Available: <https://education.minecraft.net/en-us/resources/explore-lessons>. [Accessed: Mar. 12, 2024].
- [13]C. S. Cheah, "Factors Contributing to the Difficulties in Teaching and Learning of Computer Programming: A Literature Review," *Contemporary Educational Technology*, vol. 12, no. 2, ep272, 2020. [Online]. Available: <https://www.cedtech.net/download/factors-contributing-to-the-difficulties-in-teaching-and-learning-of-computer-programming-a-8247.pdf>
- [14]OpenAI, "Pricing," OpenAI. [Online]. Available: <https://openai.com/pricing>. [Accessed: Mar 12, 2024].
- [15]Z.-Y. Liu, Z. A. Shaikh, and F. G. Gazizova, "Using the Concept of Game-Based Learning in Education," *International Journal of Technology in Education and Science (IJTES)*, [Online]. Available: <https://doi.org/10.3991/ijet.v15i14.14675>. [Accessed: Mar 16, 2024].
- [16]J. G. Tupouniuia, "What challenges emerge when students engage with algorithmatizing tasks?" *Journal of Pedagogical Research*, vol. 7, no. 2, pp. 93-107, 2023. [Online]. Available: [https://www.researchgate.net/publication/371470302\\_What\\_challenges\\_emerge\\_when\\_students\\_engage\\_with\\_algorithmatizing\\_tasks](https://www.researchgate.net/publication/371470302_What_challenges_emerge_when_students_engage_with_algorithmatizing_tasks). [Accessed: Mar 17, 2024].
- [17]E. Vrachnos and A. Jimoyiannis, "Secondary education students' difficulties in algorithmic problems with arrays: An analysis using the SOLO taxonomy," *Themes in Science & Technology Education*, vol. 10, no. 1, pp. 31-52, 2017. [Online]. Available: <https://typeset.io/>. [Accessed: Mar 17, 2024].
- [18]Women Tech Network, "Girls are less likely to study STEM subjects at school and this continues through university and into their careers," 2024. [Online]. Available: <https://www.womentech.net/en-gb/women-in-tech-stats>. [Mar 18, 2024].
- [19]PwC UK, "Women in Tech: Time to close the gender gap," 2017. [Online]. Available: <https://www.pwc.co.uk/women-in-technology/women-in-tech-report.pdf>. [Accessed: Mar 18, 2024].
- [20]PwC UK, "Girls are less likely to study STEM subjects at school and this continues through university and into their careers," in \*Women in Tech: Time to close the gender gap\*, PwC UK, 2017. [Online]. Available: <https://www.pwc.co.uk/women-in-technology/women-in-tech-report.pdf>. [Accessed: Mar 18, 2024].
- [21]"Every planet in Ratchet & Clank PS4 (2016)," Image. Available: <https://preview.redd.it/every-planet-in-ratchet-clank-ps4-2016-v0-m3b0pd9x3ldc1.jpg>. [Accessed: Mar 24, 2024].

- [22]Humble Bundle, "Homepage," [Online]. Available:  
[https://www.humblebundle.com/?partner=edi&gad\\_source=1](https://www.humblebundle.com/?partner=edi&gad_source=1). [Accessed: Mar 24, 2024].
- [23]Unity Technologies, "Universal Sound FX," Unity Asset Store, 2023. [Online]. Available:  
<https://assetstore.unity.com/packages/audio/sound-fx/universal-sound-fx-17256>. [Accessed: Mar 26, 2024].
- [24]"Text Animator for Unity," Unity Asset Store, 2023. [Online]. Available:  
<https://assetstore.unity.com/packages/tools/gui/text-animator-for-unity-254677>. [Accessed: Mar 26, 2024].
- [25]"POLYGON - City Pack," Synty Store, 2023. [Online]. Available: <https://syntystore.com/en-gb/products/polygon-city-pack>. [Accessed: Mar. 26, 2024].
- [26]"POLYGON - Vikings Pack," Synty Store, 2023. [Online]. Available: <https://syntystore.com/en-gb/products/polygon-vikings-pack>. [Accessed: Mar. 26, 2024].
- [27]"POLYGON - Horror Mansion," Synty Store, 2023. [Online]. Available:  
<https://syntystore.com/en-gb/products/polygon-horror-mansion>. [Accessed: Mar. 26, 2024].
- [28]"Poly Universal Pack," Unity Asset Store, 2024. [Online]. Available:  
<https://assetstore.unity.com/packages/3d/props/poly-universal-pack-215157>. [Accessed: Mar. 26, 2024].
- [29]"Toon Environments - World Creator Pack Lite," Unity Asset Store, 2023. [Online]. Available:  
<https://assetstore.unity.com/packages/3d/environments/landscapes/toon-environments-world-creator-pack-lite-264325>. [Accessed: Mar. 26, 2024].
- [30]Unity Asset Store, "Jammo Character - Mix and Jam," 2024. [Online]. Available:  
<https://assetstore.unity.com/packages/3d/characters/jammo-character-mix-and-jam-158456>. [Accessed: Mar. 29, 2024].
- [31]JSONLint, "The JSON Validator," 2024. [Online]. Available: <https://jsonlint.com/>. [Accessed: Mar. 29, 2024].
- [32]OpenAI, "Homepage," OpenAI. [Online]. Available: <https://openai.com/>. [Accessed: April 14, 2024].
- [33]Epic Games, "Unreal Engine," [Online]. Available: <https://www.unrealengine.com/en-US>. [Accessed: April 14, 2024].
- [34]Unity Technologies, "Homepage," Unity. [Online]. Available: <https://unity.com/>. [Accessed: April 14, 2024].
- [35]Itch.io, "Itch.io - Download and play indie games," 2024. [Online]. Available: <https://itch.io/>. [Accessed: April 14, 2024]

[36]World Wide Web Consortium, "Security Considerations - WebGPU," 2024. [Online]. Available: <https://www.w3.org/TR/webgpu/#security-considerations>. [Accessed: 14, Apr. 2024]

## Appendices

### Links For DataDestruct

Gitlab: Can be accessed internally at <https://gitlab.eeecs.qub.ac.uk/40267145/3002-datadestructs>

Itch.io: <https://markrobbz.itch.io/datadestruct>

(Password for access is QUB2024!)

\*Recommend using Google Chrome\*

### Student Survey Summery Link

<https://forms.office.com/Pages/AnalysisPage.aspx?AnalyzerToken=uMflxIPsBlyjXOX90vfJn8tLr71pZcDU&id=-yeCOETeDkaBkAVAK4mNqPysduoS0k1Hs1EnkKrnLEdURVVVMEdUWFFNQk83TzRZQVNNNEg1R0NZQi4u>

### Student Survey Images

## Student Survey

113 Responses 05:35 Average time to complete Closed Status

---

### 1. How interested are you in IT classes?

Extremely interested	8
Somewhat interested	23
Neutral	39
Somewhat not interested	22
Extremely not interested	21



---

### 2. How difficult do you find IT subjects?

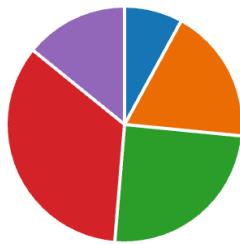
Extremely difficult	14
Somewhat difficult	39
Neutral	41
Somewhat not difficult	15
Extremely not difficult	3



---

3. For how long can you concentrate in class before getting distracted?

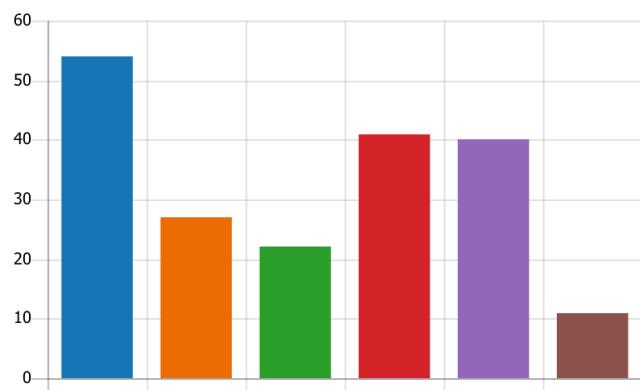
● Less than 5 minutes	9
● 5 to 10 minutes	21
● 11 to 20 minutes	28
● 21 to 30 minutes	39
● More than 30 minutes	16



---

4. What makes IT classes challenging for you? (Select all that apply)

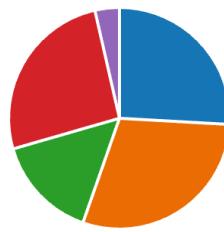
● Complex concepts	54
● Lack of practical application	27
● Pace of the class	22
● Not enough interactive or eng...	41
● I find it hard to stay focused	40
● Other	11



---

5. What would make IT classes more engaging for you?

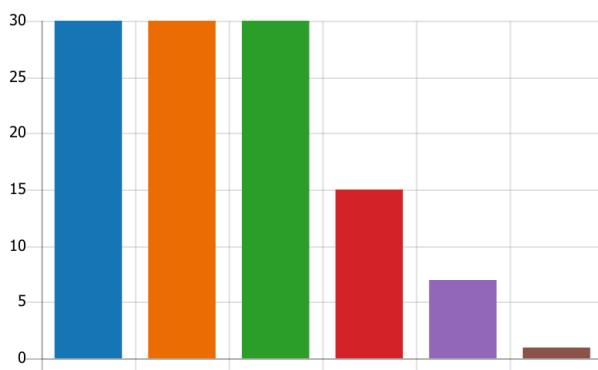
More interactive activities	29
Use of technology and games	33
Group projects and collaborati...	17
Real-world applications and e...	29
Other	4



---

6. Which method helps you learn IT concepts best?

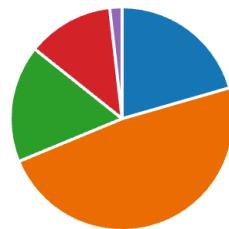
Visual aids (like videos and diagrams)	30
Interactive software and games	30
Hands-on practice and labs	30
Lectures and note-taking	15
Discussion and Q&A sessions	7
Other	1



---

7. Have you noticed a change in your ability to focus during classes since remote learning during COVID-19?

- Focus has significantly decreased 23
- Focus has somewhat decreased 54
- No change in focus 19
- Focus has somewhat increased 14
- Focus has significantly increased 2



---

8. Do you see I.T. as an male oriented subject?

- Yes, I see it as predominantly ... 15
- Somewhat, it seems to lean m... 60
- Neutral, I haven't noticed a ge... 25
- Not really, it seems fairly balan... 6
- No, I see IT as a gender-neutr... 7



---

9. Can you elaborate on the choice picked above?

85  
Responses

Latest Responses

*"men are stereotypically seen as smarter than women and more able to understand complex things li..."*

*"Generally in the industry I see less female roles and in the media I never see any female roles"*

*"Anyone can teach IT no matter what gender. I don't really care if the teacher is male or female at le..."*

---

10. Do you think your use of social media and technology affects your concentration in class?

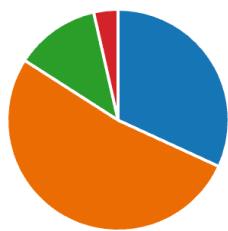
- |                                    |    |
|------------------------------------|----|
| ● Yes, it has a significant impact | 18 |
| ● Yes, but only slightly           | 50 |
| ● No, it has no impact             | 34 |
| ● I'm not sure                     | 11 |



---

11. How familiar are you with the concept of Artificial Intelligence (AI)?

● Very familiar	36
● Somewhat familiar	59
● Heard of it, but not familiar	14
● Not familiar at all	4
● Other	0



---

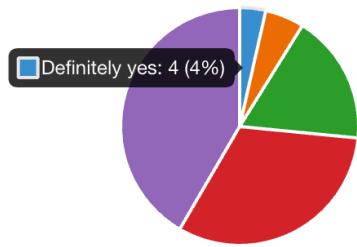
12. Would you be interested in using AI-powered tools to assist with your learning?

● Definitely yes	19
● Probably yes	40
● Maybe / unsure	36
● Probably not	9
● Definitely not	9



- 
13. Are you considering pursuing IT or a related subject at a higher education level?

● Definitely yes	4
● Probably yes	6
● Maybe / undecided	20
● Probably not	36
● Definitely not	47



- 
14. Can you briefly elaborate on your choice selected above?

92

Responses

Latest Responses

*"I don't take it as a GCSE and have no plans to take it at A-level."*

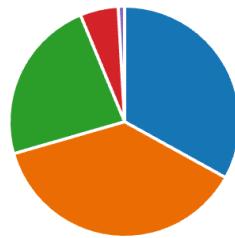
*"I want to enter the medical field and I know IT is very important in that area"*

*"Well I don't do it for GCSE but I don't know if I would want to do it for like a higher education."*

---

15. Would a game that teaches IT concepts be something you'd be interested in using?

- Definitely, I would love to try it 37
- Probably, it sounds interesting 42
- Maybe, I'm not sure how effec... 26
- Probably not, I prefer tradition... 6
- Definitely not, I'm not interest... 1



---

16. How appealing is a career in IT to you?

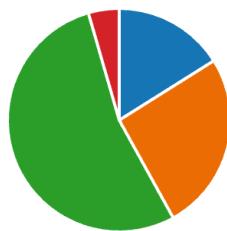
- Very appealing 6
- Somewhat appealing 32
- Somewhat unappealing 37
- Not appealing at all 37



---

17. How would you describe your attention span during IT classes?

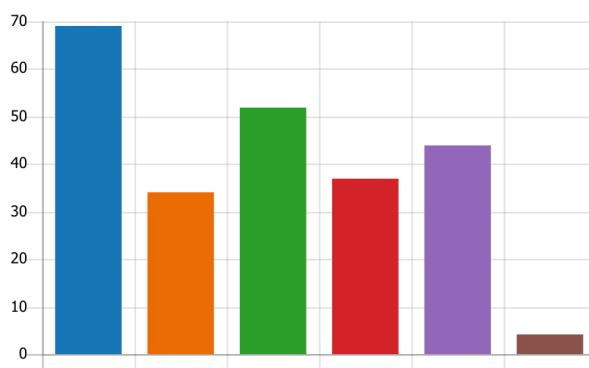
Very short	18
Somewhat short	29
Average	60
Somewhat long	5
Very long	0



---

18. What helps you maintain focus during class? (Select all that apply)

Interactive lessons	69
Engaging visuals or presentati...	34
Hands-on activities	52
Group discussions or teamwork	37
Regular breaks or changes in ...	44
Other	4



- 
19. What is one thing you would change about the IT curriculum to improve your learning experience? (Open-ended)

81

Responses

Latest Responses

*"deeper explanations into how things work, less of a "yeah this does that because idk it just does"."*

*"Breakdown complicated concepts into small easy to ingest parts brought forward in creative and eng..."*

*"More engaging and more commitment making the subject more engaging and enjoyable. "*

## **Teacher Survey Summery link**

<https://forms.office.com/Pages/AnalysisPage.aspx?AnalyzerToken=vHryEUL9zuypD6Nu9yOk6YlMS6AodM3p&id=yeCOETeDkaBkAVAK4mNqPysduoS0k1Hs1EnkKrnLEdUQ05CTDcwRkk2MTY1QzZDUUJBNE5POURJSi4u>

## **Teacher Survey Images**

### **Teacher Survey**

**15** Responses    **13:36** Average time to complete    **Closed** Status

- 
1. Since returning to in-person classes post-COVID-19, have you observed any changes in student engagement levels?



---

2. Please elaborate if so

15

Responses

Latest Responses

*"Lack motivation, gaps in subject knowledge"*

*"- higher levels of poor attendance - higher levels of student disengagement - higher levels of studen..."*

*"Some students attendance has not improved since returning back to face to face lessons. Students d..."*

---

3. What general challenges do you observe students facing in the classroom across subjects?

15

Responses

Latest Responses

*"stressed, anxiety, lack of resilience"*

*"- higher levels of students experiencing mental health issues - higher levels of students experiencing..."*

*"Lack of motivation Inability to work independently Cannot manage their own time or adhere to guide..."*

---

4. In your experience, how do digital distractions (such as smartphones and social media) affect students' ability to focus during class?

15

Responses

Latest Responses

*"Students are not able to communicate face to face as well, students are coming to class tired becaus..."*

*"- If monitored and used in a positive manner, smart devices can be very beneficial to Learning and T..."*

*"Older students are very distracted with their phones. They have them constantly in class and as they..."*

---

5. Why do you think some students struggle more than others in class? Do you believe there's a link to their digital habits, including social media use?

15

Responses

Latest Responses

*"Yes, students dont spend the time trying to solve or work things out for themselves, they google eve..."*

*"- overuse of smart devices/prolonged periods of time spend on social media will result in more scree..."*

*"I do not think there is a link to digital habits and attainment. I think students struggle due to lack of ..."*

---

- 
6. Which teaching tools or methods have you found most effective in maintaining student engagement and facilitating learning? (well-received or effective in class)

15

Responses

Latest Responses

*"interactive quizzes, interactive white board, video clips, PowerPoints"*

*"- Onenote - Youtube (cognito) - echalk"*

*"QR codes Google classroom One note Kahoot"*

---

7. How do you perceive the potential of game-based learning to improve student engagement and learning outcomes across subjects? (Educational Games)

15

Responses

Latest Responses

*"Would help students to engage and remain focused as they would see it as a game and also be lea..."*

*"I believe that will appropriate training for teaching staff, this would improve student engagement."*

*"I saw this being used alot when working in America. It was very well received and really engaged th..."*

---

8. Have you used game-based learning tools in your teaching?

● Yes

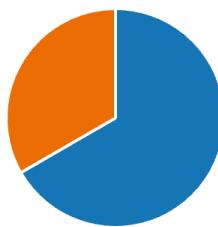
10

● No

5

● Maybe

0



- 
9. If Yes, what was the game/tool and would you consider it effective?

11

Responses

Latest Responses

*"Kahoot"*

---

- 
10. If educational games were to be used in your subject, what features or elements do you think would make them effective?

15  
Responses

Latest Responses

*"interactive quizzes where they compete with peers"*

*"- opportunities to apply knowledge to real life scenarios - opportunities to apply mathematical skills -...  
"Students can access them quickly on their mobile phones. They are user friendly with good visuals a..."*

---

11. Have you noticed a particular reason why students struggle with IT subjects?

● Yes 5  
● No 10



- 
12. If yes, please elaborate

4  
Responses

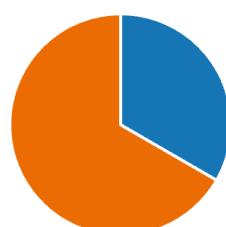
Latest Responses

*"Not engaged in the program that is being taught."*

---

13. Have you observed reasons for students lacking interest in IT subjects?

● Yes 5  
● No 10



---

14.

If yes, could you share your insights on why students might not be interested compared to other subjects?

5  
Responses

Latest Responses  
*"Not engaged, feel it is a more boy orientated subject."*

---

15. Have you implemented AI-based tools or resources in your classroom to enhance teaching and learning?

● Yes      1  
● No      10



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16. Could you briefly describe if, how, and why you have implemented AI-based tools or resources in your classroom?

2  
Responses

Latest Responses

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17. Any other additional information or insights that you think might be useful or this survey? (End of Survey)

4  
Responses

Latest Responses  
*"I would like to learn more on how I can use AI effectively in the classroom."*

## DataDestruct Playtest Survey Summery Link:

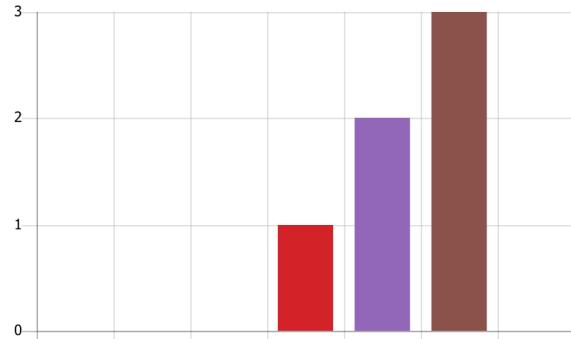
<https://forms.office.com/Pages/AnalysisPage.aspx?AnalyzerToken=LjNmrgF7SS9YqVAK1XD0w3jWo1T9S7Ig&id=yeCOETeDkaBkAVAK4mNqPysduoS0k1Hs1EnkKrnLEdUQjQ4WjNORUM2UFNDV01YQIJLMDkzSFILQi4u>

## DataDestruct Playtest Survey Images

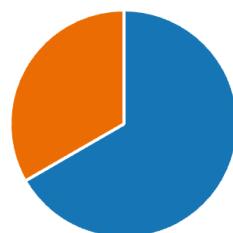
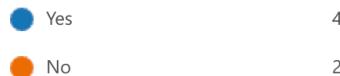
### DataDestruct Playtest Survey

6 Responses 12:15 Average time to complete Closed Status

#### 1. What Year group are you in?



#### 2. Do you study ICT for GCSE OR A Level?



- 
3. Prior to playing DataDestruct, how would you rate your interest in IT and computer science subjects? (0 point)

[More Details](#)

● Very Interested	1
● Somewhat interested	3
● Neutral	1
● Somewhat uninterested	1
● Not interested at all	0



- 
4. Describe your first impressions when you started playing DataDestruct. (0 point)  
What stood out to you?

[More Details](#)

6  
Responses

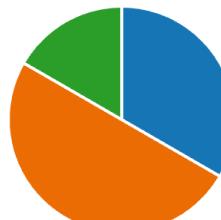
#### Latest Responses

"Game looks large and has good-looking graphics. The sm...  
"Game looks colourful, I wanted to explore the world straig...  
"I really like the small robot character you play as and the ...

- 
5. How did you find the overall experience of playing DataDestruct? (0 point)

[More Details](#)

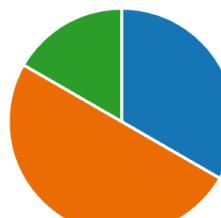
● Very enjoyable	2
● Somewhat enjoyable	3
● Somewhat okay	1
● Somewhat unenjoyable	0
● Not enjoyable at all	0



- 
6. Did playing DataDestruct increase your interest in learning more about data structures? (0 point)

[More Details](#)

● Significantly increased	2
● Somewhat increased	3
● No change	1
● Somewhat decreased	0
● Significantly decreased	0

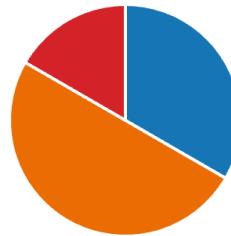


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7. How intuitive did you find the game controls and mechanics? (0 point)

[More Details](#)

- |                                       |                      |   |
|---------------------------------------|----------------------|---|
| <span style="color: blue;">●</span>   | Very intuitive       | 2 |
| <span style="color: orange;">●</span> | Somewhat intuitive   | 3 |
| <span style="color: green;">●</span>  | Somewhat unintuitive | 0 |
| <span style="color: red;">●</span>    | Not intuitive at all | 1 |

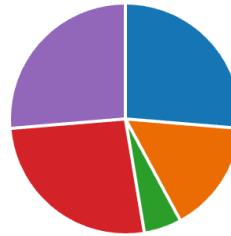


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8. Which features of DataDestruct did you find most engaging? (Select all that apply) (0 point)

[More Details](#)

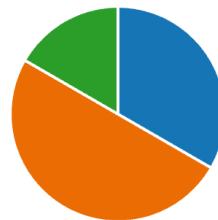
- |                                       |                          |   |
|---------------------------------------|--------------------------|---|
| <span style="color: blue;">●</span>   | Interactive puzzles      | 5 |
| <span style="color: orange;">●</span> | Theme                    | 3 |
| <span style="color: green;">●</span>  | Visual and sound effects | 1 |
| <span style="color: red;">●</span>    | Quizzes                  | 5 |
| <span style="color: purple;">●</span> | A.I. Chat                | 5 |



9. To what extent did playing DataDestruct increase your interest in IT and computer science? (0 point)

[More Details](#)

- |                           |   |
|---------------------------|---|
| ● Significantly increased | 2 |
| ● Increased               | 3 |
| ● No change               | 1 |
| ● Decreased               | 0 |
| ● Significantly decreased | 0 |



10. How did DataDestruct keep you engaged and motivated to learn throughout the gameplay? (0 point)

[More Details](#)

6  
Responses

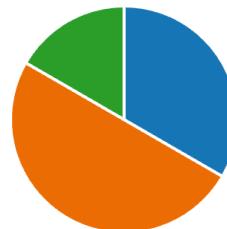
Latest Responses

*"Doing a task while being able to ask any questions to the ..."*  
*"It made the concepts easier to understand and I could ask..."*  
*"Collecting coins was addictive and helped to lead me in di..."*

11. How effective was DataDestruct in improving your understanding of data structures? (0 point)

[More Details](#)

- |                                     |   |
|-------------------------------------|---|
| ● Very effective                    | 2 |
| ● Somewhat effective                | 3 |
| ● Neither effective nor ineffective | 1 |
| ● Somewhat ineffective              | 0 |
| ● Very ineffective                  | 0 |



12. How do you prefer to learn IT and computer science concepts? (Select all that apply) (0 point)

[More Details](#)

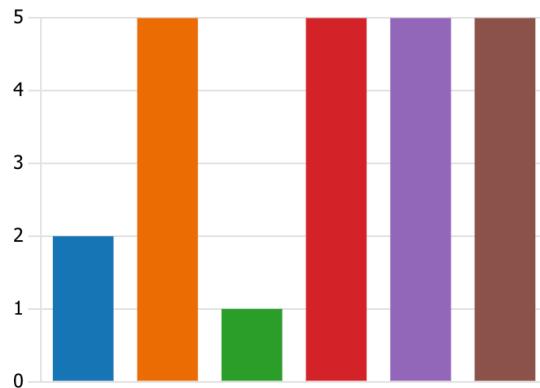
- |  |   |
|--|---|
| ● Traditional lectures and textbooks   | 0 |
| ● Interactive software and online t... | 5 |
| ● Hands-on projects and labs           | 6 |
| ● Video tutorials                      | 4 |
| ● Game-based learning platforms        | 5 |



13. In what ways do you think DataDestruct could be improved? (Select all that apply) (0 point)

[More Details](#)

- More levels or content 2
- Clearer instructions or tutorials 5
- Enhanced graphics or interactivity 1
- More sound FX 5
- Additional help or hints for diffi... 5
- More real-world applications or ... 5



14. Having used DataDestruct, how likely are you to use similar game-based learning tools in the future? Would you recommend DataDestruct to other students learning about data structures? (0 point)

[More Details](#)

6  
Responses

#### Latest Responses

- "I will tell my friends about DataDestruct, it could become ...  
"If there was more games like this for all my subjects I woul...  
"I would use them more if there were more options out the...

15. Please provide any additional feedback on your experience with DataDestruct. What did you like the most, and what could be improved? (0 point)

[More Details](#)

6  
Responses

#### Latest Responses

- "I like the look of the game, sometimes the character woul...  
"More helps and explanations on some of the sections, the...  
"I think making the sections a bit more fleshed out would ...

## **Student Feedback Responses**

**Question:** Describe your first impressions when you started playing DataDestruct.

What stood out to you?

**Responses:**

- “I quite liked the cartoony look to the game”
- “Seems like an interesting game, not quite sure what the story is or anything it just puts you straight into it after the tutorial but I quite like the look of the game though.”
- “Game looks like it is for a younger audience, I don't play games so I struggled a bit with getting used to the keyboard controls.”
- “I really like the small robot character you play as and the AI character you can talk with. I didn't know what to expect, the tutorial was a good intro to the controls and how the game works with buying doors and doing questions etc.”
- “Game looks colourful, I wanted to explore the world straight away, I first went through the tutorial which helped me to learn the controls, I haven't played a game on computer with controls like this so was new to me.”
- “Game looks large and has good-looking graphics. The small robot you play as is adorable. Being able to explore the world is interesting.”

**Question:** How did DataDestruct keep you engaged and motivated to learn throughout the gameplay?

**Responses:**

- “I like collecting the coins to progress to the next area. Being able to ask questions on the topic with the AI chat was interesting as I could get help that way and learn a bit more.”
- “Being able to run and jump around the game is fun and trying to find the trash in the alleyway section of the game. The robot in the game gives a bit of background on the structure then I got to go off and have fun while learning about it.”
- “I have never used AI before so it was interesting to ask the AI robot questions and it'd respond to what you've said. I don't know too much of IT so it was useful for asking questions about the data structure in that section.”
- “Collecting coins was addictive and helped to lead me in direction of items that you

interact with, jumping about and exploring the world while being able to get tested by quizzes was a nice feature, when I didn't understand what the robot was saying I would just ask it a question"

- "It made the concepts easier to understand and I could ask questions if I didn't understand with the BMO robot. Collecting coins and jumping about while avoiding the cars is fun. I wanted to find and collect all the trash items straight away to put into the on screen array boxes."
- "Doing a task while being able to ask any questions to the AI was really good and kept me interested. Then, being able to explore the world and do quizzes at the end of a task to reinforce the learning was beneficial."

**Question:** Having used DataDestruct, how likely are you to use similar game-based learning tools in the future? Would you recommend DataDestruct to other students learning about data structures?

**Responses:**

- "If the game was a bit more finished and had tips for help etc I would play more games that taught a subject to you as it breaks up learning from reading textbooks."
- "I would definitely use more in the future as it helps to break up learning and get enjoyment from the difficult subjects. I'd recommend DataDestruct to friends when it is more finished as my understanding was that Mr Roberts said it was a prototype."
- "If the game was on a phone or iPad I would be interested in it more as I think this could be really useful for learning the boring and hard topics of a subject."
- "I would use them more if there were more options out there like this. There are apps that help teach you programming, etc., but not many that are like 'actual' games like this one."
- "If there was more games like this for all my subjects I would definitely play more of them as I feel like in playing the game for fun but are still learning at the same time."
- "I will tell my friends about DataDestruct, it could become something really impressive and a useful resource to assist us in classes."

**Question:** Please provide any additional feedback on your experience with DataDestruct. What did you like the most, and what could be improved?

**Responses:**

- "More guidance on some of the sections and more information on the topic, the

section with the statues I didn't quite understand the concept. More sound effects and music too as there was only sound for coins is what i noticed”

- “I think maybe having a bit of a story would help to build up the world and get you invested in it more and also have more sounds and effects when you do something in the game.”
- “I can see the game could be fun if I could use the controls better, I also got a basic understanding of how the data structures work but the AI helped a lot. If I was more interested in IT I would get more enjoyment out of it.”
- “I think making the sections a bit more fleshed out would be useful to get the point across. Speaking with the Robot chat was a nice feature, but it felt like I was relying on it a lot to explain the concepts. If this was its purpose, it could be made to feel more natural in the game. (I only got to the maze section)”
- “More helps and explanations on some of the sections, the maze part of the maze needs more directions as I struggled getting to the nodes as I forgot the way to them from the map board at the start. It would be good if you could play it on ipad. I am not too intrested in ICT but this was enjoyable and has interested me a bit more in it.”
- “I like the look of the game, sometimes the character would get stuck on objects though. Another thing I noticed was a lack of sound effects. Some of the task too weren't the most clear but using the ask question A.I was useful to clear up anything I didn't quite understand about that data structure. It would be good if it came to a mobile or tablet device.”