SEA SOUL:
A VIRTUAL REALITY EXPERIENCE BRINGING FUN AND WELLNESS TOGETHER

A Capstone Project Presented to
the Graduate School of
University of North Carolina Wilmington

In Partial Fulfillment
of the Requirements for the Degree
Master of Science
Computer Science & Information Systems

Sabrina Balcerak

Computer Science
University of North Carolina Wilmington

2023

Committee Members:
Dr. Toni Pence, Committee Chair
Dr. Jeffrey Cummings
Dr. Kevin Matthews

TABLE OF CONTENTS

ABSTRACT

Sea Soul: A Virtual Reality Experience Bringing Fun and Wellness Together.
Balcerak, Sabrina, 2023. Capstone Paper, University of North Carolina Wilmington.

Purpose: The aim of this project is the creation of *Sea Soul,* which brings fun and wellness together in an immersive virtual reality (VR) game environment by the sea. The goal is to target users of all ages and abilities and to promote the well-being benefits that VR can provide.

Background: The major findings of this research explore the physical, mental, and educational benefits of VR. Engagement in VR is shown to decrease for older adults; however, it is increasing for use in senior care, so *Sea Soul* is designed to appeal to a wide range of users.

Methods: Usability was tested with user experience survey results that have a quantitative rating scale, with success being middle to high on the rating scale. Qualitative data was obtained through open-ended questions on the survey.

Results: *Sea Soul* was designed and developed. User testing was performed, and feedback obtained used a 5-point Likert scale, with 1 being the lowest-rated option and 5 being the highest-rated option. The survey results showed the mean value being over 4.20 for all user responses.

Discussion: Quantitative data over 4.20 supports that *Sea Soul* usability results meet the success criteria of having a mean value of middle to high on the rating scale. User testing was limited because a full-fledged range of age groups did not participate.

Conclusion: The working VR application model of *Sea Soul* infers that fun and wellness can be brought together to promote well-being benefits for users of all ages and abilities.

LIST OF TABLES

Table Page

LIST OF FIGURES

Figure Page

CHAPTER 1: INTRODUCTION

The essence of *Sea Soul* is that not only is it fun to play, but it's good for your soul. *Sea Soul* is a virtual reality game that gives you the feeling that you are at the beach. It is for all ages and particularly includes the elderly and people with different abilities who are not able to get out to the beach, so everyone can enjoy the immersive experience. Though virtual reality is being used for senior care, it is not widespread in general gaming applications available to use in one's own home, and the applications being used have their limitations. *Sea Soul* is a proposed virtual reality application that is a fun, immersive beach experience that incorporates a wholesome approach and is presented as a solution to this problem. Since we all age, aging is a process that affects everyone, and *Sea Soul* brings fun and wellness together for all ages and abilities.

To coin a phrase, *Sea Soul* brings "beach therapy" to beach lovers alike. Some of the major findings of this research explore the physical, mental, and educational benefits of virtual reality and how they can be incorporated together in an application, *Sea Soul*, which can contribute to virtual reality technology and further research in games that bring fun and wellness together.

While attending UNCW, I developed an interest in how virtual reality (VR) has progressed from gaming to being used in a wide range of fields, including health care, and how it can be used to benefit humankind. First, the inspiration for *Sea Soul* is that I was inspired to learn that VR was being used in assisted living facilities and homes for the elderly for their well-being. Secondly, remembering my mother was an inspiration and motivation for me and my idea of *Sea Soul*. She, like us all, experienced the aging process; she could not get out to places like she used to, and I know how much she loved

the beach and picking up seashells. So, I wanted to give beach lovers and people who love to pick up seashells a way to go have some "beach therapy" when they are unable to.

Feedback for the development of *Sea Soul* is collected through user survey results that are used to obtain data that evaluates the player's experience. For this study, a 5-point Lickert scale is used, with 1 being the lowest-rated option and 5 being the highest-rated option. The survey results show the mean value being over 4.20 for all user responses, which met the established success criteria for having a mean value of middle to high on the rating scale. The principal conclusions derived from the results are that *Sea Soul* is a working VR application that promotes wellness by bringing fun and wellness together for users of all ages and abilities.

This paper presents a review of the literature and analysis in Chapter 2 about what VR is, the benefits and challenges of VR, relevant VR applications, and the proposed VR application. Chapter 3 explains the methodology for the research, which is conducted in six phases. Furthermore, Chapter 3 contains the design phase and requirements phase of the research. Chapter 4 includes the development, testing, and evaluation of *Sea Soul*. Chapter 5 is a discussion about inferences, lessons learned, and future work. Finally, Chapter 6 is the conclusion of the research project.

CHAPTER 2: REVIEW OF LITERATURE REVIEW AND ANALYSIS

Relevant literature is presented and reviewed that enables an analysis of what virtual reality is and several of the benefits and challenges of VR. Specifically, physical health, mental health, and educational benefits and challenges are reviewed. Several relevant VR applications are reviewed with a contrast and comparison to *Sea Soul*. The relevant applications are then analyzed by examining the strengths, weaknesses, opportunities, and threats in what is known as a SWOT analysis. Following the review of the relevant literature and applications, the rationale and relation in significance for the research project are summarized. The research problem is stated, and the solution of the virtual reality application of *Sea Soul* is presented.

2.1 What Is Virtual Reality?

Virtual reality uses graphics, hardware, and art-rendered experiences to create a computer-simulated environment that gives the user an immersive and realistic experience (Meta). Head-mounted displays allow the users to experience this high degree of immersion (Radianti et al.). The word immersion is used to describe how a user engages in a virtual reality environment where his or her awareness of being in the real world with real time is disconnected and the user has a sense that they are in the virtual reality experience instead (Radianti et al.). The computer-simulated environment enables the user to feel like they are physically there. Steven LaValle describes the definition of VR as “Inducing targeted behavior in an organism by using artificial sensory stimulation, while the organism has little or no awareness of the interference” (LaValle 1). Targeted behavior is the experience, the organism is the life form, and artificial sensory simulation

is where the organism's senses are somewhat co-opted due to their inputs being replaced or enhanced (LaValle 1-3).

With VR headsets, a user sees a display that is split between the eyes so that they see a different feed, the user hears sound, and their position is tracked so that the user's point of view is oriented (Meta). This combination contributes to the overall effect of immersion. VR is not new, but the recent developments in VR technology and lower budget headsets have made it more attractive and more affordable for people to use. Headsets can be affordably purchased and are increasing in demand. See Figure 1 for the head-mounted display market rates. The head-mounted display market, valued at $3.77 billion in 2020, is projected to reach $113.55 billion with a compound annual growth rate (CAGR) of 46.0% (Exactitude Consultancy).

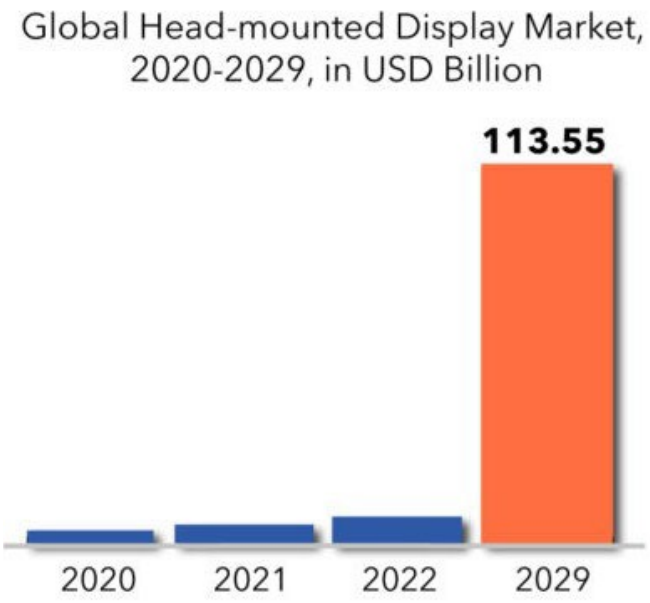


Figure 1. Global Head-mounted Display Market, 2020-2029 (USD Billion) (Exactitude Consultancy, 2022).

In addition to head-mounted displays, there are other devices and software that are used for VR, such as for mobile VR and VR that is connected to a desktop or

PlayStation. VR offers applications to industries such as healthcare, automotive, retail, gaming, and entertainment (Fortune Business Insights). The immersive technology adopted by these industries is for uses such as virtual training, simulation, engineering and maintenance, marketing, and designing (Fortune Business Insights). The devices, software, industries adopting the use of VR technology, the advancement of 5G technology and infrastructure, and key market players driving the advanced hardware and content for the improvement of the user experience are all included in a study by Fortune Business Insights in the projected growth of the global virtual reality market size. The global VR market size in 2021 was valued at $11.64 billion (Fortune Business Insights). See Figure 2 for specific details on the North American VR market size for 2018-2019. "The global virtual reality market is projected to grow from $16.67 billion in 2022 to $227.34 billion by 2029, at a CAGR of 45.2% in the forecast period 2022-2029" (Fortune Business Insights).

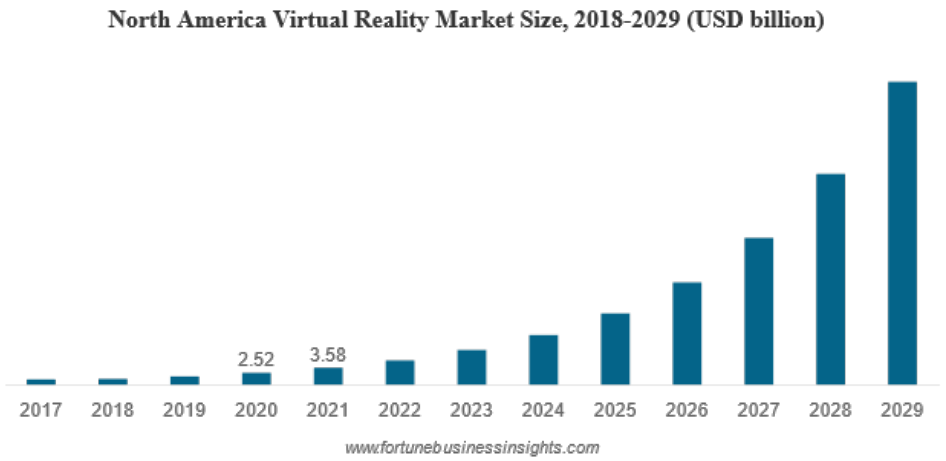


Figure 2. North America Virtual Reality Market Size, 2018-2029 (USD billion).
(Fortune Business Insights, 2022).

According to Fortune Business Insights, per VR statistics and industry experts' analysis, the market expansion will be fueled by the growing potential in the healthcare industry, reflecting a radical change with VR applications. "The technology has

showcased potential in improving the healthcare provisions, patient care system, planned surgeries, and medical training, among others" (Fortune Business Insights).

In the entertainment industry, VR offers gaming. Gaming is fun, and users like the immersive and realistic experience of gaming in VR. Beyond gaming, VR provides an entirely new level of entertainment; it has something for everyone (Meta). It enables you to explore, travel, learn new things, and experience things you have never done before. "And it has the potential to transform how we play, work, learn, communicate, and experience the world around us" (Meta).

An October 2018 research study conducted by a market research company GlobalWebIndex (GWI) studied the percentage by age group of 3,938 internet users in the UK and US on if they had used a virtual reality headset in the last month (Buckle). The engagement with virtual reality was mainly clustered around the 16-34 age groups at 35% with the remaining age group percentage figures decreasing by user engagement to 6% in the 55–64-year-old age group (Buckle). See Figure 3 presenting the categorical data.

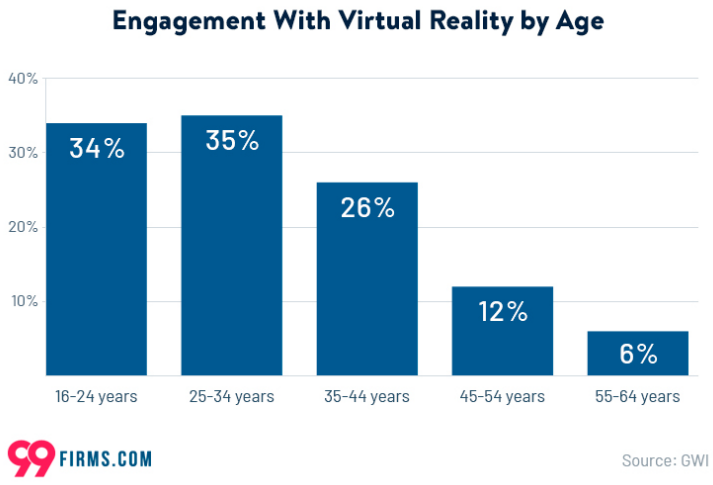


Figure 3. Engagement with Virtual Reality by Age (Blagojević).

2.2 Benefits of Virtual Reality

There are many benefits to VR, besides the major perk of a VR experience being fun. First, there are general benefits that all users experience. Next VR offers health benefits that can help your well-being, encompassing a wide range of physical and mental health benefits. Lastly, VR offers educational benefits too.

2.2.1 General Benefits. The impact of the virtual experience can be incredibly positive and fun due to the immersion. The user is not limited by mobility; in VR, the user can go places virtually that they may not be able to do in real life since the experience is not reliant on their physical ability. In VR, you can move all around. VR is feasible in many locations. You can play a VR game at home or anywhere you can take and set up the devices you are using. Travel is possible in VR by visiting a destination virtually. One can also use VR to preview a vacation destination to see if it is where they want to go on vacation and plan accordingly. With VR, dangerous real-life situations are physically safe. Simulation and training in VR provide a safe environment for the user.

2.2.2 Health Benefits. Not only is VR fun and improves feelings of happiness, but it also helps reduce symptoms that are associated with various health conditions. It has a wide range of physical and mental health benefits for people of various ages, skills, and abilities. However, the minimum age limit for VR gaming is seven and up, but manufacturers of headsets set their age limit based on their hardware, so age restrictions are usually twelve and up or thirteen and up (Mirage VR). VR is not just for gamers anymore and is not associated just with the younger generation anymore; it is becoming extremely popular among senior citizens (Reality Well).

VR programs are being offered to residents of assisted living facilities, nursing homes, and senior care centers across the country (Reality Well). "This technology

provides a source of entertainment; but more importantly, it can be highly therapeutic and have a profound impact on the physical, mental, and social well-being of ageing adults" (Reality Well). Aging is a process we all experience through our lifespan, and aging affects all the body's functions, both physical and cognitive. VR can be used for diagnosing medical issues and improving medical conditions. For example, VR has been used to find symptoms of Alzheimer's disease (Medical Alert).

2.2.3 Physical Health Benefits. Not only has VR been used to help find symptoms of health conditions, but it can also be used to help people with their physical health. Particularly among the elderly, it has been used for gait improvement, balance, and posture improvement (Pragya et al.). There have been positive results from VR applications, and research shows that maintaining balance, orientation, and stepping patterns are stimulated via sensory cues when in a virtual interactive environment (Pragya et al.).

VR has been used in the rehabilitation of joint range of motion and for higher-level tasks in stroke rehabilitation. The VR methods have enhanced stroke rehabilitation by modifying auditory and visual sensory input with using a haptic interface (Pragya et al.). By using a haptic angle with devices such as gloves, pens, and joysticks, there is a sense of touch where patients can feel textures and can feel changes in textures (Pragya et al.). Some VR systems only use a headset, but systems can also be used with sensors that can be placed on the body's limbs (Medical Alert). When moving through a simulated environment, users can be forced to move their limbs in order to promote movement (Medical Alert).

There are VR exercise games that help promote exercise and physical well-being. Anyone may be more willing or engaged to exercise if they are immersed in a virtual

reality environment. Having something to look at could help a senior to be more motivated to do daily exercise or physical therapy (Medical Alert). In addition, by being immersed in a VR environment, it can help with managing pain. By having something else to focus on, such as a calming beach scene or an invigorating mountaintop, a person can be distracted from pain from disease, arthritis, or normal aging (Medical Alert). VR has been used to distract from pain since it first existed and can help patients ranging from burn victims to cancer patients (Medical Alert).

Women with metastatic breast cancer (MBC) were tested in their own homes for the acceptability and efficacy of VR interventions for debilitating physical and psychological symptoms in a pilot study (Reynolds et al.). Results were demonstrated that showed improvements in the quality of life with benefits of less pain, fatigue, anxiety, stress, and depression (Reynolds et al.). See Figure 4 for example screen captures of the VR experiences. Participants reported feelings of enjoyment and relaxation after experiencing the two different VR interventions called "*Happy Place*" and "*Ripple*" (Reynolds et al.).

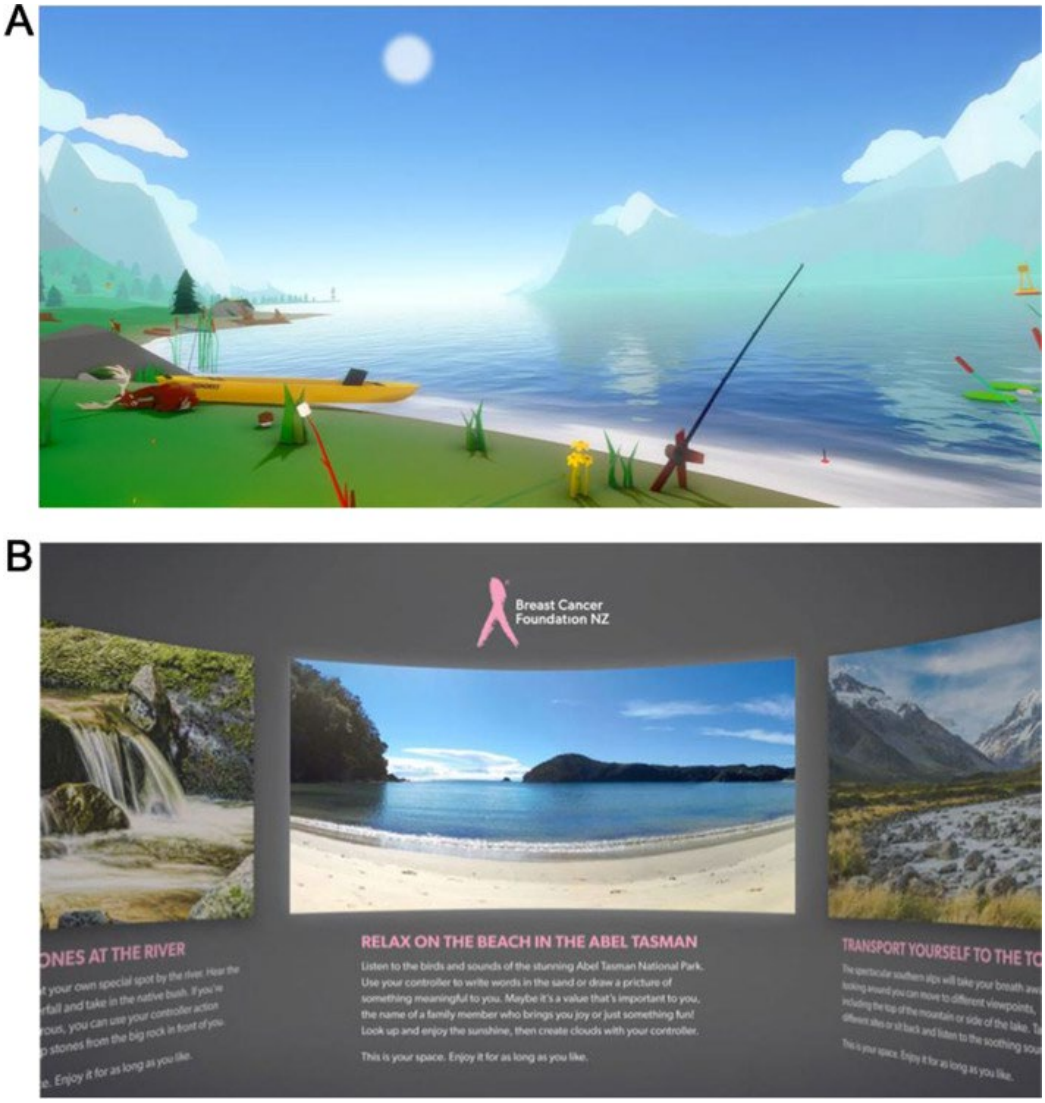


Figure 4. Example Screen Captures from the *Happy Place* and *Ripple* VR Experiences. (**A**) a scene from the *Happy Place* VR experience. (**B**) the menu in the *Ripple* VR experience, where participants can choose between the river (left) beach (middle) or mountain (right) experiences (Reynolds et al.).

2.2.4 Mental Health Benefits. VR provides mental stimulation that offers "exercise" for the brain to stay active and alert (Reality Well). Because of this, it helps improve cognitive function. Studies have shown that the symptoms of patients with dementia have improved with the interaction of VR (Reality Well). It helps sharpen their critical thinking, reasoning, decision making, and recall of information (Reality Well). This is important for older adults who suffer from forms of dementia because, with VR,

they can participate in this interactive and fun way to enjoy an activity that stimulates their brain.

A study involving video game training enhanced cognitive control in older adults. By playing a game called *NeuroRacer* in a multitasking training mode, older adults from 60 to 85 years old attained levels that had a significant reduction in multitasking cost that were beyond the levels achieved by untrained participants that were 20 years old (Anguera et al.). See Figure 5 for where the change in midline frontal theta can be seen in the multitasking post-training of older adults that is beyond the levels of the younger adults that were untrained participants.

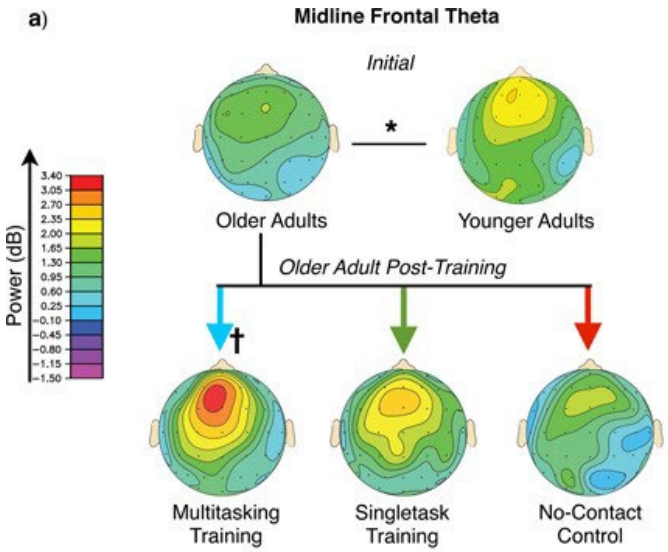


Figure 5. (a) *NeuroRacer* Study midline frontal theta activity pre- and post- training of older adults compared to younger adults untrained participants (Anguera et al.).

With elderly cognitive impairment, dementia, and Alzheimer's disease, behavioral symptoms can be present, such as stress, agitation, and mood swings. VR has been helpful in lowering symptoms of anxiety, where researchers have found that viewing nature helps reduce stress and improve moods (Pragya et al.). Programs in VR can enable older adults to return to places of their youth by showing images from their past or places where they have been before to help evoke memories. It can be hard for

elderly adults or people with disabilities to get out, so VR can be used as a tool to enhance socialization. In assisted living facilities, residents can participate in the same VR event and share their experiences with each other, which promotes socialization among the residents (Reality Well).

VR can help with social isolation, loneliness, anxiety, and depression among all age groups. It can improve a person's mood so that they feel happier, thus reducing depression. By alleviating many other physical and mental symptoms that people may have, VR can reduce the depression that is associated with these ailments. VR can help alleviate many symptoms associated with post-traumatic stress disorder (PTSD). It has been used as "prolonged exposure therapy for trauma that was military related" (Pragya et al.). Schizophrenia patients often suffer from auditory verbal hallucinations (AVHs), where VR has shown results that are promising (Pragya et al.). Patients are able to engage in a dialogue with a representation of their own voices or an avatar about their hallucinations, explore locations that cause anxiety, and practice talking to others in a no risk environment to work through their fears (Pragya et al.). Treatment of phobias have been effective with VR environments since it is a safe environment, improves postural control, lowers the risk of falling, helps with reflex control, helps with attention, stimulates the nervous system, and related phobia symptoms (Pragya et al.).

2.2.5 Educational Benefits. After participating in VR learning experiences, a study suggests that more information can be retained and better applied, and on top of that, VR has been described as the "learning aid of the 21st century" (Radianti et al.). Using VR is an immersive learning experience that inspires creativity and imagination, motivates academic interest, helps to grasp difficult concepts, understand other perspectives, and exposes the user to other cultures (American University). Difficult or

complex concepts can be viewed from different angles to help better understand and learn from them. A geometry student can view a 3D geometric form from multiple perspectives by rotating it around, and they can even view the inside of it (American University). Growing evidence indicates that VR can improve learning outcomes, help with memory retention, and help with recalling the information learned (American University).

2.3 Challenges of Virtual Reality

There are so many wonderful benefits to VR, but on the other hand, there are some challenges. Challenges can be situational, depending on each individual user. Challenges range from general challenges users may experience in VR to health, physical, mental, and educational challenges.

2.3.1 General Challenges. A user may experience general challenges in VR depending on their individual level of technological experience or their level of VR experience. Someone who does not have any technological experience at all may have more difficulty than a new VR user who does have technological experience. In addition, the level of skills an individual has to learn new concepts or troubleshoot may be a challenge for one individual but not for another. Regardless of the skill level, an initial use of a VR experience may be challenging to a new user.

2.3.2 Health Challenges. A health challenge of VR revolves around the concern of having adequate physical space for movement because, to move in VR, a person often moves their hands, arms, and feet, and sometimes will move in distance. So, it is important to have the space to move and to keep the area where you will be having a VR experience safe. There may be a challenge in controlling multiple components for some individuals who have a health condition.

2.3.3 Physical Health Challenges. There is an amplified concern to have adequate physical space for movement of frail individuals such as the elderly or someone who is weakened from a healthful state. There may be physical discomfort for some individuals when wearing the headset or holding the controllers. VR can overwhelm the senses and lead to fatigue or motion sickness (LaValle 9).

2.3.4 Mental Health Challenges. A user may be uncomfortable using VR due to anxiety or an emotional response from the immersion of virtual reality. Sometimes a new user of VR may need time for their brain to adjust because they are coming from a virtual reality experience and transitioning back to normal reality. This process can be overwhelming and cause anxiety. VR has a strong situational presence, so it can elicit intense emotional responses.

2.3.5 Educational Challenges. Many educators are embracing the benefits of VR, but there is some reluctancy due to reasons such as high cost, bulky equipment, glitches, quality, availability, and "pushback from school administrators" (American University). However, despite the challenges, VR is expected to grow in education, and educators can learn about the benefits, learn that there are many free and low-budget resources, ensure ample space, learn what topics VR works well with, and develop a VR learning plan for their students (American University). For learning at home, the same challenges can be faced.

2.4 Relevant Virtual Reality Applications

The VR applications selected for research are relevant to *Sea Soul* and include a VR travel experience, an exercise game (exergame), a meditation game, and a seashell collection application. Each application is compared and contrasted with *Sea Soul*. Finally, an analysis examining the strengths, weaknesses, opportunities, and threats

(SWOT) was conducted to focus on the significance of the relevant VR applications to the proposed virtual reality project *Sea Soul.*

2.4.1 Seniors Travel Using Virtual Reality. Users of VR can travel to places they have never been before or have already visited across the globe. In a video, a couple travels to places they had visited before when they were younger. Leo and Laura Cornfeld are a couple that are 90 years old (Upworthy). They considered themselves lucky and to have lived a good life because they traveled the globe in their youth (Upworthy). They have been to places such as London, Paris, Cuba, Guam, Japan, and China (Upworthy). Nathan Windsor, a therapist, comes out to their home and integrates virtual reality into their therapy (Upworthy). See Figure 6 where Leo is wearing a VR headset to experience virtual travel and relive memories.

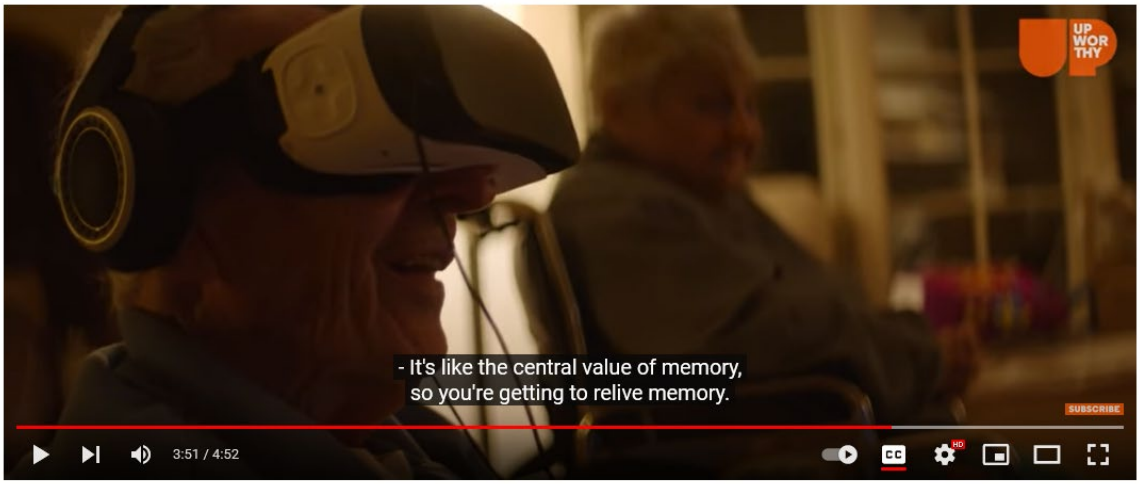


Figure 6. Leo experiences virtual travel (Upworthy).

By experiencing virtual travel, Leo recognizes a street he had been to before in Guam, and Laura sees the beach, ocean, and mountains (Upworthy). See Figure 7 for the virtual travel scene Laura sees while immersed in the VR experience.

Figure 7. Laura sees the beach, ocean, and mountains through virtual travel (Upworthy).

The immersion in VR takes them back to places they cannot physically get to, but it also helps bring back memories by recalling where they have been before. The therapist comments about how amazing it feels to be able to empower Leo and Laura with such happiness and joy (Upworthy).

With *Sea Soul,* a person is able to travel to the beach virtually. The beach here is not specifically tailored for where a specific person has been, but it is designed to be an immersive game-play interaction experience of being by the sea and on the beach for anyone. The similarity of meaningful symbolic assets of the beach are meant to remind a person of times they have had on the beach, the present situation of being on the beach, and to look forward to returning to the beach again.

2.4.2 Seas The Day. *Seas The Day* is a co-designed VR exergame with exercise professionals and was created for people with dementia as a virtual reality interactive experience to foster well-being (Muñoz et al.). Dementia is an umbrella term for a variety of diseases, including Alzheimer's and Parkinson's, in which symptoms include memory loss, difficulty reasoning, behavioral and mood changes, and difficulty performing daily

tasks (Muñoz et al.). By regular participation in physical activity, an improvement can be seen in functional performance, activities of daily living (ADLs), mobility, cognition, and balance (Muñoz et al.). VR can provide an immersive and interactive environment that is motivational, engaging, and entertaining for desired physical activity obtained through playing a game (Muñoz et al.). *Seas The Day* has activities aligned with the game levels of Tai Chi (warm-up), rowing (conditioning), and fishing (cool-down) (Muñoz et al.). For warm-up, the setting is a beach at sunset; for conditioning, the scene is a tropical environment where the user rows a boat; and for cool-down, the user fishes with a rod (Muñoz et al.). See Figure 8 for *Seas The Day* screenshots of the different game levels.

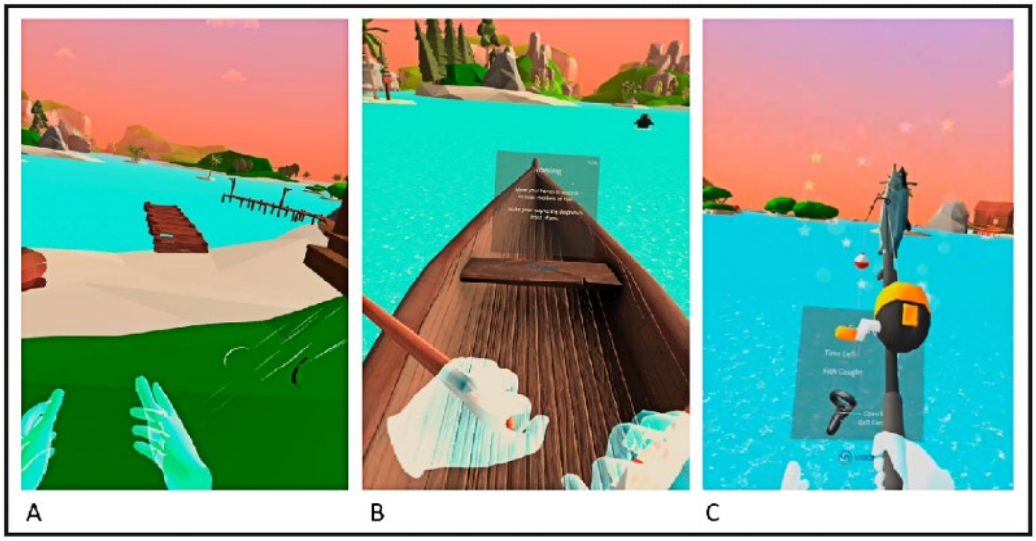


Figure 8. *Seas The Day* screenshots of the game levels. A) Tai Chi (warm-up) B) Rowing (conditioning) C) Fishing (cool-down) (Muñoz et al.).

Since *Seas The Day* is a VR exergame that was created for the well-being of people with dementia, it is similar to *Sea Soul* in that the focus is on well-being. However, with *Sea Soul,* it is proposed to be created for the well-being of a wider range of target users for the game application. Furthermore, *Sea Soul* is not just an exergame; it integrates several game genres into one application.

2.4.3 Maloka. *Maloka* is a VR game that offers mindfulness and meditation. It is designed in a way that teaches and reinforces mindfulness habits and healthy meditation on your own island, which transforms as you make a consistent habit of meditation (Meta Quest). The player is rewarded with plants and different objects for every meditation to use to enhance their island (Meta Quest). You have a spirit guide that is with you through your journey and grows and evolves alongside you as you become more mindful but shrinks if you fail to meditate (Meta Quest). See Figure 9 for a screenshot of *Maloka* that portrays the spirit guide and island.

Figure 9. The spirit guide and island in *Maloka* (Meta Quest).

Instead of closing your eyes to meditate, *Maloka* has a color-changing vortex of psychedelic patterns that pulse in and out while you are guided to align your breathing to the movements of it (Baker et al.). See Figure 10, which depicts the color-changing vortex in *Maloka*.

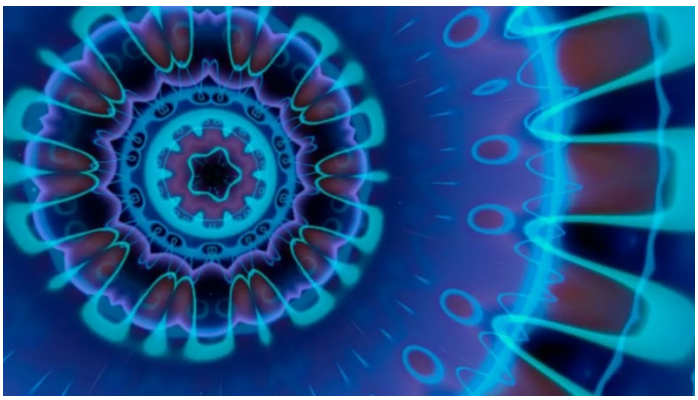


Figure 10. The color-changing vortex in *Maloka* (Baker et al.).

Maloka and *Sea Soul* have meditation and well-being in common. *Sea Soul* differs from *Maloka* because meditation is only part of the game's interaction. With *Sea Soul,* the meditation game is relaxing due to the familiar associations of the sea and beach, which contrast to the fantasy scenery that is used in *Maloka*. *Maloka* uses a color-changing vortex that the user is guided to breathe in and out to the pulse of the vortex. *Sea Soul* has different choices of scenery to meditate in, and one of the choices is to go into a kaleidoscope dome tent that is on the beach, where the user can watch the color-changing kaleidoscope patterns while listening to ambient music.

2.4.4 Educational VR Game. *Seashell* is a VR game application that allows you to pick up and examine seashells, and you can see their names displayed. It is a one-scene application. You get points as you collect the different types of seashells. There are ten "research level badges" that you earn and ten achievements that you can unlock while playing the game, which takes 1 to 2 hours to fully complete (Steam). The seashells you collect are written in a notebook, and your points for finding the seashells are displayed. You can learn all about the seashells and the creatures that built the seashells (Steam). See Figure 11 for a screenshot of collecting the seashells in *Seashell*.

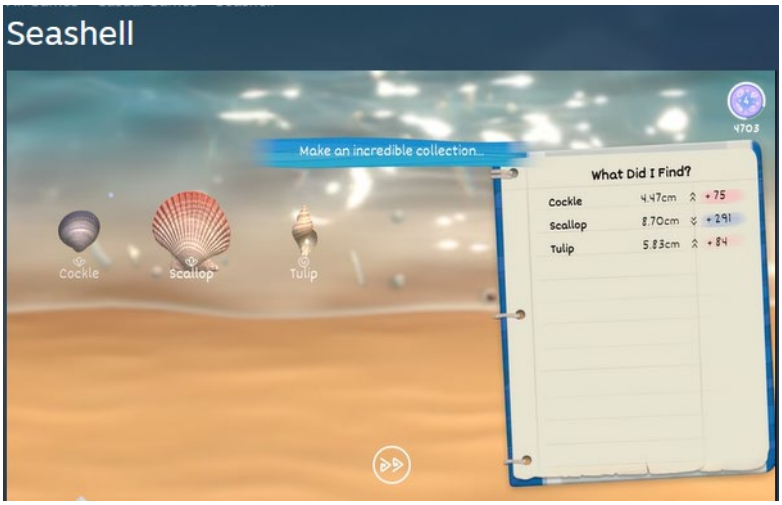


Figure 11. Screenshot of collecting seashells in *Seashell* (Steam).

Seashell and *Sea Soul* both have a place where you can collect and learn about seashells. The two differ because in *Seashell,* the user can collect points and find seashells, whereas in *Sea Soul,* the user collects seashells and can toggle the name of the seashell on and off. The user in *Sea Soul* has the option to learn more about seashells, but also has the option to save their seashell collection. *Sea Soul* is a game with scalability where there are several different scenes and the user has various movements to move throughout scenes and to be transported to different scenes, which contrasts to the one-screen scene of *Seashell*.

2.4.5 SWOT Analysis of Relevant Applications. In the analysis conducted, examining the strengths, weaknesses, opportunities, and threats (SWOT) is often used to evaluate marketing, strategy building, and project planning among companies (Muñoz et al.). *Sea Soul* uses the significant information gathered from the SWOT analysis as a tool that examines and uses the successful strengths of the applications by incorporating relaxation, exploring, and learning into a fun game that fosters well-being. The weaknesses of not being engaging, having the potential to be monotonous, not having a realistic environment, and having a one-scene game create opportunities to take advantage of to improve their applications. Lastly, a threat is what may produce a negative impact on the applications, and thus a competitor may capitalize on this emerging opportunity to enter the VR application market. So, *Sea Soul* capitalizes on the threats since it has interactivity in virtual travel to the beach; it targets a wide range of users; there is scalability; and *Sea Soul* has several game genres in one application, which are a seashell, meditation, and underwater scene where users can relax, learn, and explore. See Table 1 for the SWOT analysis.

Table 1. SWOT Analysis of Relevant VR Applications

VR applications	Strengths	Weaknesses	Opportunities	Threats
VR travel	• Demonstrates that with VR you can go places you physically cannot • Realistic • Exploratory and fun • Fosters well-being	• Lack of controller interactivity • Lack of gamified activities	• Include engaging game mechanics • Integrate game activities	• VR travel with game play interaction
Seas The Day	• Interactive and fun exergame • Designed by exercise professionals • Targeted for persons living with dementia • Fosters well-being	• Limited emphasis on exploration • Limited emphasis on meditation • Potential to be monotonous	• Promote meditation • Promote exploration • Implicit and explicit learning • Neuroplasticity	• Wider range of target user for game application • A game with several VR game genres in one game application
Maloka	• Meditation & Mindful • Makes meditation fun and relaxing • Great graphics • Fantasy scenery great • Fosters well-being	• Fantasy scenery may not appeal to a wide range of people	• More of a realistic island	• A meditation game that is relaxing due to the familiar associations of the sea and beach
Seashell	• Collect & learn about seashells • Realistic seashells • Fun and educational • Fosters well-being	• One screen scene	• Increase scene and size of application	• Seashell game with scalability

2.5 Proposed Virtual Reality Application

Drawing on the key findings of the research, *Sea Soul* addresses the framework for the proposed VR application because of the high VR market that is fueled by the healthcare industry and the gaming entertainment industry. By bringing healthcare and entertainment together, *Sea Soul* brings fun and wellness together. There are a lot of benefits to VR: it is immersive, feels real, and provides a safe environment to do things you have never done before. There is a wide range of health benefits in VR, including physical, mental, and educational benefits that can promote well-being for people in their lives because VR can be highly therapeutic. Gaming is not just for the younger generation anymore; it is becoming popular for senior care; however, VR engagement is shown to mainly cluster in the 16-34 age groups at 35%, with remaining age group percentages decreasing to only 6% of user engagement in the 55–64-year-old age group. Being that VR is being used for senior care more through the health care system but engagement with VR otherwise is decreased by groups higher in the aging process, it is reasonable and significant to hypothesize that this is a problem, for we are all aging and VR offers benefits and fun to all ages. *Sea Soul* takes advantage of the full potential of VR benefits by offering these benefits to all ages through a gaming experience that's fun.

Furthermore, the SWOT analysis shows that *Sea Soul* uses the successful strengths of the relevant applications by incorporating relaxation, exploration, and learning into a fun game that fosters well-being. In addition, *Sea Soul* capitalizes on the emerging opportunity to enter the VR market because it has interactivity in virtual travel to the beach; it targets a wide range of users, including the elderly; there is scalability; and it has several game genres in one application.

2.5.1 Problem. VR for senior care is increasing but VR engagement for groups higher in the aging process is decreased compared to younger age groups. We are all aging.

2.5.2 Solution – Sea Soul. *Sea Soul* provides a bridge to this problem, as an interactive virtual reality experience created as a game to play in a user's own home where users of all ages and abilities can have healthy well-being benefits while exploring the sea. *Sea Soul* is fun, and it's Soul good!

On the start menu of *Sea Soul*, the user reads, "Welcome to *Sea Soul." A*s you hear fun and uplifting ambient music, a Star Fish Guide welcomes you to *Sea Soul* by dancing happily to the music. By clicking on the enter button, you are brought into the *Sea Soul* experience. You are greeted by the Star Fish Guide standing on the ocean shore, who tells you to click on the conch shell because it is a "shellPhone" that transports you into different places in *Sea Soul*. Beside the Star Fish Guide is the shellPhone Directory, which explains what the icons on the shellPhone visually are and what each icon represents. The icons serve as a way for cognitive recall to associate a picture with its meaning. From the shellPhone, the user may come back to where the Star Fish Guide and directory are to jog their memory if needed by reading what each icon represents.

To reach the shellPhone, a large conch with the shellPhone icon on it is in every scene where the user can click on it, and it is to this main large view of the shellPhone that the user comes. In addition, each user interface (UI) screen has a small shellPhone icon in the bottom right corner of the screen, which will take the user to the main shellPhone screen. From the shellPhone, the user can click on the buttons to make a shellPhone call, where they are transported to the places in *Sea Soul* that are visually represented by the different icons on the button. If a user wants to learn more about how

to use the VR game controllers, they may select the appropriate icon to view a video on using the controllers. The user may enter the Seashell Scene of *Sea Soul,* where the beautiful ocean waves are seen and heard as the user stands on the shore looking out to the sunny sea level horizon where the ocean meets the sky. Here is where one can pick up seashells just for fun or enjoyment of collecting them or click a toggle button so that they can see the name of a seashell as they are collecting it. Users who used to love picking up seashells on the beach but are physically unable can still enjoy the peaceful beach therapy that they used to. By toggling the seashell name, this can help a user learn the different seashells and also aid in a cognitive memory learning system. The user can see the seashell from a 3D perspective and see its name for the learning process. In addition, the user may go to all about shells, where they can learn more about each seashell that they have collected. Seashells are saved in a seashell collection bag that can be stored in a treasure chest. A note can be saved with the seashell collection bag, such as the date the collection was made, who the user picked seashells with if they had someone play the game with them, or even as a special tribute to someone.

For meditation, the user enters the Meditation Scene, where the peace and serenity of the beach and ocean sounds can benefit and relax the user. Within the Meditation Scene, the different options the user has are the Waterfall Cave, the Sea Salt Cave, the Kaleidoscope Dome, or to write a message in a bottle. The Waterfall Cave is behind a cascading waterfall on the beach. Within the cave is also a pool of blue water that is soothing to look at. If the user prefers, they may go to the Sea Salt Cave, which has pink sea salt crystals all inside it and provides a calming experience too. Furthermore, on the beach shore is a dome tent that the user can step inside, and a kaleidoscope of ever-changing colors can be visually looked at as the user hears ambient music. Journaling

offers mental health benefits, and within the Meditation Scene of *Sea Soul,* the user may journal and throw their message in a bottle out to sea.

In the Seashell Scene or in the Meditation Scene, the user may want to just virtually walk along the beach. However, a user may want to jog in place or do a form of exercise such as stretches or yoga while being able to virtually be on the beach shore by the sea. Also in *Sea Soul* is the Underwater Scene, where the user virtually swims and explores the different sea life that lives underwater in the sea, such as fish, crabs, sea turtles, or whales. When the user has finished immersing themselves in the VR environment of *Sea Soul*, they may exit the game by pressing the exit icon on the shellPhone. Here, the user reads, “Sea You Soon!” and hears relaxing ocean waves that are accompanied by chime sounds and a harp sound of sweet beach memories.

CHAPTER 3: METHODOLOGY

To conduct the research, an approach is detailed in six phases. See Figure 12 for the six phases that the methodology is divided into.

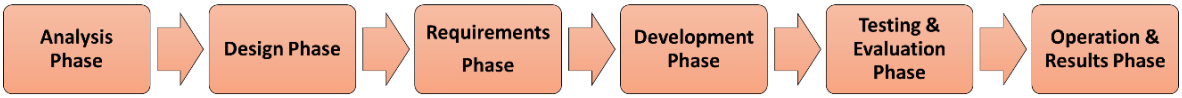


Figure 12. Phases of the methodology.

During the analysis phase, literature and similar game applications were reviewed to summarize a research rationale for the proposed virtual reality application. The ideas and goals for *Sea Soul* were established. The design phase establishes target groups, plots, tasks, and settings in personas and scenarios that show different users, their actions, and reasons to immerse themselves in the VR world of *Sea Soul*. Use cases are based on showing the functional requirements of the system that define the steps that the user can take in their virtual reality experience. Visual displays of a storyboard detail the virtual reality that is being created for *Sea Soul* and build the foundation of the scenes and interactions that the user can explore and experience. Within the design phase, the assets are listed because they are the building blocks that build the virtual world. Here, the graphic 3D assets will be the basis for scenes and the general environment. In addition, listed are the audio assets for sounds that accompany animations, ambient music, and scripts.

Within the requirements phase, functional requirements, non-functional requirements, tools and software requirements are chosen that serve as a roadmap to build and meet the specific needs for project development. In addition, a timeline of activities is provided for a realistic basis of scheduled deliverables.

The development phase is achieved through iterations of testable and functional product deliverables of the virtual environment. Testing and evaluation are performed within the iterations, as well as in-depth software testing for code, functionality, and performance. The final phase of operation and results collect data through a user experience survey that quantitatively rates feelings evoked from the experience, navigation, character movement, and aesthetics of the game appearance of *Sea Soul* by using a rating scale. Furthermore, qualitative data will be gathered through user feedback on the survey's open-ended questions.

3.1 Design

For VR game design, it is typical and essential to use tools to perfect the experience of the user by using personas and scenarios that help identify the user and keep the design on track. Personas are an archetype of fictional but realistic characters that show the needs of users, and scenarios describe how those needs are met by interacting with the game. Further typical elements of game design beyond interacting with the game are the game mechanics, which are the set of functional rules for the interactions known as use cases. The game design process uses a storyboard to sketch out scenes to create the game environment and populates the environment with elements called assets.

The designing process of *Sea Soul* is where the creation of *Sea Soul* starts to come to life. Here, personas of different users are shown, and within the scenarios, it is seen how the user may immerse themselves in the VR experience of *Sea Soul*. The scenarios paint a visual image of the different experiences the user can have in *Sea Soul* by describing the scenes and interactions that they have. Use cases show the steps the user will take in terms of the functional requirements needed. A storyboard is presented that

literally gives visuals of the scenes and interactions. Finally, in the design phase, the assets that will build the virtual world of *Sea Soul* are listed.

3.1.1 Personas. For the personas, a wide range of users are considered so that people of all ages and abilities can reap the health and well-being benefits of the immersive experience of *Sea Soul*. Specifically, the personas used for *Sea Soul* start with an 81-year-old and range to an 8-year-old. See Figure 13 for the persona of Barbara, a 73-year-old. To emphasize the well-being of those with senior care needs and their need to improve their quality of life, as well as the needs of the aging process, the personas are presented from eldest to youngest (see Appendix A for all the *Sea Soul* personas).

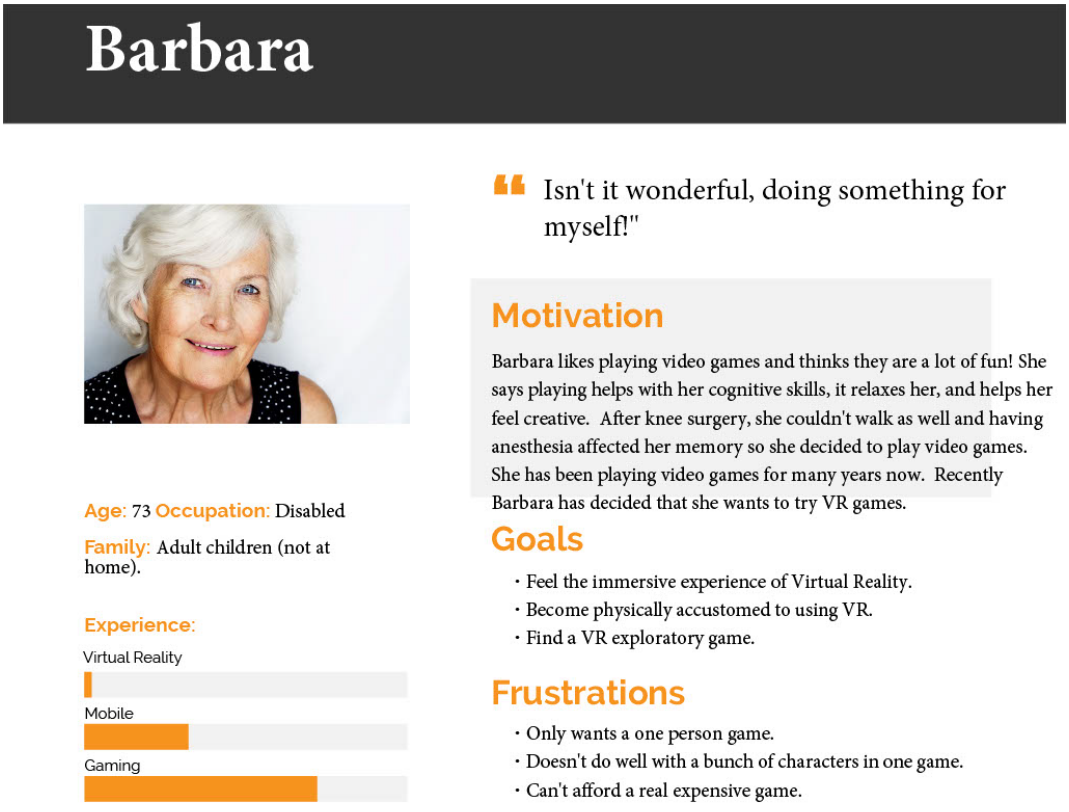


Figure 13. 73-year-old Barbara Persona.

3.1.2 Scenarios. Each persona has two scenarios that describe what the user's experience is like (see Appendix B for all the *Sea Soul* scenarios). By doing this, the

scenarios incorporate each scene, case, and several life situations where the user would use the game. These scenarios represent situations that will differ for individual users, yet the outcome will be the same. For example, the reason someone may just want to play for fun will differ for individuals, but the goal of the situation is to have fun. Users will have different reasons to want to journal via message in a bottle, but the goal will be to write a message, put it in a bottle, and send the bottle out to sea. Following are the two scenarios for the persona presented previously for Barbara, a 73-year-old.

Scenarios for 73-year-old Barbara

73-year-old Barbara Scenario 1. Barbara enjoys playing video games and wants to try playing virtual reality games. Her son picks her up and drives her over to his house for dinner because Barbara does not drive. After dinner, he surprises her with a virtual reality headset and controllers as an early birthday present. She is overjoyed and gives her son a big hug. She wants a VR game that is exploratory. Her son brings up some VR games on the internet so that she can choose which one she wants to try. She looks closely at the games and chooses one that is exploratory, is on the beach, and involves picking up shells. She really likes how in the game you can be on the beach, pick up shells, and learn the names of the shells. She misses being able to go out on the beach and pick up shells. She also likes how it is a one-character game in the video clip. He puts on the VR headset and gets the *Sea Soul* game downloaded from the application store as he explains what he is doing. Barbara puts on the headset, and once she enters the game, she sees a Star Fish that explains how to be transported to different places in the game by a shell that is called a shellPhone. Barbara is happy to go to a video tutorial where she learns how to move the controllers since she only tried it briefly a couple times before with her son on his VR set. Barbara takes her headset off, smiles super big, and hugs her

son again. She tells him how happy she is with how it feels so real, and she likes being able to be on the beach again since she cannot get out to go places much anymore.

73-year-old Barbara Scenario 2. Barbara likes to play video games because she knows they help with her cognitive skills, and they are fun! She said that before she played video games, she would do crossword puzzles; next, she graduated to solitaire on her iPad tablet; and then she played video games. So now she is excited to play her new VR game again. From the shellPhone in *Sea Soul,* she selects to go pick up shells on the beach. Here the beach is nice and sandy, and along the shore are lovely seashells. She walks along the shore and can look out at the ocean waves if she wants. The waves lap up toward the shells, but just far enough away that she is able to pick up the different shells she sees. It feels so satisfying and fun to pick up the shells in the game for her. Since her knee surgery, she has not been able to bend down to pick up shells on the beach, and she sure has missed being able to do that. She decides to toggle on the shell name for a while to see the common name of the shells she picks up displayed. She then toggles the name back off to pick up more shells and enjoy the beauty and fun of being on the shore. She notices she is already remembering the names of some without seeing the name on the screen when she picks up the same kind of shell again.

3.1.3 Use Cases. From the end user's perspective, the use cases show the steps the user will be able to take with regard to the functional requirements of the system. Once the user enters *Sea Soul* from the Start Menu, transports via the shellPhone, then the user may engage in activities within their *Sea Soul* journey to explore the Seashell Scene, Meditation Scene, and Underwater Scene. The *Sea Soul* use cases follow in Tables 2-6. The use cases in bold were implemented; however, the remaining items were not implemented due to a few scene modules that were moved to future work.

Sea Soul - Use Cases

Table 2. *Sea Soul* Start Menu

• **User will be able to put on headset and look around**	• **User will be able to be greeted by the Star Fish Guide**	• **User will be able to point with ray to select enter button**

Table 3. shellPhone

• **User will be able to select shellPhone Directory**	• **User will be able to select the Waterfall Cave**	• **User will be able to select training tutorial**
• **User will be able to select the Seashell Scene**	• **User will be able to select journaling via message in a bottle**	• User will be able to select Sea Salt Cave
• **User will be able to select Underwater Scene**	• **User will be able to select to exit the game**	• User will be able to select leave a shell collection note via treasure chest
• **User will be able to select Meditation Scene**	• **User will be able to select kaleidoscope meditation**	• User will be able to select to learn about shells

Table 4. Underwater Scene

• **User will be able to look around underwater**	• **User will be able to be idle in motion underwater**	• **User will be able to select shellPhone icon**
• **User will be able to walk forward, backward, left, and right underwater**	• **User will be able to stop in motion underwater**	• **User will be able to stand underwater in the ocean**
• **User will be able to run forward, backward, left, and right underwater**	• **User will be able to point with ray**	• User will be able to swim forward, backward, left, and right underwater in the ocean

Table 5. Seashell Scene

• **User will be able to look around the beach**	• **User will be able to stand on the beach**	• User will be able to collect shells
• **User will be able to walk forward, backward, left, and right on the beach**	• **User will be able to pick up "grab" shells**	• User will be able to select leave a shell collection note via treasure chest
• **User will be able to run forward, backward, left, and right on the beach**	• **User will be able to toggle on and off shell common name**	• User will be able to write shell collection note
• **User will be able to be idle in motion on the beach**	• **User will be able to point with ray**	• User will be able to store shell collection in the treasure chest
• **User will be able to stop in motion on the beach**	• **User will be able to select shellPhone icon**	• User will be able to select to learn about shells

Table 6. Meditation Scene

• **User will be able to look around the beach**	• **User will be able to stop in motion on the beach**	• **User will be able to write a message to go in a bottle**
• **User will be able to walk forward, backward, left, and right on the beach**	• **User will be able to stand on the beach**	• **User will be able to submit their message into a bottle**
• **User will be able to run forward, backward, left, and right on the beach**	• **User will be able to point with ray**	• User will be able to grab and throw their message in a bottle out to sea
• **User will be able to be idle in motion on the beach**	• **User will be able to select shellPhone icon**	• User will be able to sit on the beach

3.1.4 Storyboard Design 1. Storyboarding is the plan or "blueprint" in the design phase for *Sea Soul*. Storyboard Design 1 is a pencil sketched storyboard that depicts the start menu, main scenes, and the transportation provided by choosing different options of

the shellPhone in the game (see Appendix C for *Sea Soul* Storyboard Design 1). The Star Fish Guide emphasizes how icons can be selected on the shellPhone. See Figure 14 which provides details of the Star Fish Guide and the shellPhone.

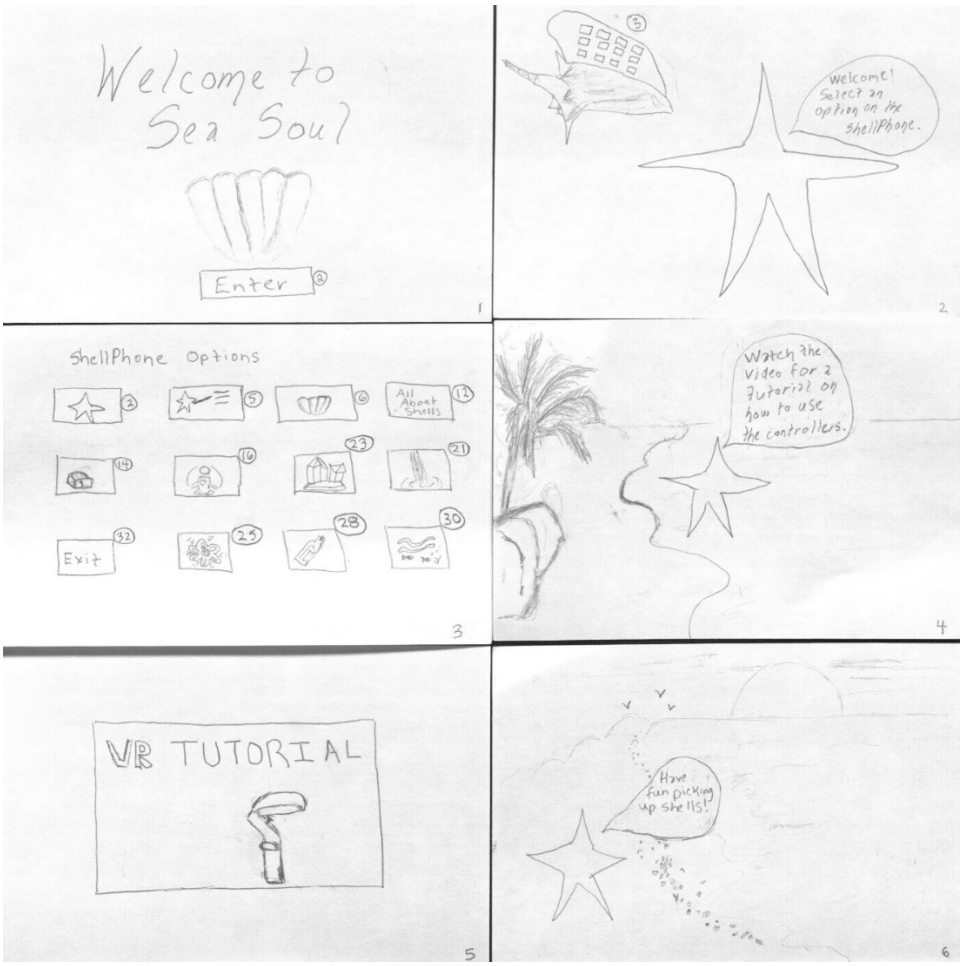


Figure 14. Storyboard Design 1, Page 1.

3.1.5 Assets. Assets for *Sea Soul* are the building blocks to build the virtual world, with the goal for the user to be immersed in the environment of *Sea Soul* and to feel as if they are really in an environment at sea. The graphic 3D assets listed are chosen for the scenes of the sea environment that the user will visually experience. Listed are sound assets that will contribute to the auditory experience at sea and the playing of the game. Sounds will accompany animations, sea life, game buttons, shellPhone icon buttons, and

movements. Relaxing ambient music will be played. The *Sea Soul* assets follow in Tables 7-11.

Sea Soul - Assets

Table 7. *Sea Soul* Environment

• Ocean	• Beach sand scene	• Palm trees
• Mountain rocks	• Beach sand dunes	• Coconut trees
• Beach skyboxes	• Rocks on sea	• Bushes
• Sea Salt Cave	• Waterfall	• Grass
• Waterfall Cave	• Cave pool	• Flowers
• Dome tent	• Cave crystals	• Mushrooms

Table 8. *Sea Soul* Sea Life

• Star Fish	• Conch shell	• Manta ray
• Coral	• Seaweed	• Lobster
• Hermit crab	• Seashells	• Sea turtle
• Fish	• Jellyfish	• Sand dollar
• Crabs	• Sea urchin	• Sea horse
• Dolphins	• Whales	• Sea gulls

Table 9. *Sea Soul* Items

• Beach bucket	• Bottle with message in it	• Shipwreck
• Treasure chest	• Meditation rug	• Anchor

Table 10. *Sea Soul* Icon Buttons

• Enter icon button	• Meditation Scene icon button	• Sea Salt Cave icon button
• ShellPhone Directory icon button	• Waterfall Cave icon button	• Kaleidoscope meditation icon button
• shellPhone icon button	• Message in a bottle icon button	• Treasure Chest icon button
• Seashell Scene icon button	• Submit icon button	• Learn about shells icon button
• Underwater Scene icon button	• Exit Game icon button	• Training Tutorial icon button

Table 11. *Sea Soul* Sound and Music List

• Ocean breeze	• Palm trees swaying	• Ocean wave sound
• Waterfall sound	• Sea gull sound	• Water ripple sound
• Bird flight sound	• Whale sound	• Welcome Ambient music
• Person swimming sound	• Dolphin sound	• Meditation Ambient Music
• Enter sound	• Submit sound	• Underwater Ambient Music
• Exit sound	• Click sound	• Ocean Ambient music

3.2 Requirements

Requirements serve as the modes to utilize and build to meet the specific needs for the project development of *Sea Soul*. Following are the functional requirements, nonfunctional requirements, and tools and software requirements.

3.2.1 Functional Requirements. In *Sea Soul*, the user will have the ability to select appropriate buttons for game interaction. The shellPhone icon buttons function to go directly to each scene. Game interaction buttons function within different scenes, such as to toggle the shell name, learn about shells, leave a shell collection note, and submit a text box to write a message in a bottle. The user will be able to enter and exit the game to play *Sea Soul*. During game interaction, the user will have the ability to perform specific movements such as looking around, standing, sitting, walking, running, stopping, pointing, grabbing, and throwing.

3.2.2 Nonfunctional Requirements. The nonfunctional requirements of *Sea Soul* fall into three categories: personal playability, mechanical playability, and artistic playability. These categories are to highlight the player's experience in terms of the personal outlook of feelings or emotions evoked, the mechanical quality of the game, and the artistic experience of the player. First, personal playability means that *Sea Soul* feels

good for your soul; it is a VR experience by the sea, is fun to play, and adds to your well-being. It seems real, interesting, and engaging. The game is relaxing and tranquil. Second, mechanical playability means that the system, navigation, and movement seem smooth and easy to use. Third is artistic playability, where the user interfaces are pleasing and informative. Sounds will be engaging, relaxing, and appealing. The overall atmosphere will be pleasant, memorable, and spark your imagination.

3.2.3 Tools and Software Requirements. There are several software engines that can be used for game development, but the two main ones in today's market are Unity and Unreal Engine (Pixo VR). Both are a 3D engine and software framework for designing a game and support a variety of immersive technologies. I chose Unity because it is good for beginning VR developers due to its tutorials and wide range of documentation, targets VR programming, and uses the C# programming language (Garbett). In contrast, Unreal Engine is good for more experienced developers, is known for the latest graphics, and uses the C++ programming language (Garbett).

To elaborate more on why I chose Unity, I did so because I used it previously in game development for a virtual reality class that I was enrolled in, so I am familiar with the software framework and the C# programming that it uses. Unity has a free student plan that will be used. Unity has many tools for creating VR games, and it has high-quality, rich 3D visualizations. It is supported across a wide range of platforms that include personal computers, consoles, mobile devices, augmented reality (AR), and VR experiences. Unity offers a multitude of learning resources for building your Unity skills. It has written tutorials, video tutorials, and tutorials that help test and certify your skills. It also has documentation that provides knowledgeable information on developing VR in Unity and solutions for troubleshooting.

As mentioned, C# is used for coding since Unity uses C# as the primary object-oriented scripting language. For the integrated development environment (IDE), Visual Studio will be used. For the VR immersive experience, development is using Meta Quest 2 for the VR headset and controllers, which is a Unity-supported platform. What is a really nice perk of using Unity is that there is a Unity asset store that provides lots of assets that are ready to use for free or at a set price. In addition, 3D models from sources on the web will be used, such as Sketchfab and CGTrader. Free stock images for certain things will be utilized. For the tutorial in *Sea Soul* on how to use the VR controllers, a YouTube video will be integrated.

3.3 Timeline of Activities

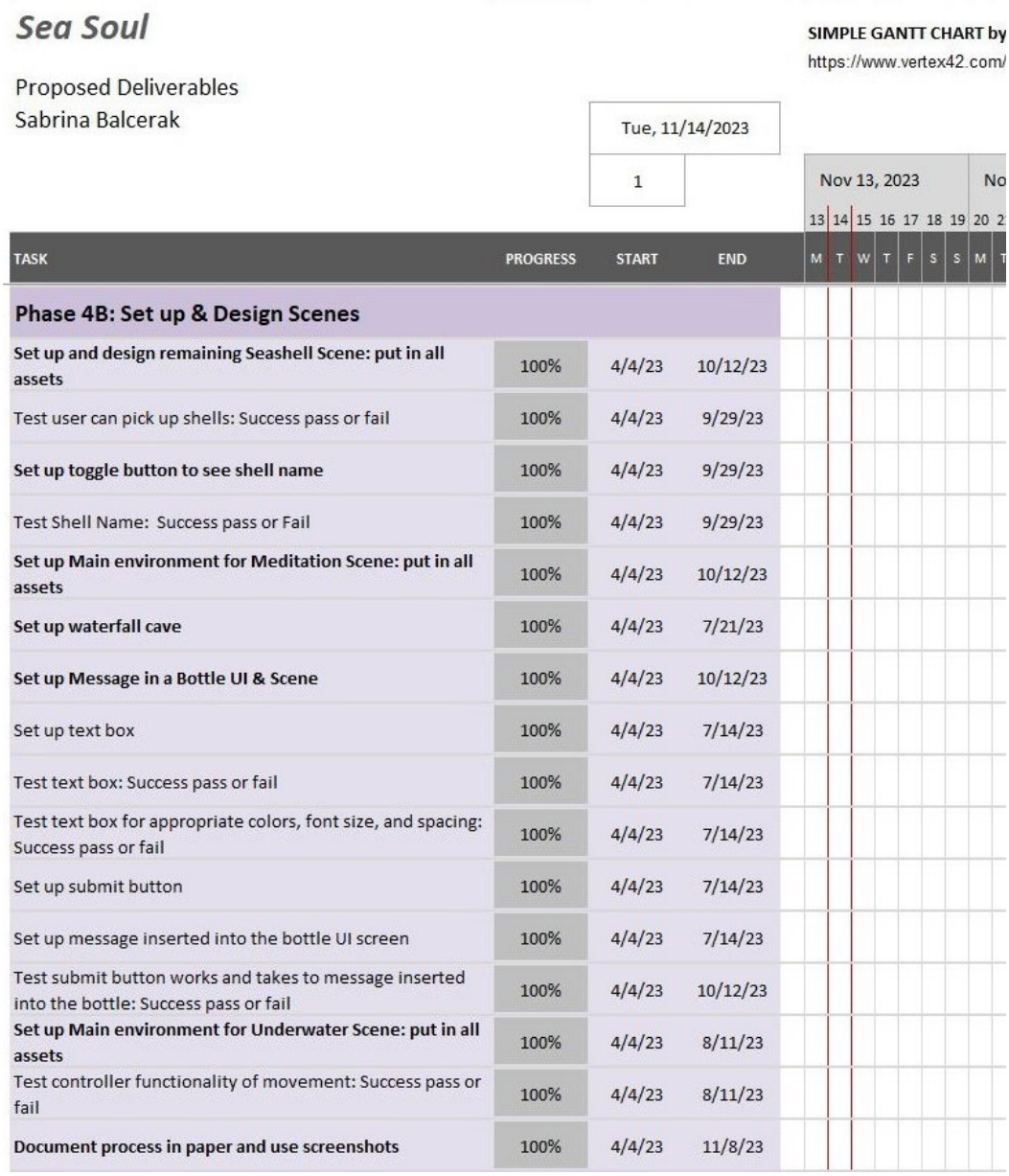
To establish a timeline of activities for *Sea Soul,* a realistic basis of scheduled activities are included in a Gantt chart that includes all phases of the *Sea Soul* Project. In the process of preparing the Gantt chart, it was realized that some modules in the development phase needed to be moved to a ranked wish list. The redesign consists of the major environmental scenes of *Sea Soul* of the Seashell, Meditation, and Underwater Scenes. The Seashell Scene will have a place where the user picks up seashells and can toggle the name. The Meditation Scene will have the Waterfall Cave and the message in a bottle journaling experience. The Underwater Scene will remain exploratory as planned. The remaining modules that were originally depicted in Storyboard Design 1 have been moved to the ranked wish list. To encompass the design changes of the modules on the ranked wish list, Storyboard Design 2 illustrates visually the new storyboard.

The shellPhone designed in Storyboard Design 1 was redesigned so that the ranked wish list items would appear as icon buttons that are after the pertinent applications. See Figure 15, where Design 2 has the pertinent application icons on the

first row and the ranked wish list icons are on the second row after the exit button on the shellPhone.

Figure 15. shellPhone Options Design 1 & 2.

3.3.1 Gantt Chart. The Gannt chart covers six pages and is the proposed schedule for deliverables for *Sea Soul* (see Appendix D for the *Sea Soul* Gannt chart). It consists of the six phases of the methodology previously described for *Sea Soul*: Analysis Phase, Design Phase, Requirements Phase, Development Phase, Testing & Evaluation Phase, and Operation & Results Phase. Each phase has scheduled tasks with a start date and an end date. The progress displayed can be depicted as a percentage of the progress made toward completing the task. The development phase has subheadings, Phases 4A to 4F, that break the development phase up into iterative and incremental development. See Figure 16, which shows the development Phase 4B with scheduled tasks. The last development phase, 4F, has the ranked wish list. The testing plan is included in both the development phase and the Testing & Evaluation Phase and is therefore integrated into the Gantt chart at each task.



Sea Soul

Proposed Deliverables
Sabrina Balcerak

SIMPLE GANTT CHART by
https://www.vertex42.com/

Tue, 11/14/2023
1

Nov 13, 2023 | No
13 14 15 16 17 18 19 20 2
M T W T F S S M T

TASK	PROGRESS	START	END
Phase 4B: Set up & Design Scenes			
Set up and design remaining Seashell Scene: put in all assets	100%	4/4/23	10/12/23
Test user can pick up shells: Success pass or fail	100%	4/4/23	9/29/23
Set up toggle button to see shell name	100%	4/4/23	9/29/23
Test Shell Name: Success pass or Fail	100%	4/4/23	9/29/23
Set up Main environment for Meditation Scene: put in all assets	100%	4/4/23	10/12/23
Set up waterfall cave	100%	4/4/23	7/21/23
Set up Message in a Bottle UI & Scene	100%	4/4/23	10/12/23
Set up text box	100%	4/4/23	7/14/23
Test text box: Success pass or fail	100%	4/4/23	7/14/23
Test text box for appropriate colors, font size, and spacing: Success pass or fail	100%	4/4/23	7/14/23
Set up submit button	100%	4/4/23	7/14/23
Set up message inserted into the bottle UI screen	100%	4/4/23	7/14/23
Test submit button works and takes to message inserted into the bottle: Success pass or fail	100%	4/4/23	10/12/23
Set up Main environment for Underwater Scene: put in all assets	100%	4/4/23	8/11/23
Test controller functionality of movement: Success pass or fail	100%	4/4/23	8/11/23
Document process in paper and use screenshots	100%	4/4/23	11/8/23

Figure 16. *Sea Soul* Gantt Chart Development Phase 4B.

3.3.2 Storyboard Design 2. More detail and elaboration of *Sea Soul* are in the colorful images of the Design 2 Storyboard (see Appendix E for *Sea Soul* Storyboard Design 2). This design has realistic scheduled modules expected to be completed in the development phase. After this, there are the remaining Ranked Wish List modules. Figures 17 and 18 illustrate the Welcome screen and the shellPhone Directory of Storyboard Design 2.

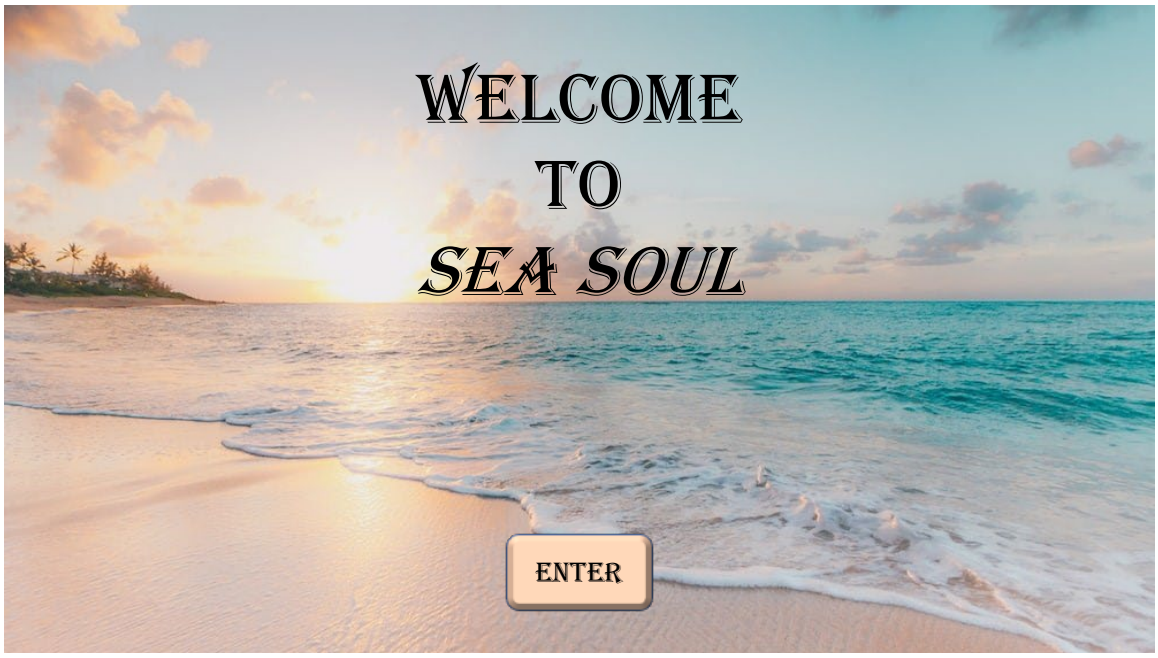


Figure 17. Storyboard Design 2, Welcome screen.

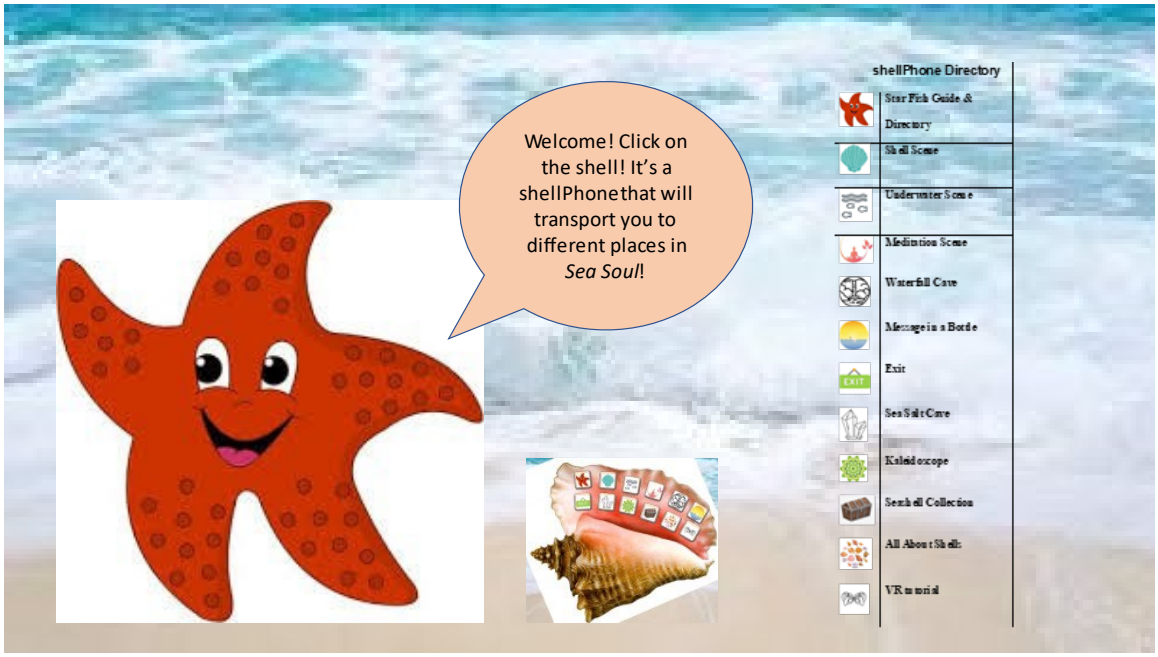


Figure 18. Storyboard Design 2, shellPhone Directory.

3.4 Development

To start development Unity version 2021.3.22f1 and Unity Hub version 3.4.1 were installed to be used as the game engine for development. Visual Studio 2022 was installed to be used for coding C# in Unity. The Meta Quest 2 VR headset and controllers were connected to Unity each time development was performed. Development was broken into six different phases and performed incrementally and iteratively throughout the development process (see Appendix F for a full range of developed *Sea Soul* gameplay screenshots).

3.4.1 Establish Controller Movement. Setting up a "skeleton" environment that consists of a basic scene with camera functionality was of the first importance so that the main movement for the environment could be established. The functional movements that were developed are to look around, stand, walk, run, stop, be idle in motion, to point with the ray and to grab. Swim, sit, and throw controller movements were not implemented and are moved to future work for *Sea Soul*.

3.4.2 Design Scenes. Sea Soul is designed as an island. The main areas of the island are considered to be the Seashell, Meditation, and Underwater scenes. Each area has detail, elaboration, and activities that are involved in it so technically *Sea Soul* consists of many scenes in Unity because scenes are how a game is designed and built in different pieces. The island I designed as a sandy terrain with mountains that have caves, a waterfall, and is surrounded by the sea. Assets for the items on the island environment used are 3D models obtained from Unity Asset Store, Sketchfab, and CGTrader via the web. See Figure 19 for an ariel view screenshot of the *Sea Soul* Island displayed in the Seashell Scene and built in Unity.

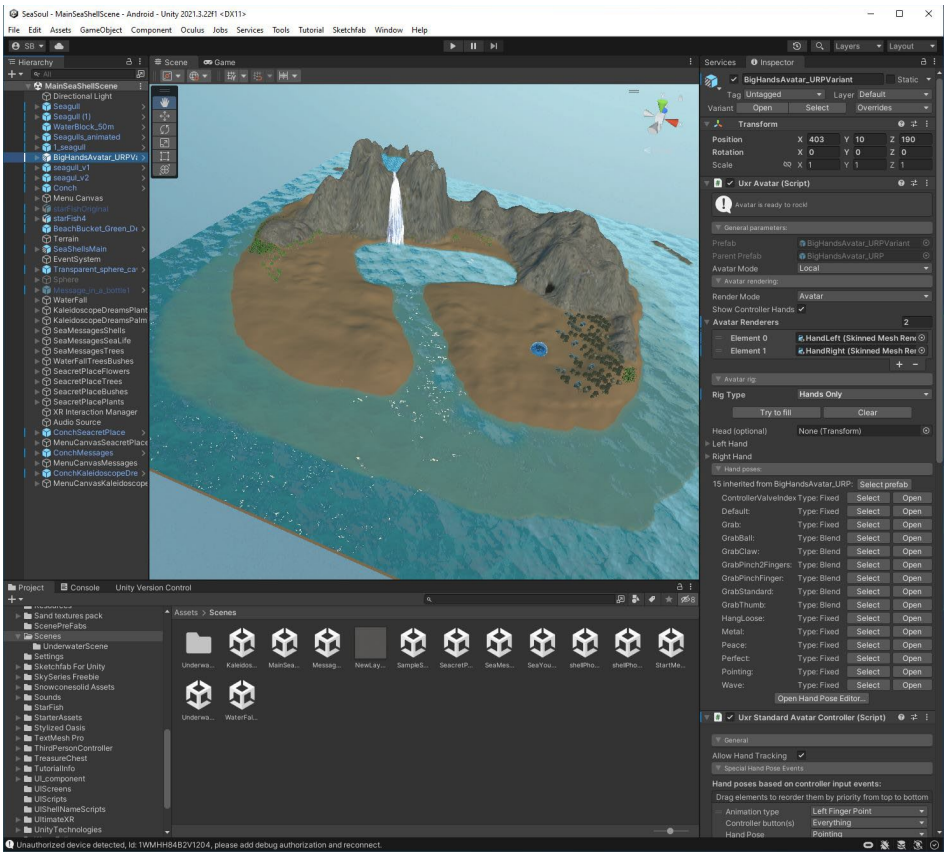


Figure 19. The *Sea Soul* Island in the Seashell Scene, built in Unity.

The scenes designed in this development phase are the Seashell, Meditation, Waterfall Cave, Message in a Bottle Scene, Message in a Bottle UI for typing the message, and Underwater Scene. When the user selects the blue seashell icon on the shellPhone, they enter the Seashell Scene, where they are facing the waterfall that can be seen in the distance, but when they turn to their right, there is an area where they can pick up seashells. See Figure 20, which shows the Seashell area in gameplay.

Figure 20. The Seashell area of *Sea Soul* in gameplay.

When the user walks up toward the green beach bucket there are shells that can be picked up and put into the bucket. By picking up the shell and holding it the seashell common name is displayed over the ocean. See Figure 21 and Figure 22 which illustrate a common seashell name displayed. In the Underwater Scene that was developed the user can explore different sea life. See Figure 23 for an illustration of the Underwater Scene.

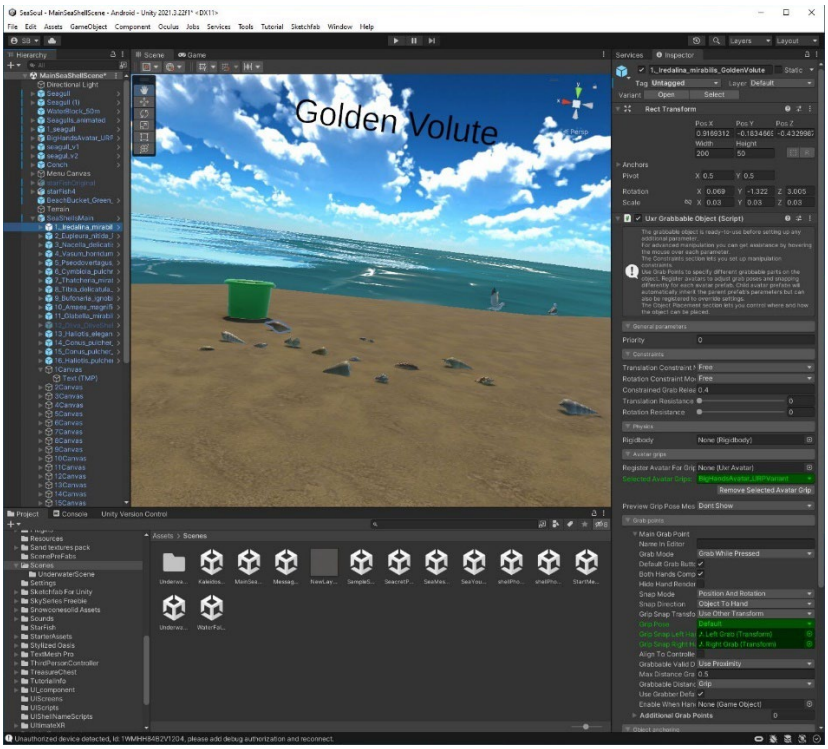


Figure 21. A seashell common name displayed in Unity.

Figure 22. A seashell common name displayed in gameplay.

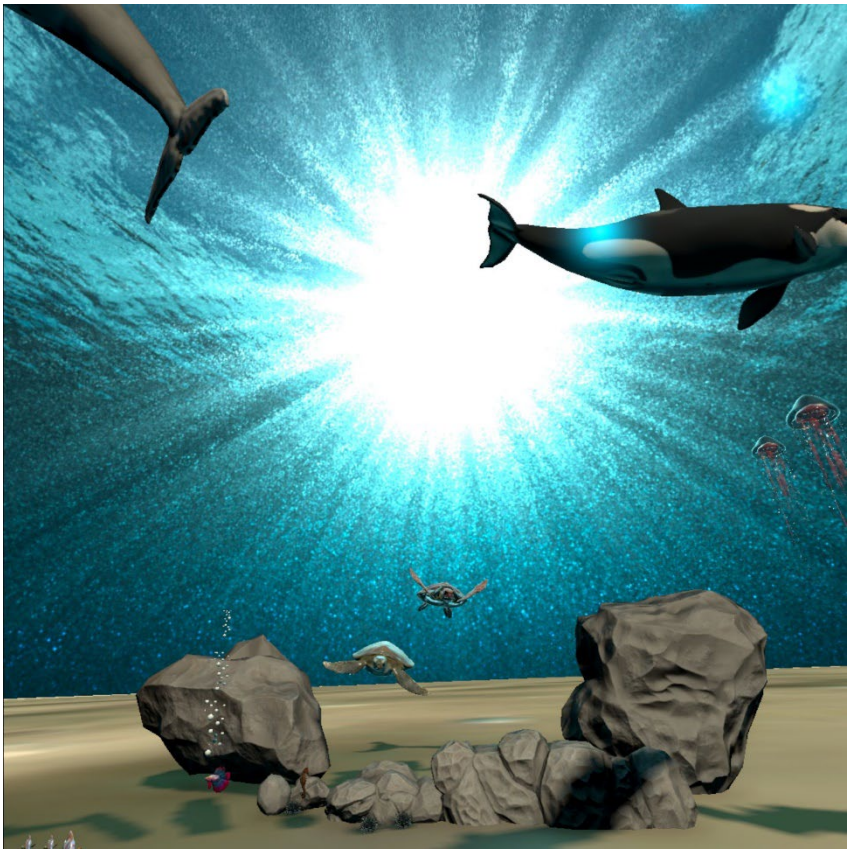


Figure 23. Part of the Underwater Scene in gameplay.

3.4.3 shellPhone & Transport UI Screens. The shellPhone UI screen and all the functionality to be able to press the button icons and be transported were implemented for all five scenes that were designed in the previous phase.

3.4.4 Welcome & shellPhone Directory & Exit UI Screens. The remaining UI screens for the Welcome, shellPhone Directory, and Exit menus and the functionality to be transported from the shellPhone were developed.

3.4.5 Audio. Sounds were implemented when the user selected buttons for game interaction. Other sounds that contributed to the auditory experience were different types of ambient music to add to the atmosphere of the particular scene the user was in or the sea life the user encountered. For example, when the user first enters *Sea Soul*, happy, fun, upbeat music is chosen; for the Seashell Scene, the user hears the ocean and seagulls;

in the Waterfall Cave, relaxing music with wooden flutes is heard to accompany meditation. Since the full functionality for swimming was not developed, in order for it to appear that the user was swimming visually, special effects for bubbles were applied as the user heard the sound of bubbles and heard themselves breathing in and out with ambient music of it sounding like they were underwater.

3.4.6 Ranked Wish List. From the ranked wish list, two modules were included in the development of *Sea Soul*. A YouTube video was integrated into the tutorial UI screen. The tutorial shows the user how to use the Meta Quest 2 controllers. A Kaleidoscope Dome was included as a scene in *Sea Soul* that provides a different type of atmosphere to meditate in since it has a sunset view at dusk with soft patterns of a kaleidoscope within the dome's outer edge structure. The Sea Salt Cave, Seashell Collection, and All About Shells scenes were not developed and were moved to future work. In addition, extra pop-ups in the game to have the Star Fish appear more as a guide to explain parts of the game were not implemented and moved to future work.

3.5 Testing & Evaluation

Testing for the development phase was iterative, along with the development tasks. After each feature or functionality was developed, it was tested with a success criterion of pass or fail. Controller functionality of each movement, each component, selecting buttons, transporting, and UI windows were tested with a pass or fail success criteria. For example, movement for picking up items was considered a success if the controller functions for picking up each item passed the test. If any individual feature or function failed, then it was developed appropriately until it successfully passed. UI windows were tested for button functionality and the appropriate colors, font size, and spacing. After each set-up of a transportation method, it was tested to ensure it

successfully passed by being able to transport. The audio development was tested in the same manner; after each sound or audio, it was tested with a pass or fail criteria.

In the Testing & Evaluation Phase, in-depth testing of all functionalities of scenes, UIs, and audio was conducted after the completion of the Development Phase with the same pass or fail criteria. Next, the *Sea Soul* project committee members, on separate days, tested, evaluated, and provided feedback. This worked out well because adjustments to development were made after each evaluation. For example, the UI screen and the font size for the shellPhone Directory needed to be larger for readability, so these adjustments were made and then passed. However, after another round of testing, evaluation, and feedback, the table lines of the directory appeared blurry and seemed to flicker, so it was suggested to put a color panel behind the directory to see if that would help. After I implemented and tested a black, white, and sandy tan colored panel, it worked best to take out the black table lines of the directory all together and to have the sandy tan colored background. See Figure 24 for the shellPhone Directory UI screen illustration of before (Figure 24A) and after in-depth testing (Figure 24B).

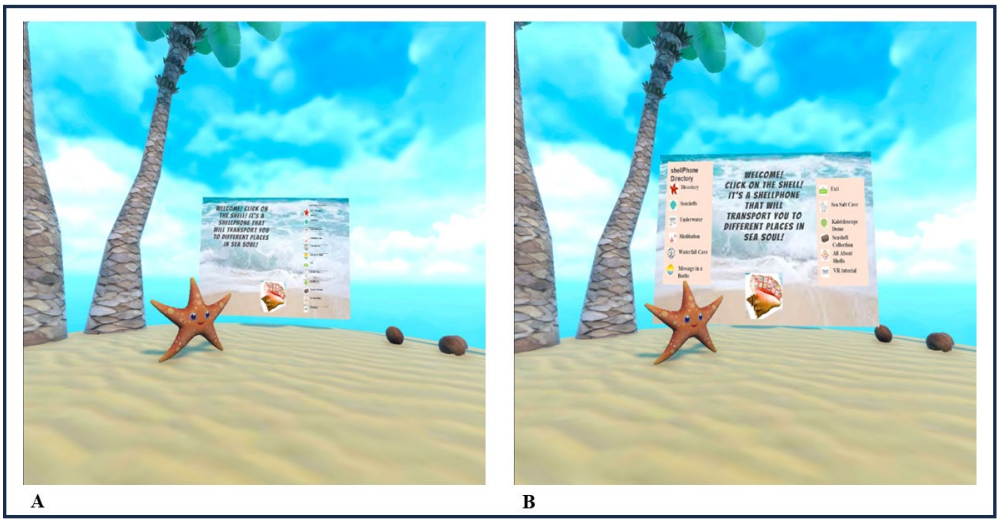


Figure 24. shellPhone Directory UI screen. (A) Before in-depth testing. (B) After in-depth testing.

Finally, usability was tested with user experience survey results and analysis that have a rating scale, with success being middle to high on the rating scale. There was also qualitative data obtained from open-ended questions in the user experience survey. The participants tested out the application for *Sea Soul* before completing the survey. Each participant was shown a diagram of the Meta Quest 2 controller movement for *Sea Soul* as they held the controllers in their hands. The diagram was explained as well as showing them the appropriate thumbsticks and buttons for movement on the actual controllers that would be used to move through the environment. See Figure 25 for the diagram of controller movement used in *Sea Soul* that was demonstrated.

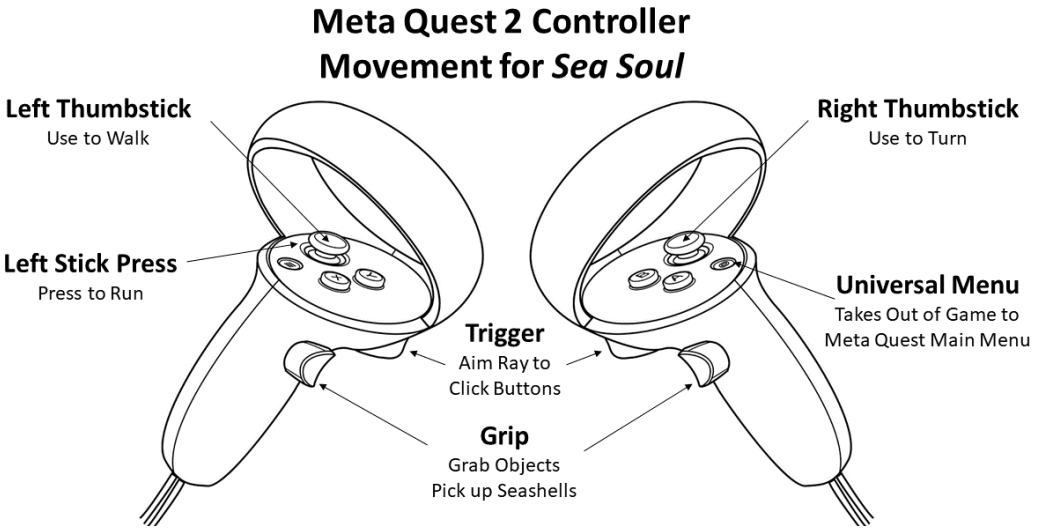


Figure 25. Meta Quest 2 Controller Movement for *Sea Soul*.

The participants were informed about the first three UI screens. See Figure 26 for the first three UI screens. As the participant looked at each illustration it was explained that once the user entered from the Welcome screen (Figure 26A) that transportation in *Sea Soul* is by using a shellPhone, so there is a shellPhone Directory screen (Figure 26B) where the user can return to if needed. The third UI screen is the shellPhone menu (Figure 26C), which is returned to from each scene by clicking on an icon that is on a

large conch. I asked that each participant test the Seashell Scene to pick up seashells and see the seashell names, the Underwater Scene to explore, and the Waterfall Cave for meditation. The user was welcome to try any more scenes if they wanted to.

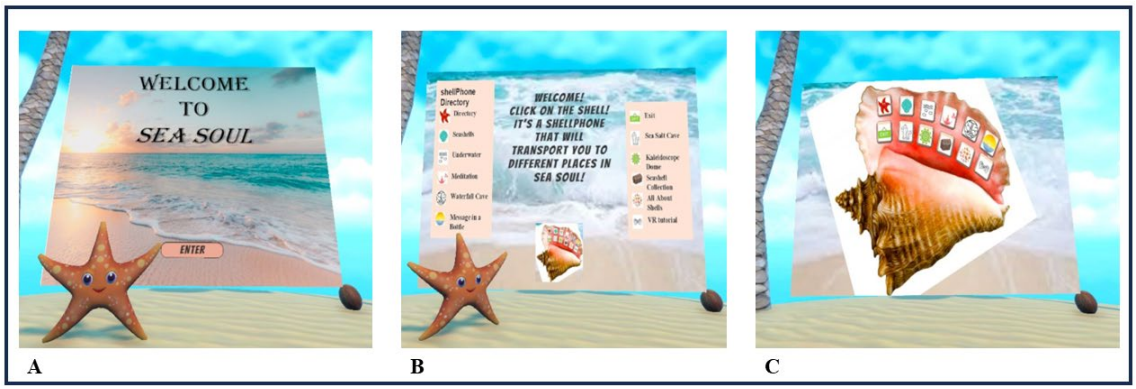


Figure 26. The first three UI screens in *Sea Soul*. (A) Welcome UI. (B) shellPhone Directory UI. (C) shellPhone UI.

Participants were asked to put on a VR headset and use the Meta Quest 2 controllers while seated to navigate through the application. I helped the participant adjust the headset as needed and told the participant that I was right there beside them to make sure that they did not bump into their surroundings, and if they needed anything, I would help them.

CHAPTER 4: OPERATION & RESULTS

For feedback on the development of *Sea Soul*, a survey was created and administered through Qualtrics that evaluated the player experience in three categories: personal playability for the feelings or emotions evoked, mechanical playability for navigation and movement, and artistic playability for the artistic and aesthetic experience of the player (see Appendix G for the *Sea Soul* User Survey Report). A 5-point Likert scale was used for each question, and respondents chose the answer that best corresponded to their opinion. Each item was given a score from 1 to 5, which is a rating scale, with 1 being the lowest-rated option and 5 being the highest-rated option. There were also a few open-ended questions for user feedback.

4.1 User Experience Survey Results & Analysis

User feedback was obtained from students and faculty at the University of North Carolina Wilmington. There were 10 participants who were asked a few demographic questions, with 40% being in the age group of 18–24, 50% in the age group of 25–34, and 10% in the age group of 45–54. Males were 70% of the participants, and females were 30% of the participants. Students consisted of 90%, and faculty consisted of 10%. The participants were asked to rate, “What frequency do you play Virtual Reality games?" A Lickert 5-point scale was used for frequency: 1. Never; 2. Rarely; 3. Sometimes; 4. Often; 5. Always. There were 50% of participants who had never played, 40% rarely played, and 10% played often.

4.1.1 Personal Playability. Participants were asked to rate the following items based on how much they agreed or disagreed with each statement. The Lickert 5-point scale for agreement was used: 1. Strongly disagree; 2. Disagree; 3. Neither agree nor

disagree; 4. Agree; 5. Strongly agree. The mean response to the statement "*Sea Soul* created an environment that felt as if I were by the sea" was 4.50. The mean response to the statement "The VR experience was fun" was 4.70. The mean response to the statement "*Sea Soul* was relaxing" was 4.50. The mean response to the statement "I found the different scenes engaging" was 4.40. The mean response to the statement "The experience felt as if it fosters wellness" was 4.40.

4.1.2 Mechanical Playability. Participants were asked to rate the following questions in terms of their level of difficulty. The Lickert 5-point scale for difficulty was used: 1. Very Difficult; 2. Difficult; 3. Neutral; 4. Easy; 5. Very Easy. The mean response to the question "Overall, how was your experience navigating through the game?" was 4.20. The mean response to the question "Overall, how was your character movement?" was 4.40. The mean response to the question "Overall, how was transportation via the shellPhone?" was 4.90.

4.1.3 Artistic Playability. Participants were asked to rate the following items based on how much they agreed or disagreed with each statement. The Lickert 5-point scale for agreement was used: 1. Strongly disagree; 2. Disagree; 3. Neither agree nor disagree; 4. Agree; 5. Strongly agree. The mean response to the statement "I found the user interfaces pleasing" was 4.20. The mean response to the statement "The sounds were appealing to me" was 4.60. The mean response to the statement "The virtual scenes were visually appealing to me" was 4.50. The mean response to the statement "The overall atmosphere was pleasant" was 4.70.

4.1.4 Open-Ended Questions. Participants were asked a few open-ended questions regarding suggestions to improve the VR experience, what their favorite thing was, and any additional feedback they had. Some suggestions to improve the VR experience were

to have more items to be picked up, allow items to be collected, allow more items to be identified, allow the user to be able to swim in the ocean, to have instructions for movements or breathing exercises, and to be able to watch the sunrise or sunset.

Some feedback on what their favorite things were was picking up seashells and seeing their name, the Underwater Scene, the Waterfall Cave, the shellPhone that took them places, the Star Fish Guide, the music and the sounds, the relaxing environment, and how the opportunities to relax encouraged people to slow down and meditate. Some additional feedback provided was that the user liked how easy it was to find the shellPhone and to navigate, that it is a fantastic idea for mental wellness, especially for a populous that has limited access to resources, that it perfectly captures the beach and collecting seashells on a sunny day, that people who are unable to physically go to the beach would enjoy the game and love the environment, that the user was interested in further production and ideas for this game, and that it was impressive.

CHAPTER 5: DISCUSSION

The main findings of the research show that the global virtual reality market size is projected to grow and that the market expansion will be fueled by the healthcare industry. This research emphasizes the physical, mental, and educational benefits of VR. There is an increase in VR being used for senior care, yet there is a decrease in engagement for older adults and seniors compared to younger age groups. *Sea Soul* is significant in that it bridges the age gap for the benefits that can be provided by VR in both healthcare and entertainment. A key contribution of the development of *Sea Soul* is that it is a working VR application model that creates a by-the-sea beach experience that blends several game genres and several benefits into one application to appeal to a wide range of users.

Supporting quantitative data from the user survey concludes that *Sea Soul* usability results meet the success criteria of the 5-point Likert rating scale used since for every question that was asked in the three categories of playability, the user responses resulted in a mean value of middle to high on the rating scale. See Table 12 for the supporting data for *Sea Soul* user testing conclusions.

Table 12. *Sea Soul* User Testing Conclusions

#	**Personal Playability** Field	Minimum	Maximum	**Mean**	Std Deviation	Variance	Count
1	Sea Soul created an environment that felt as if I were by the sea.	4.00	5.00	**4.50**	0.50	0.25	10
2	The VR experience was fun.	4.00	5.00	**4.70**	0.46	0.21	10
3	Sea Soul was relaxing.	3.00	5.00	**4.50**	0.67	0.45	10
4	I found the different scenes engaging.	3.00	5.00	**4.40**	0.66	0.44	10
5	The experience felt as if it fosters wellness.	3.00	5.00	**4.40**	0.66	0.44	10
#	**Mechanical Playability** Field	Minimum	Maximum	**Mean**	Std Deviation	Variance	Count
1	Overall, how was your experience navigating through the game?	4.00	5.00	**4.20**	0.40	0.16	10
2	Overall, how was your character movement?	3.00	5.00	**4.40**	0.66	0.44	10
3	Overall, how was transportation via the shellPhone?	4.00	5.00	**4.90**	0.30	0.09	10
#	**Artistic Playability** Field	Minimum	Maximum	**Mean**	Std Deviation	Variance	Count
1	I found the user interfaces pleasing.	3.00	5.00	**4.20**	0.60	0.36	10
2	The sounds were appealing to me.	4.00	5.00	**4.60**	0.49	0.24	10
3	The virtual scenes were visually appealing to me.	4.00	5.00	**4.50**	0.50	0.25	10
4	The overall atmosphere was pleasant.	4.00	5.00	**4.70**	0.46	0.21	10

5.1 Inferences

In consideration of the nonfunctional requirements of *Sea Soul,* the survey has three categories that highlight the player's experience. The questions were designed so that the gameplay goals of *Sea Soul* were asked to see if they were met. Under personal playability, the goals for the environment were met by the mean value being over 4.40 for all questions in that category, so it is inferred that *Sea Soul* feels as if it is by the sea; it's

fun, relaxing, engaging, and it fosters wellness. Mechanically, the navigation, movement, and transportation via the shellPhone all had a mean value over 4.20, thus *Sea Soul* has easy navigation, movement, and transportation to its game play. Furthermore, the mean value of over 4.20 stands for the artistic category as well. It is reasoned that the scenes, user interfaces, and sounds are appealing or pleasing, and that the overall atmosphere of *Sea Soul* is pleasant.

A consensus that *Sea Soul* brings fun and wellness is made from the user's written feedback on the survey and by observing the user because they thought it was fun and relaxing. The consensus was high for users who really liked being able to pick up seashells and the surrounding environment in the Seashell Scene. Also, many users thought that the Waterfall Cave Scene was very relaxing and commented on liking the music in that scene, which had a wooden flute in the composition. Music with a wooden flute was chosen for this scene because it is generally used in meditation music for the body and spirit to bring relaxation and positive energy across many diverse cultures. Users commented on liking the exploration found in the Underwater Scene and also liking the relaxing atmosphere in other meditative scenes. It is summarized that the educational, exploratory, and meditative well-being benefits are highlighted by users liking the Seashell, Underwater, and Waterfall Cave scenes that embrace those genres.

Sea Soul's solution to provide a bridge to all ages and abilities due to the higher use in senior care but lower use by aging adults in VR engagement is somewhat limited because a full range of age groups were not present in the participants who participated in user testing. A full-fledged user testing with a population of all age groups would be more applicable to ascertain this. For the scope of this project, user testing for *Sea Soul*

consisted of 10 users, with 40% in the age group of 18–24, 50% in the age group of 25–34, and 10% in the age group of 45–54.

However, it is implied that *Sea Soul* is successful in targeting the aging population since the game was developed with ease of use to target people with different abilities. The controller movement functions, consisting of only general, basic movement functions, navigation, and transportation via the shellPhone, were tested on the users. The majority of users found the game easy or very easy to play. The combined totals for being easy or very easy for navigation were at 100%; for movement, 10% were neutral, and the remaining 90% were easy or very easy; and for transportation via the shellPhone, 100% were easy or very easy. The ease of use is significant because the quantitative data shows that 50% of users had never played a VR game before, 40% rarely played, and only 10% played often. The high rate of tested users who had never or rarely played VR would be indicative of those who generally aren't typically engaged and would not be skilled in being able to use the controllers or navigate, as well as those who normally engage more in VR games.

In addition, in development to pick up seashells in the environment, the height away from the seashell to grab the seashell was set high so that a user who wasn't able to bend low could pick them up easily. Once the seashells were picked up, they remained in space, so the user could have a close look at them and not have to struggle to see or go after a dropped shell. The seashell common name was displayed in a very large font in the sky for ease of reading. Though *Sea Soul* can be played in a standing or seating position, the users were all tested in the seating position, which simulates users who would not be able to stand, have difficulty standing, or not be able to physically go to the beach. There was a high success rate of users who enjoyed picking up seashells virtually,

and from feedback, users thought that people who are unable to physically go to the beach would be able to do so and would enjoy it.

5.2 Lessons Learned

For the research proposal timeline of this project, by creating a Gannt chart, the importance and interplay of scope, methods used, resources, and time estimations were learned. The Gannt chart was successfully reviewed and adjusted according to the research project changing over time, feedback, and challenges. However, the timeline of completion took longer than what was originally planned. By realizing my project scope was too large and communicating with the project committee members, I was able to move some modules to a ranked wish list. The ranked wish list served as a list of items that could be developed but were not essential to getting a working application model that would be suitable for the aims of this research. The items from the ranked wish list that were not completed are moved to future work for this project.

5.3 Future Work

Item modules that would like to be completed for future work are the Seashell Collection, All About Shells, the Sea Salt Cave, and for the Star Fish to be more of a guide that pops up throughout the different scenes. In the Seashell Scene, when the user puts the seashells into the green-colored beach bucket, the seashells will be saved into a collection in inventory. When the user selects the Seashell Collection icon on the shellPhone, they will be able to write a seashell collection note to go with their seashell collection bag and put it into a treasure chest. Also, the user would be able to select the All About Shells icon from the shellPhone, where the different seashells that are in *Sea Soul* can be clicked on to learn the scientific name and some interesting facts about that specific seashell. In the Sea Salt Cave Scene, the user would be able to go to another

place to meditate. Star Fish Guide extra pop-ups in the game would help the user to be able to navigate the different areas of *Sea Soul*.

In order to incorporate more of the physical benefits of VR into *Sea Soul,* the Star Fish would be able to guide and motivate the user in meditation and yoga. The full function of swimming would be implemented and used to promote movement, exercise, or physical therapy. Swimming in *Sea Soul* could be incorporated into the whole ocean on the island and not just in the Underwater Scene.

To add the sit function would allow the user to virtually sit to meditate, and to add the throw function would allow the user to be able to throw the message in the bottle out to sea. If the user were able to sit, then they would be able to get closer to objects to view them. Also, enabling more items to be picked up in all the scenes would allow the user to be able to view the objects more closely, see them in more detail, and have more interactivity to engage the user.

From user feedback on the survey, talking to others, and observation, some of the users really liked the simplicity within *Sea Soul* and had the opinion that it added to the ease of use, relaxation, and blissfulness of the gameplay. On the other hand, for those who suggested more interactivity, more items could be picked up and collected, and points could be rewarded for different rarities of items. So, to ensure there is an appeal to a wide range of users, there could be different skill levels of *Sea Soul* that would be offered for gameplay. The rarity of items would be, for example, in the Seashell Scene items that are harder to find, such as sand dollars or a clam with a pearl. The cave scenes in *Sea Soul* could have different gems with diamonds or a special type of crystal, which would have more points rewarded. The Underwater Scene could have higher points for finding coins from the shipwreck.

In general, for the future work of *Sea Soul*, different scenes would be embellished more, such as having more seashells, more details for exploration, and more sound effects. The shellPhone that is in each scene would have the full range of icon buttons on the conch for transportation in *Sea Soul,* so there would not be a need to select the icon to go to the main shellPhone menu; however, the user would still be able to select the shellPhone Directory if needed. A virtual keyboard with two hand-direct touch typing could be implemented for more of a journaling experience for *Sea Soul*'s message in a bottle. Finally, it would be lovely to be able to watch the sunrise or sunset in *Sea Soul*.

CHAPTER 6: CONCLUSION

This research provides insights on how VR can incorporate general, mental, physical, and educational benefits for wellness. It is the goal of *Sea Soul* to promote the well-being benefits that a VR by the sea environment can provide to users of all ages and abilities, in particular the aging population. *Sea Soul* aims to give all people a way to go to the beach, especially with people in mind who would love to be able to pick up seashells on the beach again but are physically unable to. The development of *Sea Soul* as a working VR application model intends to contribute to virtual reality technology, furthering research in immersive experiences that bring fun and wellness together.

REFERENCES

American University. “Virtual Reality in Education: Benefits, Tools, and Resources.” *School of Education Online Programs*, American University, 16 Dec. 2019, https://soeonline.american.edu/blog/benefits-of-virtual-reality-in-education/.

Anguera, J. A., et al. “Video Game Training Enhances Cognitive Control in Older Adults.” *Nature*, vol. 501, no. 7465, Sept. 2013, pp. 97–101., https://doi.org/10.1038/nature12486.

Baker, Harry, et al. “Maloka Offers Fantastic Meditation With Stunning Visuals On App Lab For Quest.” *UploadVR*, UVR Media LLC, 31 May 2021, https://uploadvr.com/maloka-vr-meditation-app-lab-quest/.

Blagojević, Ivan. “Virtual Reality Statistics - 2023.” *99firms*, 19 May 2023, 99firms.com/blog/virtual-reality-statistics/#gref.

Buckle, Chase. “Ar vs VR: The Challenges and Opportunities in 2019.” *GWI*, GWI, 19 Nov. 2018, blog.gwi.com/chart-of-the-week/augmented-virtual-reality/.

Exactitude Consultancy. “Head-Mounted Display Market with COVID-19 Impact Analysis by Type (Slide-on HMD, Integrated HMD, Discrete HMD), Technology (AR, VR) and Component (Processors and Memory, Displays, Lenses, Sensors, Controllers, Cameras, Cases and Connectors, Others) and Region (North America, Latin America, Europe, Asia Pacific and Middle East & Africa): Global Opportunity Analysis and Industry Forecast 2022–2029.” *Exactitude Consultancy*, Exactitude Consultancy, Apr. 2022, https://exactitudeconsultancy.com/reports/5078/head-mounted-display-market/.

Fortune Business Insights. “Virtual Reality Market Size, Share & COVID-19 Impact Analysis, By Component (Hardware, Software, Content), By Device Type (Head Mounted Display, VR Simulator, VR Glasses, Treadmills & Haptic Gloves, Others), By Industry (Gaming, Entertainment, Automotive, Retail, Healthcare, Education, Aerospace & Defense, Manufacturing, Others), and Regional Forecast, 2022-2029.” *Fortune Business Insights | Hardware & Software IT Services / Virtual Reality Market*, Fortune Business Insights, May 2022, https://www.fortunebusinessinsights.com/industry-reports/virtual-reality-market-101378.

Garbett, Samuel L. “Unreal vs. Unity for VR Game Development: Which Is Best?” *MUO*, Make Use Of, 4 June 2022, https://www.makeuseof.com/unreal-vs-unity-vr-best-game-development/.

LaValle, Steven M. “Steven M. LaValle.” *Steven M. Lavalle*, Cambridge University Press, 2020, http://msl.cs.uiuc.edu/vr/vrbook.pdf.

Lodha, Pragya, et al. “Virtual Reality and Its Therapeutic Uses in the Elderly: A Narrative Clinical Review.” *Journal of Geriatric Mental Health*, Wolters Kluwer - Medknow, 29 June 2020, https://www.jgmh.org/downloadpdf.asp?issn=2348-9995;year=2020;volume=7;issue=1;spage=21;epage=28;aulast=Lodha;type=2.

Medical Alert Advice. “How Virtual Reality Benefits Seniors & Improves Their Lives.” *Medical Alert Advice*, Medical Alert Advice, 18 Oct. 2019, https://www.medicalalertadvice.com/articles/how-virtual-reality-benefits-seniors-improves-their-lives/.

Meta. “What Is Virtual Reality All about?” *Meta Quest*, Facebook Technologies, LLC, 9 Oct. 2021, https://www.oculus.com/blog/what-is-virtual-reality-all-about/.

Meta Quest. “Find Your Breath: Meditate and Become More Mindful With 'Maloka,' Out Now on the Quest Platform.” *Meta*, Meta Quest, 14 Dec. 2021, https://www.meta.com/blog/quest/find-your-breath-meditate-and-become-more-mindful-with-maloka-out-now-on-the-quest-platform/.

Mirage VR. “Should You Send Your Kids For Virtual Reality Gaming?” *Mirage VR*, Mirage VR Inc., https://miragevr.ca/should-you-send-your-kids-for-virtual-reality-gaming. Accessed 10 Nov. 2022.

Muñoz, John, et al. “Immersive Virtual Reality Exergames for Persons Living with Dementia: User-Centered Design Study as a Multistakeholder Team during the COVID-19 Pandemic.” *JMIR Serious Games*, vol. 10, no. 1, 2022, https://doi.org/10.2196/29987.

Pixo VR. “Comparing Virtual Reality Software Engines.” *Pixo VR*, Pixo VR, 12 June 2019, https://pixovr.com/comparing-vr-software-engines/.

Radianti, Jaziar, et al. “A Systematic Review of Immersive Virtual Reality Applications for Higher Education: Design Elements, Lessons Learned, and Research Agenda.” *Computers & Education*, Elsevier Ltd., 9 Dec. 2019, https://www.sciencedirect.com/science/article/pii/S0360131519303276.

Reality Well. “VR Is Helpful for Seniors and the Elderly.” *Reality Well - A Virtual Reality Healthcare Platform*, Reality Well. VR Vision Group., 5 Sept. 2019, https://realitywell.com/vr-for-retirement-homes/vr-is-helpful-seniors-and-the-elderly/.

Reynolds, Lisa M., et al. “The Benefits and Acceptability of Virtual Reality Interventions for Women with Metastatic Breast Cancer in Their Homes; a Pilot Randomised Trial.” *BMC Cancer*, vol. 22, no. 1, 2022, https://doi.org/10.1186/s12885-021-09081-z.

Steam. “Seashell on Steam.” *Steam*, Valve Corporation, https://store.steampowered.com/app/1829540/Seashell/.

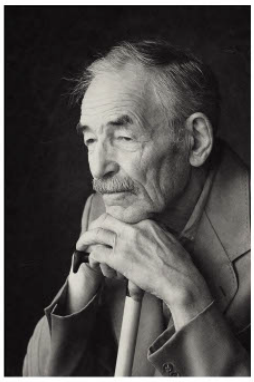
Upworthy, director. "VR Takes This Elderly Couple Back To The Places They Visited a Long Time Ago!". *YouTube*, 1 Dec. 2016, https://www.youtube.com/watch?v=Gq0tRgpOvnA. Accessed 7 Mar. 2023.

APPENDICES

APPENDIX A: *Sea Soul* User Personas

The personas used for *Sea Soul* start with an 81-year-old and range to an 8-year-old. To emphasize the well-being of those with senior care needs and their need to improve their quality of life, as well as the needs of the aging process, the following personas are presented from eldest to youngest.

John



Age: 81
Occupation: Retired
Family: Widower

Experience:
Virtual Reality
Mobile
Gaming

"I will be glad not to feel so alone anymore."

Motivation

John lives in a nursing home and hardly has any visitors. He wants to learn how to play a virtual reality game because he tried virtual travel one time in a group session at the nursing home. He wants to be able to play a game and then discuss it with others at group time. John always lived near a beach and he really misses being able to get out and go to one. He wants to be extroverted, social, and active like he was in his younger years. John feels happy when he has something to keep his mind occupied.

Goals

- Would like to play a game so I am not so lonely.
- To feel like I am really at the beach.

Frustrations

- Things too hard to learn.
- Not keeping my mind active.

Figure A1. 81-year-old John Persona.

Barbara

Age: 73 Occupation: Disabled

Family: Adult children (not at home).

Experience:

Virtual Reality

Mobile

Gaming

"Isn't it wonderful, doing something for myself!"

Motivation

Barbara likes playing video games and thinks they are a lot of fun! She says playing helps with her cognitive skills, it relaxes her, and helps her feel creative. After knee surgery, she couldn't walk as well and having anesthesia affected her memory so she decided to play video games. She has been playing video games for many years now. Recently Barbara has decided that she wants to try VR games.

Goals

- Feel the immersive experience of Virtual Reality.
- Become physically accustomed to using VR.
- Find a VR exploratory game.

Frustrations

- Only wants a one person game.
- Doesn't do well with a bunch of characters in one game.
- Can't afford a real expensive game.

Figure A2. 73-year-old Barbara Persona.

Ramona

Age: 41

Occupation: Corporate Accountant

Family: Married with two teenage children

Experience:

Virtual Reality

Mobile

Gaming

"I would love to feel more relaxed!"

Motivation

Ramona needs to take some time for herself. With her job as a corporate accountant, being a wife, and the mother of two teenage children, she is always so busy. She has played VR games before because her children do. VR is enjoyable to her because of the immersive experience.

Goals

- To feel more relaxed.
- Take time to enjoy the ocean.

Frustrations

- Sometimes I feel anxiety and stressed out.
- I get depressed because I don't take time for myself.

Figure A3. 41-year-old Ramona Persona.

Susan

"Invest in your health!"

Motivation

Running and exercising for good health. Eating healthy. Helping others to discover healthy eating choices. Going to the beach.

Age: 25
Occupation: Health Food Store Associate
Family: Single

Experience:

Virtual Reality

Mobile

Gaming

Goals

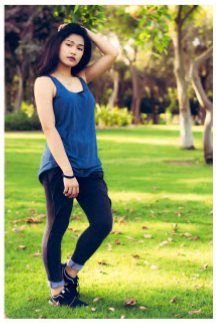
- To stay fit.
- Exercise more on rainy days.

Frustrations

- When doesn't take time to meditate.
- Negative thoughts.

Figure A4. 25-year-old Susan Persona.

Olivia



"I just want to have fun and be at peace with everything."

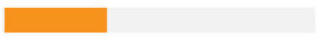
Motivation

Having fun with friends. Graduating from high school. Getting a car. Going on vacation.

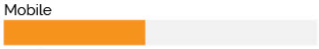
Age: 18
School Year: 12th grade Senior
Family: Parents and a younger Brother

Experience:

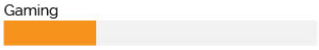
Virtual Reality



Mobile



Gaming



Goals

- To graduate high school.
- To feel more at peace.

Frustrations

- Expressing my emotions.
- Meeting demands of school work.

Figure A5. 18-year-old Olivia Persona.

Marcel

"I miss my best friend."

Age: 15
School Year: 9th grade
Family: Has mom and no siblings

Experience:
Virtual Reality
Mobile
Gaming

Motivation

Likes underwater sea life, playing video games, and VR games. Enjoys swimming and bike riding. Wants to learn to scuba dive.

Goals

- To learn more about marine life.
- To learn to scuba dive.

Frustrations

- Best friend moved away.
- Not meeting new friends with the same interests.
- People who are bullies.

Figure A6. 15-year-old Marcel Persona.

Justin

"Happiness is having a seashell collection!"

Age: 8
School Year: 3rd grade
Family: Parents and an older sister

Experience:
Virtual Reality
Mobile
Gaming

Motivation

Justin loves looking for seashells and exploring! He likes to learn about nature and animals. He enjoys playing VR games, but he also loves to play outdoors! Justin looks forward to going to the beach with his family.

Goals

- To learn more about seashells and animals in the ocean.

Frustrations

- VR games that are too scary.

Figure A7. 8-year-old Justin Persona.

APPENDIX B: *Sea Soul* Scenarios

Scenarios for Sea Soul Virtual Reality Game

81-year-old John Scenario 1. The nursing home that John is at works with a therapeutic virtual reality company that comes to their facilities. John tried virtual travel in group therapy one time and really liked it. Now he has his mind set on trying a virtual reality game. Today is a big day for him because the VR therapist is coming to his room today to help him with just that! Due to John's health, he is not always able to join a group activity. The VR therapist arrives and talks to John about the kind of game he is interested in. He tells John about the game *Sea Soul*. He places the hand controllers in John's hands and the headset on his head. John clicks the enter button on the welcome screen. He is greeted by a Star Fish Guide that tells him to click on a conch shell that allows him to go to different scenes in the game. If he chose to, he could watch a video tutorial on how to use the hand controllers. He decides to go to the Shell Scene, where he hears the calming sound of the ocean as he walks along the beach and picks up shells. Next, John decides to be transported to the Underwater Scene with more shells, fish, and life under the ocean. He feels happy and is smiling. He tells the therapist how it was comforting to have the Star Fish as a guide and how the sea animals made him not feel so lonely.

81-year-old John Scenario 2. Today John is feeling depressed, but he is reminded by his nurse aid that the VR therapist is coming out again with the new game he liked playing. The therapist arrives, and John chooses to go to the Meditation Scene today because he finds out that there are different sea caves there. He walks along the beach and listens to the sweet sound of the ocean. He sees sea gulls on the shore as he walks. To get to the caves, he rounds a curve in the seashore, and he sees a cave ahead. He enters

the cave, and seeing the beauty of the underground reminds him of when he used to go hiking and caving in his younger years. He really likes this because it makes him feel like he can do things like he used to. John takes off his VR headset and tells the therapist how happy playing the game makes him feel.

73-year-old Barbara Scenario 1. Barbara enjoys playing video games and wants to try playing virtual reality games. Her son picks her up and drives her over to his house for dinner because Barbara does not drive. After dinner, he surprises her with a virtual reality headset and controllers as an early birthday present. She is overjoyed and gives her son a big hug. She wants a VR game that is exploratory. Her son brings up some VR games on the internet so that she can choose which one she wants to try. She looks closely at the games and chooses one that is exploratory, is on the beach, and involves picking up shells. She really likes how in the game you can be on the beach, pick up shells, and learn the names of the shells. She misses being able to go out on the beach and pick up shells. She also likes how it is a one-character game in the video clip. He puts on the VR headset and gets the *Sea Soul* game downloaded from the application store as he explains what he is doing. Barbara puts on the headset, and once she enters the game, she sees a Star Fish that explains how to be transported to different places in the game by a shell that is called a shellPhone. Barbara is happy to go to a video tutorial where she learns how to move the controllers since she only tried it briefly a couple times before with her son on his VR set. Barbara takes her headset off, smiles super big, and hugs her son again. She tells him how happy she is with how it feels so real, and she likes being able to be on the beach again since she cannot get out to go places much anymore.

73-year-old Barbara Scenario 2. Barbara likes to play video games because she knows they help with her cognitive skills, and they are fun! She said that before she

played video games, she would do crossword puzzles; next, she graduated to solitaire on her iPad tablet; and then she played video games. So now she is excited to play her new VR game again. From the shellPhone in *Sea Soul,* she selects to go pick up shells on the beach. Here the beach is nice and sandy, and along the shore are lovely seashells. She walks along the shore and can look out at the ocean waves if she wants. The waves lap up toward the shells, but just far enough away that she is able to pick up the different shells she sees. It feels so satisfying and fun to pick up the shells in the game for her. Since her knee surgery, she has not been able to bend down to pick up shells on the beach, and she sure has missed being able to do that. She decides to toggle on the shell name for a while to see the common name of the shells she picks up displayed. She then toggles the name back off to pick up more shells and enjoy the beauty and fun of being on the shore. She notices she is already remembering the names of some without seeing the name on the screen when she picks up the same kind of shell again.

41-year-old Ramona Scenario 1. Ramona is excited because she heard about a new VR game that has a few ocean scenes, one of which is a Meditation Scene. She puts on her VR headset and gets the new game, *Sea Soul*. She enters the Shell Scene and thinks it looks cool; however, she quickly transports to the mediation screen. Here she sits down on the beach sand, listens to the ocean, and relaxes while watching the ocean view. She watches birds fly by and a lost kite soar through the sky. Next, she goes to the dome tent on the ocean shore and watches a relaxing kaleidoscope of colors as she listens to ambient music. Ramona is feeling so very, very relaxed.

41-year-old Ramona Scenario 2. Today Ramona has had a stressful day. She is a corporate accountant, a wife, and the mother of two teenage children. Though she has paved a successful career and has been with the firm for 15 years, it gets difficult to

manage her time between everything. She rarely takes time for herself, and stress takes a toll sometimes. Now that she has discovered meditation on the *Sea Soul* game, she is feeling more relaxed, and the relief from anxiety is lifting her depression. She is greeted by the Star Fish Guide as she enters the game. Once in the meditation screen, she walks down the beach for a while and decides to visit the Sea Salt Cave to meditate there since she has not tried it yet. She selects the shellPhone from the meditation screen and decides to transport to the Sea Salt Cave. There is shimmering pink and white crystalized sea salt rock lining the walls and the high ceiling of the inner cave. Inside, beneath her feet, is the untouched-looking blanket of white sand covering the ground. She sits down on the blanket of sand and starts her meditation.

25-year-old Susan Scenario 1. Being on the beach is inspiring to Susan when she works out for fitness. She is extremely healthy and regularly exercises by running or doing yoga. She enjoys meditation as well. The beach is not too far away, but sometimes it is not feasible with her schedule or weather permitting. Hearing about the game *Sea Soul* seemed like it would be nice to mediate with. In addition, she thought she would enjoy being able to use it to exercise with when she cannot get to the beach. From the shellPhone, Susan selects the Shell Scene, even though she is not going to pick up shells. She looks out at the awe-inspiring sunny day on the beach and is energized by how the sun shines and reflects out over the ocean. She runs in place as she virtually goes down the coast, looking at the shimmering water. It helps her to keep her mind off any negative thoughts and zone in on just running down the beach.

25-year-old Susan Scenario 2. Another day, Susan decides she is ready to do some meditation in *Sea Soul*. When she enters the Meditation Scene, she meditates right there on the beach, listening to the ocean rhythm of the waves for a while. Susan decides

she wants to go to the Waterfall Cave, which is a cave behind a waterfall. She uses the shellPhone to select and be transported to the cave, which is right in front of her. The waterfall playfully cascades down to the sand and foams, reaching out to eventually meet the sea. Behind the waterfall, inside the cave, the cool, hard, earth-colored rock juxtaposes against a serene pool of clear blue water on the cave floor. Susan feels tranquil and starts to meditate.

18-year-old Olivia Scenario 1. It has been six months since Olivia's grandma passed away. She was remarkably close to her grandma, and she loved her dearly. She went with her grandparents often to their place at the beach, even though it was a four-hour trip. Ever since she was a little girl, they had gone. They would often fish. But it was her and her grandma that she would pick up seashells with. Olivia goes on her *Sea Soul* VR game to pick up seashells. Picking up seashells takes her mind off everyday worries; the ocean sounds tranquil; and she feels a sense of peace. She decides to save her shells in a virtual bag today. When she saves the shells, the game gives you the option to write a note to go with your seashells in the collection bag. Olivia puts her name on the note, dates it, and puts it in memory of her grandma.

18-year-old Olivia Scenario 2. Olivia likes the Meditation Scene in *Sea Soul* a lot. She does not do any physical meditation techniques with it, but she enjoys the relaxing ambient music. What she likes even better is that you can write a message in a bottle here. When you finish writing your message in the bottle, you throw it out to sea. Previously, she had written messages to her grandma who had passed away. Writing messages in a bottle has been a way of journaling for her. It has been a rough week for Olivia. She and her boyfriend broke up, and she feels like she is struggling in school. It is her senior year in high school, so she knows she needs to do well because she is looking

forward to graduating. So today, for her message in a bottle, she is going to write out her feelings about the breakup and anything else on her mind. Her true, raw feelings. Stuff she wants to say but is private. Her anger, her despair, and her broken heart. She types it all out, puts it in the bottle, and tosses it out to sea. No one will physically see what she has written for which she is thankful. However, she feels as if somehow someone else or something else knows now, and she does not feel alone. She feels cleansed, and her spirit is restored. As her message is washed out to sea, her soul feels good.

15-year-old Marcel Scenario 1. Marcel is fascinated by what lives in the sea. He likes underwater life and wants to be able to learn to scuba dive. His mom bought him a new VR game in the online store application. She thought that *Sea Soul* would give him a good experience to increase his awareness of marine life and be fun for him. To her, he seems a little down lately. His best friend and family moved recently, and she thinks it may have to do with that. When she surprises him with the new game, he seems really happy about it. Marcel plays VR and console games already. It does not take him long at all to get to the Underwater Scene. He swims through the clear ocean water. He sees different kinds of fish swimming around a coral reef. The coral is a sight to see. There are peach, orange, and blue colored coral. Nestled amongst the coral is a sea anemone, and sure enough, he sees some clownfish. Swimming further out, he sees a pair of sea turtles. Sea turtles are one of his favorite animals. He goes back toward the bottom of the ocean and views a crab stretching its pincher claws out. To his surprise, behind the crab is an open shell with a pearl in it. It is as if the crab is guarding it. He looks ahead and is in awe of a large animal in the distance. Marcel exclaims, "It's a whale!" Marcel thinks the underwater adventure is so cool already. "It's time for supper," his mother says. He cannot wait to explore some more after supper.

15-year-old Marcel Scenario 2. The underwater exploration has been fun in *Sea Soul* for Marcel. He noticed that in the meditation screen he could do a message in a bottle. His mom had talked to him some about his best friend moving. He thought about what she had said and felt that she was right because he does miss him. Not only that, but a couple of guys who live in his neighborhood and play basketball down at the park have started bullying him more since his best friend is not with him. He and his best friend liked riding their bikes through the park and playing video and VR games. The guys that bully him say mean things to him and call him names because he does not like to play basketball or football for that matter. He is embarrassed to tell his mom about it and is concerned she may contact the school or the other guy's parents and make it worse for him. He knows he should reach out to someone, but in the meantime, he wants to write a message to put in a bottle. He decides to write all about how he misses his friend and about how the guys are bullying him. He writes how he feels sad and angry at the same time. While writing it all out, he realizes he is feeling lonely too and discovers how much he believes in himself and likes the things he does. He thinks to himself that he knows there are other people out there who like the same things. He decides he will call his uncle about it. After all, he looks up to his uncle, who in fact has been scuba diving.

8-year-old Justin Scenario 1. Justin loves going to the beach with his family and looking for seashells. He also loves playing VR games. He wondered if there was a game that would help him learn the names of seashells. After searching through his VR headset, he found one! He entered the game and could pick up seashells, and the common name for the shells would show up. He saw that once you picked up the shells, you could go to another scene where you could learn more about the seashells! To Justin, this was such a fun way to learn more about shells. What he thought was cool is that after he

finished picking up seashells, his collection was saved in a virtual bag where you could put your name and a message in it. He went to go get his mom to get her to play next so they could both do a collection in the virtual *Sea Soul* treasure chest! He thought it would be really neat if next time he sees his grandma, they could save their shells in a virtual bag too, since grandma has not been able to go to the beach with them in a long time.

8-year-old Justin Scenario 2. After school, Justin finished all his homework and was ready to play *Sea Soul* again. He had fun learning about different shells the last time, but he was ready to check out the underwater part of the game because he likes to explore, and he likes animals. From the shellPhone screen, Justin can select the Underwater Scene. The shellPhone lets him select a scene to go to by selecting the conch shell here or in any scene. It enables you to transport by making a "shellPhone" call. Justin thinks this is so funny, and he just laughs and laughs. He sees the different icon buttons on the expanding lip of the conch shell. Here he can choose to select the underwater button to transport. Justin makes a "shellPhone" call by selecting the appropriate icon. He is transported to the Underwater Scene and is surrounded by a school of fish.

APPENDIX C: *Sea Soul* – Storyboard Design 1

Sea Soul – Storyboard Design 1

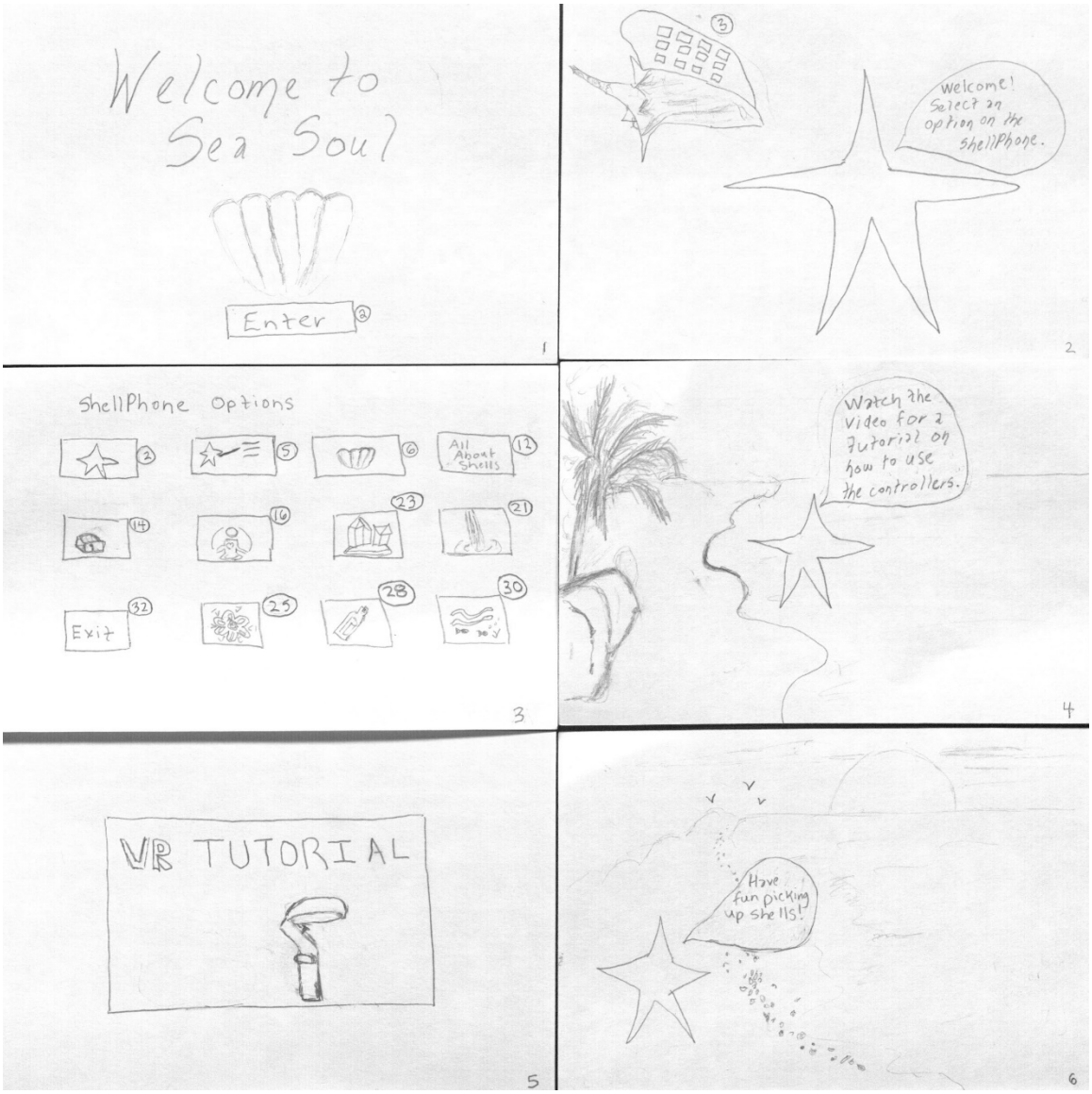


Figure C1. Storyboard Design 1, Page 1.

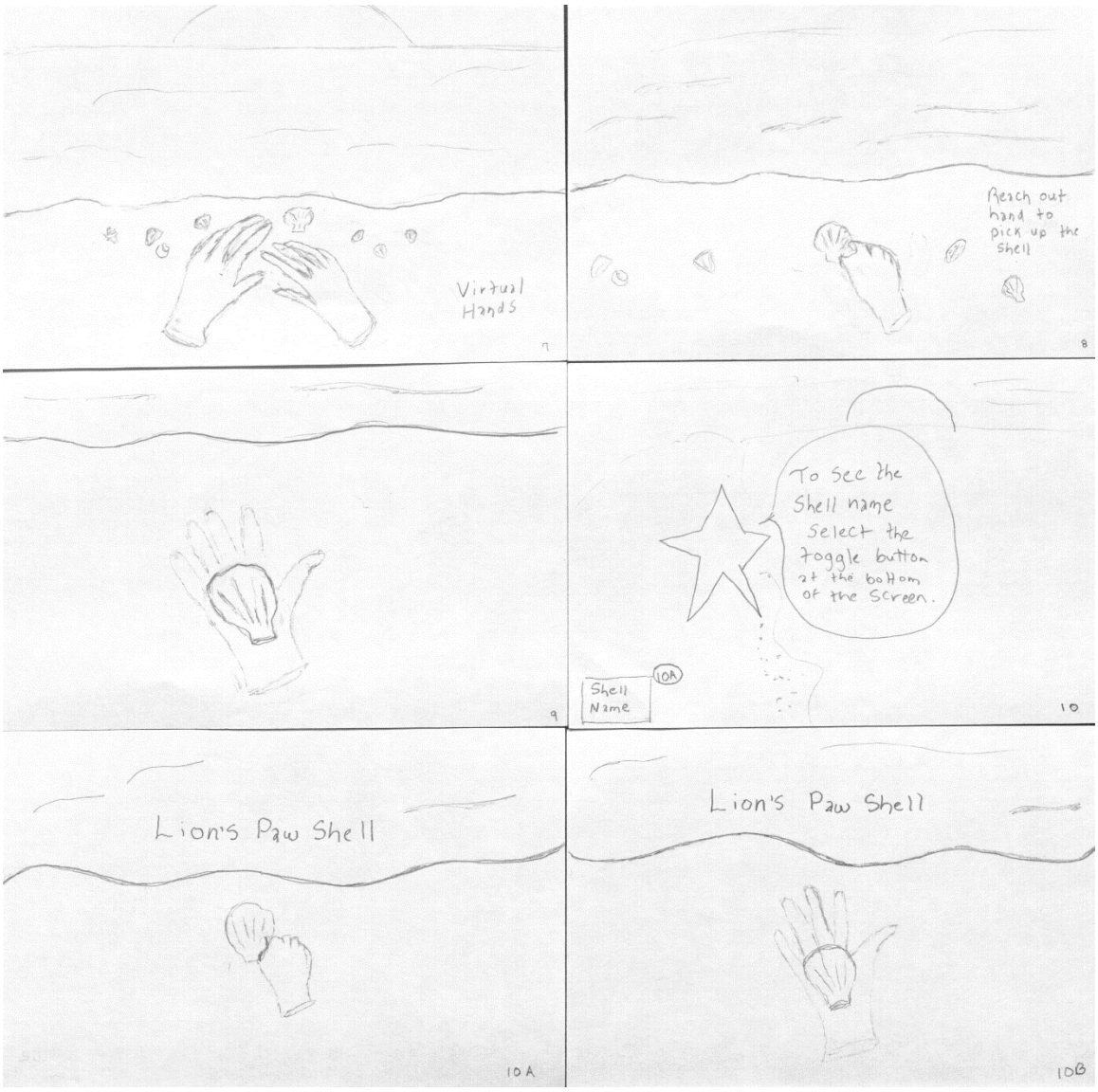


Figure C2. Storyboard Design 1, Page 2.

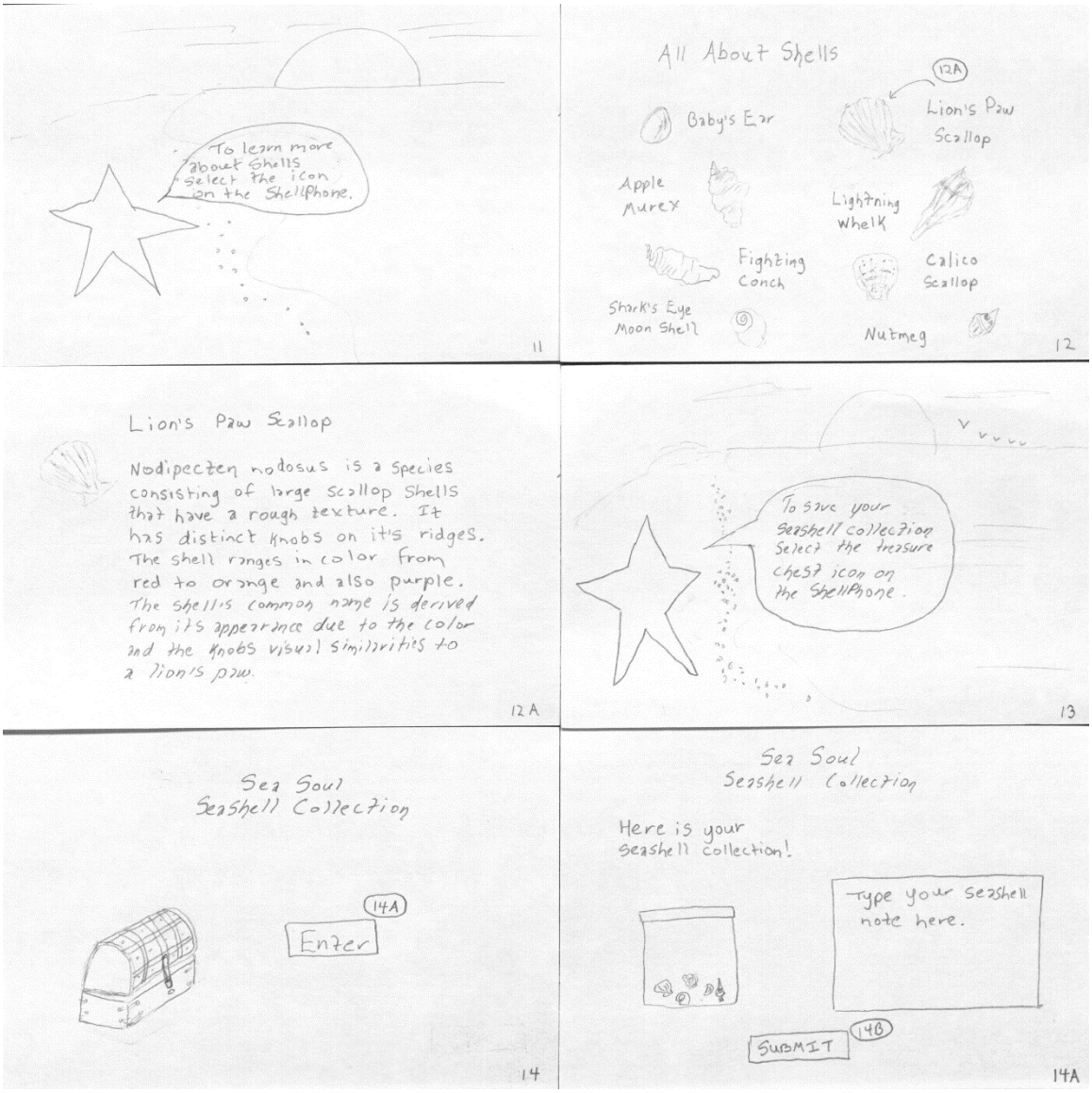


Figure C3. Storyboard Design 1, Page 3.

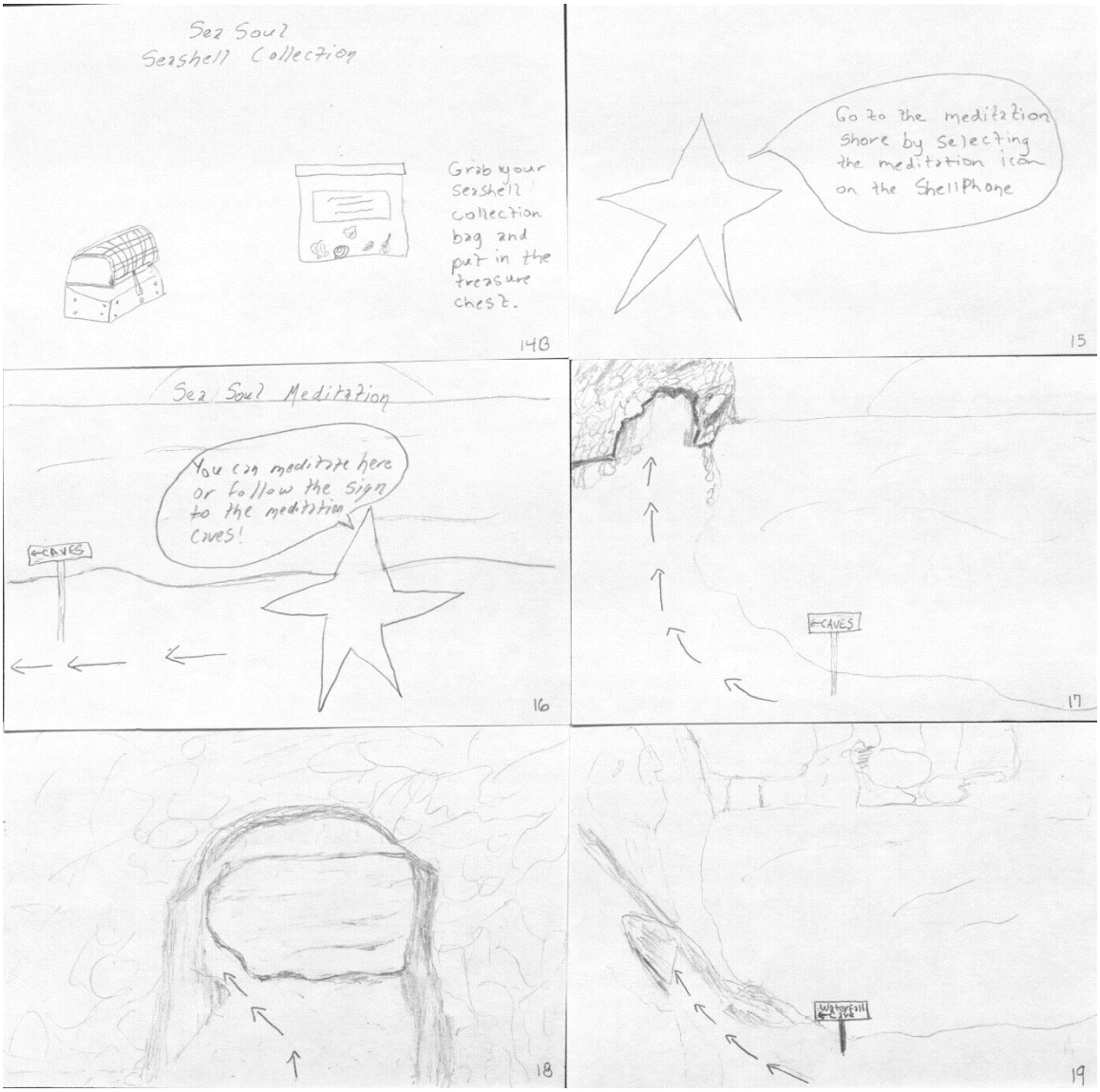


Figure C4. Storyboard Design 1, Page 4.

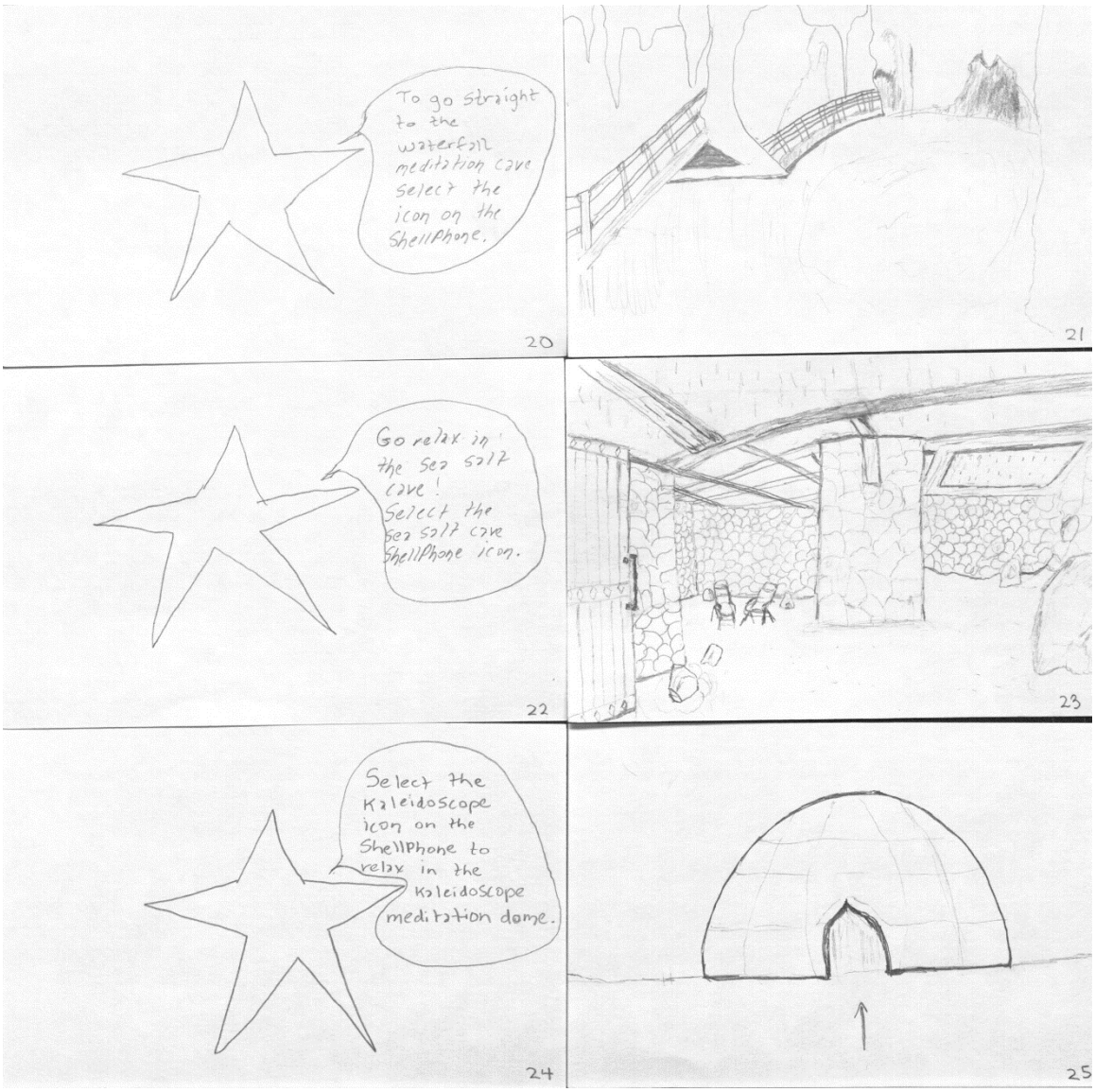


Figure C5. Storyboard Design 1, Page 5.

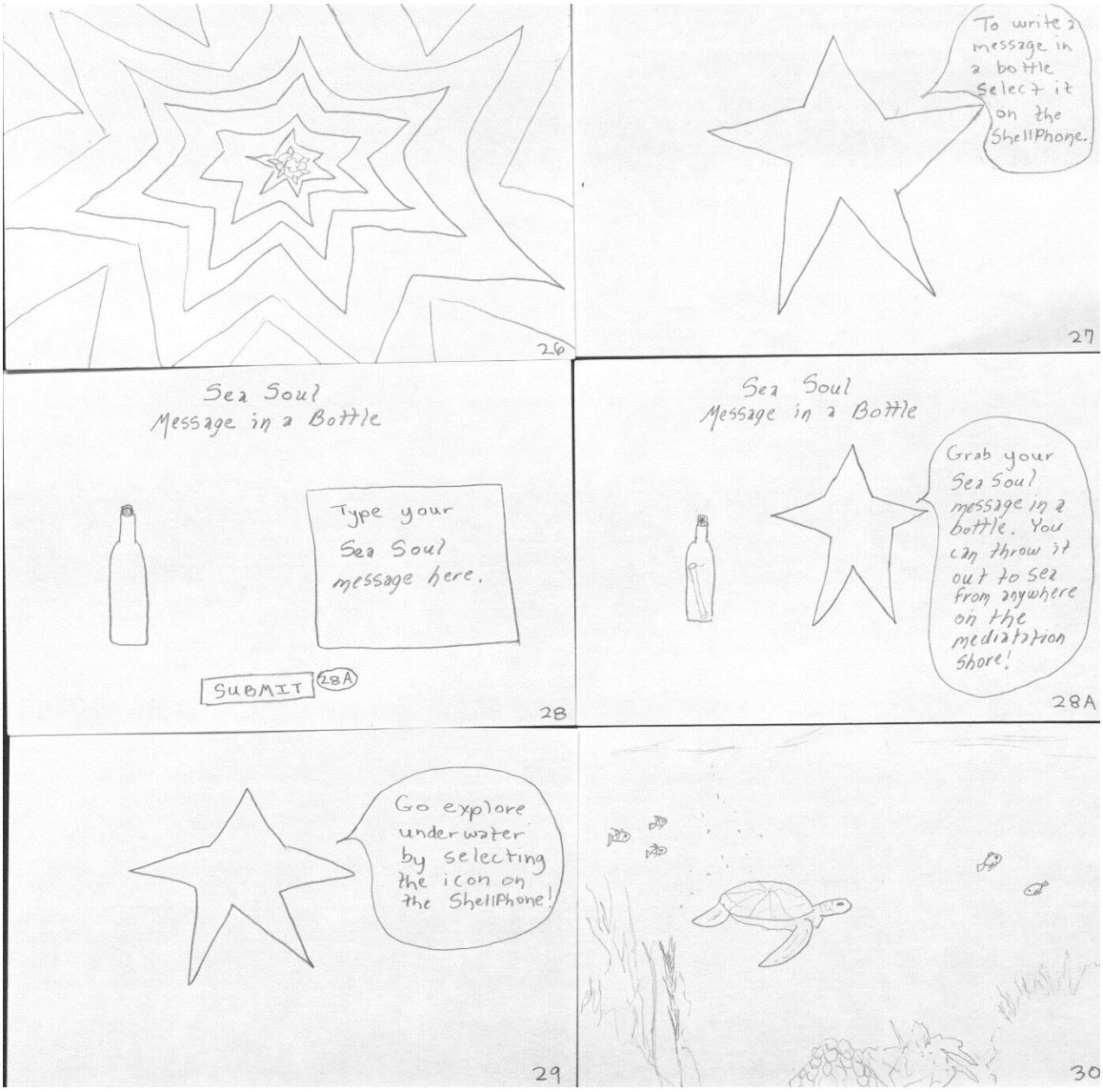


Figure C6. Storyboard Design 1, Page 6.

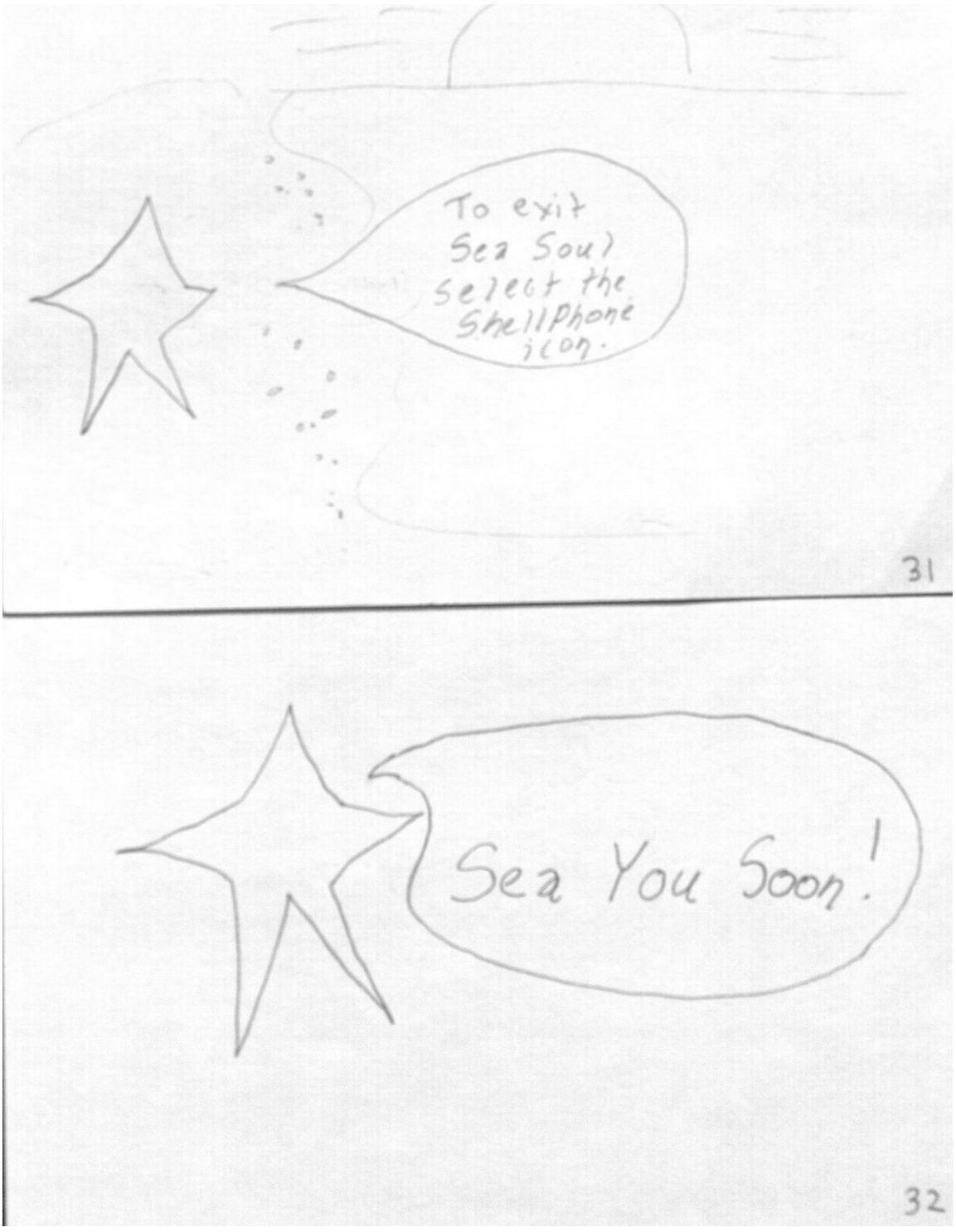


Figure C7. Storyboard Design 1, Page 7.

APPENDIX D: *Sea Soul* Gantt Chart

Sea Soul Gantt Chart

Sea Soul

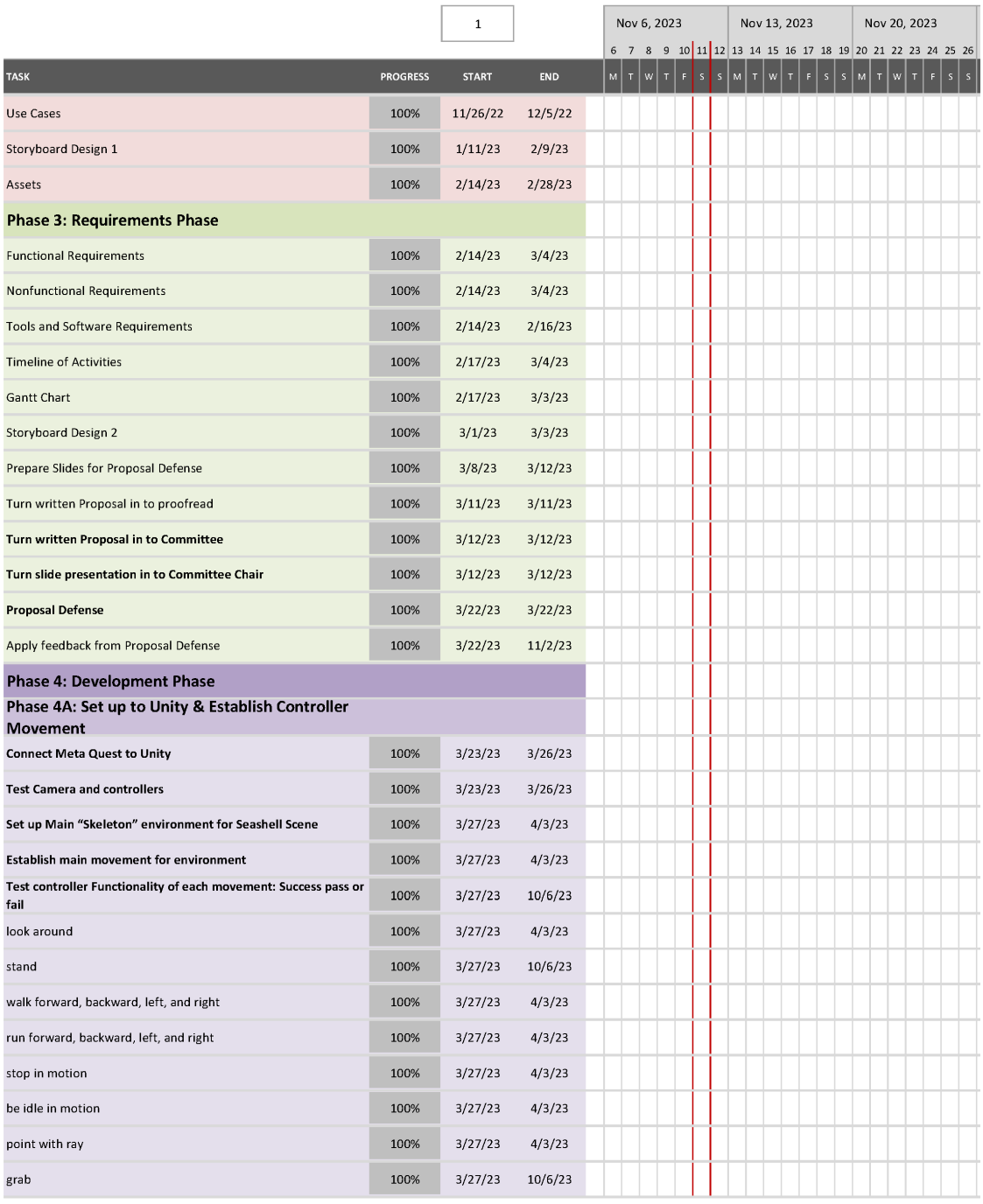
Proposed Deliverables
Sabrina Balcerak

SIMPLE GANTT CHART by Vertex42.com
https://www.vertex42.com/ExcelTemplates/simple-gantt-chart.html

Sat, 11/11/2023
1

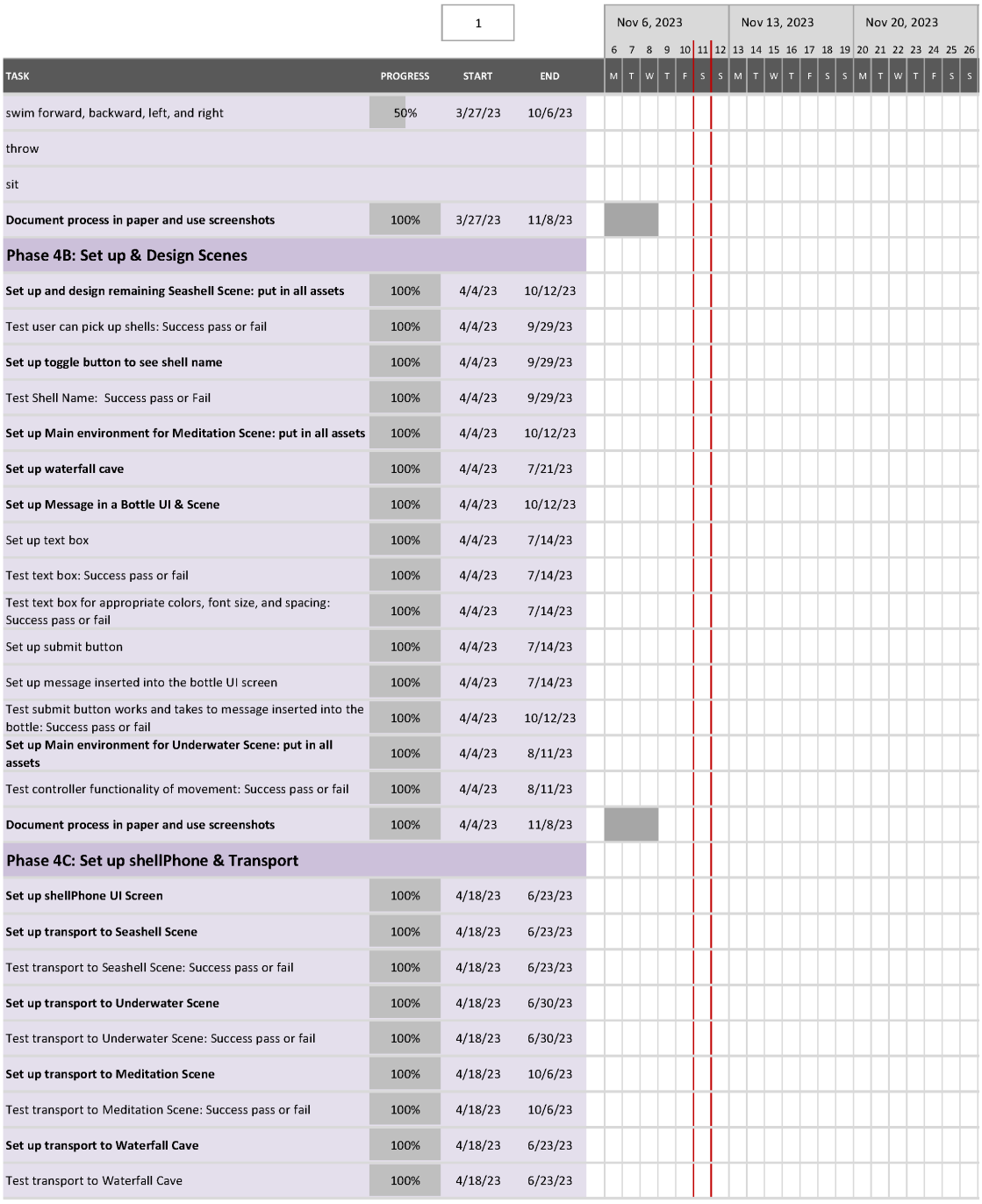
TASK	PROGRESS	START	END
Phase 1: Analysis Phase			
Establish ideas and goals for *Sea Soul*	100%	8/24/22	9/14/22
Review Literature and similar game applications for research rationale	100%	8/24/22	9/14/22
Write Outline of Research Paper	100%	8/24/22	9/14/22
Write Abstract (For Proposal)	100%	3/9/23	3/10/23
Ch. 1: Write Introduction (For Proposal)	100%	3/9/23	3/10/23
Ch. 2: Write Review of Literature (Consists of items below)			
What is VR	100%	9/15/22	9/29/22
General Benefits of VR	100%	9/30/22	10/6/22
Health Benefits	100%	10/7/22	10/13/22
Physical Health Benefits	100%	2/10/23	2/13/23
Mental Health Benefits	100%	3/4/23	3/5/23
Educational Benefits	100%	3/4/23	3/5/23
Health Challenges of VR	100%	3/4/23	3/5/23
Physical Health Challenges	100%	3/4/23	3/5/23
Mental Health Challenges	100%	3/4/23	3/5/23
Educational Challenges	100%	3/4/23	3/5/23
Relevant VR Applications: (Consists of items below)			
Seniors Travel Using Virtual Reality	100%	3/6/23	3/8/23
Seas the Day	100%	3/6/23	3/8/23
Maloka	100%	3/6/23	3/8/23
Educational VR game	100%	3/6/23	3/8/23
Do Table pro and con	100%	3/6/23	3/8/23
Proposed VR Application Idea & Goal	100%	3/6/23	3/8/23
Phase 2: Design Phase			
Ch. 3: Write Methodology			
Personas	100%	10/14/22	11/4/22
Scenarios	100%	11/5/22	11/25/22

Figure D1. *Sea Soul* Gantt Chart, Page 1.



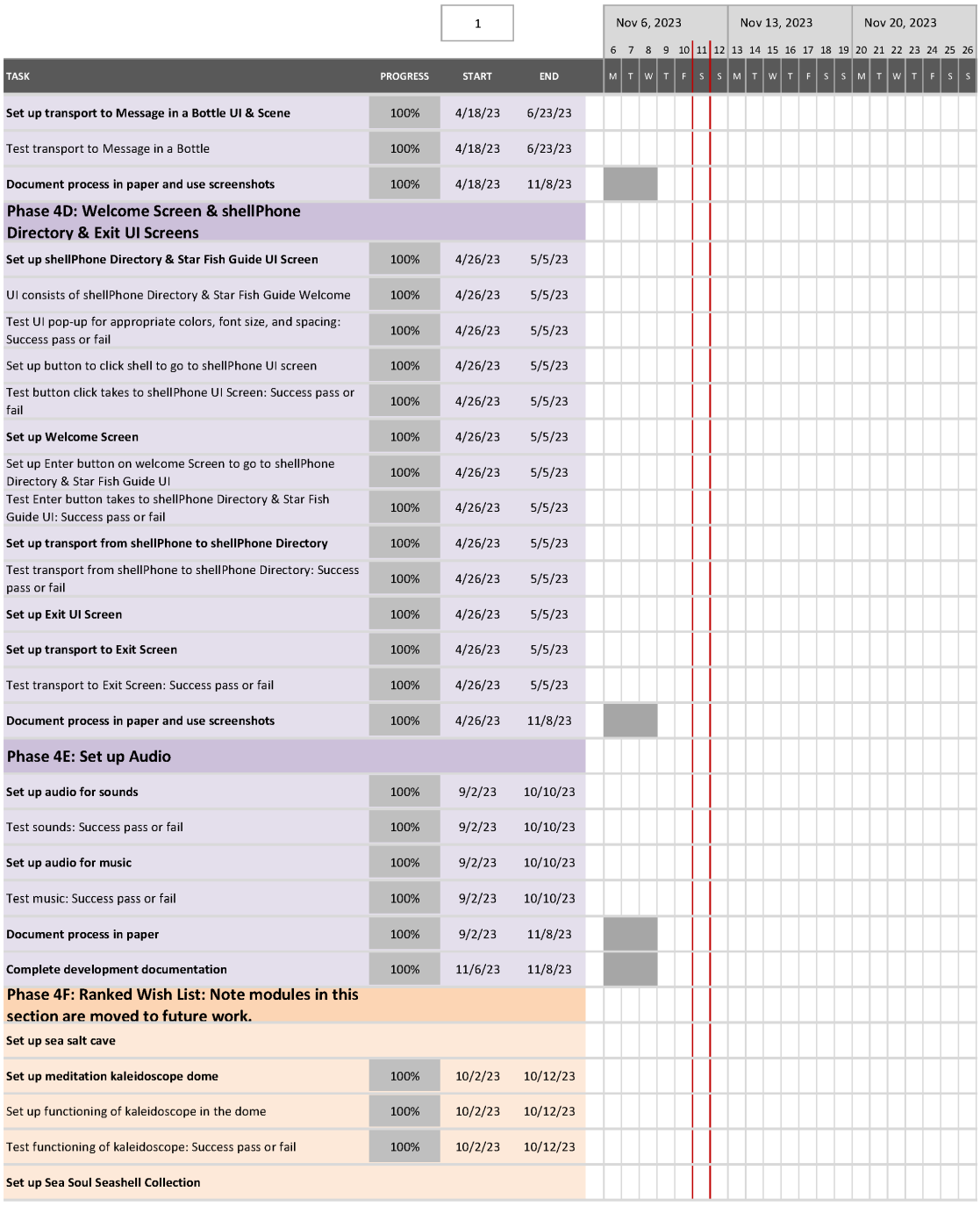
TASK	PROGRESS	START	END
Use Cases	100%	11/26/22	12/5/22
Storyboard Design 1	100%	1/11/23	2/9/23
Assets	100%	2/14/23	2/28/23
Phase 3: Requirements Phase			
Functional Requirements	100%	2/14/23	3/4/23
Nonfunctional Requirements	100%	2/14/23	3/4/23
Tools and Software Requirements	100%	2/14/23	2/16/23
Timeline of Activities	100%	2/17/23	3/4/23
Gantt Chart	100%	2/17/23	3/3/23
Storyboard Design 2	100%	3/1/23	3/3/23
Prepare Slides for Proposal Defense	100%	3/8/23	3/12/23
Turn written Proposal in to proofread	100%	3/11/23	3/11/23
Turn written Proposal in to Committee	100%	3/12/23	3/12/23
Turn slide presentation in to Committee Chair	100%	3/12/23	3/12/23
Proposal Defense	100%	3/22/23	3/22/23
Apply feedback from Proposal Defense	100%	3/22/23	11/2/23
Phase 4: Development Phase			
Phase 4A: Set up to Unity & Establish Controller Movement			
Connect Meta Quest to Unity	100%	3/23/23	3/26/23
Test Camera and controllers	100%	3/23/23	3/26/23
Set up Main "Skeleton" environment for Seashell Scene	100%	3/27/23	4/3/23
Establish main movement for environment	100%	3/27/23	4/3/23
Test controller Functionality of each movement: Success pass or fail	100%	3/27/23	10/6/23
look around	100%	3/27/23	4/3/23
stand	100%	3/27/23	10/6/23
walk forward, backward, left, and right	100%	3/27/23	4/3/23
run forward, backward, left, and right	100%	3/27/23	4/3/23
stop in motion	100%	3/27/23	4/3/23
be idle in motion	100%	3/27/23	4/3/23
point with ray	100%	3/27/23	4/3/23
grab	100%	3/27/23	10/6/23

Figure D2. *Sea Soul* Gantt Chart, Page 2.



TASK	PROGRESS	START	END
swim forward, backward, left, and right	50%	3/27/23	10/6/23
throw			
sit			
Document process in paper and use screenshots	100%	3/27/23	11/8/23
Phase 4B: Set up & Design Scenes			
Set up and design remaining Seashell Scene: put in all assets	100%	4/4/23	10/12/23
Test user can pick up shells: Success pass or fail	100%	4/4/23	9/29/23
Set up toggle button to see shell name	100%	4/4/23	9/29/23
Test Shell Name: Success pass or Fail	100%	4/4/23	9/29/23
Set up Main environment for Meditation Scene: put in all assets	100%	4/4/23	10/12/23
Set up waterfall cave	100%	4/4/23	7/21/23
Set up Message in a Bottle UI & Scene	100%	4/4/23	10/12/23
Set up text box	100%	4/4/23	7/14/23
Test text box: Success pass or fail	100%	4/4/23	7/14/23
Test text box for appropriate colors, font size, and spacing: Success pass or fail	100%	4/4/23	7/14/23
Set up submit button	100%	4/4/23	7/14/23
Set up message inserted into the bottle UI screen	100%	4/4/23	7/14/23
Test submit button works and takes to message inserted into the bottle: Success pass or fail	100%	4/4/23	10/12/23
Set up Main environment for Underwater Scene: put in all assets	100%	4/4/23	8/11/23
Test controller functionality of movement: Success pass or fail	100%	4/4/23	8/11/23
Document process in paper and use screenshots	100%	4/4/23	11/8/23
Phase 4C: Set up shellPhone & Transport			
Set up shellPhone UI Screen	100%	4/18/23	6/23/23
Set up transport to Seashell Scene	100%	4/18/23	6/23/23
Test transport to Seashell Scene: Success pass or fail	100%	4/18/23	6/23/23
Set up transport to Underwater Scene	100%	4/18/23	6/30/23
Test transport to Underwater Scene: Success pass or fail	100%	4/18/23	6/30/23
Set up transport to Meditation Scene	100%	4/18/23	10/6/23
Test transport to Meditation Scene: Success pass or fail	100%	4/18/23	10/6/23
Set up transport to Waterfall Cave	100%	4/18/23	6/23/23
Test transport to Waterfall Cave	100%	4/18/23	6/23/23

Figure D3. *Sea Soul* Gantt Chart, Page 3.



TASK	PROGRESS	START	END
Set up transport to Message in a Bottle UI & Scene	100%	4/18/23	6/23/23
Test transport to Message in a Bottle	100%	4/18/23	6/23/23
Document process in paper and use screenshots	100%	4/18/23	11/8/23
Phase 4D: Welcome Screen & shellPhone Directory & Exit UI Screens			
Set up shellPhone Directory & Star Fish Guide UI Screen	100%	4/26/23	5/5/23
UI consists of shellPhone Directory & Star Fish Guide Welcome	100%	4/26/23	5/5/23
Test UI pop-up for appropriate colors, font size, and spacing: Success pass or fail	100%	4/26/23	5/5/23
Set up button to click shell to go to shellPhone UI screen	100%	4/26/23	5/5/23
Test button click takes to shellPhone UI Screen: Success pass or fail	100%	4/26/23	5/5/23
Set up Welcome Screen	100%	4/26/23	5/5/23
Set up Enter button on welcome Screen to go to shellPhone Directory & Star Fish Guide UI	100%	4/26/23	5/5/23
Test Enter button takes to shellPhone Directory & Star Fish Guide UI: Success pass or fail	100%	4/26/23	5/5/23
Set up transport from shellPhone to shellPhone Directory	100%	4/26/23	5/5/23
Test transport from shellPhone to shellPhone Directory: Success pass or fail	100%	4/26/23	5/5/23
Set up Exit UI Screen	100%	4/26/23	5/5/23
Set up transport to Exit Screen	100%	4/26/23	5/5/23
Test transport to Exit Screen: Success pass or fail	100%	4/26/23	5/5/23
Document process in paper and use screenshots	100%	4/26/23	11/8/23
Phase 4E: Set up Audio			
Set up audio for sounds	100%	9/2/23	10/10/23
Test sounds: Success pass or fail	100%	9/2/23	10/10/23
Set up audio for music	100%	9/2/23	10/10/23
Test music: Success pass or fail	100%	9/2/23	10/10/23
Document process in paper	100%	9/2/23	11/8/23
Complete development documentation	100%	11/6/23	11/8/23
Phase 4F: Ranked Wish List: Note modules in this section are moved to future work.			
Set up sea salt cave			
Set up meditation kaleidoscope dome	100%	10/2/23	10/12/23
Set up functioning of kaleidoscope in the dome	100%	10/2/23	10/12/23
Test functioning of kaleidoscope: Success pass or fail	100%	10/2/23	10/12/23
Set up Sea Soul Seashell Collection			

Page 4 of 6

Figure D4. *Sea Soul* Gantt Chart, Page 4.

TASK	PROGRESS	START	END
Test Enter button to go to text screen: Success pass or fail			
Set up text screen for collection message			
Test text works: Success pass or fail			
Test UI pop-up for appropriate colors, font size, and spacing: Success pass or fail			
Set up submit button			
Test submit works and takes to treasure chest			
Set up Treasure chest and seashell bag assets			
Set up user to be able to grab bag and put in treasure chest			
Test can put bag in treasure chest: Success pass or fail			
Set up transport to Sea Soul Seashell collection			
Test transport to Sea Soul Seashell Collection: Success pass or fail			
Set up All About Shells			
Test Can click on shell and description pops up: Success pass or fail			
Test UI pop-up for appropriate colors, font size, and spacing: Success pass or fail			
Set up transport to All About Shells			
Test transport to All About Shells: Success pass or fail			
Set up VR tutorial UI screen	100%	10/18/23	10/18/23
Test Video works	100%	10/18/23	10/18/23
Set up transport from shellPhone to VR tutorial UI screen	100%	10/18/23	10/18/23
Test transport to tutorial UI screen: Success pass or fail	100%	10/18/23	10/18/23
Star Fish Guide Extra Pop Up's in Game:			
Star Fish Guide pop-up UI to explain toggle button, about shells icon on phone, and treasure chest icon on phone			
Test Star Fish Guide pop-up: Success pass or fail			
Test UI pop-up for appropriate colors, font size, and spacing: Success pass or fail			
Set up Star Fish Guide pop-up UI to explain mediate here, go to the caves, or select shellPhone icon			
Test Star Fish Guide pop-up: Success pass or fail			
Test UI pop-up for appropriate colors, font size, and spacing: Success pass or fail			
Phase 5: Testing & Evaluation Phase			
In depth Final testing of all functionalities of scenes and UIs: Success Pass or Fail	100%	5/17/23	10/24/23
In depth testing of audio sounds: Success Pass or Fail	100%	9/2/23	10/15/23
Document process in paper and use screenshots	100%	5/17/23	11/4/23

Figure D5. *Sea Soul* Gantt Chart, Page 5.

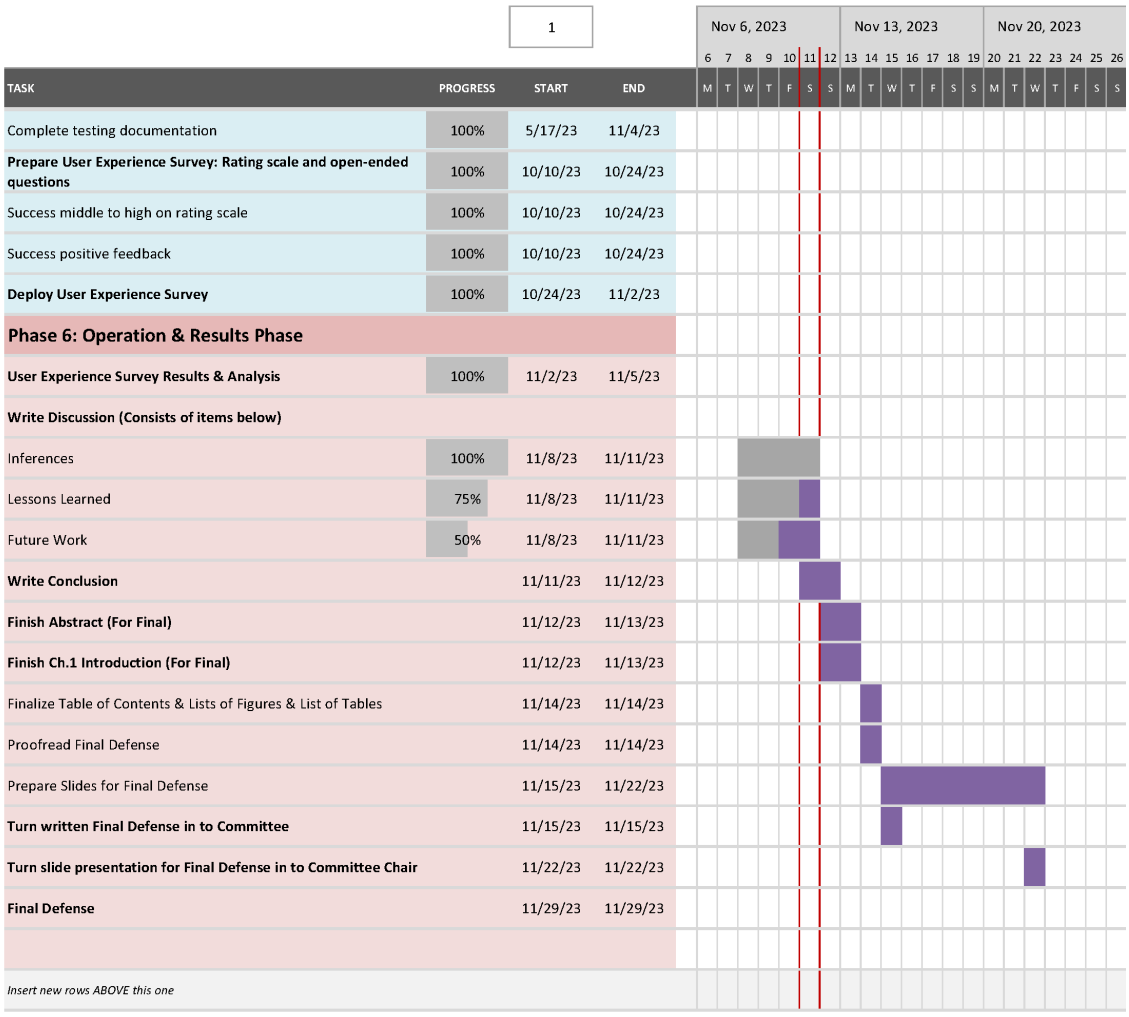


Figure D6. *Sea Soul* Gantt Chart, Page 6.

APPENDIX E: *Sea Soul* – Storyboard Design 2

Sea Soul – Storyboard Design 2

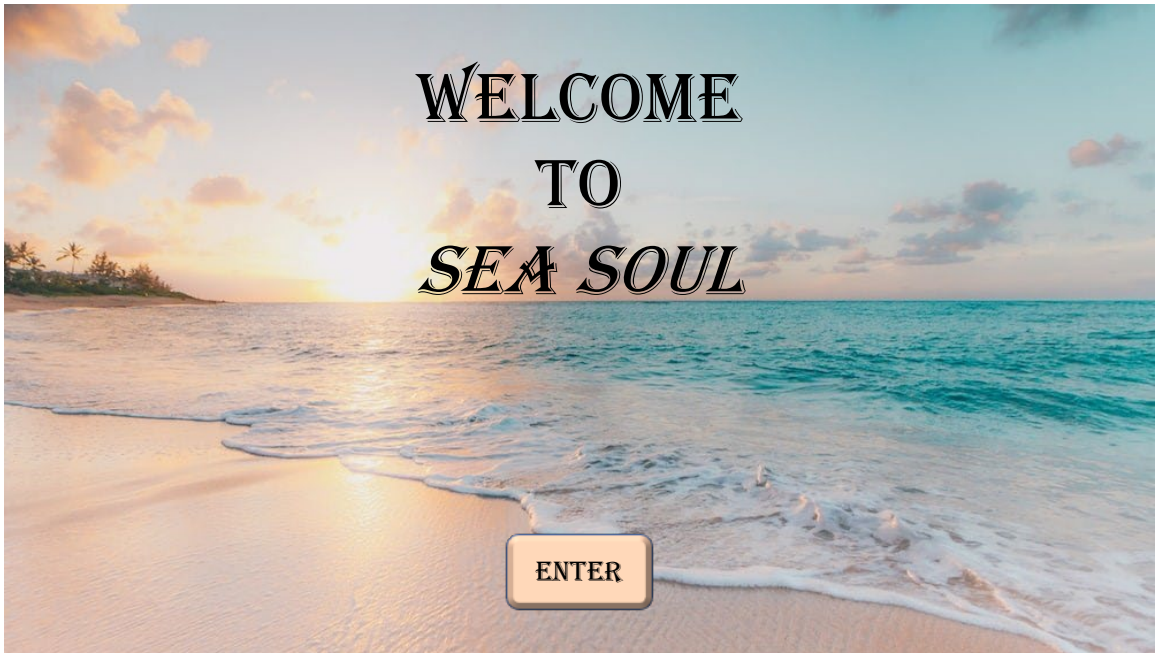


Figure E1. Storyboard Design 2, Page 1.

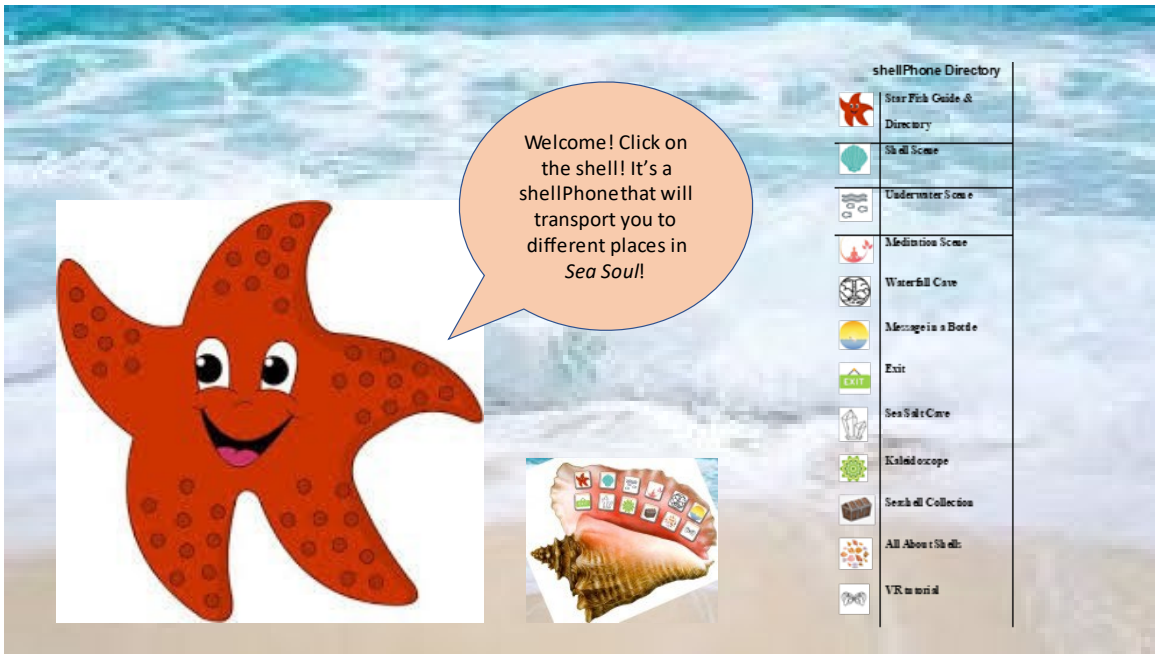


Figure E2. Storyboard Design 2, Page 2.

Figure E3. Storyboard Design 2, Page 3.

Figure E4. Storyboard Design 2, Page 4.

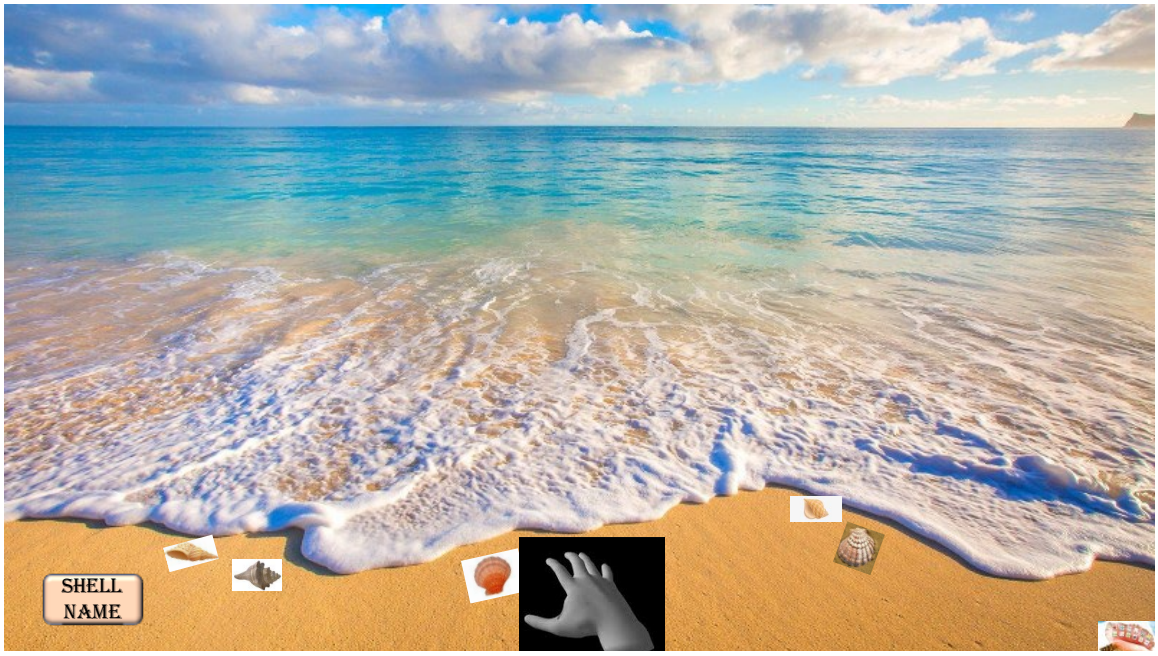


Figure E5. Storyboard Design 2, Page 5.

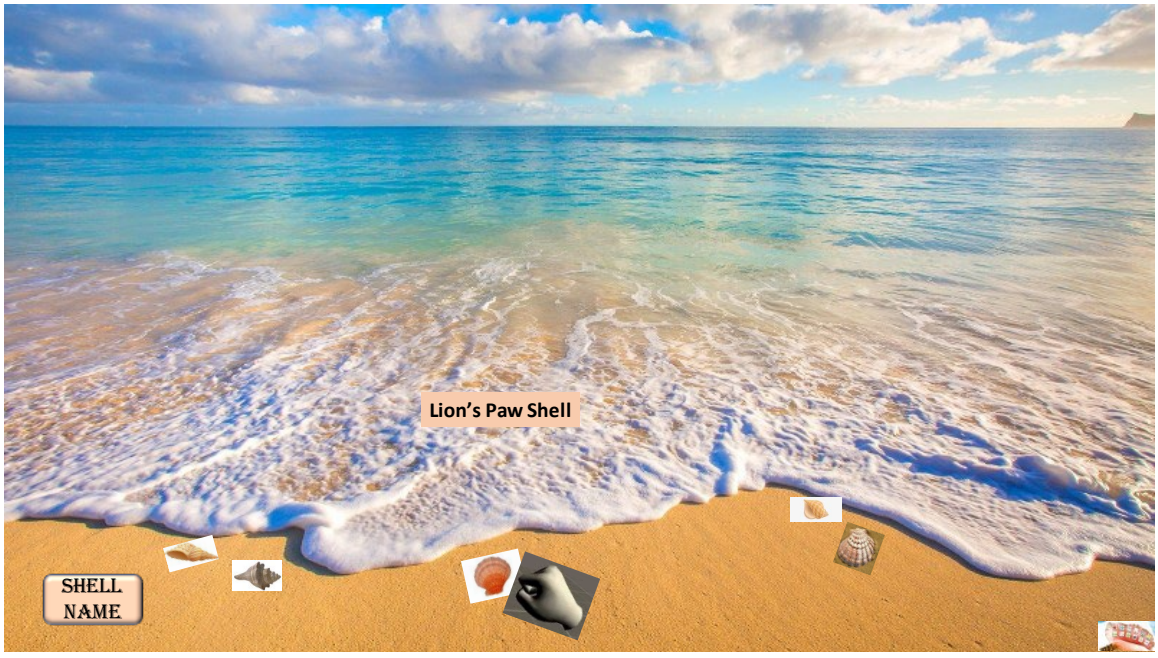


Figure E6. Storyboard Design 2, Page 6.

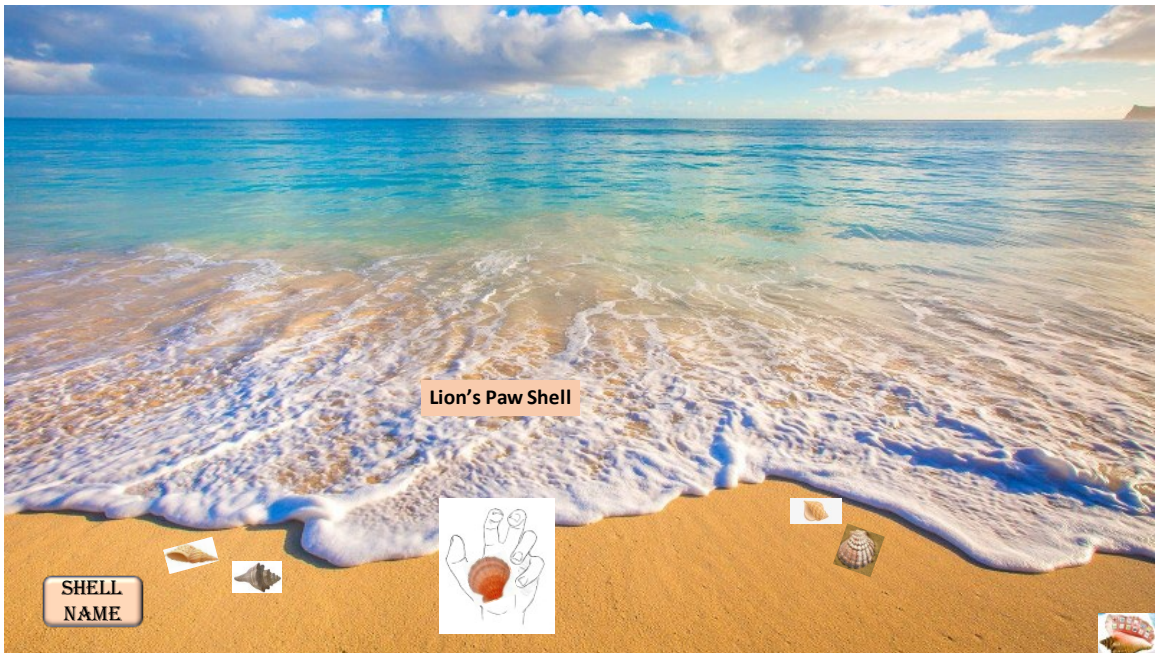


Figure E7. Storyboard Design 2, Page 7.

Figure E8. Storyboard Design 2, Page 8.

Figure E9. Storyboard Design 2, Page 9.

Figure E10. Storyboard Design 2, Page 10.

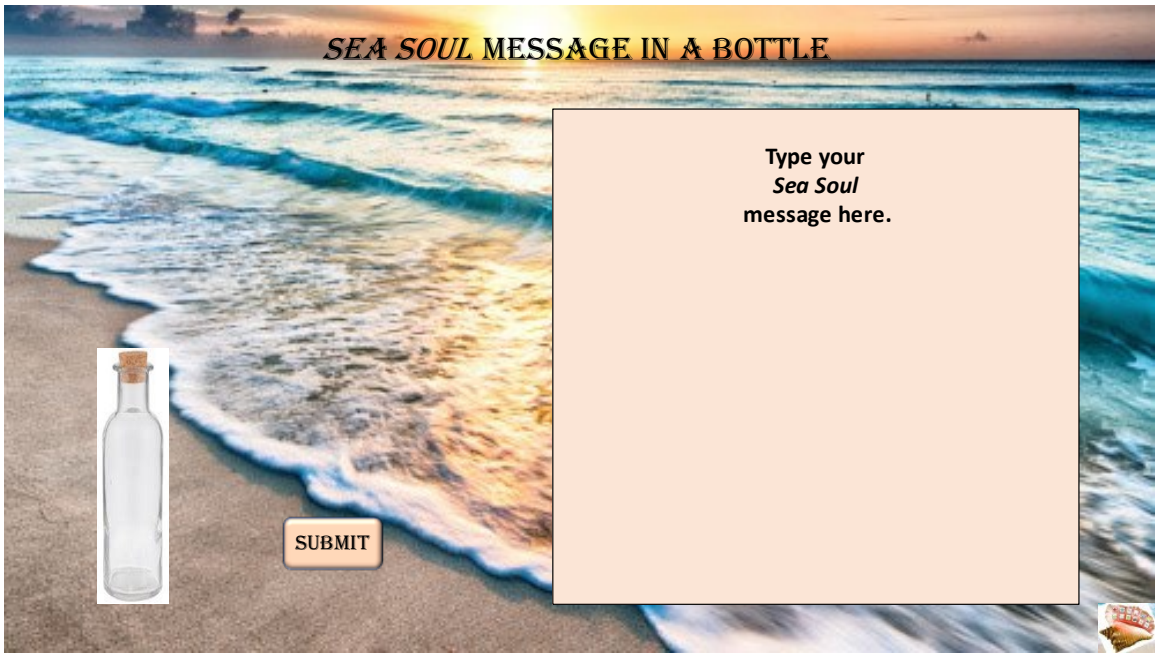


Figure E11. Storyboard Design 2, Page 11.

Figure E12. Storyboard Design 2, Page 12.

.
Figure E13. Storyboard Design 2, Page 13.

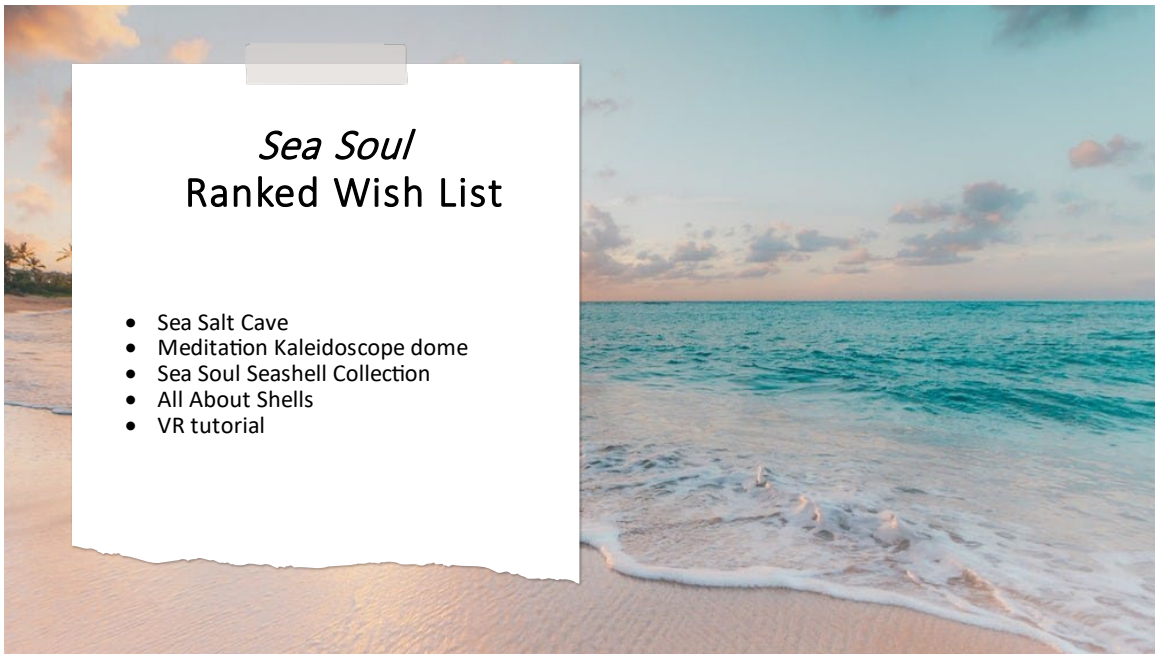


Figure E14. Storyboard Design 2, Page 14.

Figure E15. Storyboard Design 2, Page 15.

Figure E16. Storyboard Design 2, Page 16.

Figure E17. Storyboard Design 2, Page 17.

Figure E18. Storyboard Design 2, Page 18.

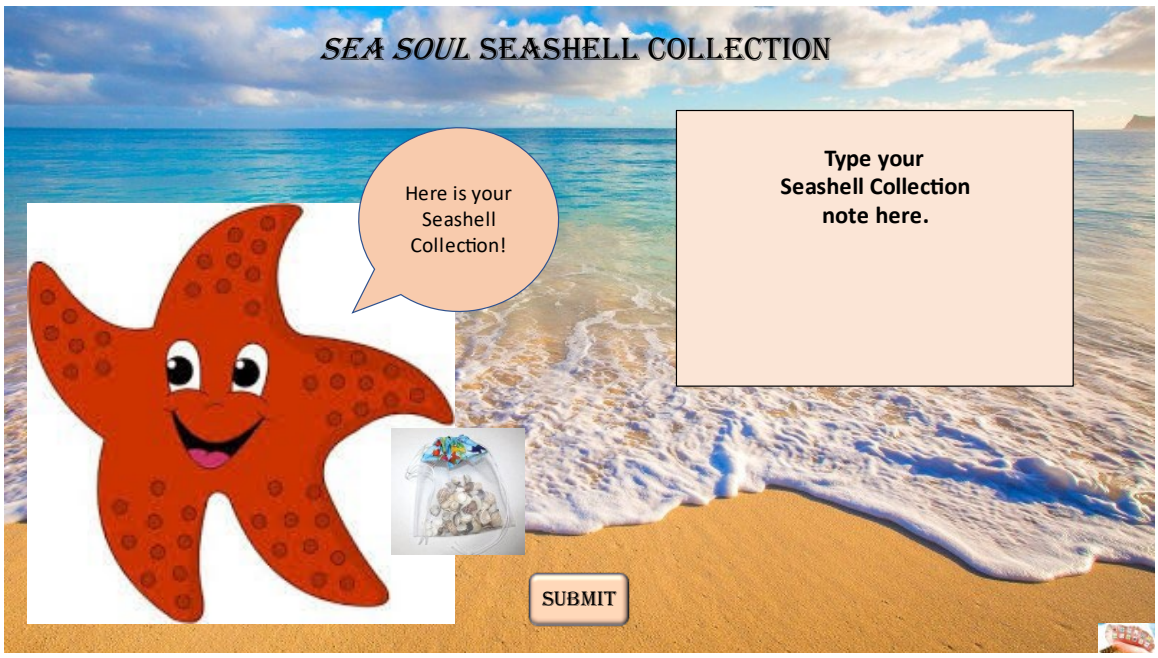


Figure E19. Storyboard Design 2, Page 19.

Figure E20. Storyboard Design 2, Page 20.

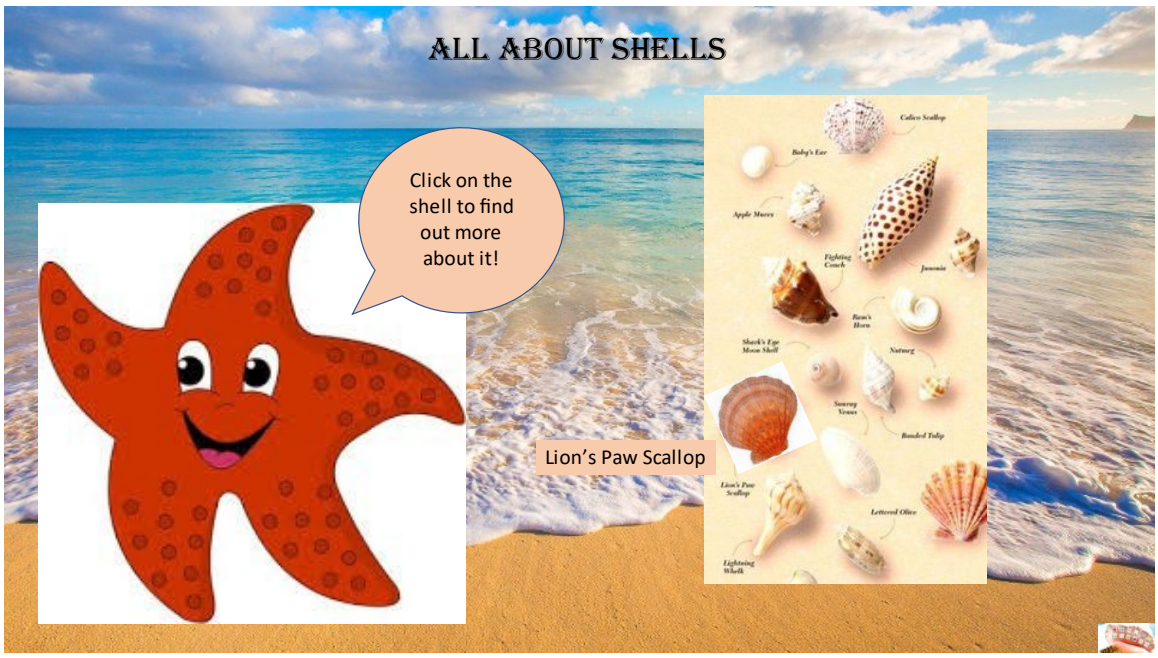


Figure E21. Storyboard Design 2, Page 21.

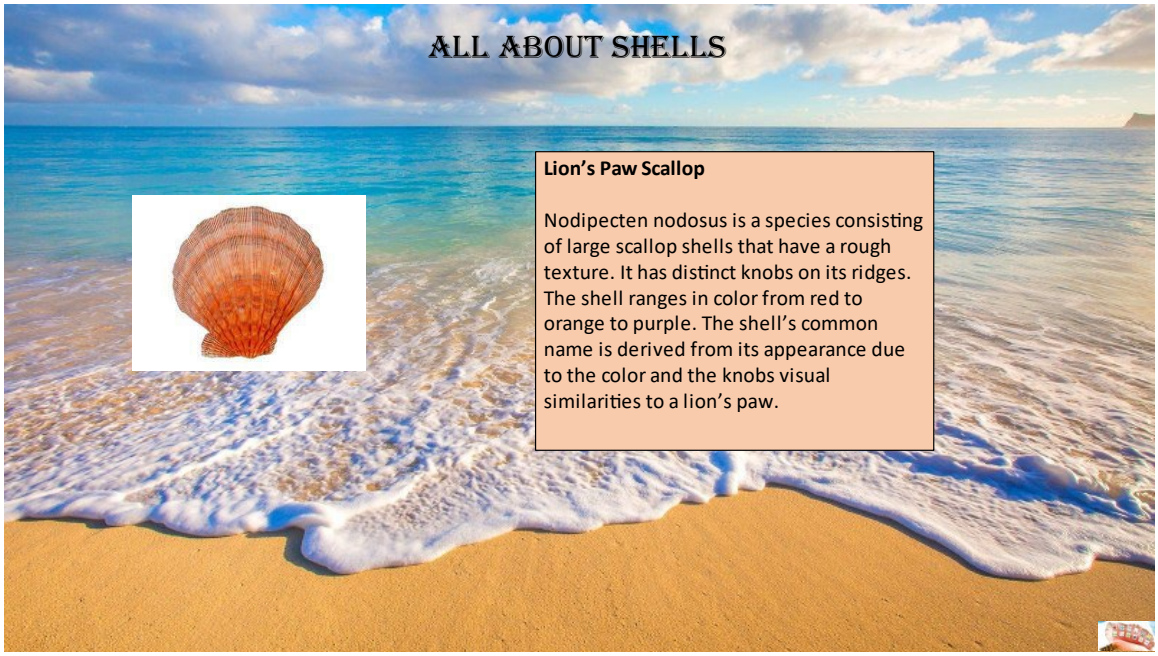


Figure E22. Storyboard Design 2, Page 22.

Figure E23. Storyboard Design 2, Page 23.

APPENDIX F: *Sea Soul* Gameplay Screenshots

Figure F1. Welcome Screen UI.

Figure F2. shellPhone Directory UI.

Figure F3. shellPhone UI.

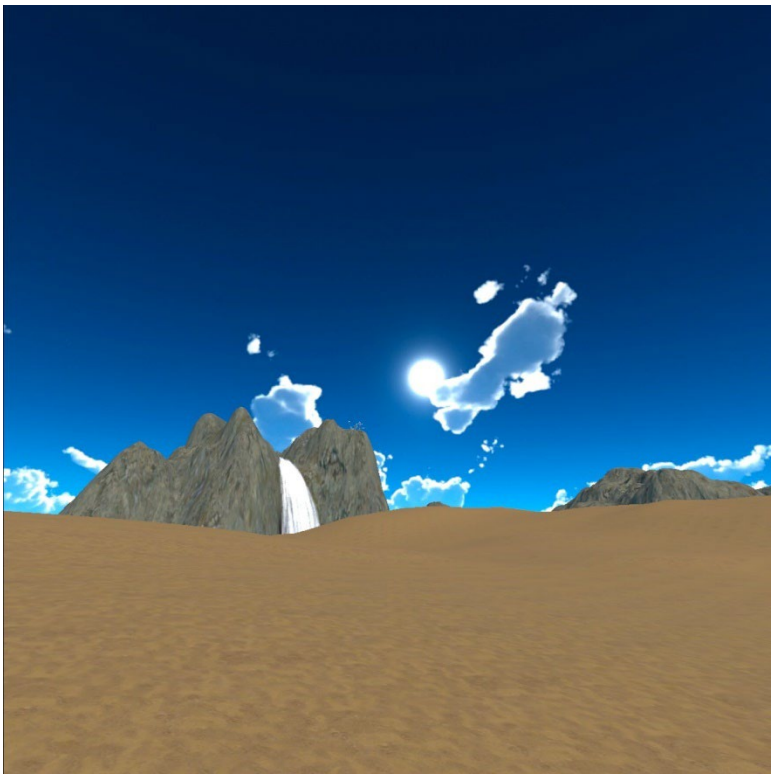


Figure F4. Seashell Scene view toward the waterfall.

Figure F5. Seashell Scene view toward seashell area.

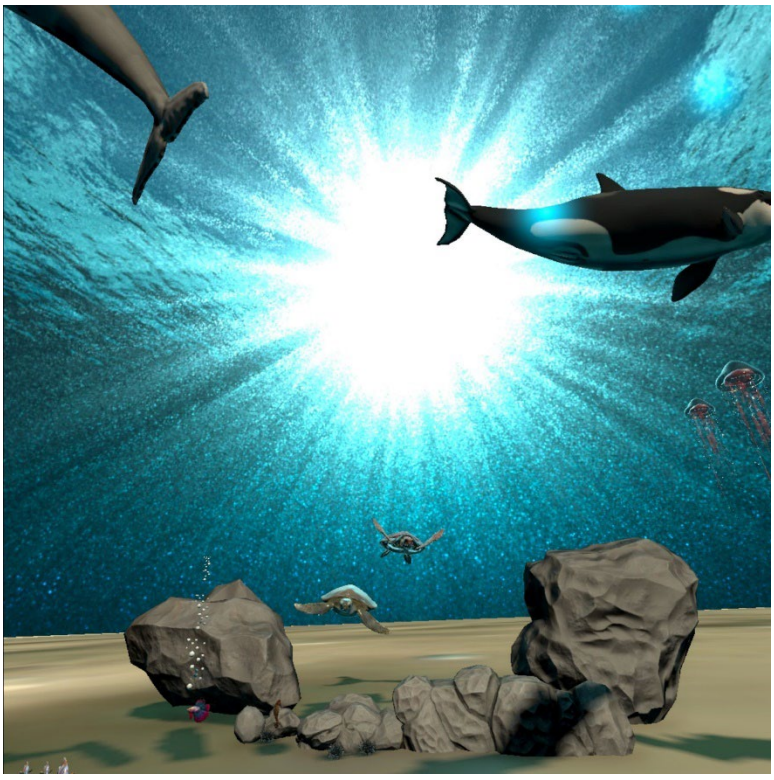


Figure F6. Underwater Scene view toward Sea Turtles.

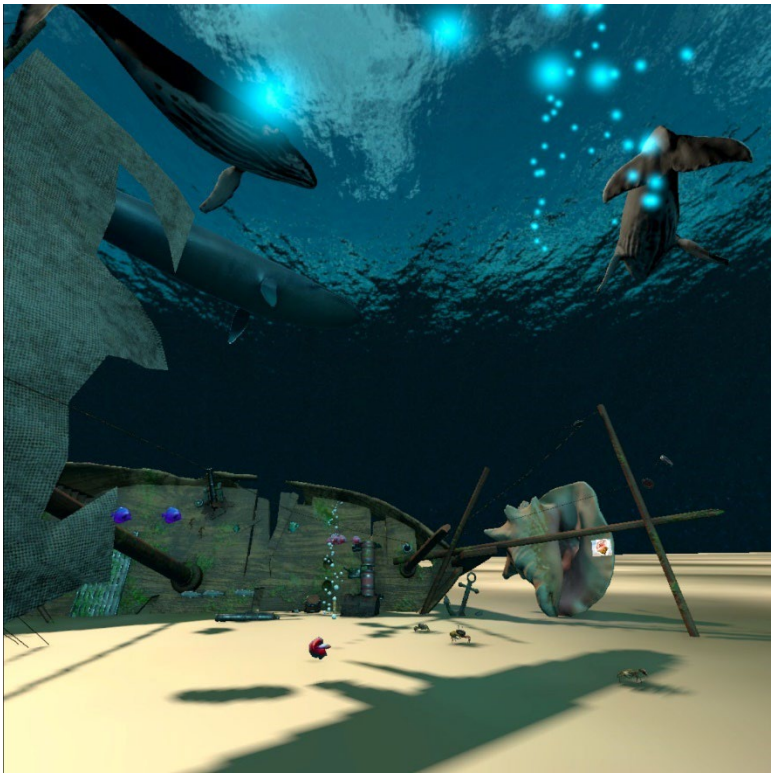


Figure F7. Underwater Scene view toward Shipwreck.

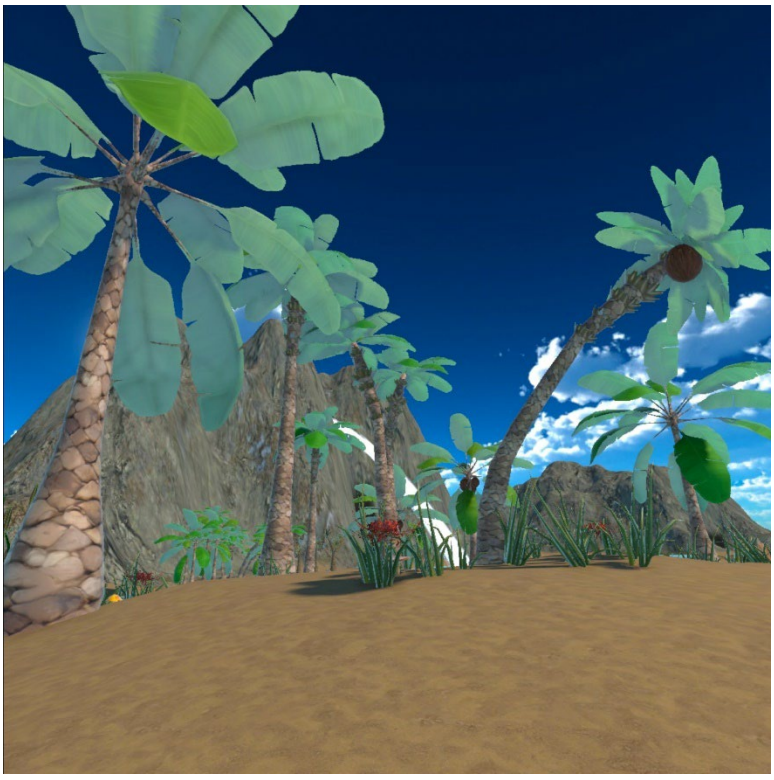


Figure F8. Meditation Scene.

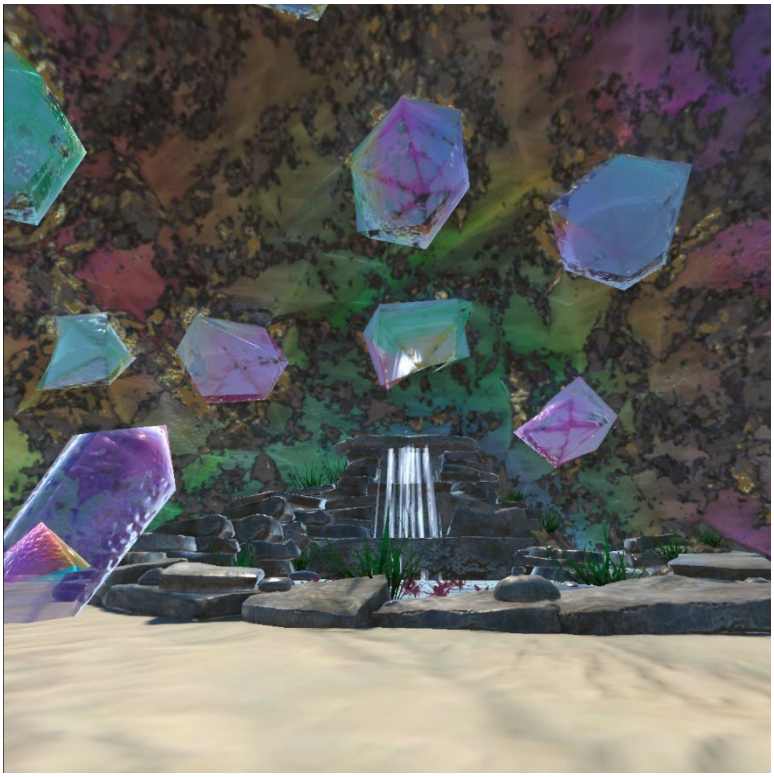


Figure F9. Waterfall Cave Scene.

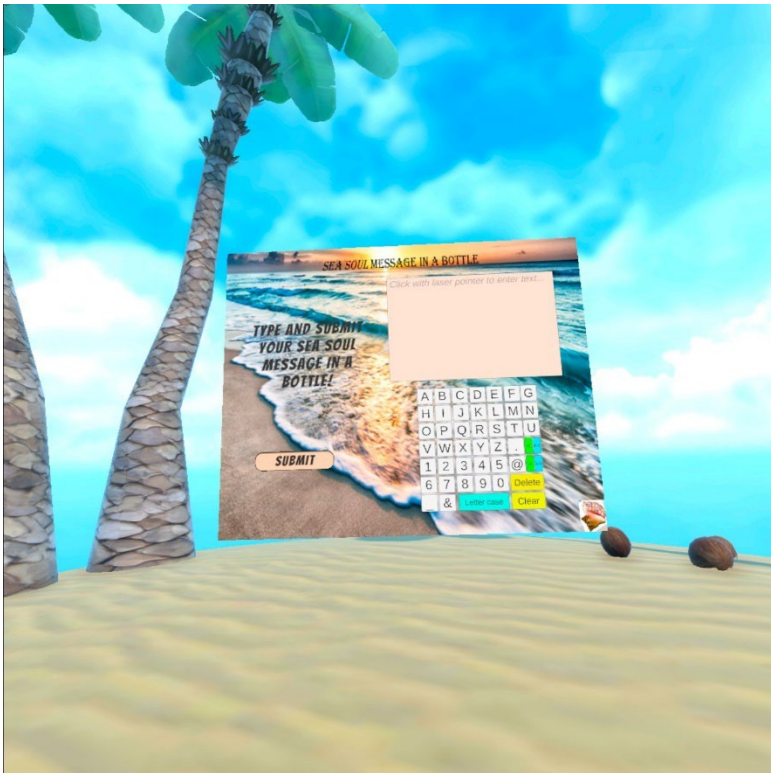


Figure F10. Message in a Bottle UI screen for typing the message.

Figure F11. Message in a Bottle Scene view after user submits message.

Figure F12. shellPhone in Message in a Bottle Scene.

Figure F13. Kaleidoscope Dome Scene.

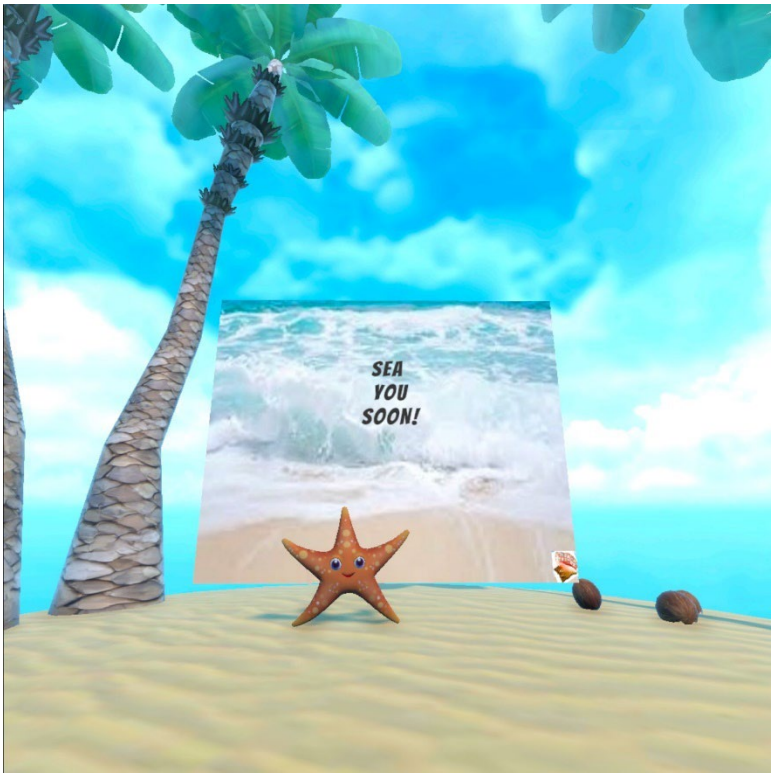


Figure F14. Exit UI.

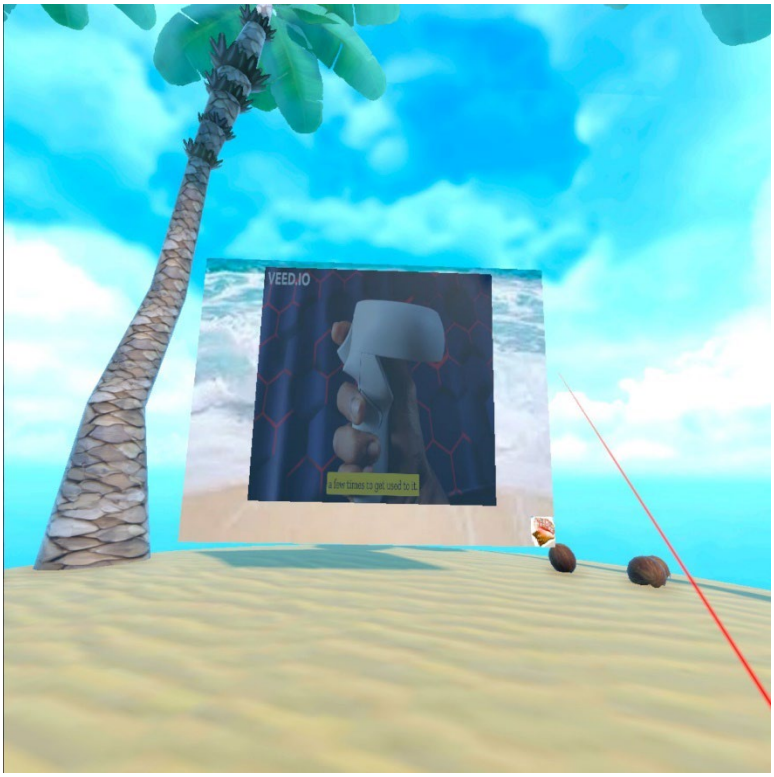


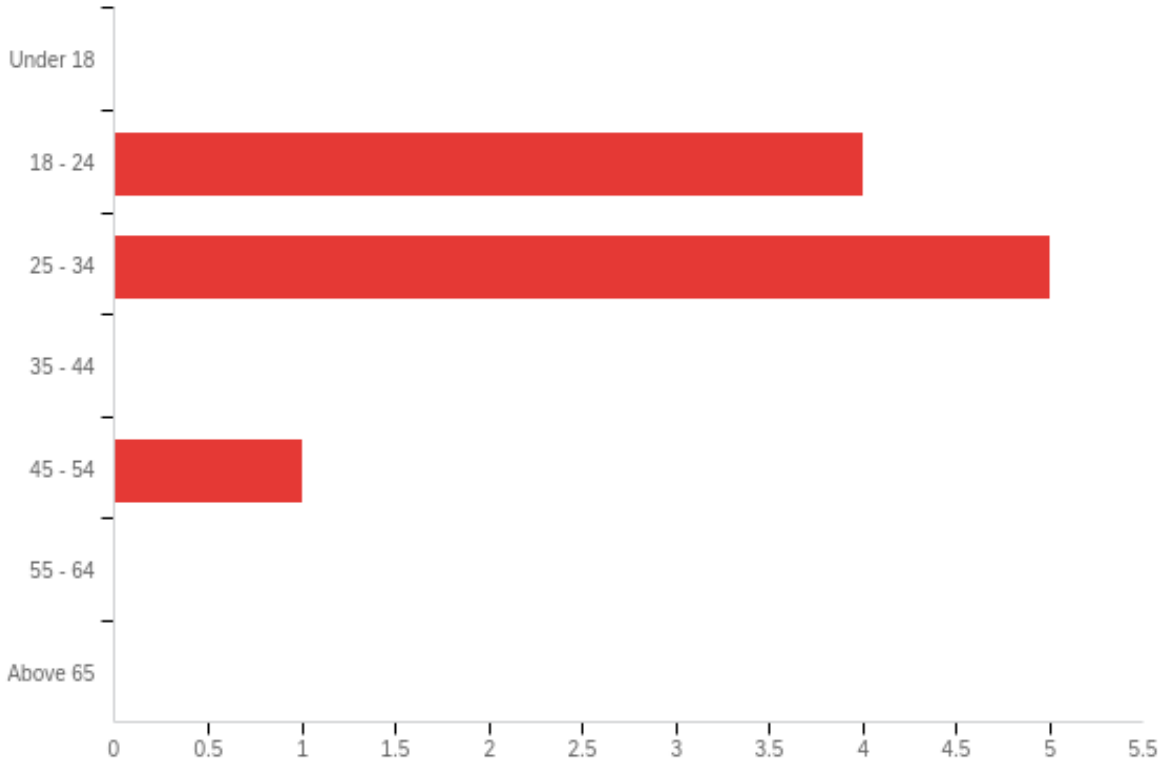
Figure F15. Tutorial UI.

Sea Soul User Survey Report

Sea Soul User Survey

November 5, 2023, 7:47 pm EST

Q1 - Please select your age group.



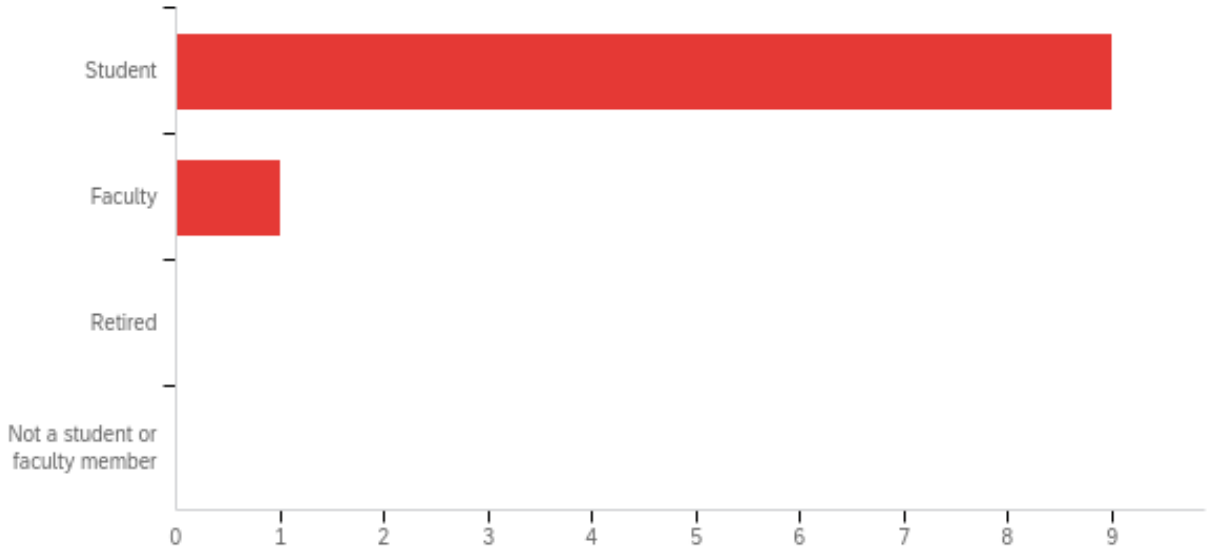
#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Please select your age group.	2.00	5.00	2.80	0.87	0.76	10

#	Answer	%	Count
1	Under 18	0.00%	0
2	18 - 24	40.00%	4
3	25 - 34	50.00%	5
4	35 - 44	0.00%	0
5	45 - 54	10.00%	1
6	55 - 64	0.00%	0
7	Above 65	0.00%	0
	Total	100%	10

Q2 - Gender Identity

Gender Identity
Female
Female
Male
female
Male
Male
MALE
Male
Male
Male

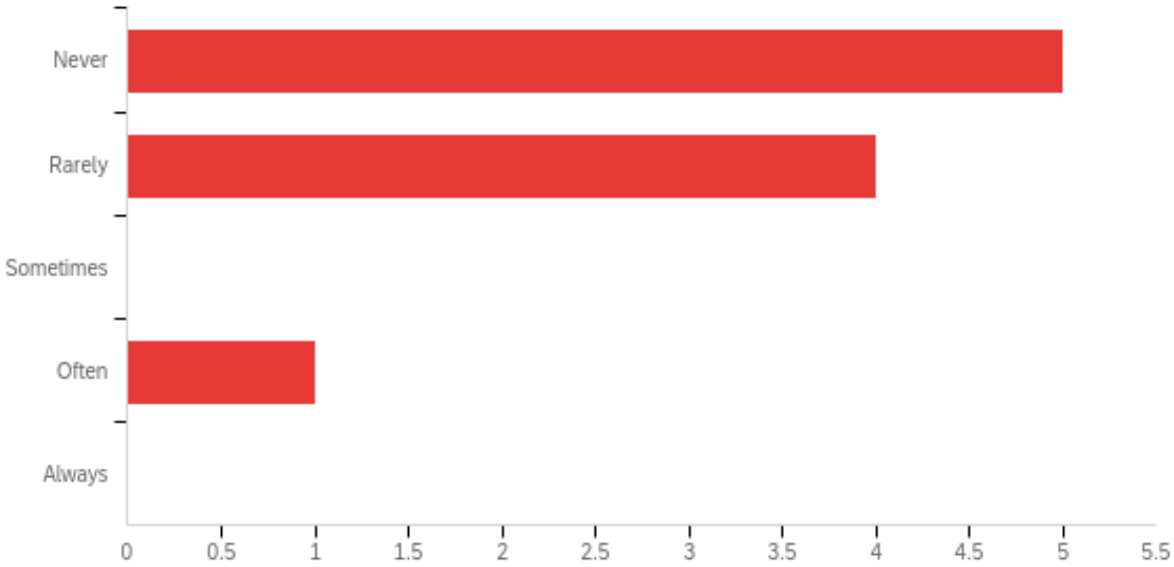
Q3 - Please select the occupation that best describes yourself.



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Please select the occupation that best describes yourself.	1.00	2.00	1.10	0.30	0.09	10

#	Answer	%	Count
1	Student	90.00%	9
2	Faculty	10.00%	1
3	Retired	0.00%	0
4	Not a student or faculty member	0.00%	0
	Total	100%	10

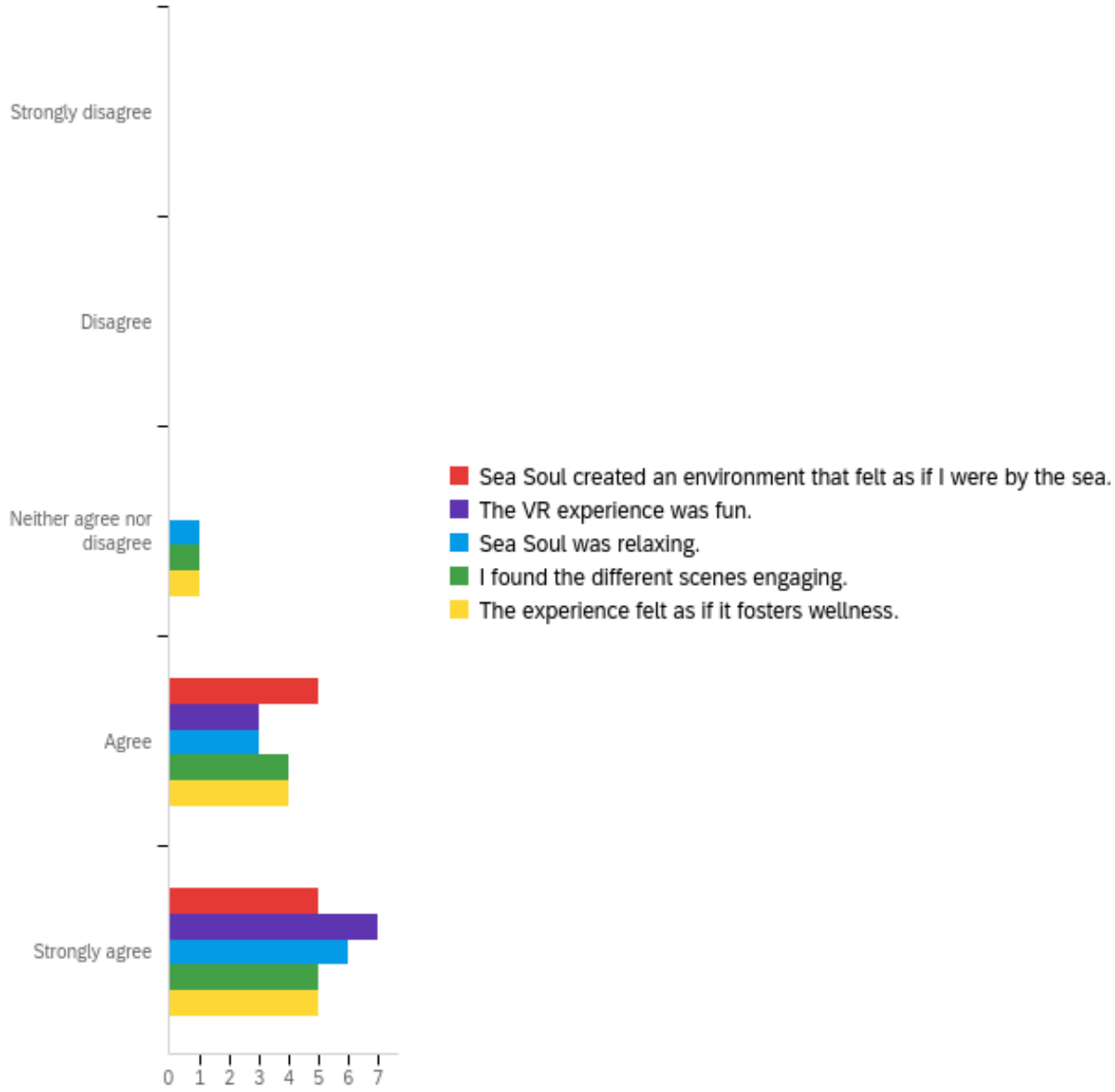
Q4 - Please rate the following.



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	What frequency do you play Virtual Reality games?	1.00	4.00	1.70	0.90	0.81	10

#	Answer	%	Count
1	Never	50.00%	5
2	Rarely	40.00%	4
3	Sometimes	0.00%	0
4	Often	10.00%	1
5	Always	0.00%	0
	Total	100%	10

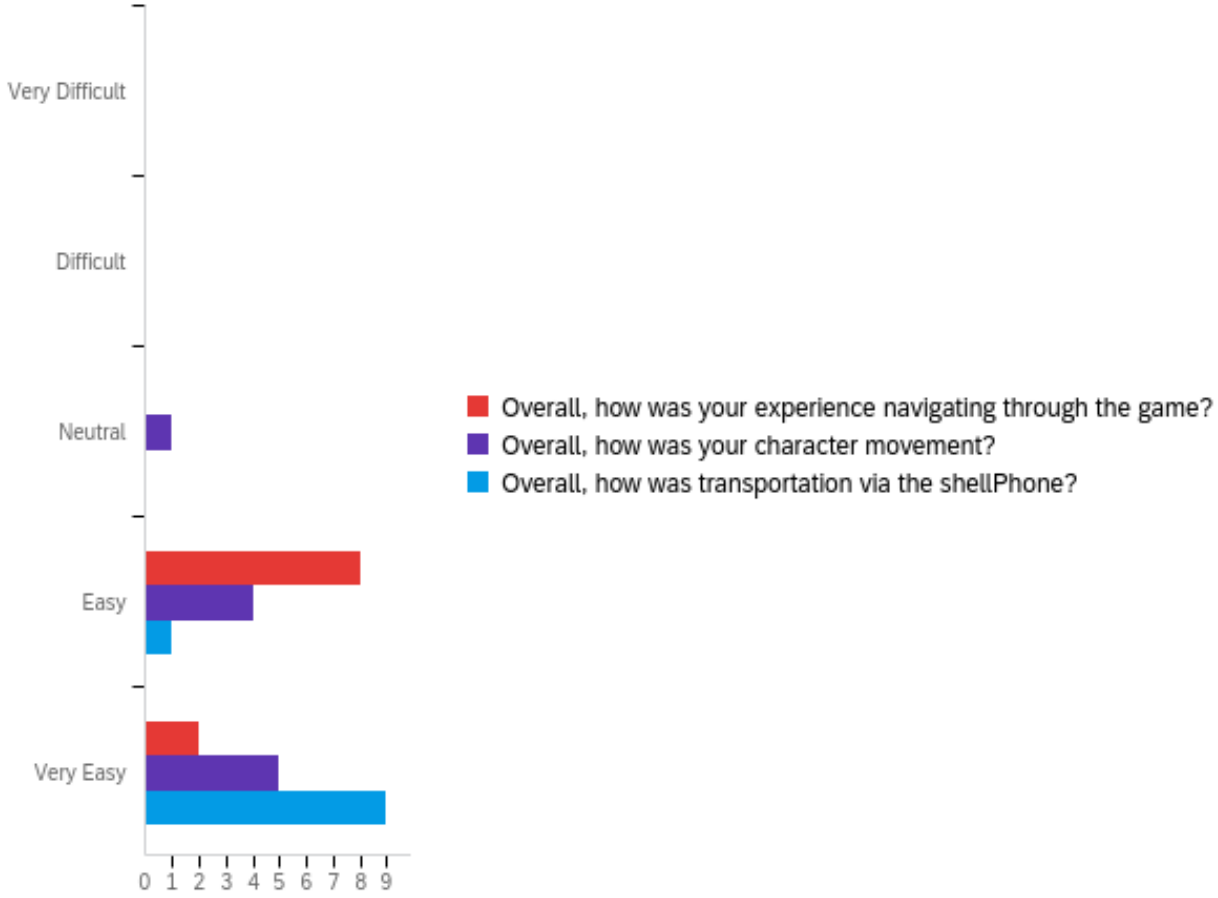
Q5 - Please rate the following in terms of how much you agree or disagree with each statement.



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Sea Soul created an environment that felt as if I were by the sea.	4.00	5.00	4.50	0.50	0.25	10
2	The VR experience was fun.	4.00	5.00	4.70	0.46	0.21	10
3	Sea Soul was relaxing.	3.00	5.00	4.50	0.67	0.45	10
4	I found the different scenes engaging.	3.00	5.00	4.40	0.66	0.44	10
5	The experience felt as if it fosters wellness.	3.00	5.00	4.40	0.66	0.44	10

#	Question	Strongly disagree		Disagree		Neither agree nor disagree		Agree		Strongly agree		Total
1	Sea Soul created an environment that felt as if I were by the sea.	0.00%	0	0.00%	0	0.00%	0	50.00%	5	50.00%	5	10
2	The VR experience was fun.	0.00%	0	0.00%	0	0.00%	0	30.00%	3	70.00%	7	10
3	Sea Soul was relaxing.	0.00%	0	0.00%	0	10.00%	1	30.00%	3	60.00%	6	10
4	I found the different scenes engaging.	0.00%	0	0.00%	0	10.00%	1	40.00%	4	50.00%	5	10
5	The experience felt as if it fosters wellness.	0.00%	0	0.00%	0	10.00%	1	40.00%	4	50.00%	5	10

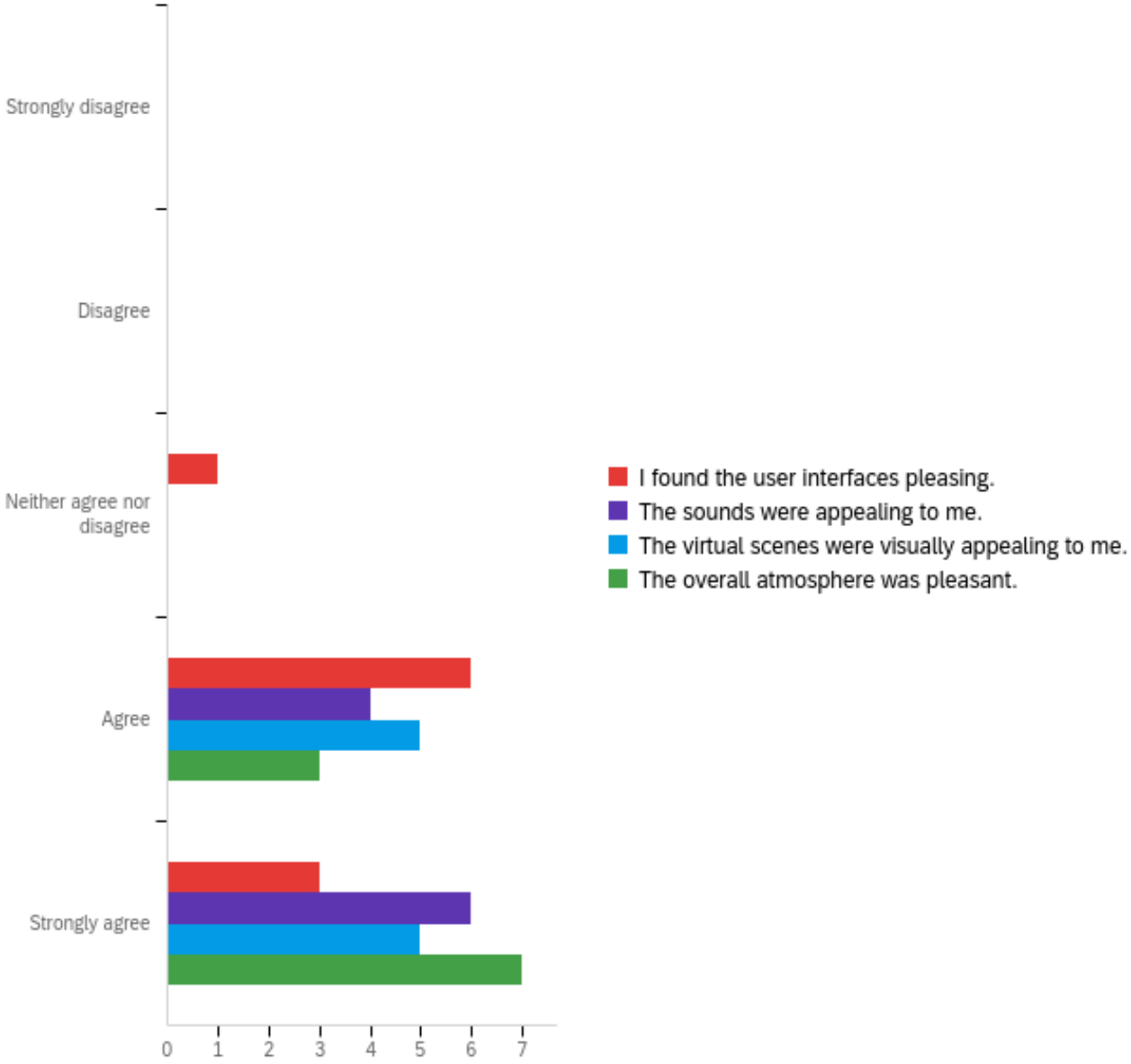
Q6 - Please answer the following questions in terms of the level of difficulty.



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	Overall, how was your experience navigating through the game?	4.00	5.00	4.20	0.40	0.16	10
2	Overall, how was your character movement?	3.00	5.00	4.40	0.66	0.44	10
3	Overall, how was transportation via the shellPhone?	4.00	5.00	4.90	0.30	0.09	10

#	Question	Very Difficult		Difficult		Neutral		Easy		Very Easy		Total
1	Overall, how was your experience navigating through the game?	0.00%	0	0.00%	0	0.00%	0	80.00%	8	20.00%	2	10
2	Overall, how was your character movement?	0.00%	0	0.00%	0	10.00%	1	40.00%	4	50.00%	5	10
3	Overall, how was transportation via the shellPhone?	0.00%	0	0.00%	0	0.00%	0	10.00%	1	90.00%	9	10

Q7 - Please rate the following in terms of how much you agree or disagree with each statement.



#	Field	Minimum	Maximum	Mean	Std Deviation	Variance	Count
1	I found the user interfaces pleasing.	3.00	5.00	4.20	0.60	0.36	10
2	The sounds were appealing to me.	4.00	5.00	4.60	0.49	0.24	10
3	The virtual scenes were visually appealing to me.	4.00	5.00	4.50	0.50	0.25	10
4	The overall atmosphere was pleasant.	4.00	5.00	4.70	0.46	0.21	10

#	Question	Strongly disagree		Disagree		Neither agree nor disagree		Agree		Strongly agree		Total
1	I found the user interfaces pleasing.	0.00%	0	0.00%	0	10.00%	1	60.00%	6	30.00%	3	10
2	The sounds were appealing to me.	0.00%	0	0.00%	0	0.00%	0	40.00%	4	60.00%	6	10
3	The virtual scenes were visually appealing to me.	0.00%	0	0.00%	0	0.00%	0	50.00%	5	50.00%	5	10
4	The overall atmosphere was pleasant.	0.00%	0	0.00%	0	0.00%	0	30.00%	3	70.00%	7	10

Q8 - What is a suggestion that would improve this virtual reality experience?

What is a suggestion that would improve this virtual reality experience?
Maybe being able to collect the shells to look at them later to remember names etc., same for the animals. Having some instructions for movements or breathing exercises. Being able to watch the sunrise or sunset. Have the weather changing.
No suggestions per say. I think it was great!
It would be nice, if possible, to have a floating scene menu. Make sprint a little faster.
I don't know I thought navigation, and everything was really easy to do.
I would allow for more items to be picked up or maybe a sound when you touch something weird.
If there was a way to negate the weight stress of the virtual reality headset, it would go a long way in aiding total immersion into the environment.
I would suggest that each scene has something such as "seashells" that you can collect. For example, in the crystalized cave you could pick up gems or diamonds off of the ground and identify what those gems are as well. I also think that being able to have different types of rarity levels of seashells or collectibles would be interesting as well. Also being able to swim in the ocean would be a unique experience.
Probably adding jump and crawl.

Q9 - What is your favorite thing about Sea Soul?

What is your favorite thing about Sea Soul?
I really like the underwater world, the seashell scene and the music and sounds.
The shell that took me places and the ability to walk around and not be restricted to certain areas.
I enjoyed the atmosphere of every scene.
I really liked the creativity with the crystal cave and the kaleidoscope. I also really liked all the opportunities to relax and how it encourages people to really slow down and meditate.
The underwater part was fun, then holding the seashells and seeing their name was fun too. The dance starfish was nice to see a nice visual part.
I liked how easy it was to change scenes and the sounds were really good.
The simplicity and blissfulness of the environments and the background music.
I really liked the waterfall scene with the wood flutes. The music was really relaxing.
My favorite thing to do in the game was collecting seashells and being able to see the name of the shell. I learned a few things and it was a very relaxing environment.
Seashells. Collecting them and learning their names.

Q10 - Please share any additional feedback you have:

Please share any additional feedback you have:
Great work! I also liked how easy it was to find the seashell phone and navigate the icon.
I think maybe adding a yelp sound effect when I try to pick up the sea urchin.
It is a fantastic idea for mental wellness, especially for a populous that has limited access to resources!
Overall, this was a neat experience. Great job!
Overall, I think the game is great for the purpose that it serves. It perfectly captures the essence of being at the beach and collecting seashells on a sunny day. People who are unable to physically go to the beach would enjoy this game and love the environment that has been created. There is so many different directions the game can go, and I am interested in the further production and ideas behind this game's future!
Great job! This is impressive.