# Eat Me Up

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**Abstract.** To achieve the goals of sustainable development [1], especially "Life Below the Water", we have developed an innovative study exploring how to raise public awareness of Ocean Plastic Pollution by using Virtual Reality (VR). And we developed a VR project for the CAVE*™ Virtual Environment [2]. By utilizing the interactive experience with VR technology, our main goal is to show the public the huge damage of plastic pollution on whales and the ocean ecosystem. The reason why we designed this game was to allow players to experience the serious consequences of plastic pollution in person and to show some positive changes after successfully cleaning up the ocean. Our Virtual Reality experience emphasizes a practical solution by using "Aspergillus tubingensis" [3], a plastic-degrading fungus. After playing the game, players not only realize a deep understanding of the bad influence of plastic pollution in the ocean but also see the effectiveness of our solutions for reducing plastics. So that we can pay more attention to Sustainable Development Goals.

**Keywords:** Microplastics · Marine Debris · Biodegradable Plastics · Fungus · Whale

## 1 Introduction

It has been estimated that over 9 million tons of plastic have entered the oceans since the 1970s, and a tremendous increase in the production and use of various manmade polymers has become a huge threat to the environment due to their unabated disposal [4]. Eighty percent of the plastics circulating the oceans are believed to come from shorelines, 10% from fishing gear, and 10% from boats and ships many of which end up in our oceans and along our beaches [4].

According to research conducted on filter-feeding whales, they consume millions of particles of microplastic pollution a day, making them the largest consumers of plastic waste on the planet.

Given the research on white pollution in the ocean, VR technology provides players with an unparalleled avenue for engaging in a simulation of a real-life environment and observing firsthand the detrimental effects of plastic waste.

Additionally, VR can offer an interesting way of gaming to show the public how to solve this problem. And can lead to discoveries of cleanup strategies and effective solutions to preserve our ocean.


C. Stephanidis et al. (Eds.): HCII 2024, CCIS 2321, pp. 215–228, 2025.
https://doi.org/10.1007/978-3-031-78561-0_22

In our design, VR serves as a medium for users to actively participate in the cleanup efforts, virtually "clearing" the ocean floor of plastic pollutants using the plastic-degrading fungus, "Aspergillus tubingensis" [3]. Users navigate through the environment as a game through a fish's perspective, enabling them to seamlessly traverse both confined spaces and expansive oceanic landscapes, including the interior of a whale's stomach.

As they navigate, users expose themselves to various elements of marine life, gaining valuable insights, and are tasked with the mission of collecting and dragging the fungus to the plastic objects to complete the game, which enhances the users understanding of their ecological impact and the critical need for proactive intervention. The VR experience also encourages users to come up with strategies to complete the game, by navigating through certain scenes successfully and avoiding the plastic objects. Building upon the interactive aspects of VR, it has the capability of emulating ocean environments and spreading awareness about plastic waste on whales, which lie in its capacity to create immersive, interactive, and educational experiences that evoke empathy and inspire action for the preservation of marine ecosystems (Fig. 1).

Table 1: The Data on the Proportion of Different Marine Pollution

| Position of the pollution | Type of the pollution | Proportion | Ranking |
|---|---|---|---|
| Sea surface | Plastic | 41% | 1 |
| | Styrofoam Packaging | 19% | |
| | Wooden Products | 15% | |
| | Else | 25% | |
| Beach | Plastic | 66% | 1 |
| | Styrofoam Foam | 8.5% | |
| | Paper | 7.6% | |
| | Fabrics | 5.8% | |
| Below the sea | Plastic | 41% | 1 |
| | Metal | 22% | |
| | Glass | 15% | |
| | Wooden Products | 11% | |

**Fig. 1.** The table of the data on the proportion of different marine pollution.

## 2 Solution

Have you ever walked along a beautiful beach and been surprised to find a piece of plastic at your feet? You might be even more surprised to learn that together with volunteers like you, we've picked up more than 348 million pounds of trash in the last 35 years [6]. And the problem goes deeper than what you're seeing on the beaches, especially under the sea world.

As a result of our research, we have found that the molecular structure of plastics is very stable. This is because plastics are made up of polymers that are made up of many identical molecular units. The chemical bonds between these molecular units are very strong, making plastics very difficult to break down. Even if it's not the bottom of the ocean, in the natural environment, plastic still needs hundreds of years to be completely broken down.

How does the Fungus Eat Plastic?

So, is there another way to speed up the breakdown of plastic? So, we started a study—the special fungus (Fig. 2).

Among these marine pollutants, diatoms have attracted a lot of interest from scientists with their mysterious ability to attach themselves. How do these tiny and amazing organisms adhere closely to different substrates? We will start from the relationship between diatoms and marine plastics and discuss the importance and application value of diatoms in marine litter attachment one by one. Diatoms utilize their tiny but structurally complex cell walls and filamentous protrusions to firmly bind themselves to the surface of plastics, forming a biofilm with stability and sustainability [7]. This phenomenon not only reveals the importance of diatoms in marine litter attachment but also provides us with new ideas for finding solutions to marine plastic degradation.

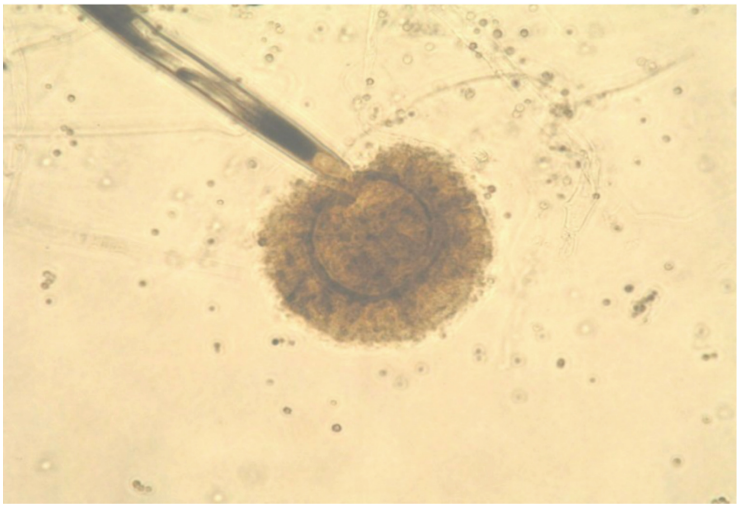

**Fig. 2.** "Aspergillus tubingensis"

Secondly, we discovered an amazing fungus called Aspergillus tubingensis, which is a fungus, which ordinarily lives in the soil. In laboratory trials, the researchers found that it also grows on the surface of plastics. It secretes enzymes onto the surface of the plastic, and it secretes enzymes onto the surface of the plastic, and these break the chemical bonds between the plastic molecules, or polymers [3].

It secretes enzymes onto the surface of the plastic, and these break the chemical bonds between the plastic molecules, or polymers [7]. The study indicates that under the action

of Aspergillus tubingensis, the biodegradation of plastics, which are difficult to degrade in the natural environment, can be clearly seen in two weeks, and the plastic polymers on the culture medium basically disappeared after two months [7]. Aspergillus tubingensis can grow on the surface of polyurethane, and through the enzymes produced during the growth process, it reacts with the plastic to break the chemical bonds between the plastic molecules or polymers; at the same time, the fungus also utilizes the physical strength of its hyphae to help "break" the plastic polymers [8]. So, these data and research give our team the inspiration to think the idea of how to clean the ocean. Our main design was using the typographic design to represent the Aspergillus tubers. represent the Aspergillus tubingensis-fungus), and after the players grab the fungus and put it on the plastic, the plastic will successfully break down.

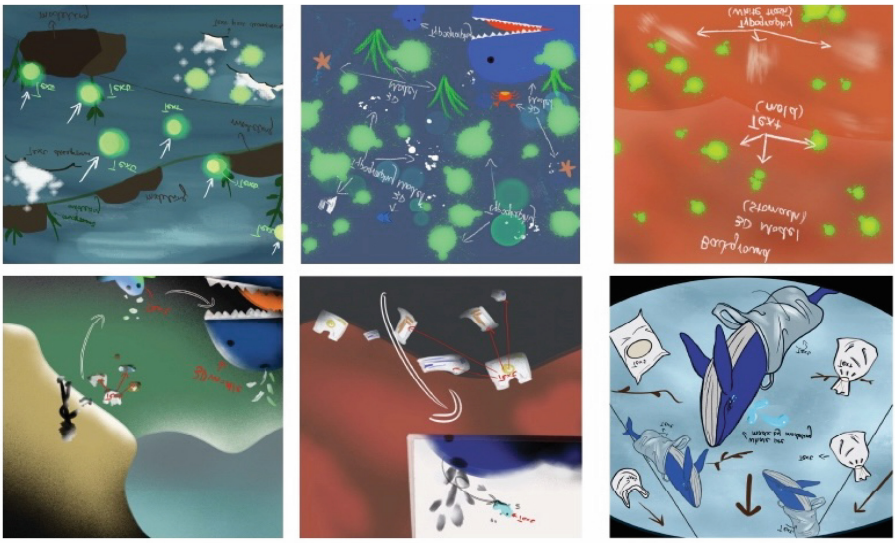

**Fig. 3.** Rough draft of the first storyboard

## 2.1 Design Process

We started by conceptualizing the main characters of the story as a whale and a fungus. The first version of the storyboard is shown in (Fig. 3), which is a sketch of our first storyboard, we briefly explained that the player will experience the whole game as a fish and will experience the four main interactions: being eaten by the whale - escaping from the whale - discovering the fungus - cleaning up the ocean. The final version of the storyboard is shown in (Fig. 4), where we added more details to the sketch using Procreate and AI, ID, and so on. We also started to think about the initial design of the typeface in Maya. The final version of the foundation design in Unity was completed in a series of revisions. We created a foundation and experimented with it. We were very careful with the texture of the foundation, the cubic effects, and the extension and overlay

of each piece of the foundation. This was to allow the player to get more involved in the physicality of the game. We also created grass that swings back and forth in the water and placed it on the foundation. The foundations are undulating and bumpy, making it more challenging for the fish to swim around.


**Fig. 4.** Final storyboard

## 2.2 Aesthetic and Typography

Aesthetic and Typography were the most important parts of the project. From the choice of the skybox in unity to the lighting, color palette and vibe of the game, it was all well thought out. All our typography is based on real images, and we wanted everyone to be able to understand our design except for those who are familiar with the project. So, first we simply drew the outline of plastic, whale with the simplest lines. Secondly (the whale), as we can see from the picture, we deformed and liquefied each letter to fit the shape of the whale's outline better. After designing the basic whale Typography, we combined it with the theme of whales being harmed by plastic trash under the sea. Finally, we succeeded in designing (Fig. 5) our final version of the main model.

Fungus (Fig. 6), random elements such as twinkling stars, suggesting a return to clarity and purity in the game's water features. The randomness of the twinkling controlled by the code ensures that each player's experience is unique and may leave them with a sense of wonder and fulfillment.

This Unity project and its interactive C# scripts appear to be a thoughtful presentation of an underwater journey, each contributing to the overarching theme of environmental awareness and conservation. It depicts the journey from pollution to purity, utilizing the interactivity of the medium to convey a powerful message.

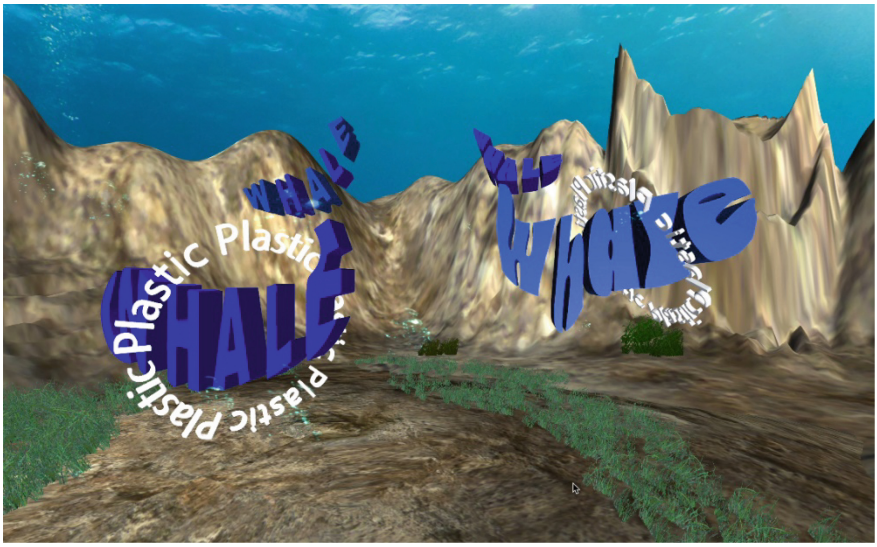


**Fig. 5.** Type design of whale


**Fig. 6.** Type design of fungus

### 2.3 Interactive Experience

Creating interactive experiences (especially in Unity) requires carefully orchestrated code and assets to build immersive environments. Here we're going to describe the # code in the images we made in unity and what each of them does. There are some that are used to control sound, DisappearOnDistance and Pickup Sound are coordinated with spatial audio effects, so that when the player enters an object it has a sound! and it disappears when they move away from whatever distance they are at. The purpose

of the visual is to prevent confusion caused by too much sound, thus eliminating the need to reduce the player's immersion in the game. Also, about some thought-provoking interactions. Let's go through the interactive scenes for each level in order.

In the first scene (Fig. 7) as presented in our storyboard, it's like starting from the point of view of a small fish. Here we applied a stop-down effect to the white trash design itself and turned off the gravity to achieve an effect of the trash floating in the water. This interaction uses the Falling-Object script to simulate the effect of garbage floating underwater without the effect of gravity, which may be a visual metaphor for pollution. The touch interaction Shake Object, implied by scripts such as, can simulate the pain of a small fish trapped by trash, adding a narrative layer to the gameplay.

**Fig. 7.** The interaction scene in Eat Me Up.

The narrative progresses as the Teleporter script progresses, suggesting that the player is reset to the starting point when interacting with certain objects, which in this case could be giant garbage bags. (Fig. 8) The clever use of stealth teleportation adds to the challenge and unpredictability of the environment.

The most noticeable thing in the third scene (Fig. 9) is the randomly moving white garbage bags some quivering and some moving left and right. The purpose of such trembling is to end the player's path to the challenge they need to face. Here again we used code that made these 3D fonts available just as the item was expected to move. Further interactivity is demonstrated in scripts such as Move on Click, Particle Script, and Pickleable Object, which demonstrate the ability to manipulate objects in the game, perhaps clearing paths or solving puzzles, thus evoking a sense of immersion and accomplishment in the player.


**Fig. 8.** The main models and scenes in Eat Me Up.

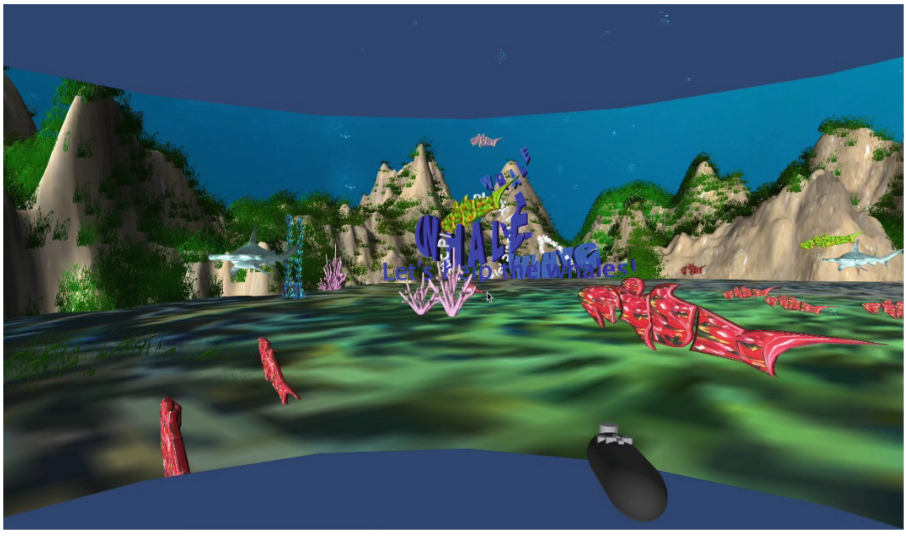

**Fig. 9.** The main models and scenes in Eat Me Up.

The fourth scene (Fig. 10) is also the most interactive in the whole, and the experience seems to culminate in a visually and interactively rich environment Disappear scripts such as and others Contact show that touching certain objects triggers them to disappear, altering the surroundings in the process. This not only represents the player cleaning up pollution, but also symbolizes the improvement of the environment. This includes a garbage bag that disappears when the player grabs a fungus and touches it. The C# here is very tedious and complex. Because we need all the garbage bags and fungi to disappear. We also need to make them disappear after the environment has changed.


**Fig. 10.** The main models and scenes in Eat Me Up.

So, we can't make the bags and fungi disappear. Instead, we make C# code that renders all the missing models that are labeled with special names. And when the rendering disappears the surroundings change. The goal of our objective is to have the environment rendered by the little fish picking up the fungus change dramatically. This would also allow the player to feel a sense of realization.

Finally, the atmosphere is enhanced by scripts that control random elements such as twinkling stars (Fig. 11), suggesting a return to clarity and purity in the game's water features.

The randomness of the twinkling controlled by the code ensures that each player's experience is unique and may leave them with a sense of wonder and fulfillment.

This Unity project and its interactive C# scripts appear to be a thoughtful presentation of an underwater journey, each contributing to the overarching theme of environmental awareness and conservation. It depicts the journey from pollution to purity, utilizing the interactivity of the medium to convey a powerful message.

### 2.4 Auditory Experience

The creation of the auditory experience in our game design is a carefully curated process designed to enhance player immersion and emphasize the theme of environmental conservation. The following is a more detailed and scholarly description of our auditory design:

Sound Selection and Environmental Integration: The underwater world sounds we chose were not merely intended to provide background sound effects but were designed to tie in with the game's core theme of the preservation of the marine environment. Each sound was carefully selected and adapted to ensure that they conveyed the message of environmental protection while enhancing the game's environmental perception and emotional appeal.

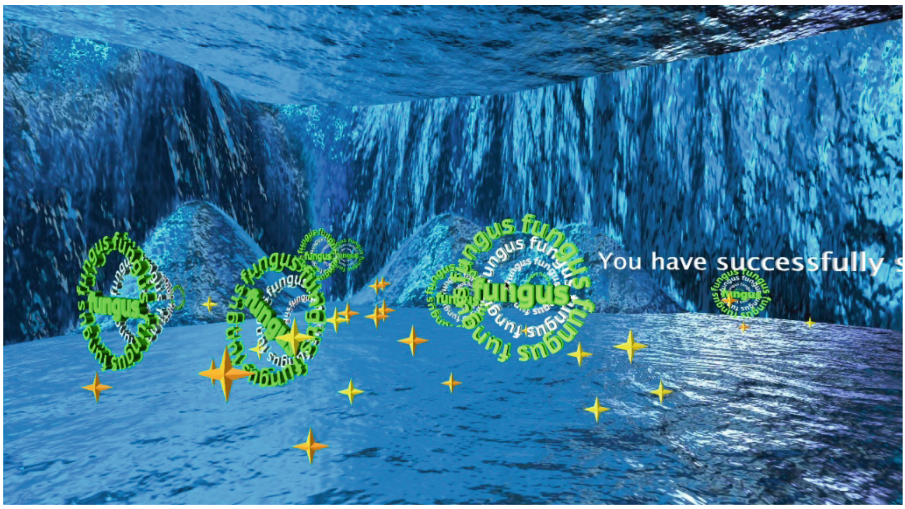


**Fig. 11.** The main models and scenes in Eat Me Up.

Technical implementation: Application of C#: We used C#. (Fig. 12) to control the sound resources, taking advantage of its efficiency and flexibility to implement complex sound control logic. For example, through programming, we can dynamically adjust the play and stop of the sound according to the player's position in the virtual environment. This interactive sound design enhances the realism of the game.

Spatial properties of sound: For different sound effects, we set different spatial distance thresholds. This design considers the propagation characteristics of sound in space, enabling players to feel the changes in sound intensity and clarity when approaching or moving away from the sound source, thus providing a richer and more realistic listening experience.

Cyclic playback and consistency of sound resources: We have carefully designed the cyclic playback mechanism of sound resources to ensure the consistency and uninterruptedness of the sound during the startup and progress of the game. This not only avoids abrupt switching of sounds, but also increases the continuity and realism of the game world. Layers and details of sound effects: From the sound of bubbles to the sound of falling garbage piles to whale calls and water currents, our sound design contains multiple layers and details. Each sound not only represents an element of the marine ecosystem, but also serves as a metaphor for the topic of marine pollution and ecological protection.

Emotional and thematic connection: In key scenes, such as the moment when the small fish encounters the healing.

Fungus, we specifically chose emotionally charged audio as a way of highlighting the importance of marine pollution solutions. This design not only enhances the players' emotional experience, but also deepens their understanding and empathy for the theme of environmental protection.

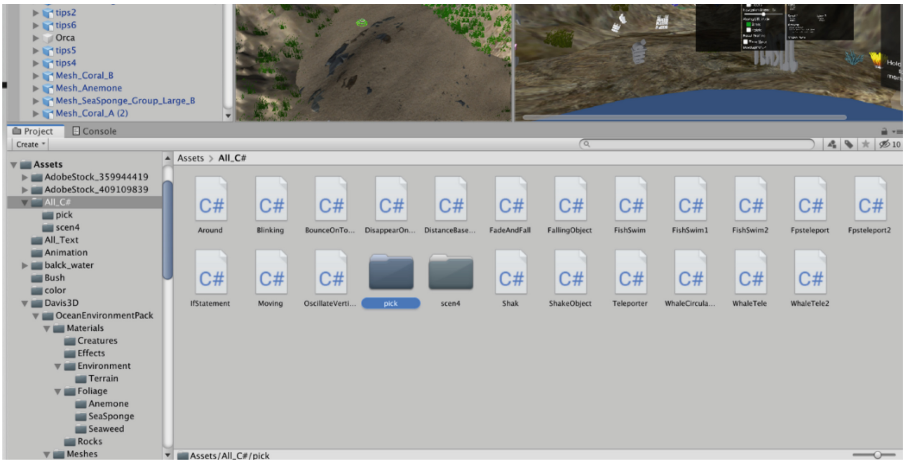


**Fig. 12.** Utilization of the Eat Me Up Method in C# Programming.

Symbolism of sound: At the end of the game, the sound of shining particles symbolizes the solution of the ocean pollution problem. We elevate the sound design to a symbolic and metaphorical level, which not only strengthens the narrative of the game, but also profoundly expresses the theme of environmental protection. Through such detailed and multi-layered sound design, our game not only provides an engaging entertainment experience, but also conveys an important message about environmental protection and ecological balance, thus realizing the perfect combination of entertainment and education.

## 3 Exhibition

During the exhibition (Fig. 13) EAT ME UP received a lot of high-quality reviews and feedback. We were exhibited in the CAVE2 in EVL/UIC with 50 audience visitors providing feedback and comments about the project design and exhibition. Also, we collaborated with the global IBM Design Technology Theater Group, and the project was developed in the Electronic Visualization Laboratory (EVL) at the University of Illinois Chicago. We really appreciate our university and professors for giving us this amazing experience and the opportunity to explore the development of Visual reality.


**Fig. 13.** The Exhibition of Eat Me Up.

## 4 Conclusion

The core objective of this project is to raise public awareness of the marine pollution problem and to stimulate their interest and action in marine ecosystem protection through an immersive VR experience. Through the perspective of a small fish, we not only present the damage of marine pollution to the ecosystem, but more importantly the vulnerability of the whale as a marine creature in this environment. By "experiencing" the journey of the small fish, the player will gain a deeper understanding of the importance of protecting the marine environment.

Through this project, we hope to cultivate a sense of responsibility for the marine ecosystem in the minds of the players. The ocean is not only the cradle of life on earth, but also the foundation of our human existence. When the marine ecosystem is threatened, not only marine life is victimized, but the future of human beings is also at risk.

Therefore, to protect the ocean is to protect ourselves.

In addition, this project also emphasizes the potential of technology in education and environmental protection. By utilizing VR technology, we can create a virtual environment that is both realistic and engaging, allowing players to gain important knowledge and insight about ocean conservation while playing the game.

Ultimately, our goal is to inspire players to act in their daily lives and get involved in ocean conservation.

Whether it's reducing plastic use, participating in beach cleanups, or spreading the message of ocean conservation through education and social media, everyone's contribution is vital. We want this VR project to be more than just a virtual experience, but a bridge to inspire real-life action, working together to take action to protect our blue planet (Fig. 14).


**Fig. 14.** Final Poster of Eat Me Up.

**Acknowledgments.** We really appreciate Professor Daria Isoupikova, Professor Andy Johnson, and Farah Kamleh for their invaluable support and guidance. Their feedback and suggestions have been instrumental in shaping our project, 'Eat Me Up'.

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