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UG FINAL YEAR DISSERTATION REPORT

- Interactive Storytelling Application that utilizes Mobile Sensors and -
Augmented Reality to teach Computer Science

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Augmented Reality to teach Computer Science**

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I hereby declare that this dissertation is all my own work, except as indicated in the text:

Signature _____



Date 02 / 05 / 2023

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Abstract

This dissertation aims to explore the development and evaluation of an innovative educational approach that proposes to integrate interactive storytelling with mobile sensors and augmented reality to teach computer science. This study will focus on the design and the development of a mobile application that will utilize these technologies to provide an engaging and immersive learning experience.

The study examines the theoretical foundations and pedagogical methods that support the suggested educational model and provides a thorough review of the literature on the use of emerging technologies in education. The selection and integration of mobile sensors as well as the augmented reality content are all covered in-depth in the paper's detailed description of the development process.

On top of that, this research focused on evaluating the effectiveness of the proposed approach in improving the student engagement, learning outcomes and most importantly, their motivation. It will provide a quantitative and qualitative analysis of the data that has been collected from students from different backgrounds. This study will show how the proposed method and research will affect the students' learning and will highlight its potential as a new innovative educational tool.

Keywords: Interactive storytelling, Computer Science, Mobile Sensors, Augmented Reality, User Engagement, Innovative

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Chapter 1: Introduction

As technology proceeds to be an integral aspect of our everyday life, there is a demand that continually develops for individuals to have a very good understanding of the technology that powers our daily life such as computer science. The computer science space is a very all-encompassing sector that covers a range of applications that helps our everyday life be more productive and easier. With the increasing importance of computer science in our current generation, there is a need to find new and innovative ways to teach the topic. One method that looks promising is educating people about computer science through the use of mobile sensors and augmented reality applications. By utilizing these cutting edge technologies, we are able to design an interactive storytelling application that will engage students and promote a form of intuitive learning. This application can then be developed to allow users and students to learn computer science concepts in a more engaging and natural way by allowing them to interact with virtual environments through the use of their mobile device.

The proposed project will be an interactive storytelling application that would utilize mobile sensors to allow students to interact with a virtual environment to create a more interactive and immersive experience while being able to learn computer science. “An effective learning environment is crucial for improving a student’s performance in computer programming” (Mow, nd). Through this form of approach, the user would be able to learn about various computer science concepts such as algorithms, loops and functions in more of an entertaining and effective method. The implementation of augmented reality component of the application would be able to provide the students with a more visual representation of certain concepts that they learn in order to understand and visualize these concepts in a more solid method.

An interactive storytelling application is a digital platform that allows users to interact with a narrative in a more immersive and interactive form. Compared to the traditional methods of storytelling where the target audience is more passive, the interactive storytelling application will offer the user the opportunity to play a more active part in the story’s overall development. By implementing multiple interactive features such as the touch, movement and even augmented reality, we are able to use these platforms to enable the users to participate in the story and even

control the narrative's direction to make decisions that affect the overall story. Interactive storytelling has become ever increasingly popular in a variety of industries which include the entertainment and marketing sectors as they provide a more unique and engaging method to communicate certain ideas and lessons. In an educational sector standpoint, the interactive storytelling application can be implemented to educate complex concepts in a more memorable and intuitive manner. By including the mobile sensors and augmented reality, the interactive storytelling application is able to bridge the gap between the digital experience and the real world. There are several existing interactive storytelling applications that have been developed to enhance the user's experience of a story. These applications take various forms, including video games, mobile apps and virtual reality systems. One such application is the interactive movie Bandersnatch, produced by Netflix. This movie allows the viewer to make choices at different points in the story, affecting the outcome of the narrative. A study conducted by Roth et al (2019) showed that interactors of the Bandersnatch show felt that had an impact on the narrative progression on the show which led to higher levels of engagement and enjoyment. In addition to enhancing the entertainment value of a story, interactive storytelling applications have also been developed for educational purposes. For instance, the game Minecraft has been used as an educational tool to teach students mathematics. It was proven that using Minecraft's gamification approach, it was able to assist low-achieving students learn the concept of probabilities much more effectively (Kok, 2020). A research by Song et al (2012) focused on utilizing digital interactive storytelling to teach history and was able to prove that interactive storytelling was able to motivate the users to learn more about history through this medium. A study conducted by Tsai et al (2011) showed that interactive storytelling was able to educate students about bullying and allowed them to learn about the consequences of bullying and how it can be prevented. Gamification is a concept that interactive storytelling relies upon by implementing game design elements in non-gaming context (Deterding et al, 2011). Overall, these examples show how interactive storytelling applications can involve users in fresh and creative ways, encouraging them to actively engage with a story as opposed to passively consuming it. The interactive storytelling application suggested in this essay aims to further improve the user's experience of a story by giving them a more interactive and immersive environment by fusing mobile sensors and augmented reality technology.

Mobile sensors have become an incredibly integral component of education due to their ability to enhance the learning process. They have been used for various purposes in the educational sector which include tracking their location, detecting their location and even measuring their temperature among many others. The mobile sensor refers to the hardware components that are installed into the mobile devices that are able to sense and gather the environmental data. Mobile sensors can also be used for learning. These include things such as the users walking and or driving habits and can be used as the framework for analyzing their behavior (Marcias et al, 2013). They are designed to capture and transmit different types of data from the sensors such as the acceleration, orientation, light and temperature. These types of data collected can help many types of applications which include navigational applications, games and most importantly, educational applications. These mobile sensors are becoming ever increasingly more popular and will only continue to be an integral part of our everyday technology. Due to how accessible and powerful these mobile sensors are, these sensors are going to remain a vital aspect of mobile devices. Mobile applications have also been shown to be able to promote physical activities. A research by Almeida & Alves (2017) were able to develop a prototype application that was able to promote physical activity in their users. Additionally, these sensors are then going to help us develop a more interactive and immersive application as the combination of the sensors with interactive storytelling mechanics has the potential to revolutionize both the gaming and educational industries and can also enhance the user experience overall. Integrating mobile sensors with an interactive storytelling application can significantly improve user engagement and overall experience. For instance, mobile sensors can provide real-time data and capture users' physical movements and interactions, enabling the story to adapt and respond to the user's actions. Overall, integrating mobile sensors with an interactive storytelling application can provide a more engaging and personalized learning experience for users.

Augmented reality (AR) is a form of technology that can help us transcend the technological barrier that exists between the real world and the digital world. Its guiding premise is to simulate the real world before applying computer-generated virtual information—such as text, photographs, 3D models, music, and video to it (Chen et al,2019). It basically allows us to interact with the digital environment in our reality. As our technology has developed over time, the sector of augmented reality has grown evermore popular. Games such as Pokemon Go have

pioneered the path for augmented reality games to be more than just a simple mobile phone game and instead made it almost a lifestyle for certain players. The fact that it utilized augmented reality with a great game design made it such a success. The Pokemon Go game utilized Uses and Gratification in their augmented reality game to motivate their users to play the game (Bueno,2020). This shows that if implemented well, it can provide an incredibly engaging and immersive experience for everyone. The same can be said for the educational sector. Augmented reality can really help educational games to thrive if implemented well. This is because augmented reality can help provide new and interesting ways to interact with the subject matter and the concept related. This is where the implementation of augmented reality can really shine. This is because augmented reality can be a really great tool to teach computer science in a new and interesting way. One of the biggest reasons this is the case is that augmented reality is going to allow users from all backgrounds to understand more abstract concepts in a more realistic and concrete way. A systematic review that has been done by Garzón, Pavón, and Baldiris (2019). This research focused on the utilization of augmented reality in an educational setting. It can be seen from this paper that the advantage of augmented reality systems in education is that it will increase motivation along with learning gains in the educational sector. On top of that, augmented reality can help with motivation to learn. This is because compared to learning about a subject the more conventional way, using augmented reality can allow the users to push boundaries and develop new methods of interaction with the subject matter. A research by Wang et al (2017) focused on the potential of using AR tools to educate in large scale subjects. They discussed the viability of the AR tools such as handheld AR devices including smartphones and even wearable AR technology such as head mounted displays in an educational sense. These projects show that augmented reality can really change how we approach a subject. It can be suggested that as AR becomes more advanced, it can slowly blur the line between the real world and the digital one. Another thing is that augmented reality can provide us with a new learning environment for the user to experience. This process allows users to work in teams to solve problems and work together towards a common goal. This in turn will allow the participants to develop both communication and teamwork skills. A study done by Osadchy, Valko and Kuzmich (2021) shows that the utilization of augmented reality in the STEM field was able to motivate teamwork and group cooperation.

1.1 Aims

The aim of this application is to create an educational experience that is very engaging and approachable to people from all backgrounds and regardless of skill levels. By utilizing the mobile sensors and augmented reality technologies, this application has the potential to develop a revolutionary method of teaching computer science. By utilizing the mobile sensors in this application, we are able to allow the target audience to have hands-on experience with the various sensors that are available on their phones. This application will then allow the students to have a better understanding of how these sensors operate in real world applications. On top of that, by implementing augmented reality, we can allow the users to have a more stimulating and immersive learning experience. To conclude the aim of this project, interactive storytelling with mobile sensors and augmented reality is an incredibly powerful piece of technology that can be employed to teach computer science. All of the benefits that come along with it allow it to have incredible potential when it comes to utilizing it for teaching the computer science sector. Students will be able to benefit from an engaging and immersive learning environment.

1.2 Objective

The objective of this project is to discover and identify the potential of utilizing interactive storytelling with mobile sensors and augmented reality technology as an invaluable tool to promote the sector of computer science in an educational sector.. For computer science, the field is an incredibly important sector as a whole as it is involved in everything that we do and use in our daily lives. However, due to this fact, it may also seem more difficult and intimidating to access although being so integral to individuals that may not have a background in this field. By implementing the powerful immersive and interactive capabilities of interactive storytelling, this research is aimed towards developing an approach for users to learn and interact with computer science that is engaging, interesting and most importantly accessible for everyone that wants to learn from all ages and backgrounds.

1.3 Overview of Project

This research will focus on the design, development and the evaluation of an interactive storytelling application that will utilize mobile sensors and augmented reality to educate users about computer science by having the users go on an adventure to save another dimension that's in peril with the power of computer science. The goal of this story will be to familiarize the users with basic computer science concepts. A few examples may include the accelerometer, front camera sensor and even the pedometer to experience the interactive story. The goal of this is to enhance the users experience and also motivate the users to participate and feel a sense of contribution.

The research will be focused on a mixed methods approach that will combine both quantitative and qualitative methods of data collection as well as analysis techniques. These data will be collected and analyzed through user engagement surveys which will analyze the users engagement factors, overall satisfaction and their retention throughout the interactive experience.

The expected outcome of this entire research project will be for the users to reach a deeper understanding of the interactive storytelling as well as the implementation of mobiles sensors and augmented reality as such works for the educational benefit of not only computer science, but for all sectors that may seem daunting to the average person. This development of an interactive storytelling application may also be used for further research to fields that go beyond our current scope. This research intends to contribute to the further goal of promoting inclusion as well as reducing the barrier of entry for the field of computer science by allowing the topic to be more engaging and simpler for learners regardless of their backgrounds.

1.4 Motivation

1.4.1 Problem Statement

Computer science is quite the complicated subject to learn. This concept can also be said when it comes to teaching the topic. At the pace that the subject of computer science is progressing, it can always present new challenges for educators to face when it comes to this ever changing landscape. Since new and different technologies are always being created, it can

make it so much more difficult to keep yourself up to date with the most current and relevant materials to teach.

Another thing is that some concepts can prove to be quite difficult to understand by conventional means. Computer science although is an incredibly interesting topic, it is also an incredibly vast and difficult topic to understand. Aspects of this subject such as logical thinking and complicated math may prove to be more difficult to present to students in a normal fashion. According to a study conducted by Schilling and Klamma (2010), it can be determined that computer science, still mainly taught in traditional lecture formats, will often result in “inert” knowledge. This may in turn lead to a more negative perspective when it comes to learning about the subject material. However, we can overcome this issue by implementing augmented reality into the teaching method. The students will be able to interact and understand concepts in a whole new way. Being able to learn about logic and algorithms in a more engaging way may allow them to see certain topics in a new light compared to reading it from a book.

Lack of resources may also be another reason for difficulty in the spread of the subject. Computer science is a very technology focused subject. However, to properly educate the subject requires a high number of resources. These resources such as computers and software may not be available to everyone so this can negatively affect their ability to learn the subject. According to Wang et al (2017), one main challenge that augmented reality is facing is the difficulty to create deployable content by teachers. Implementation of augmented reality can help overcome this issue. They can learn and interact with the subject matter in a way that they could not before. Another benefit of this is that the only thing they need to learn and experience the subject is just a mobile phone. This level of accessibility allows to reduce the barrier to entry for this subject.

One more issue that comes along with teaching computer science in a conventional method is that there are always going to be either underqualified and or lack of educators. This can be seen in lower income areas. This can lead to lack of proper education on the topic of computer science for those students. A research conducted by Aman et al (2017) showed that the Royal Society has assessed that the condition of computer curriculum in the UK has a declining interest in computer science due to a lack of teachers with adequate subject-matter expertise as well as non-specialist teachers teaching the lessons will lead towards unfavorable attitudes towards computing. However, this can be solved by having the ability to learn this topic through new means such as the utilization of augmented reality. Although a single source to learn about

the vast subject may not be the best idea, it is a step in the right direction that may lead to a chain effect that can change the overall landscape of the topic in whole.

Overall, these challenges that are present when teaching computer science may be plenty and daunting. Challenges such as the fast progression of the topic, lack of resources, difficulty in understanding and lack of qualified educators may exist in this sector. However, with this implementation, I hope that we can try our best to help combat these issues and help progress the landscape in a more positive fashion.

1.4.2 Need for Solution

In our current age of technology, computer science is a crucial field that has changed the way we live and work. Due to this, it is essential that our future generation of students are taught computer science concepts in a way that is more engaging and comprehensive. However, the current methods that we still use to teach can be often seen as dry and uninteresting which may lead to the students being disinterested or lacking the feeling of engagement.

This is where a solution such as interactive storytelling utilizing mobile sensors and augmented reality comes in. By using cutting-edge technology, this solution can be seen as a unique and innovative way to teach computer science concepts while also making the learning experience interesting and engaging. The students will be able to participate in the interactive stories that will be able to fit to their individual learning needs and styles.

The blending of interactive storytelling with the mobile sensors and augmented reality into computer science education has the potential to transform the way students learn and engage with the subject. By making the learning experience more fun and engaging, students are more likely to take an active interest in the subject that may lead to a higher retention of the information and a deeper understanding of computer science concepts.

Chapter 2: Related Work

2.1 Literature Review

2.1.1 Interactive Storytelling

For interactive storytelling, a research that was conducted by Flórez-Aristizábal et al (2019) showed that digital interactive storytelling was able to help children with disabilities such as deafness to be motivated to learn more about literacy. This was because the children enjoyed the experience and were engaged during the educational process. This showed that a combination of interactive storytelling and education was able to boost the moods of the children while learning and made them more engaged in learning. Another study conducted by Weng et al (2011), they were able to determine that through utilizing interactive storytelling with fifth grade students about nature science, they found that the learning satisfaction rate and the collaboration rate were much higher than conventional methods. The students were motivated to help others when facing certain problems. This study also showed that the students were much more inquisitive about nature science through this experiment as well. E-Learning has also been a sector that has been crucial for the sector of interactive storytelling as it focuses on the digital aspect of interactive storytelling. A research conducted by Alsumait & Al-Musawi (2013) showed that the framework that is utilized is crucial to a successful interactive storytelling experience such as user interface, pedagogy, cultural conventions, assessment, story elements and technology. All of these aspects need to work together in order to achieve a truly immersive experience for students. Interactive storytelling has also been utilized to teach lessons and morals. A study conducted by Melcer et al (2020) was able to determine through a pilot study that interactive storytelling was very effective toward responsible conduct of research due to its ability to educate their users on complex ethical topics. Another reason for this is due to the fact that the users are the ones which are making the decisions in the game, allowing each action to feel more personal thus leaving them much more immersed in the lesson as compared to conventional methods.

2.1.2 Mobile Sensors

For mobile sensors, a study conducted by Jeng et al (2010) determined that pedagogical learning strategies that are applied in mobile learning environments were much more impactful than traditional electric learning. It also showed that the mobile learning added the benefits of mobility and also including a vivid learning environment was also very impactful when it came to utilizing mobile learning. Another study regarding the mobile sensors was conducted by Özden & Demirci (2018) where they were able to determine through the use of educational game-based mobile applications that using the sensors was very motivating to the students. Another reason why the students were so motivated with this mobile application was the inclusion of a high score system. Due to this system, the students were very competitive when it came to the scores of each other. This score system brings along a competitive edge when it comes to the game that motivates the students to beat each other's score by answering more questions correctly in the application. A research conducted by Dabney (2013) similarly utilized mobile devices for computing education and was able to determine that the students were able to understand programming concepts through the use of an application along with a camp experience. This method of education was able to interest the students due to its out of the box approach that allowed students to experience programming concepts in more interesting ways.

2.1.3 Augmented Reality

A research done by Lee (2012) has shown that augmented reality in training and education is a very efficient technology in higher education. The combination of the higher student engagement along with the ability to learn complicated theories and concepts in a new context can help students learn and understand more easily and efficiently. One way that we can utilize augmented reality to teach is through the medium of making the experience into a game. A study by Zhonggen (2019) focused on the use of serious games for education. The study researched the effects on education through the platform of games compared to the conventional learning methods such as in a classroom and workplace. The results were quite eye opening. Among the positive findings, education through games was able to be effective in such things as boosting the positive effects of learning. It also proved to produce better educational results and is able to provide educational experience in a more flexible way so that the users are able to

better understand the subject material. Another research paper by Koutromanosa, Sofosb and Avraamidou (2016) focused on the use of augmented reality games in education. The study focused on the different types of games that augmented reality could be used to implement and its effects on the users in the educational sector. They tested different types of theories of learning as well as different types of learning environments with augmented reality. They were able to conclude that through augmented reality, educational curriculum has shown results that it will improve real-world, active learning. A study that emphasizes my theory of the benefits of augmented reality is a paper written by Demitriadou, Stavroulia and Lanitis (2019) that discusses and compares the standard teaching strategies and the AR/VR based teaching strategies. This paper focuses on the modernization of teaching strategies. It also discusses whether the implementation of AR methods can actually make the teaching of mathematics more engaging and interesting and contribute to more easily learn and understand the certain concepts of mathematics. The students were subjected to similar experiments with different methods of approach. The result of these experiments showed that although the conventional methods prove to still be the better method to engage the interest of the students at a younger age, augmented reality and virtual reality has shown to produce a higher level of interest and motivation in the learning of mathematics.

Chapter 3: System Design and Requirements

The proposed approach for this project as a whole will focus on the development of an interactive storytelling application that will utilize mobile sensors and augmented reality (AR) to create an engaging learning experience that allows the user to interact with the story as well and learn core computer science concepts along the way. The design of this interface will be created in such a way that is intuitive to use and easy to understand for users. There will be clear instructions as well as feedback so that the learners will be able to understand whether the answers they chose were accurate or not. The application will also feature the integration of multiple different sensors. The application will include the camera's sensors, accelerometer, gyroscopes and even incorporate AR technology to provide an immersive experience that will allow the users to be able to interact with digital objects in the virtual environments.

The aim for this project is to create a mobile application that will allow users to interact with an interactive story to learn about computer science. It should include the use of various mobile sensors to allow the user to interact with aspects of the story and augmented reality space where the users will have to move around the virtual environment and interact with surroundings.

For the storytelling and game design of the application, the application will include and incorporate multiple different elements to make the application both engaging and motivating for the learning experience. The story will not only be focused on being engaging but also be designed to introduce users to key computer science concepts in a fun and interesting way. The application will also give the user a practical opportunity to utilize the concepts that they learn from the game. For the learning objectives and assessments, the clear objective of the application will be to make sure that the users will be able to progress their general understanding of computer science concepts. The application will provide feedback for the users to understand how they are performing as well as provide opportunities for users to understand and practice key concepts.

3.1 Design and Implementation Constraints

One of the first things we needed to do was to determine the requirements needed for such a project. This process involved determining the target audience as well as the learning objectives that were required along with the technical requirements to develop an application.

After this we focused on the design and implementation of the project. The design and implementation constraints for this project consists purely on the design and creation of the app. The app will have a clean and simple design that will allow the user to understand and interact with the application functions with ease. For the integration of the sensors, implementation of the latest AR technology and sensor integration techniques will be utilized. The application must be able to perform the functions that we have listed such as the various sensors as well as the AR section as well. The focus on integrating storytelling elements as well as game design will be a priority to create a motivating and engaging experience for the users. For the testing and evaluation of the application, the application will be extensively tested and checked to make sure it functions properly as well as meets the requirements that have been mentioned earlier. We must also make sure that the application is effective in achieving the objectives of teaching core computer science concepts. Lastly, we will ensure that the application that is deployed to the users is maintained to ensure that it continues to function as originally designed.

3.2 Technological Approach

For this interactive storytelling application, it will prioritize three features within the application which is the storytelling aspect. The storytelling aspect will allow the users to experience a riveting story while using the application. The users will also be able to control the flow of the story. This is because the application utilizes a branching storytelling method that will allow the users to choose what happens next in the story by choosing what happens next. The next feature that the application will prioritize will be the various games that are included into the story. These games will serve as a form of task that the users will use to progress the story. This will in turn allow the user to feel more engaged while enjoying the story. These games will make the user complete tasks that affect the story in a narrative way. The last feature that is prioritized in this project will be the quizzes that will occasionally pop up. These quizzes will serve as a form of reflection that the users will be able to use to test their knowledge based on the information that has been presented to them throughout the story. The users will be able to gain instant feedback thus allowing them to understand the information that they acquired throughout the story for better immersion.

The main design of the applications mini games revolve around implementing the proper technology to properly express the functions in the interactive storytelling application. The design needed to fulfill a plethora of requirements to properly implement it into the application. We need to be able to design the games in a way that the user will be able to easily understand and interact with. For the content in the interactive storytelling application, the main focus will be placed on teaching computer science in a story that revolves around students saving another dimension from total destruction with the power of computer science.

3.2.1 Catching a portal Activity with the Accelerometer

In the story, the main characters must use the portal to travel to different areas of the world. However, these portals are spontaneous and unpredictable. Therefore, the users must help the students catch these unpredictable portals. This mini game involves the game mechanic in which the user must help the students catch the portals by physically moving their smartphones up and down to allow the characters “catch” the portals. The accelerometer is a sensor that measures changes in motion.. The user will be able to learn about using sensors to gather information from the real world and convert it into a format that can be used by software by using it as an input device for the game. The user will also be able to learn about event-driven programming which means that instead of operating continuously, it responds to changes in the environment (like the movement of the device).**Refer Appendix for Figure 3.2.1**

3.2.2 Using a Bright Light to distract rogue robots

In one of the locations the characters end up traveling to, they end up in a dystopian cyberpunk city that is filled with rogue robots that are on a rampage. In order for the characters to distract the robots to be able to reprogram them, the characters came up with the idea to distract and blind the robots momentarily with a bright light source. The user will then be able to use the front camera sensor to shine a bright light source to “distract” the robots. This can teach the user about image processing and sensor fusion as the front camera is typically not designed to be used as a light sensor, but it can still provide useful data when combined with other sensors, such as an ambient light sensor. **Refer Appendix for Figure 3.2.2**

3.2.3 Using the gyroscope to tighten a gear

In one of the locations, the characters come across a control panel on a space station. However, the control panel doesn't seem to be functioning as there seems to be a few loose gears. To fix this issue, the characters must tighten the gears to get the control panel functional again. This is done by having the user "tighten" the gear with the gyroscope. The gyroscope is a sensor that can measure the changes in orientation and rotation. The user will be able to learn about using sensors to collect real world data and convert it data that can be used in software.

Refer Appendix for Figure 3.2.3

3.2.4 Using the Augmented Reality function to place bait for creatures

In one of the scenarios, the characters find themselves in a prison that has its security system hacked and disabled. This in turn opens up all the cages and causes the creatures that are being held there to break free and cause havoc in the facility. The students come up with a plan to use bait to lead all the creatures back into their cages and turn the security system back online to lock them back in. To do this, the characters must place bait into their cages to lure the creatures back in, The user must then place a 3D model of the bait in augmented reality with the mobile devices front camera. This game will be able to teach the user about computer vision as it will show by using the camera and image recognition that we are able to detect and track positions of virtual items in the real world. **Refer Appendix for Figure 3.2.4**

3.2.5 Using Image Detection to unlock a special box

In one of the scenarios, the characters find a suspicious box lying around. They move on to investigate it and find that the box is locked with an image detection lock. The box contains a riddle on the side that hints to the key to opening it. Once the riddle is deciphered, the characters must use that specific item to open the box. In this specific scenario, the item that is required to open the box is a pair of scissors. The user must then use the camera to take a picture of a pair of scissors to open the box. This image detection feature will utilize machine learning to determine

the object that has been captured. This means that the user will only be able to progress when they manage to capture the correct item. This game will be able to teach the users about machine learning and how the algorithms train the image detection system to recognize different objects.

Refer Appendix for Figure 3.2.5

3.3 Target Audience

The target demographic for this application will be for the 18 - 30 years old age group and it will cater to students and non-students.

3.4 Functional Requirements

- **Main Menu**

- The main menu will allow the users to start a new game and or continue from their previous saved data.

- **Start Button**

- The start button must be functional and begin the interactive storytelling experience

- **Continue Button**

- The continue button must be functional and continue the experience to where it was previously left off.

- **Illustrations**

- The illustrations should be displayed and fully functional during the experience.

- **Dialogue Box and Script**

- The dialogue box and the script for the story should be displayed along with the illustrations and should be fully functional throughout the entire experience.

- **Next Page Button**

- The next page button must send the user to the next page of the story to continue the interactive storytelling application.

- **Story Page**

- The story pages should display the illustrations along with the dialogue box and script.

- **Mini Games**
 - The mini games must be functional and be present in the interactive storytelling application.
- **Branching Pages**
 - The branching pages must allow the users to make decisions and change the outcome of the story.
- **Reflection Pages**
 - The reflection pages serve as a method to allow the users to use the information that they learned and apply it to the current situation that's occurring during the interactive storytelling experience.
- **End Page**
 - When the user completes the interactive storytelling experience, they will be greeted with an end page which will contain the final score along with the experiences that the user encountered and the reflection pages that have been achieved.
- **Augmented Reality**
 - The augmented reality must be implemented and fully functional in the interactive storytelling application
- **Mobile Sensors**
 - The mobile sensors must be implemented and fully functional in the interactive storytelling application
- **Engaging Story**
 - The story of the application must be engaging and cohesive to allow the user to experience an immersive and interactive experience.
- **Image Detection System**
 - The image detection system must utilize machine learning and must be fully functional in the interactive storytelling application.
- **Score System**
 - The score system must be able to track and store the users play data throughout the interactive storytelling experience and display them at the end screen.

3.5 Non-functional Requirements:

- **Safety Requirements**
 - The app will not affect any other app installed on the user's phone.
- **Security Requirements**
 - The app will require the users permission to use the mobile devices functions before entering the application
- **Performance Requirements**
 - The application performance will depend on the phone's specifications.

Chapter 4: Methodology

This project involves the development of an interactive storytelling application with mobile sensors and augmented reality (AR) implementations. The methodology that is implemented for this project is a software development based approach. This approach will utilize several stages during implementation which include the requirements gathering, the design and prototyping phase, development and integration phase, testing and evaluation as well as deployment and maintenance phase. One of the first things we needed to do was to determine the requirements needed for such a project. This process involved determining the target audience as well as the learning objectives that were required along with the technical requirements to develop an application. After this, we focused on the design and implementation of the project. The design and implementation constraints for this project consists purely on the design and creation of the app. The app will have a clean and simple design that will allow the user to understand and interact with the application functions with ease. This is that the user interface would be able to fulfill the functionality of the application that was stated in the requirements beforehand. For the development and integration phase, implementation of the latest AR technology and sensor integration techniques will be utilized. The application must be able to perform the functions that we have listed such as the various sensors as well as the AR section as well. The focus on integrating storytelling elements as well as game design will be a priority to create a motivating and engaging experience for the users. For the storytelling and game design phase, the main focus was on developing and engaging and motivating story and learning experience for the users. The goal was to create an investing narrative that will introduce beginners to key computer science concepts in a fun and uncommon method. This also has the goal of allowing the users to apply the things that they learned in a practical context within the game. For the testing and evaluation of the application, the application will be extensively tested and checked to make sure it functions properly as well as meets the requirements that have been mentioned earlier. We must also make sure that the application is effective in achieving the objectives of teaching core computer science concepts. Lastly, we will ensure that the lessons that are included inside the application are accurate and simple to understand to allow all users to be able to learn and understand computer science concepts with ease.

Chapter 5: Design

5.1 System Architecture

The main priority of the main design of the entire application is surrounded by the primary function of the application which is an interactive storytelling application with interactive elements for users to interact with such as mini games which involve the utilization of mobile sensors and augmented reality.

We decided on a page by page format so that the user would be able to follow along the interactive story without feeling overwhelmed with an overflow of information. Instead each page will include a block of text that will tell a cohesive story accompanied with illustrations of the current event being taken place for an even greater sense of immersion in the interactive story. There will be a button that will remain at the bottom section of the screen to allow the users to proceed towards the next story beat. The user will also come across a page where they must answer a question. The question that is asked will be provided along with multiple answers. The user will then have to choose among the multiple answers to determine which is the correct one. There may include multiple correct as well so this will allow the users to face more of a challenge. Depending on how the user answers the question, the game will track the score that they get based on the answers. On the other hand, their score will also be affected based on how they answer the question. For example, if the user manages to select all the answers available but one of the answers given was incorrect, their score will adjust based on their selection. For the interactive sections of the story, the page will transition into a mini game in which the users will need to fulfill a task that is stated on screen before they may move onto the next page. For example, the users will encounter a section in which they must find a bright light source so that they may be able to distract specific robots. In this scenario, the user will have to use the front camera sensors to detect a bright light source in order to fulfill the task as well as contribute to the story.

5.2 User Interface Design

The user interface will contain a main menu, story pages, branching story paths, mini games, reflection page, score systems and end page. The main menu will contain the title of the

game. It will also include a Start button and a Continue button. The Start button will allow the user to begin the story while the Continue button will allow the user to resume the story at where they left off. The story pages will act as the main form of storytelling as it will display an illustration and dialogue that play out the story. Throughout the story, there will be sequences of the story where the characters will be given 2 choices to proceed with the story. These in turn will be known as the branching story paths and this will allow the user to determine how they want the story to progress. The story will then change according to the user's choices. Each branching story will have a different mini game that will immerse the user into the scenario of their choice. Along with the mini game, the users will also be taught about basic computer science concepts that relate to the current dilemma. Depending on the scenario that the users face, they will be questioned on how they would utilize the computer science concept they just learned to solve the issue at hand. This will in turn allow the users to both utilize the information that they just learned and understand the correct way to apply it to the situation. The users will also be able to receive feedback on their answers instantly and will also receive an explanation for the true solution so that they will be able to understand the reason along with the correct way to apply the concept. Throughout the application, the user will earn a score after every mini game and reflection page. A study conducted by Subramaniam & Silverman (2009) showed that validation from scores can have a motivating effect on the student towards physical education. This would mean that the score system is crucial to promoting engagement from the users. After the user completes the story, the user will receive an end page that will show the final score along with the number of experiences and reflections you have encountered.

5.3 Use Case Diagram

Refer Appendix for Figure 5.3

Chapter 6: Implementation

6.1 Development Environment and Tools

For the implementation aspect of this project, the main platform that we are utilizing for the development of an interactive storytelling application is with Android Studio. Android studio is a powerful integrated development environment (IDE) that can be utilized for the development of android applications for android devices. It contains the resources and tools that are necessary for us as developers to create fully functional applications. One of the reasons that I have decided to utilize android studio as the platform for implementation of our interactive storytelling application is because it has native support for the Java language and Kotlin. These languages are considered the most important programming languages for the development of android applications. Another reason is that it provides us with a multitude of libraries and tools that are built into the IDE that will allow us to develop and integrate many different functionalities into the application. One of the functions is the AR functionality. Android Studio allows for native support for augmented reality development with the utilization of the ARCore library. This library allows us to implement AR features into the interactive storytelling application without needing additional plugins and libraries from outside sources. Android Studio was also chosen as the preferred platform due to the availability of debugging and testing resources. This would mean that resources such as an emulator would be available to be used natively. This would allow us to reduce redundancy when it comes to implementation and testing because we would be able to test out features and layouts before needing to completely code the entire project. These multitude of options allowed us the opportunities to create more complex functions for our application so that we can provide a more immersive experience for the user.

6.2 Main Menu Page Implementation

For the main menu implementation, the main menu will display the title of the application and will include two buttons which are the Start Button and Continue Button. The user will be able to begin the experience or continue the experience from where they left off from this main menu page. **Refer Appendix for Figure 6.2**

6.3 Storytelling Page Implementation

For the storytelling implementation, we designed and implemented a story that is told through illustrations and dialogue box and a script that will be the main form of delivering the interactive storytelling application. The story will follow a group of students that must travel through a portal and solve different types of crises by utilizing computer science concepts. **Refer Appendix for Figure 6.3**

6.4 Mini Game Implementation

For the game implementation, the design of the mini game will be implemented into the interactive storytelling experience. The users will need to play and complete the mini games to proceed with the applications story. The mini games will utilize the mobile sensors to function in the games to allow the user to have the feeling of immersion while experiencing the story.

6.5 Reflection Page Implementation

For the reflection implementation, the reflection pages will function as a method for solving issues that occur in the story. The reflection page will allow the user to choose from 4 different answers. There may be a single or more solution to each reflection page. This is to test the user on their knowledge. If the user manages to select an incorrect answer, the score will be deducted. This will also allow the users to get feedback for their answers as they will be able to see what questions are correct and incorrect instantly. **Refer Appendix for Figure 6.5**

6.6 Branching Page Implementation

For the branching page implementation, this page will appear and allow the user to choose what they want to do next in the story of this interactive storytelling application. They will be given two scenarios in which they can choose one to pursue. **Refer Appendix for Figure 6.6**

6.7 End Page Implementation

For the end page implementation, the end page will appear after the user completes the interactive storytelling application experience. This end page will contain the final score, experiences and reflection quiz that the user has acquired throughout the experience. **Refer Appendix for Figure 6.7**

6.8 Augmented Reality Implementation

For the augmented reality implementation, the application will utilize Android Studio's integrated AR Core library. The augmented reality section will consist of placing an item in a virtual environment where the user is able to inspect the item from every direction.

6.9 Mobile Sensors Implementation

For the mobile sensors implementation, the interactive storytelling application will utilize the mobile sensors such as the front camera, back camera, gyroscopes, accelerometer and object detection to interact with the mini games that appear throughout the application.

6.10 Score System Implementation

For the score system, the user will be able to earn points through the experience. The points can be accumulated by completing the mini games successfully. They may also earn or lose points based on how they perform in the reflection quiz that tests their knowledge on computer science. At the end of the interactive storytelling experience, the user will be able to see the final score at the end page.

Chapter 7: Evaluation

7.1 Functional Testing

For the functionality testing of this project, we will be testing each of the functional requirements to ensure that each of these functions will work properly during the interactive storytelling application.

Functional Requirements	Expected Results	Test Result
Main Menu	Opens when starting the application	<input checked="" type="checkbox"/>
Start Button	Begins the interactive storytelling application	<input checked="" type="checkbox"/>
Continue Button	Continues the application where the user left off	<input checked="" type="checkbox"/>
Illustrations	The illustration must be displayed during the application	<input checked="" type="checkbox"/>
Dialogue Box and Script	The dialogue box and scripts must be displayed	<input checked="" type="checkbox"/>
Next Page Button	Will move to the next page when pressed	<input checked="" type="checkbox"/>
Story Pages	The story pages must be displayed when the user presses the Start Button	<input checked="" type="checkbox"/>
Mini Games	The mini games must function properly	<input checked="" type="checkbox"/>
Branching Pages	The branching pages must allow the user to choose from two different story options	<input checked="" type="checkbox"/>
Reflection Pages	The reflection pages must allow the users to choose from 4 different solutions to the	<input checked="" type="checkbox"/>

	question	
End Page	The end page must display once the user has completed the overall experience	<input checked="" type="checkbox"/>
Augmented Reality	The augmented reality mini game must be fully functional	<input checked="" type="checkbox"/>
Mobile Sensors	The mobile sensors in the mini games must be fully functional	<input checked="" type="checkbox"/>
Engaging Story	The story must be cohesive and engaging	<input checked="" type="checkbox"/>
Image Detection System	The image detection system must be able to detect objects accurately	<input checked="" type="checkbox"/>
Score System	The score system must be functional throughout the experience and must be displayed at the end page	<input checked="" type="checkbox"/>

Table 7.1: Functional Requirements Testing

7.2 Usability Testing

For the usability testing of this project, a mixed method approach to the study was implemented to evaluate the overall achievement of the goals as well as the user feedback that have been put in place which includes a user engagement survey to receive feedback from the users in many aspects. These aspects include criteria such as the level of engagement of the application, the overall user experience, the ease of use and most importantly, the educational ability of the application for the users to learn about the main topic.

The main method of evaluation will be implemented under a survey where the user will answer and review the software that has been presented to them. The user engagement is one of the most important aspects when it comes to developing a project that is focused on an interactive story. The user engagement is an incredibly difficult characteristic to account for

when developing a product. This is because every user perceives things differently. Therefore, there is no way to satisfy every single user of a product.

The user engagement is a critical aspect that must be assessed. The user engagement can be categorized as the ability to sustain the users engagement while interacting with the application. For this aspect, we can implement a form of the User Engagement Survey (UES) that is influenced by the survey discussed by O'Brien and Toms (2009). This UES will be able to serve as a standard and valid method of interpreting the users engagement level in a subjective manner. The UES is a tool that is designed by developers to evaluate the user's experience. It contains a group of questions that will provide important and critical understanding into the users overall experience with the application as a whole. For the project that is currently being developed, we can use this UES to gauge how the users feel about the interactive storytelling application along with the functionality of the sensors and augmented reality sections. The UES will be able to evaluate the users satisfaction with the overall application as well as the perceived usefulness and ease of use. It will also be able to provide feedback and insight to the specific functionality of each of the features such as the multiple sensors and even the augmented reality functionality. A highly successful form of user engagement will involve a good combination of effort and reward.

7.3 User Engagement Survey (UES)

A User Engagement Survey (UES) was conducted on 50 participants. The user engagement survey consisted of 3 separate sections. The first section focused on the participants educational background and familiarity with the subject matter which in this case is Computer Science. The second section of the UES focused on evaluating the overall application as a whole. The questions in the section utilized the Likert Scale in which 1 is 'Strongly Disagree' and 5 means 'Strongly Agree'. The third section included subjective questions to allow the users to be more specific about their experience during the research. **Refer Appendix for Figure 7.3**

7.4 Results

7.4.1 First Section of UES

The evaluation was able to be conducted on 50 participants. These participants' ages range from 18-20 years old which consisted about 22%. Meanwhile, 76% of the participants were of the 21-25 years old range. Lastly, about 2% of the participants were older than 25 years old. The survey consisted of 40% of females, 58% of males and the remaining 2% preferred to not disclose their gender. The majority of the participants were students and were asked to disclose their course of study which included Psychology, Business Economics, Engineering, Biomedical Science and Computer Science to name a few. This would show that the survey would involve participants from various different educational backgrounds. **Refer Appendix for Figure 7.4.1a, Figure 7.4.1b and Figure 7.4.1c.**

7.4.2 Second Section of UES

This section is the second part of the survey which consists of the evaluation of the interactive storytelling application with the User Engagement Survey (UES). This second section consists of 14 questions that evaluate the overall application. The questions are answered through the Likert Scale in which 1 is 'Strongly Disagree' and 5 means 'Strongly Agree'.

Evaluation on User Engagement Scale	Mean (M)	Standard Deviation (SD)
I find it easy to learn how to use the application.	4.24	0.72
I find the application organized.	4.2	0.64
I feel in control of the interaction of the application.	4.3	0.65
I find the application creative and inventive.	4.38	0.75
I find the application aesthetically appealing.	4.22	0.88

I found the application interesting.	4.32	0.65
I find the application was enjoyable to use.	4.32	0.71
The application held my attention.	4.3	0.71
I find the application stimulating.	4.28	0.67
Using the application was worthwhile.	4.38	0.67
The application helped me understand the information presented.	4.48	0.68
I learned something new from the application.	4.26	0.75
I would recommend this application to others.	4.4	0.78
Overall, I was satisfied with the application.	4.54	0.58

Table 7.4.2: Evaluation Results of User Engagement Survey

7.4.3 Third Section of UES

For the qualitative feedback of the participants, the last 2 questions of the survey contained open ended questions. Through the survey, participants were asked about the aspects of the interactive storytelling experience that they enjoyed the most. Among the answers that were given, a few aspects were more adored than others. These aspects included the story and games that were included inside the interactive storytelling experience. **Refer Appendix for Figure 7.4.3a.** The last question in the survey inquired the participants on what they would add to this interactive storytelling application. There were many suggestions that were included such as more games and adding background music. **Refer Appendix for Figure 7.4.3b.**

Chapter 8: Discussion

8.1 Impact and Effectiveness of Approach

This project focused on design and developing an interactive storytelling application that uses mobile sensors and augmented reality to teach computer science to students of any background. To measure and analyze the impact and effectiveness of this approach, a survey was conducted by 50 participants.

From the survey that we were able to collect, a majority of the participants of the survey were able to successfully learn computer science concepts regardless of their educational background. Based on the survey result table, the mean was a 4.26 out of 5 on the Likert Scale when asked whether the participants were able to learn something new from the interactive storytelling application. This feedback shows very positive and satisfactory results for this method of pedagogical approach.

The open ended feedback questions were also able to give us insight into the aspects that stood out most to the participants during the experience. We were able to deduce that the majority of the participants particularly enjoyed the mini games that occur during the experience as it allowed them to interact with the application in unconventional methods. Another aspect that was well liked was the game's story and how it was able to implement computer science concepts into fun and engaging scenarios that immersed the participants. These aspects can be quantified by feedback from a user that stated:

“I like how the app would break down different concepts from computer science into easy and digestible pieces of information. Particularly I enjoy the story of the game itself, and overall it is a very interesting and interactive experience to undergo.”

The next open ended question in the survey inquired the participants on aspects they would suggest to be implemented into the interactive storytelling application. While a majority of the participants responded with none, a handful of them had very interesting suggestions. Among these suggestions would include the addition of background music, an animation focused story and more interactive games.

8.2 Challenges Faced

Throughout the development of this interactive storytelling application, there were many challenges that were encountered. One of the biggest challenges was that during the development, implementation for mobile sensors such as the flashlight and microphone would cause the game to crash unexpectedly. It was deduced that it may have been either a coding error or a hardware error. Unfortunately due to lack of resources, these mobile sensors were excluded from the overall interactive storytelling application.

Another challenge that we faced during the development was that the application would crash unexpectedly during certain events. This caused many issues during the testing phase and led to many extra resources being put to fix the issue. One more issue that was faced during the development was that the interactive storytelling application was the implementation of different endings for the game. The initial plan was to create different endings based on how the users performed during the experience. However, due to the difficulty of such implementation and lack of time, we decided to go with a branching story with a single ending.

8.3 Strength and Limitations of the Study

Throughout this study, the limitations and strengths have become quite apparent. A limitation that was very apparent during this project is that there was not a definite way to gauge the users understanding of computer science before and after the interactive storytelling application. However, through the survey, we were able to determine that the users were able to learn more about computer science concepts after experiencing the interactive storytelling experience from the feedback that was recorded by the UES. One strength that I have been able to deduce from the overall project was that the users were able to understand the concepts much more clearly compared to the traditional method of learning. This was due to the fact that they are more focused and engaged with the story which led them to absorb the lessons that have been taught during the events of the story.

8.4 Future Work

Although this interactive storytelling experience fulfills the requirements that have been set, there can still be much improvement for this study. One of the biggest aspects that we can

improve on this scale of the interactive storytelling application. Currently, the application does not utilize network functions. However, future iterations that include network functions may be recommended. The application may connect to the network to allow the application to have updates on the content that it focuses on. An online leaderboard function may also promote competition among users that may lead to higher levels of engagement. Another aspect that we need to focus on for future iterations is the evaluation method and group. Due to lack of resources and time, we were not able to conduct a very conclusive experiment for this research. However, future implementations may add to this. For example, instead of using a survey to analyze the effectiveness of this experience. We should instead conduct the study with a larger and more specific focus group to determine more detailed responses and use a more focused method of evaluation such as a test to see how much the users were able to learn and understand from the interactive storytelling experience.

Chapter 9: Conclusion

In conclusion, this dissertation is aimed to teach Computer Science to a larger audience, this research study also aimed to assess how effective an interactive storytelling application powered by mobile sensors and augmented reality would be at this task. Through this research study, the results were able to demonstrate that the users who were given access to this interactive storytelling application showed much more significant improvement in their understanding of computer science concepts.

Furthermore, addition of mobile sensors and augmented reality technology enhanced learning engagement of the users through improved immersion and engagement. This shows that by incorporating mobile sensors and augmented reality into our interactive storytelling applications, we were able to create an exciting and engaging avenue for teaching Computer Science. Through this experimental approach aimed at promoting better understanding amongst learners, our study revealed how it also serves as a way of attracting a more diverse audience, one that could include those outside of traditional demographics.

Overall, this research has been able to provide evidence that will be able to support the use of interactive storytelling applications as an innovative method to increase the interest in a subject. This method may have the potential to promote a better understanding of the subject matter of all types and will hopefully help the future generation be able to adapt and learn from the rapidly evolving digital landscape.

This research may be further conducted to explore the long term effects of this approach as well as determine the effectiveness of this method in different subject areas. We hope that this research will be able to inspire future educators and developers to entertain the potential of interactive storytelling applications as a new method of promoting more immersive and effective pedagogical approaches.

Project Management

Project management for the development of an interactive storytelling application that involves multiple mobile sensors including an augmented reality section is quite the complex challenge as it requires very thorough planning as well as time management. There were many aspects that were taken into account such as the work plan and required resources and techniques to ensure that the project will be completed on time. First off, I have devised a project plan that outlines the scope of the entire project such that we will be able to plan the deliverables as well as the timeline for each of the development phases. This plan was implemented with the goal of proposing a clear and concise breakdown of the tasks that are required to be completed at each stage. To make sure that the project timeline remained on track, I implemented a project management system to track progress on a weekly basis so that I would be able to track the development of the application. I also implemented an agile development methodology that allows me to prioritize tasks as the development of the application. Due to this prioritization method, we are able to quickly iterate on different functionalities as well as the features without losing sight of the main goal of the overall project. This would require the development methodology and tracking of the project that will allow the progress of development of the application while remaining on track with the goals of the project. Testing and quality assurance also hold a very large aspect of the development phase. The testing and quality assurance phase will be tested on both the emulators as well as other android devices to ensure that the application will remain functional regardless of the environment. This redundancy testing will also have the added benefit of identifying and also resolving any issues or bugs that may be apparent inside the software before the completion of the overall project.

Deliverables	Start Date	End Date
Literature Review and Requirements Gathering	05/10/2022	12/12/2022
Project Proposal.	05/10/2022	07/10/2022
Ethics Form.	05/10/2022	07/10/2022

Interim Report.	12/11/2022	23/12/2022
Interactive Storytelling Application Development	23/12/2022	25/04/2023
Requirements Testing	25/04/2023	26/04/2023
Survey Preparation	17/04/2023	30/04/2023
Final Report	16/04/2023	01/05/2023
Software Demo Video and Presentation Preparation	19/04/2023	01/05/2023

Table 10: Project Plan

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Appendices

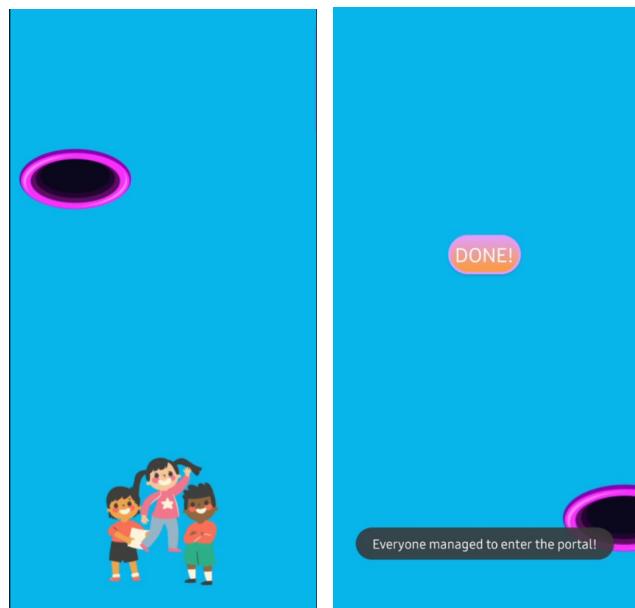


Figure 3.2.1: Catching a portal Activity with the Accelerometer

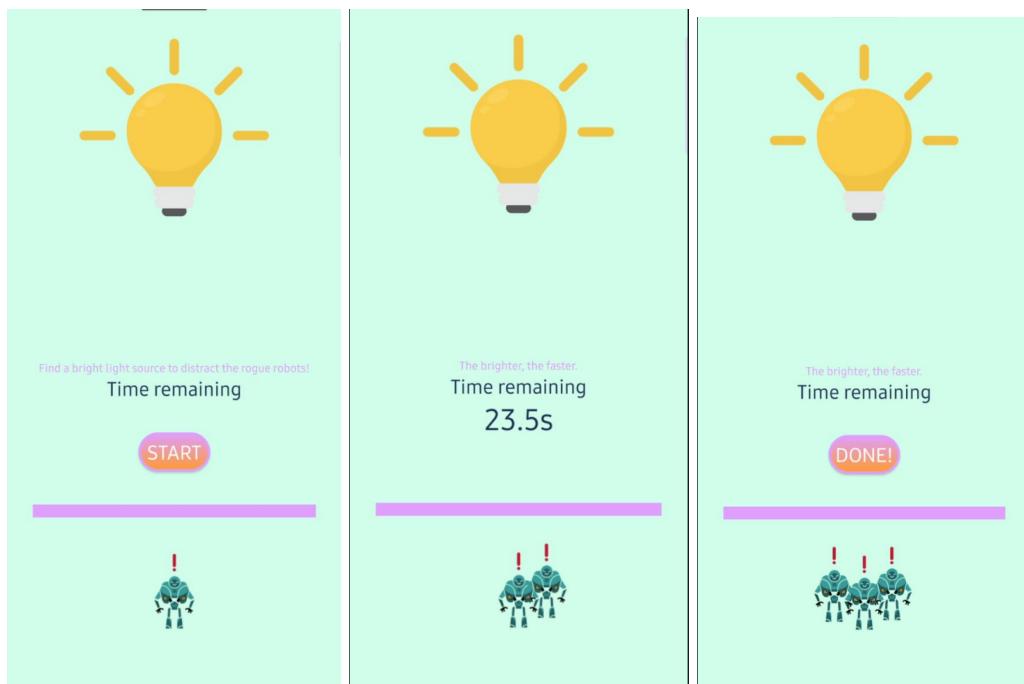


Figure 3.2.2: Using the Light Sensor to distract Rogue Robots

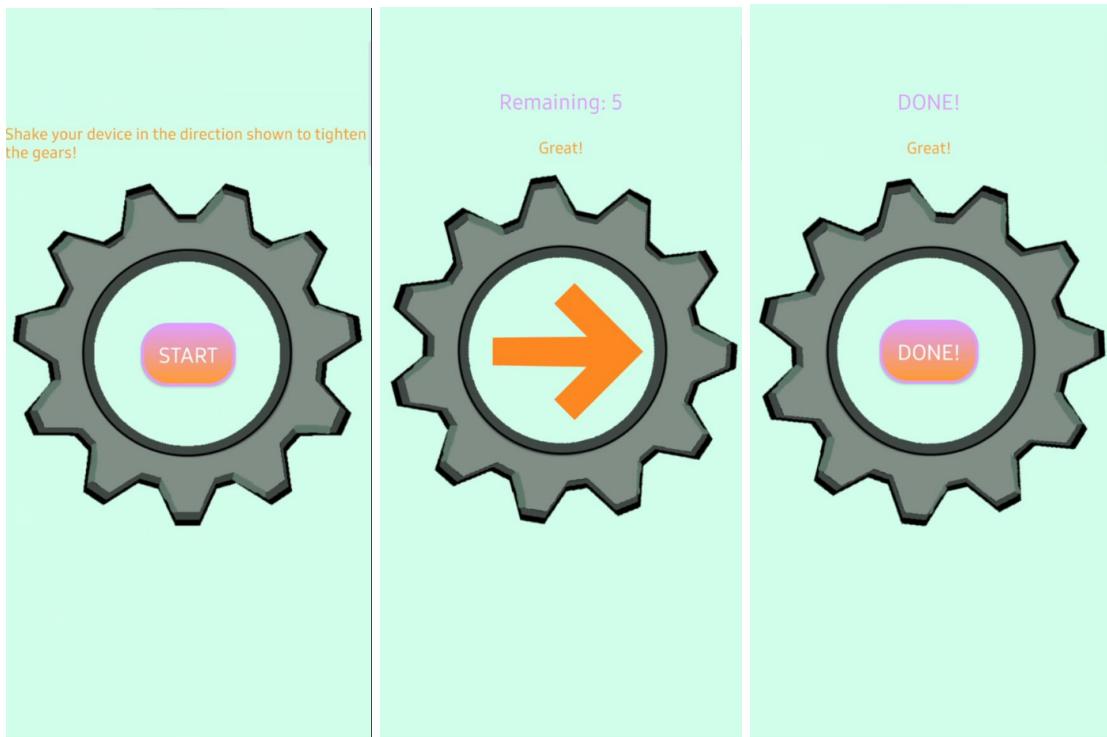


Figure 3.2.3: Using the Gyroscope to tighten a Gear

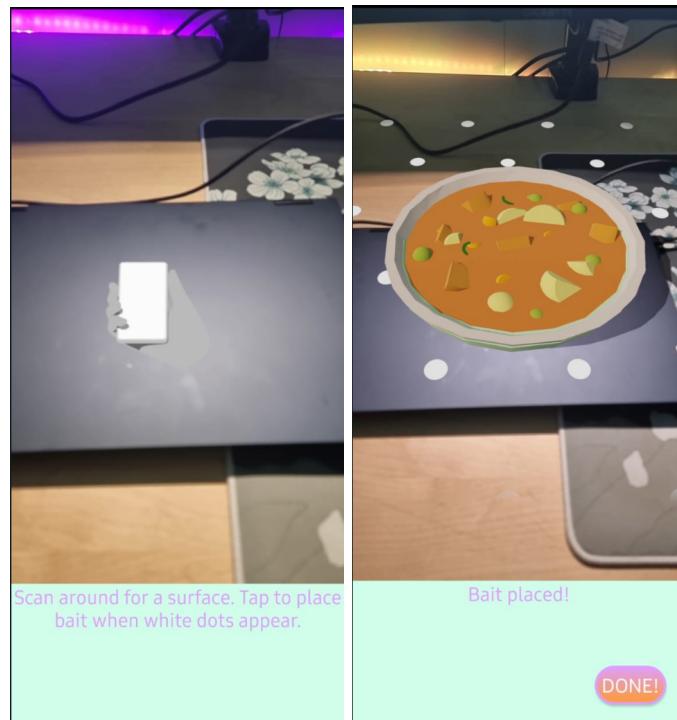


Figure 3.2.4: Using the Augmented Reality function to place bait for creatures

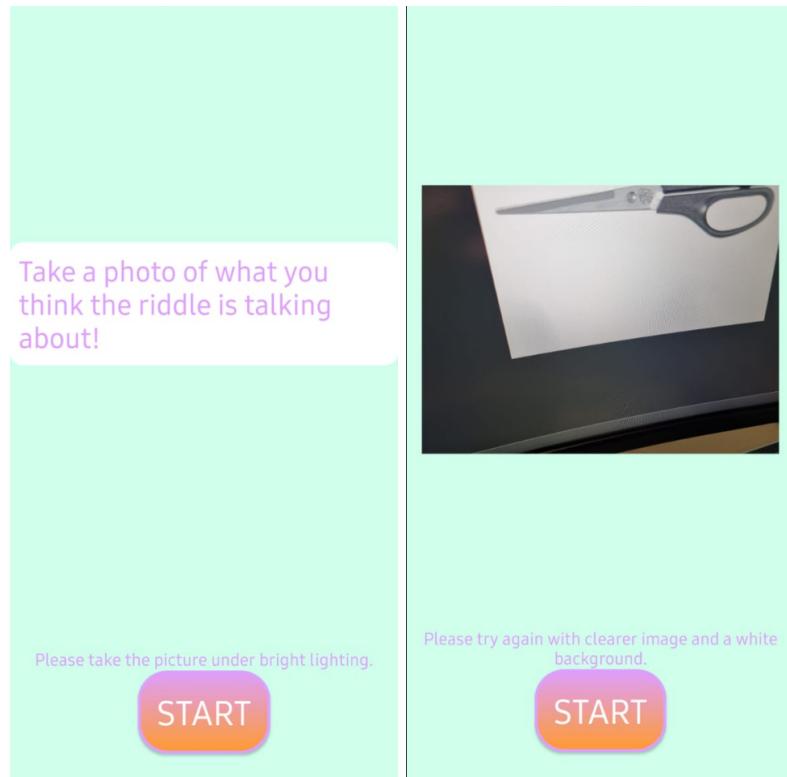


Figure 3.2.5: Using Image Detection to unlock a special box

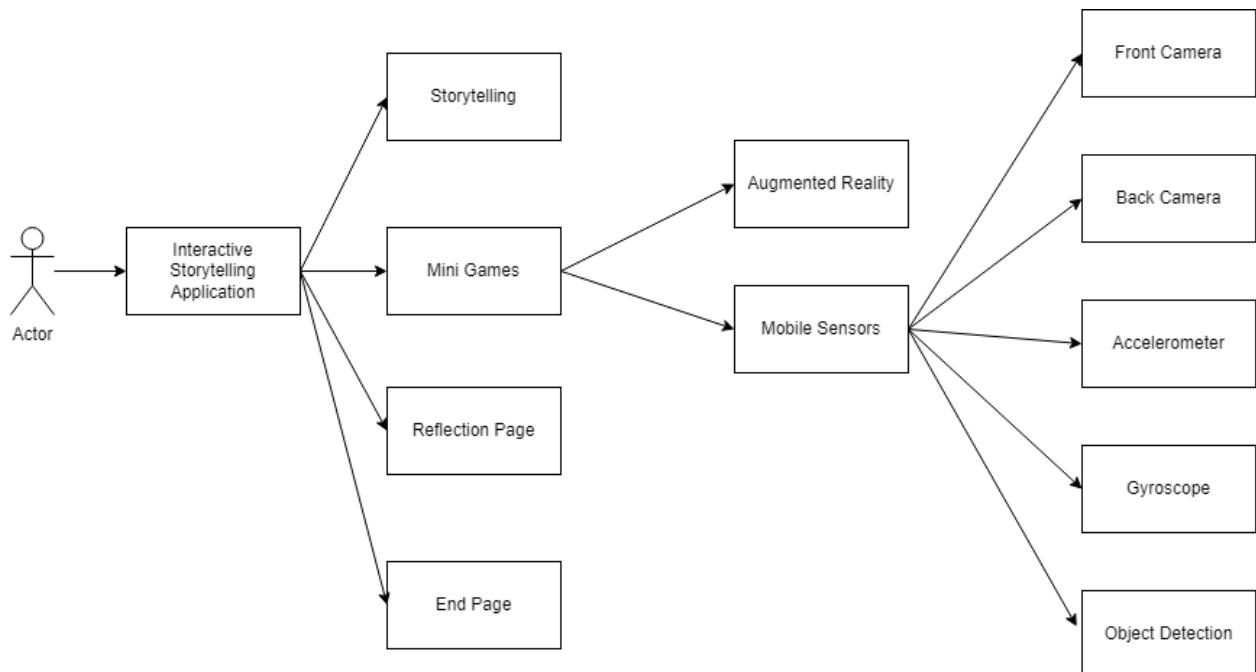


Figure 5.3: Use Case Diagram of Interactive Storytelling Application

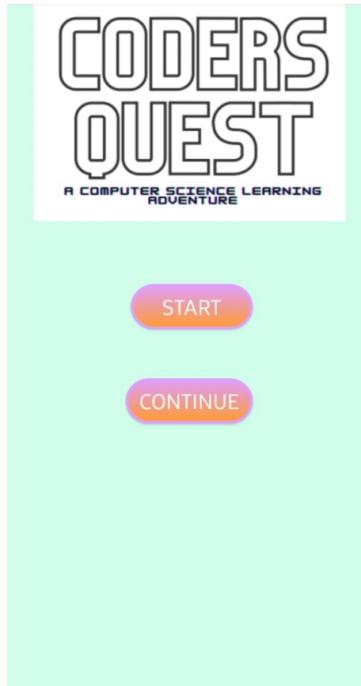


Figure 6.2 Main Menu Page Implementation

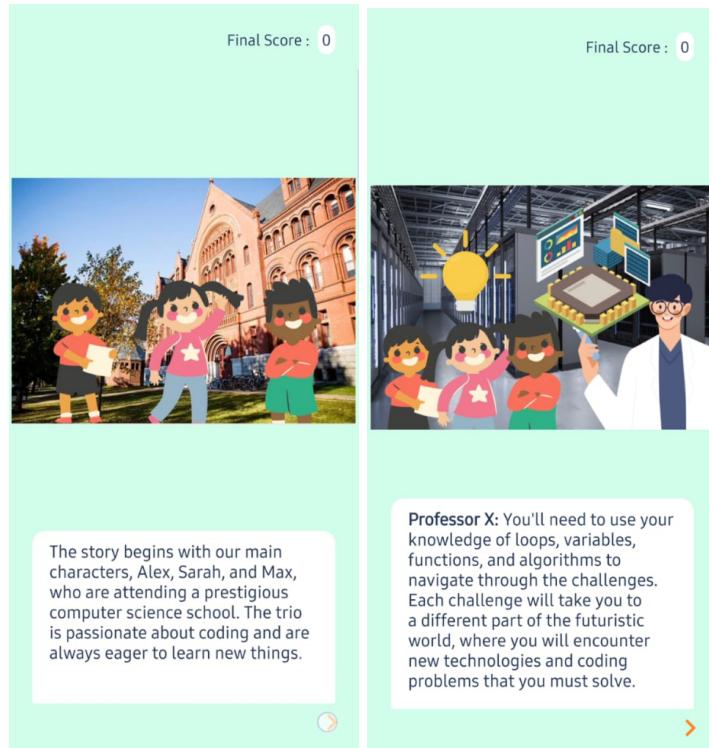


Figure 6.3 Storytelling Page Implementation

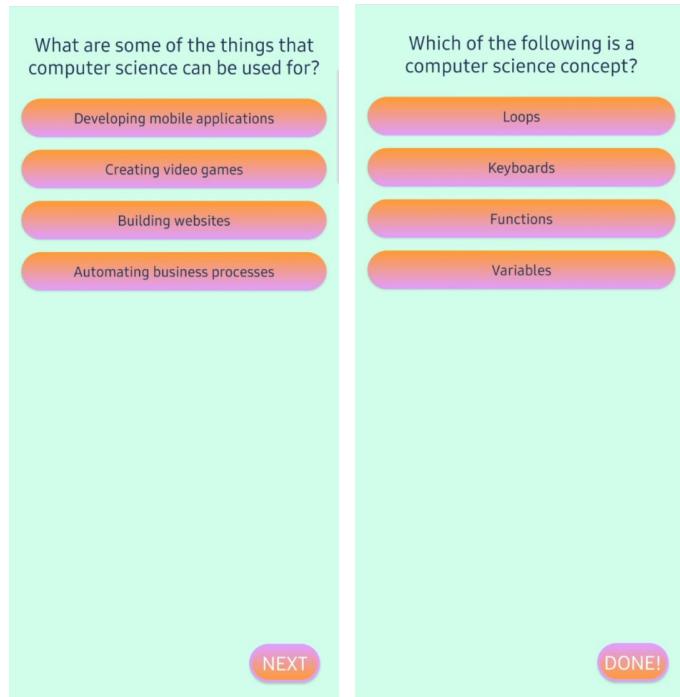


Figure 6.5 Reflection Page Implementation

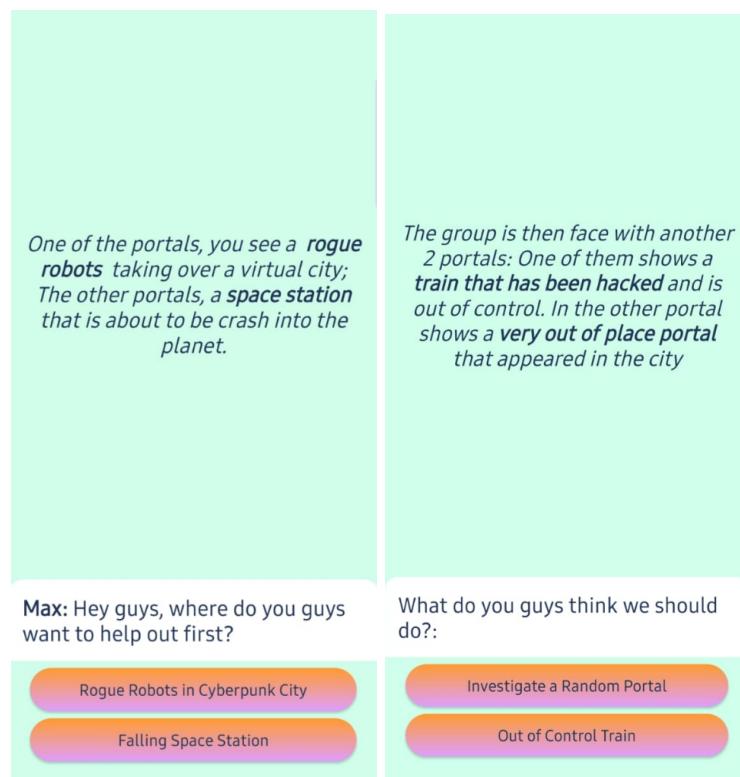


Figure 6.6 Branching Page Implementation

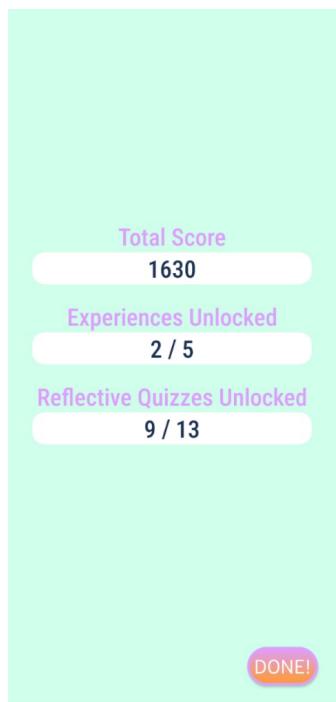


Figure 6.7 End Page Implementation

User Engagement Survey (UES) for Coders Quest: A Computer Science Learning Adventure

This survey will function as a method of analyzing the level of user engagement of the overall project. Please answer the questionnaire honestly and sincerely for accurate results.

[Sign in to Google](#) to save your progress. [Learn more](#)

* Indicates required question

Please state your age *

Your answer

Please state your gender *

- Male
- Female
- Prefer not to say

Please state your course of study *

Your answer

What is your level of understanding for Computer Science? *

1 2 3 4 5

None

-
-
-
-
-

Strong

[Next](#)

[Clear form](#)

User Engagement Scale

For this section, we will be using a 5-point scale to measure your level of agreement. The scale ranges from 1 (Strongly Disagree) to 5 (Strongly Agree). Please choose the responses that best represents your opinion for each question. If you feel neutral about a question, you can select the middle option 3 (Neutral).

I find it easy to learn how to use the application. *

1	2	3	4	5		
Strongly Disagree	<input type="radio"/>	Strongly Agree				

I find the application organized.* *

1	2	3	4	5		
Strongly Disagree	<input type="radio"/>	Strongly Agree				

I feel in control of the interaction of the application. *

1	2	3	4	5		
Strongly Disagree	<input type="radio"/>	Strongly Agree				

I find the application creative and inventive *

1	2	3	4	5		
Strongly Disagree	<input type="radio"/>	Strongly Agree				

I find the application aesthetically appealing. *

1	2	3	4	5		
Strongly Disagree	<input type="radio"/>	Strongly Agree				

I found the application interesting. *

1 2 3 4 5

Strongly Disagree

Strongly Agree

I find that the application was enjoyable to use. *

1 2 3 4 5

Strongly Disagree

Strongly Agree

The application held my attention *

1 2 3 4 5

Strongly Disagree

Strongly Agree

I find that the application was stimulating. *

1 2 3 4 5

Strongly Disagree

Strongly Agree

Using the application was worthwhile. *

1 2 3 4 5

Strongly Disagree

Strongly Agree

The application helped me understand the information presented. *

1 2 3 4 5

Strongly Disagree

Strongly Agree

I learned something new from the application. *

1 2 3 4 5

Strongly Disagree Strongly Agree

I would recommend this application to others. *

1 2 3 4 5

Strongly Disagree Strongly Agree

Overall, I was satisfied with the application. *

1 2 3 4 5

Strongly Disagree Strongly Agree

What aspects of the interactive storytelling experience did you enjoy the most? *

Your answer

What suggestions do you have for improving the interactive storytelling experience in our application? *

Your answer

[Back](#) [Submit](#) [Clear form](#)

Figure 7.3: User Engagement Survey (UES)

Please state your age

 Copy

50 responses

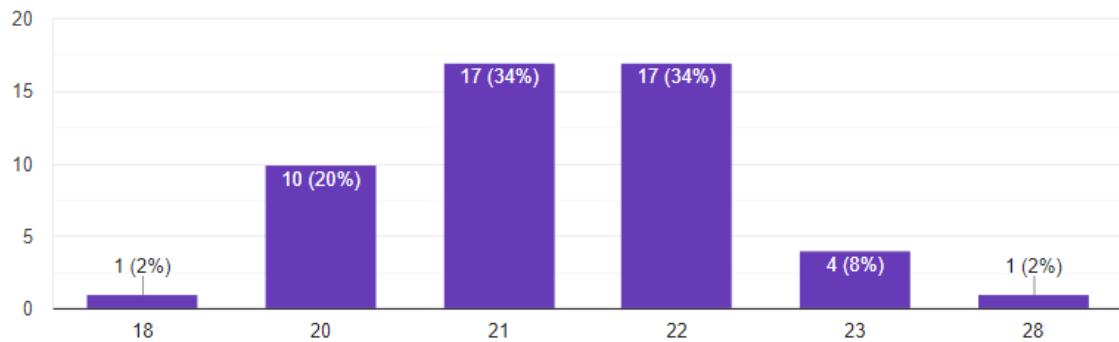


Figure 7.4.1a: The age participants from the User Engagement Survey (UES)

Please state your gender

 Copy

50 responses

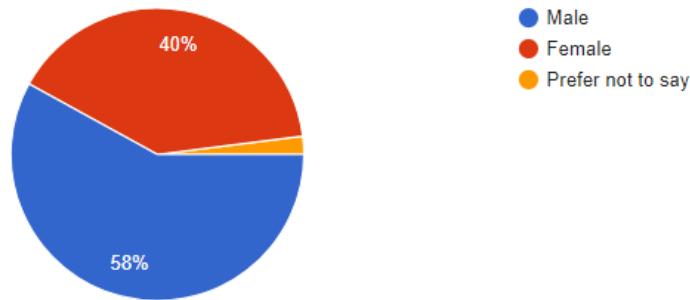


Figure 7.4.1b: The gender of the participants from the User Engagement Survey (UES)

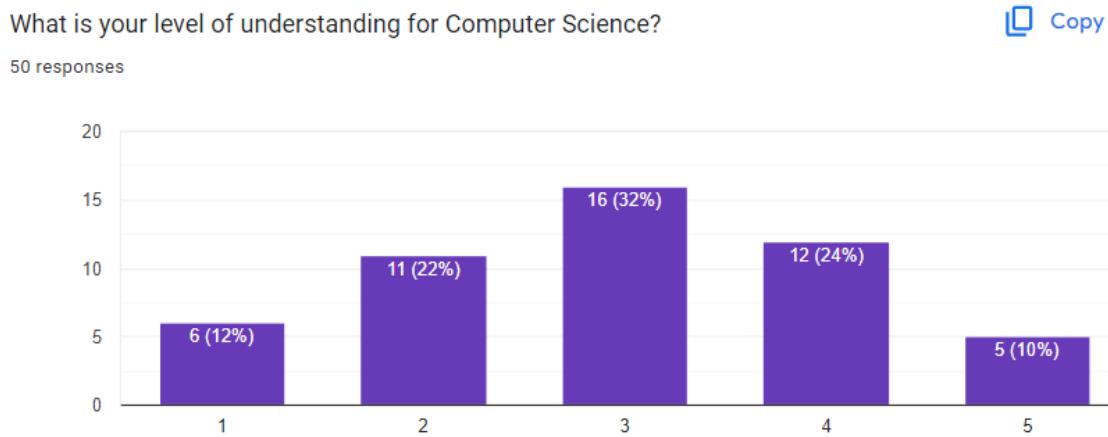


Figure 7.4.1c: The participants level of understanding of Computer Science of from the User Engagement Survey (UES)

What aspects of the interactive storytelling experience did you enjoy the most?

50 responses

Informative

The games were immersive

the story is very engaging

the flow

The game was interesting to play, and I found it informative

The storytelling was clear and engaging.

I like how the app would breakdown different concepts from computer science into easy and digestable pieces of informations. Particularly I enjoy the story of the game itself, and overall it is a very interesting and interactive experience to undergo.

The smooth interaction

Figure 7.4.3a: First Question of the Third Section of UES

	U	V	W	X
1	What suggestions do you have for improving the interactive storytelling experience in our application?			
2	Perfect enough			
3	improve the ui			
4	it good			
5	It was excellent			
6	None at the moment.			
7	maybe add some background music in the app to feel more immersive			
8	Nope it's quite perfect			
9	None			
10	None			
11	none			
12	nothing			
13	include more AR feature			
14	-			
15	Not really			
16	More mini games			
17	the dialog shown using chat bubble instead of paragraph			
18	None			
19	-			
20	no suggestions its amazing 10/10			
21	None			
22	it cannot get any better than this			
23	None			
24	None			
25	None			
26	-			
27	None			
28	Including more practical examples would be great.			
29	I would say mainly the smoothness of the experience could be improve, particularly on the graphical end, to make the app/game more unique and fun to play around longer			
30	None			
31	Add more features			
32	None			
33	None			
34	Maybe can add in some gamification and rewards tiers for long-term user engagement			
35	none			
36	Make the story animated and add text to speech			
37	No			
38	None			
39	None			
40	Too many words and need more visual aid			
41	Shorter conversations between the challenges~ but overall is perfect!			
42	Maybe you add more elements into the storytelling experience. For example, instead of it being a linear story, maybe the choices of the QNA and the scores of the games can affect the ending of the story			
43	Add more chapters			
44	With better navigation flow of the overall of the application would be nice.			

Figure 7.4.3b: Second Question of the Third Section of UES