Hoʻomalu na ʻakoʻakoʻa: Designing an Interactive Application for Coral Education in Hawaiʻi

An Interactive Qualifying Project Submitted to the Faculty of
WORCESTER POLYTECHNIC INSTITUTE
to be completed at the Hilo, Hawaiʻi Project Center
in partial fulfilment of the requirements for the
Degree of Bachelor of Science

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Submitted On:
March 6, 2020

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Abstract

The Legacy Reef Foundation (LRF) aims to develop an application to accompany their coral tank wall to increase visitors' knowledge on coral reefs and motivate them to carry on the LRF's mission to preserve and restore coral reefs. This report outlines our contribution to the development of the educational application by providing extensive background on coral reefs and the use of technology in informal science learning. We provided the LRF a basic but complete application that can be used. We also developed detailed designs for future versions of the application for a software developer to create. Additionally, we provided the LRF with recommendations for how to further develop the application.

Executive Summary

  The purpose of this Interactive Qualifying Project (IQP) was to provide the Legacy Reef Foundation (LRF) with an interactive educational application that guests can use while visiting the LRF's new coral wall exhibit. The LRF is a non-profit organization located on the Big Island of Hawaiʻi. Their mission is to restore coral reefs and educate the general public on how people can help protect reefs. Coral reefs are home to a quarter of all marine life, including over 4,000 species of fish. (Coral Reef Alliance, 2019) The reefs also provide food, income, and protect people living on the coast. By 2100, all coral reefs could be gone if no measures are taken to stop dangers that are killing the reefs. (Legacy Reef Foundation, 2019) Prior to this project, the LRF was educating their guests on how they can help protect coral by using a presentation. The coral wall and app are intended to be a more engaging way for the LRF to educate their visitors.

  To create the educational app, we decided on five main topics that should be included in the app. The topics highlighted in the app are coral ecology, importance of coral, coral in Hawaiian culture, threats to coral reefs, and how to help coral. Further details and specific information about each topic was included in the application. Most topics are broad and include subsections within them to help organize and breakdown the information covered within the section. The content within every subsection is obtained through extensive research.

  The "Coral Ecology" section was important to add because we wanted guests to understand how coral function, as well as identify different types of coral. The "Importance of Coral" section was included because we wanted to highlight the benefits of coral so guests of the LRF can better understand why coral should be saved. The "Threats to Coral" section was included because we wanted to have guests understand what specific stressors coral are facing and what harm these stressors are doing to coral reefs specifically. The "How to Help Coral" section was included because we wanted each guest to learn ways that the LRF are helping to restore coral and how they can help protect coral themselves. The "Coral in Hawaiian Culture" section was included because the LRF wanted native Hawaiians on the Big Island to help spearhead the LRF's movement by showing the LRF understands the cultural significance coral has in native Hawaiian lore. Our goal was to display the information in each section in an engaging way that connected the app to the coral wall.

  We then designed storyboards for what the app should look like and how the information should be displayed to allow for the most visitor engagement. These storyboards were created on

paper and include user stories. The user stories are descriptions underneath the storyboard that explain how a visitor of the LRF would use the app. Figure 1 shows two of the 49 created.

Figure 1: Examples of paper storyboards. On the left is the screen for all ways coral are important. On the right is the screen for how coral is important to provide tourism specifically.

The storyboards contain the five topics from above, as well as three possible activities that connect the app to the coral wall. These activities include a map of the coral wall that guests can follow, a QR code scanner that guests can use to learn about specific coral and fish, and a virtual tank that visitors can fill with coral and fish by answering questions about each organism. The interactive storyboards were then created using a design software called Sketch because we were unable to add them into the app. Figure 2 shows the title screen for the QR code scanner.

Figure 2: Example of the interactive storyboards designed using Sketch. This is the title screen of the second interactive idea where the guest walks around the coral wall and scans QR codes to learn more about coral and fish in the tank.

We then used the software Swiftic to create the educational application. After conducting a weighted decision matrix comparing four app development software platforms, Swiftic was ranked as the best choice. Swiftic is a limited software, so the actual app was not the same as the storyboards we created. Figure 3 shows screens that LRF guests can see while using the app.
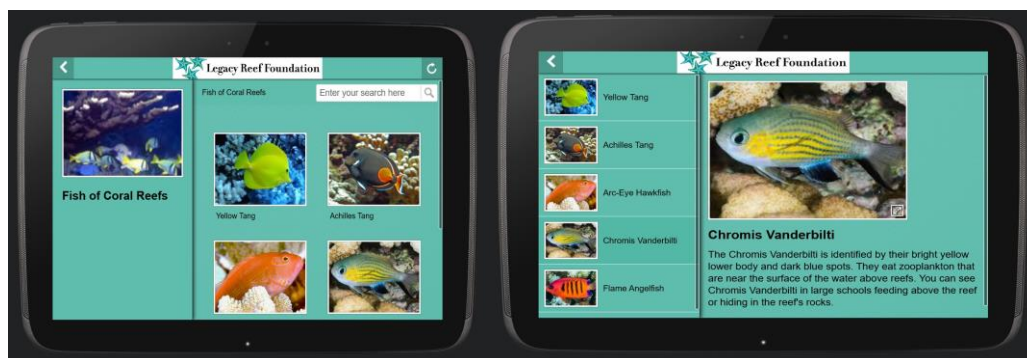

Figure 3: Examples of screens within the Swiftic app. The screen on the left shows the fish of the coral reef screen that is part of the "Coral Ecology" section of the app. The screen on the right shows information on one of the five fish, as well as buttons where guests can learn about the other five fish.

To test the app and retrieve feedback, we conducted four focus groups. These groups consisted of other Worcester Polytechnic Institute (WPI) students, high school students from West Hawaiʻi Exploration Academy (WHEA), and two separate groups of SCUBA divers. All focus groups found the app educational; however, they were often bored or disengaged with the information due to the long, in-depth explanations included in each section. The main takeaway from the focus groups was to make the information broader so guests do not become disengaged, and to shorten the length of the information. Using a summary of the feedback from the focus groups, we changed the app to the best of our ability before we had to leave the LRF.

The Swiftic app is too limited and will not be able to be connected to the coral wall. This will disengage guests with the app because we believe people would rather look at the coral wall by itself than use the Swiftic app while visiting the tank. We provided the LRF with information on over 100 freelance developers and app development companies. After a discussion with the LRF, we were able to narrow the lists down to four freelance developers and three companies. After further screening on the four freelance developers, the LRF can then hire one of the freelance developers to create a new app. If the app is a success, and the LRF decides to expand to more apps, they could then consider switching from a freelance developer to a company.

The Swiftic app can still be used by the LRF as a placeholder as they wait for future development of the full interactive app by professional software developers. We created a detailed guide that the LRF can use to make updates and changes to the app. We had employees at the LRF use the guide while we were still in Hawaiʻi to test the clarity of the guide.

Once the final application is complete, we have a few recommendations for how the LRF can improve and utilize the app. One idea was to have the final app collect data on the guests' learning of the coral wall. All three interactive components include a quiz activity. The LRF could have the quiz collect data to make sure guests are learning effectively, and if the data shows guests are not learning effectively, the LRF can change the app accordingly. Another idea was to include free raffles in the quiz portion of the app to motivate visitors to complete the quizzes and possibly increase guests' learning. The final major idea was to add a live video stream of the coral wall tank to the home screen of the LRF website. People could see the live video when going onto the LRF's website and be intrigued to see it in person.

Acknowledgements

Susanne Otero

Bill Coney

Professor Lauren Mathews

Andrea Ehlers

Sandra Romer

All Legacy Reef Foundation Volunteers

Professor Sarah Stanlick

JennyRose Coney

Professor Noelani Puniwai at the University of Hawaiʻi Hilo

Students from the West Hawaiʻi Explorations Academy High School

All WPI Students from the Hilo, HI Interactive Qualifying Project Site

All Professional SCUBA Divers from our two focus groups

Candee L. Ellsworth and the Friends of NELHA

Captain Neil Elliot

John Alexander and the Dolphin Bay Hotel staff

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1.1 Introduction

Many scientists believe that coral reefs have the highest biodiversity of all ecosystems, including the tropical rainforest. Currently, coral reefs across the globe, including those in Hawai'i, are facing extinction. There have been efforts by the United States government and other organizations to help protect the Hawaiian coral reefs and raise awareness of the global issues endangering coral. One organization is the Legacy Reef Foundation (LRF), located in Kona on the island of Hawai'i. Their main focus is the restoration and conservation of coral reefs to ensure food security for future generations (Legacy Reef Foundation, 2019). Part of the LRF's mission is to educate visitors about what people can do to help coral.

The LRF is installing a 16 foot long, 600 gallon coral reef tank in the lobby of their building, which is located at the Hawai'i Ocean Science and Technology Park. The purpose of this tank is to educate visitors about coral reefs and what they can do to help with the restoration and conservation of coral reefs. The role of the project team was to develop an educational tablet application that will accompany the coral wall and allow for visitors to learn more about coral ecology, conservation, and cultural impact. In this chapter, we present information on coral reefs, educational assessment, app development, and museum, science, and technology exhibits.

1.2 Coral Reefs

Although they only cover less than one percent of the ocean floor, coral reefs are home to over a quarter of all marine life in the world, including over 4,000 species of fish (Coral Reef Alliance, 2019). About a billion people globally depend on coral reefs in one way or another whether it be food, some source of income, or even protection (Coral Reef Alliance, 2019).

1.21 Biology of Coral Reefs

Reefs are a colony of growing coral. The part of the coral that secretes the calcium carbonate is called the polyp, which hosts single celled photosynthetic microalgae called zooxanthellae that work mutualistically with the coral itself. The zooxanthellae use photosynthesis to create energy, which is shared with the host coral; in return the microalgae are protected by the coral (Coral Reef Alliance, 2019). Polyps use dissolved calcium to secrete calcium carbonate skeletons (Coral Reef Alliance, 2019). Over long time periods, the accumulation of calcium carbonate as polyps grow over one another forms the reef structure.

Corals themselves are a biodiverse group, with about 800 known species (Barnes 1987). These show a large range of morphological variation and are distributed in tropical and subtropical shallow waters throughout the world.

1.23 Importance of Coral Reefs

Humans rely heavily on coral reefs; they are essential to businesses, economies, coasts, and the protection of lives and homes. Ecosystem services provided by coral reefs in the United States bring in a total economic value of $3.4 billion per year from tourism, fisheries, and coastal protection (Brander & Beukering, 2013). More than 500 million people across the world depend on coral reefs. Risk reduction assistance is provided by coral reefs in preventing an estimated $94 million per year in significant flood damage (Spalding, Brumbaugh, & Landis, 2016). This is because 97% of a wave's energy is absorbed by a healthy coral reef, serving as a buffer for shorelines from storms, waves, and currents. This prevents property damage, loss of life, and erosion (Ferrario et al. 2014; NOAA Office for Coastal Management, 2019).

According to the National Marine Fisheries Services, in 2001 U.S. coral reef fisheries were valued at $100 million annually and recreational fishing from coral reefs was valued at an additional $100 million annually (United States Environmental Protection Agency, 2019). Another raw material coral reefs provide is limestone which is used in cement and road building (Barbier et al. 2011). Humans and marine organisms like seagrass, and fish, living near the coast need coral reefs because they provide protection from severe storms like tsunamis and hurricanes (Barbier et al. 2011). In 1988 the estimated loss in property value for property near coral reefs in the Indian Ocean that experienced a decline in coral protection was $174 per hectare per year (Barbier et al. 2011). Coral reefs also provide revenue from recreational activities such as SCUBA diving, snorkeling, tours, and sports fishing (Barbier et al. 2011). Hawai'i, specifically, earns about $50-60 million per year from about 100 diving operations alone (Barbier et al. 2011).

1.24 Threats to Coral Reefs

Coral reefs are subject to a wide variety of threats, some of which have local sources, and some have global sources. For example, current fishing techniques can damage coral and cause undesired fish to be caught and discarded. In Jamaica, the fish biomass of fringing reefs was reduced almost 80% in 10 years due to artisanal fish trapping practices used (Hughes. 1994). With a decreased number of fish living in the coral reefs, algae flourish and can slow down the growth of coral and even kill them. Another type of local threat is pollution from nearby land.

These include sedimentation, nutrients (nitrogen and phosphorus), pathogens from sewage, runoff, and stormwater, toxic metals or chemicals, and trash including microplastics (United States Environmental Protection Agency, 2019). The main effect of pollution is disease that can slow the growth of coral and even kill them.

The two largest issues that corals face globally are ocean acidification and coral bleaching, both of which are due to global climate change. Ocean acidification is due to the absorption of carbon dioxide from the atmosphere into the seawater. The concentration of carbon dioxide in the ocean in 2007 was 560ppm, double that of pre-industrial concentrations; this caused coral calcification to decrease by 40% (Hoegh-Guldberg et al. 2007). To combat this the physical density of the coral will decrease, however this lowers the effectiveness of coastal protection from storms (Hoegh-Guldberg et al. 2007). The other major issue for coral reefs is coral bleaching, which is associated with increasing water temperatures. This is a more well-known phenomenon that happens when the zooxanthellae in the coral die, causing the corals to lose their color and turn a bleak white as seen in figure 4 (United States Environmental Protection Agency, 2019). Mass coral bleaching and mortality events have been observed worldwide since the early 1980s and have affected reefs at regional scales (Frieler et al. 2012). Although corals can re-establish themselves after mass bleaching events, in some cases it takes one to two decades for the ecosystem to return to the pre-bleaching state.

Figure 4: On the left shows a health group of coral. On the right shows the same coral after post-coral bleaching. The loss of coral is due to warmer water temperatures. If the microalgae, which produces the corals' color, can not grow back in a timely manner the coral could die. (Kravec, 2018)

A third threat that all reefs face are severe storms, which can destroy reefs (Rogers, 2019) After hurricanes Irma and Maria hit in 2017 the coral reefs in the U.S. Virgin Islands were nearly completely destroyed (Rogers, 2019).

1.3 Informal Science Learning

Science plays an essential role in changing people's lives for the better (Bell, 2009). While much of the focus to improve people's scientific knowledge is on classroom-based

learning, learners spend most of their time outside of a formal academic setting. With this comes the opportunity to learn about science in a realistic and informal setting, such as at a museum, at home during a family discussion, at a library, or even at an organization within the community (Bell, 2009).

Science and technology exhibits provide an opportunity for people to learn outside of the classroom, in an informal manner. School groups are a major target for these centers because they offer exciting exhibits and themes, providing opportunities for students to experience science and technology in a stimulating environment (Rennie & McClafferty 1995). Rennie & McClafferty (1995) argue that visits to these centers stimulate cognitive development and positive attitudes about the material being learned. Interactive exhibits provide a chance for students to put their learning to real life experiences, inspiring visitors to increase their knowledge on the topic.

Exploration and setting-oriented learning is a high priority for students in museums and science centers. These centers achieve this type of learning through interactive exhibits that visitors can learn from. When students interact with exhibits, they tend to do it in a stop-start manner, revisiting exhibits that interest them, often several times (Rennie & McClafferty 1995). Rennie & McClafferty (1995) found that the time spent at an exhibit and the nature of the interaction affects the amount of learning which occurs. Exploration of these exhibits and a little prior knowledge of the topics at study are important in a student's learning experience. Entertainment is linked with interactive exhibits in order to make visitors feel like they are not being tested, but rather having fun while learning new information. With the rapid development of technology, exhibits have become more interactive.

1.31 How Technology and Applications are Being Used in Exhibits

Technology and applications have been a significant development in museum and science center exhibits. The use of technology and apps in exhibits has driven more exhibits into becoming more interactive and engaging more visitors. Smartphone apps provide another aspect to the museum experience to visitors. There was a study done at the NEMO Science Museum, ranked fifth on the list of most visited Dutch museums in 2015 (Rozendaal et al. 2018). The museum participated in a study where they had visitors use two mobile apps during their visit (Rozendaal et al. 2018). The first app that was used to evaluate 12 interactive exhibits at the NEMO Science museum based on visitor photos of the exhibits. The app was installed on a

hand-held device that visitors could take along with them while walking through the NEMO Science Museum. The procedure started where visitors first took a picture of the activity they were involved in at the exhibit, and then typed in a keyword that expressed the feeling they had during the activity. Afterwards, they were prompted to indicate the area which produced this feeling (Rozendaal et al. 2018).

By combining all of the experience keywords that visitors expressed during the exhibit, a word cloud could be constructed that provided a visual overview of the results from the photo-app study. The data captured by the photo app allowed researchers to explore visitors' experiences of the exhibits in several different ways. Researchers were able to map out the words associated with each experience the visitor commented on, and were able to see which different features of the exhibit stood out to the visitor.

Then, a different app was used to evaluate the same 12 interactive exhibits. These exhibits were the same as the ones evaluated by the photo-app field study. This "mirror app" was installed on a tablet computer, which is larger than the handheld device used for the photo app. With the mirror app, visitors could match their experience of an exhibit with the experiences depicted by an animated virtual puppet (Rozendaal et al. 2018). The focus in the animations was on how the puppet interacts and what it feels like while interacting, without using words (Rozendaal et al. 2018). Participants were asked to report their experience by using the app after they had interacted with an exhibit.

Based on the two app studies that visitors take part in, it is shown that incorporating mobile technologies into exhibits is beneficial to engaging learning. It is found that it is critical to design a mobile technology that motivates visitors to share their experiences during their museum visit (Rozendaal et al. 2018). Mobile technologies have a strong appeal to the new generation of students and entice them into learning more information about the exhibit. It is also found that mobile technologies should be designed in a way that does not disrupt social interaction (Rozendaal et al. 2018). When a mobile app is given to an individual in a visitor group, it soon becomes the focus of everyone in the group. Mobile technology is *shared* (Rozendaal et al. 2018). In designing mobile technologies, the appeal of the technology is important in order to stimulate visitors to share their experiences. It is recommended to give emphasis to the design in terms of usability and aesthetics (Rozendaal et al. 2018). Ultimately, a

successfully designed mobile app is a great opportunity to make exhibits even more social and interactive.

One way that museums and science centers are using technology in their exhibits is by using the concepts of gamification. Gamification is defined as the use of game design elements in non-game concepts (Albertazzi, Ferreira & Forcellini, 2018). The use of gamification brings a new tool that educators can use to reach students and also gives students a different experience than they are used to. Two organizations that have been key players in the gamification of museums are Aardman, an animation studio contracted by museums to develop interactive software, and New York's American Museum of Natural History (Maunder, 2017). One project Aardman has worked on is with Brunel's SS Great Britain in Bristol, England. Brunel's SS Great Britain was a passenger ship designed by I.K. Brunel in 1843 that is known as the first modern steam ship, and it now has been converted into a museum. Aardman created an educational application for visitors to teach them about the work of Brunel. This app involved a game that allows users to build their own virtual ship and simulate if the ship would work. Users are given challenges, such as carrying weight or crossing the ocean. The game is set up on kiosks throughout the ship. In an analysis of the app's effectiveness, Maunder (2017) found that this game attracted more students to the exhibit, and playing the game taught the students about what Brunel went through when designing his ships (Maunder, 2017). At the Museum of Natural History, a game was developed to accompany the museum's exhibits on biodiversity. This game is an app that allows visitors to role play and have their character in the game shrink down and engage with microbiomes at a microscopic level, or increase in size to interact with biodiversity at a global level. At the Hall of Ocean Life, the app teaches visitors about bioluminescence. The app has the players shrink down to microbial level and go inside the marine life to observe what is happening with the photobacteria. The players learn that it is pollution that is making it difficult for the photobacteria to breathe and this causes the lack of bioluminescence. The gameplay of the app involves users clicking on the pollution they see to get rid of it and see the marine life glow. Although there were no statistics reported, the museum has said that the app has given visitors higher engagement with their exhibits, as the visitors are being challenged to learn and self-direct their learning experience (Maunder, 2017). Gamification has been proven to give museum visitors more engagement and insight on the exhibits that they are viewing.

2.0 Methodology

The following chapter outlines our methods for completing our four objectives to create an educational application for the LRF that visitors can use while looking at the coral wall exhibit.

2.1 Gathering Content and Information for Application

The first step was to gather the information that we judged to be useful for the coral wall. The LRF supplied us with an outline of what topics they wanted to be included in the app (as seen in Appendix A). Based on the outline, we determined which topics about coral and coral reefs were most important for visitors to learn while at the LRF.

The first topic that we determined to be important for guests to learn about is the ecology of coral reefs. To gather information on reef ecology, we used our research conducted prior to coming to Hawai'i. We also had discussions with the laboratory manager at the LRF, Andrea Ehlers, who has knowledge on important and common coral in Hawai'i. Andrea Ehlers presented a slide show to our team covering common coral as well as how a coral grows, eats, and reproduces.

The second topic that we determined to be important for guests to learn about was the importance of coral and reefs for marine life as well as coastal communities. To gather this information we used our research prior to coming to Hawai'i. We also had discussions with Andrea Ehlers, LRF co-founder Bill Coney, LRF co-founder Susanne Otero, and a local fisherman, Captain Neil Elliot, who is close friends with the LRF. Captain Elliot, as well as many other fishermen in Hawai'i, rely on coral reefs for food and employment.

The third topic that we determined to be important for the LRF visitors was threats to coral reefs. To gather information on threats to coral reefs, we used our research conducted prior to coming to Hawai'i. We also had discussions with Andrea Ehlers, as she gave us a presentation that had information on the many threats the coral reefs face.

Then, we determined that the topic of how to help coral would be important for LRF visitors to learn. To gather information on what can be done to help coral, we used our research conducted prior to coming to Hawai'i. We also had discussions with Andrea Ehlers, Bill Coney, Susanne Otero, and former LRF operations manager Sandra Romer. They all were able to provide information on how the LRF helps coral along with how average people can help.

The last important topic for visitors to learn about while at the LRF was how coral is connected to Native Hawaiian culture. To get this information, we interviewed two different experts: JennyRose Coney and Noelani Puniwai. The reason for conducting interviews instead of a survey or another method is because an interview is more flexible and can lead to more in depth answers (Seale, 2012). Ms. Coney is a senior at the Kamehameha School and the daughter of Bill Coney. Kamehameha Schools are competitive and selective schools in the Hawaiian islands that give preference to Hawaiians of pure or part aboriginal ancestry (Kamehameha Schools, 2020). The school system puts a strong emphasis on educating their students on Hawaiian culture. Ms. Coney was recommended as a resource by the LRF for her knowledge on coral reefs and their relation to the mythological creation of the Hawaiian Islands. Noelani Puniwai is a professor at the Hawaiʻinuiake School of Hawaiian knowledge at the University of Hawaiʻi. She specializes in "Indigenous and ocean users' knowledge to better understand and manage natural resources, seascapes" (University of Hawaiʻi, 2019). See Appendix B for questions asked during these interviews as well as the full transcript for each interview..

2.2 Storyboarding Educational Application for Coral Wall

Our second objective was to storyboard the application for the LRF's coral wall. A storyboard is a linear sequence of illustrations, arrayed together to visualize a story (Babich, 2017). In the software design process, storyboarding is a tool that usually predicts and explores a user's experience with a website, web app, or a mobile app (Babich, 2017). We chose storyboarding as our second objective because it is a key technique in designing interactive software. We picked out information from our first objective to create a storyboard for the app, which included a home screen, a screen about coral ecology, coral reef threats, ways that we can help coral, and coral in Hawaiian culture. We then added basic information we wanted to include on the screens of the app.

We designed the app to incorporate interactive components that would enhance users' experiences in viewing the coral wall exhibit. Susanne Otero, told us that she wanted the content of the app to complement the coral wall, and have the app directly related to the coral wall so visitors will be more engaged with the exhibit.

We developed user stories to accompany the storyboards. A user story is a short statement or abstract that identifies the user and their need or goal (Justinmind, 2017). User stories go along the lines of, "As a user, I want a feature where I can.." (Justinmind, 2017). Since

the LRF is looking for an interactive design that supplements the user's experience at the coral wall exhibit, user stories allowed us to plan how users would interact with the app, along with the coral wall. On the bottom of each storyboarded screen, we wrote the user stories, which went along the lines of "LRF visitor Sally opens up the app to the coral reef ecology screen...". After hearing recommendations that Susanne Otero had on the user stories, we collaborated as a group and adjusted the app's design where needed to increase the interactivity of the app. Some of these recommendations included simplifying the explanations of the user stories on the screens as well as including additional information that we did not think of.

2.3 Building and Testing the Educational Application for the Coral Wall

Because we are inexperienced in app development, we have explored software options that allow app development for those with little or no coding experience. While most such software options require paying a monthly fee, this approach provided us with a practical and feasible solution to tackle this project with our current technical skills in seven weeks' time.

We used a weighted decision matrix approach to compare four alternative app development platforms, using a set of criteria we judged to be important to the effectiveness of the final app. For example, collaboration, which was determined by how easy it was to have multiple people working on the app at once, is an important feature and was weighted high in making our final decision (see Appendix C for full weighted decision matrix).

We ultimately chose to build the app on the platform Swiftic. With Swiftic, however, we faced a challenge that prohibited us from advanced development. The task that was given to us was to build an interactive app, but Swiftic does not have the advanced capabilities that are needed to do this. The app that we made on Swiftic does not highlight the interactivity that is needed for the LRF's app complementing the coral wall. To compensate, we did more storyboarding on a software called Sketch, which allowed us to redesign the app so it could be more interactive. Swiftic then became more of a sample design of the completed app that was to be developed.

We tested the completed Swiftic application with three different groups of people. The first group consisted of expert divers. They were selected as a test group because of their knowledge on coral reefs, they were asked to give feedback on the information in the app to make sure it was accurate, they also were asked to give ideas for what other information could be added. The second group was a group of high school students from West Hawaiʻi Explorations

Academy (WHEA). They were chosen to give us feedback from the viewpoint of a younger audience, they were more familiar with how to use the technology required for the app, they also had good insight on what they would like to see on the app in terms of information and appearance. The final group was the other WPI students completing projects with other organizations in Hilo, Hawaiʻi with us. From them, feedback was obtained from the average person who may not know much about coral reefs. They were able to give us feedback from the viewpoint of another younger audience who knew how to use the technology required for the app. They were not able to give us much feedback on the information in the app but were able to give suggestions about how to make the app look better and be more interactive. We recorded this feedback using a focus group (as seen in Appendix D). A focus group was chosen for this evaluation because a focus group is flexible and can lead to in depth answers (Seale, 2012).

2.4 Establish Plans for Future Development of Application

After completing the prototype of the application for the LRF, the next objective was to develop a guide for continuous development of the app. The guide we created includes instructions for how to make changes to the Swiftic app. We added to the guide whenever we used new features on Swiftic. During our second week at the LRF, we had two LRF staff members who were unfamiliar with Swiftic make changes to the app using the guide. The purpose of this was to test the clarity of the guide and make necessary alterations to it while we were still in Hawaiʻi.

To ensure future development to the app, we created a list of software developers, both freelancers and companies, that the LRF could hire to make improvements. The reason for this was that there were features that we wanted to add to the app but were unable to due to Swiftic's capabilities or our time constraint. We used the website Upwork to find freelance software developers. On Upwork freelancers have profiles that show their prior work, their feedback on projects, their hourly cost, and their success rate of jobs. To narrow down the list of freelancers we found we sat down with Susanne Otero to determine what criteria was most important for the LRF. We used the website Clutch to find software development companies. The information we took from Clutch included the percentage of their work that is in mobile development, the percentage of their work that is in education, the minimum project cost, their hourly rates, and their feedback on projects. To narrow down the list of companies we once again sat down with Susanne Otero to determine what criteria was most important for the LRF.

3.0 Results

The following chapter outlines our results from our four objectives to create an educational application for the LRF that visitors can use while looking at the coral wall exhibit.

3.1 Gathering Content and Information for Application

The following section summarizes our results for gathering content and information for the application. The content of the app is outlined in Figure 5. Below, we describe in [Grab your reader's attention with a great quote from the document or use this space to emphasize a key point. To place this text box anywhere on the page, just drag it.] general terms the contents we selected to include in the app, and detailed contents can be found in Appendix E.

Figure 5: The outline for information within the app shows the five main topics we included. Within each topic the subsections that pertain to that topic can be seen.

Within the "Coral Ecology" section, we determined to have three separate subsections: "Most Common Coral", "Biology", and "Fish in Coral Reefs". We chose to highlight "Most Common Coral" because we felt it was important that visitors would be able to identify and differentiate the different types of coral they see in the tank. We chose to highlight "Biology" because we felt it was important to give visitors background information on what corals are and how they function. Finally we chose to highlight "Fish in Coral Reefs" because we wanted to have visitors identify and be able to differentiate the fish that they see in the tank.

Within the "Importance of Coral Reefs" section, we determined to highlight information on the many reasons that we need coral. We chose to add information on the importance of coral because we felt it was important for people to know why the LRF is making such a large effort in the conservation of coral reefs. The visitors will not feel the need to try and help save coral reefs if they do not understand why coral is important.

Within the "Threats to Coral" section, we determined to have two separate subsections: "Global Threats" and "Local Threats." Each of these subsections contained information on several topics that fall into those subsections. We chose this information because one of the primary goals of the LRF is to educate people on why coral is in danger. We chose the

information in this section because we wanted visitors to learn about the threats that coral reefs face and what effect these dangers have on coral.

Within the "How to Help Coral" section we determined to highlight information about what is currently being done to help the conservation of coral and what else can be done. One of the LRF's primary goals is to help in the conservation of coral reefs and educate people on what actions they can take to participate in the conservation and restoration efforts. We chose the information in this section because we wanted to educate visitors about what role the LRF plays in helping coral reefs and to give them ideas of what they can do to help as well.

Within the "Coral in Hawaiian Culture" section, we determined to highlight information regarding the Kumulipo chant and how coral plays a role within the chant. According to Ms. Coney, the Kumulipo chant is the creation story of how the Hawaiian islands and everything on the islands came to be. From this story, coral is the first living thing to come from the darkness and is the oldest ancestor to all living things, including people. We added the information on the Kumulipo because the LRF wanted to target native Hawaiians on the Big Island as a group of people that can help spearhead the LRF's movement to help protect reefs by showing how the LRF understands the cultural significance coral have in native Hawaiian lore.

3.2 Storyboarding Educational Application for Coral Wall

Our second objective was to storyboard the app for the coral wall. In this section, we present and describe part of the storyboard, and provide full information about all components of the storyboard in Appendix F. Each page of the storyboard features a drawing of what visitors will see, and underneath each screen is a user story talking about what the user would see when they opened the screen and how they would interact with it.

Figure 6: Example storyboards for the app. The screen on the left is the home screen where guests can click on a topic to learn more about it. The screen on the right shows the "How to Help Coral" screen where guests can learn about each way they can help protect coral.
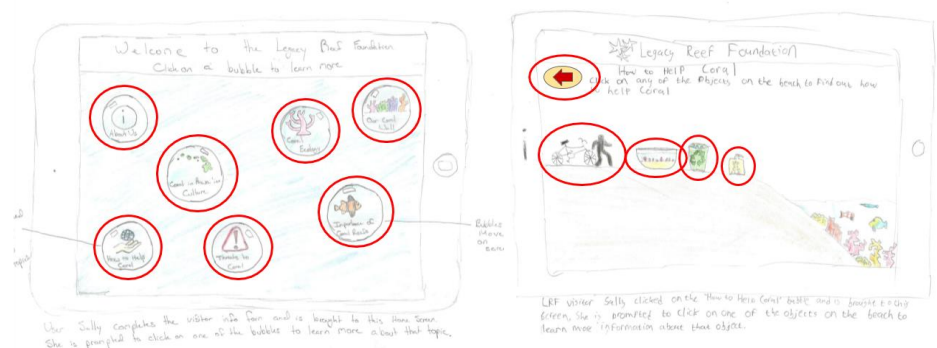
We decided that the app should open up with a main welcome screen. On this screen, we included different buttons with different information. On this screen, we included different buttons with different information. Here, there is a button for "About Us", "Coral in Hawaiian Culture", "Coral Ecology", "Threats to Coral", "How to Help Coral", "Our Coral Wall" and "Importance of Coral Reefs". The reason for using buttons is that they are very easy to comprehend what information you are about to learn more about; also it added a small part of interactivity by having the visitor expand a section by clicking a topic.

The screen on the right in figure 6 is what visitors would see if they clicked on the "How to Help Coral" button. To access this information, a visitor would click on individual items on the "How to Help Coral" page. The main screen displays different types of objects that represent ways that people can help preserve coral. For example if the user clicks on the "sunscreen" object, it takes them to another screen with facts about the harmful ingredients in sunscreen and what visitors can do instead to help coral reefs. The reason for this design is that we wanted to inform visitors on what changes can be made to help preserve coral reefs and motivate them to contribute to that movement. By including this section along with the "Importance of Coral Reefs" section, visitors will understand why we need coral and why they should want to help.

We also created storyboards for more interactive components of the app. The three interactive ideas for the apps were a map app, an app where users have the opportunity to scan QR codes to learn more about the coral tank, and a virtual tank app. These storyboards do a better job of connecting the coral wall to the app. Figure 7 below shows the title screens for all three interactive ideas we came up with. To see all of the interactive storyboards and descriptions of the screens, see Appendix G.

1. The first interactive app idea is the "Explore Our Coral Map" app. The main screen of the app shows a birds-eye view of the coral wall tank at the LRF. Multiple different types of coral are displayed, and visitors have the option to click on any of the coral to learn more about it. Along with the birds-eye view of the coral tank, there will also be an "Explore Our Fish". The "Explore Our Fish" button will take visitors to another screen where there will be a virtual aquarium where fish will be swimming around, and visitors can click on any of the fish to learn more about them. This design connects the app to the tank as it

shows the user where everything is located in the coral wall. This will be the easiest option to develop as there are no QR codes. This option, however, will produce the least engagement out of the three because it does not require the visitor to walk around and scan what is in the tank, as both of the other options do.

2. The second interactive app idea is the "Explore Our Coral Wall" QR Code app. The visitor starts out with an iPad and the app prompts the visitor to either scan a QR code on the wall to learn more about the coral in the tank or the user has the option to press on a button to quiz themselves about the coral in the tank. Each of the QR codes will be spread out on the glass of the coral wall next to the corresponding coral for visitors to scan. As visitors walk around and are looking at the coral wall, they have the interactive ability to choose what they want to learn more about. The drawbacks of this option are that the user may not want to scan every code on the wall because there is no end goal like filling the virtual tank, as in option 3 below. This will result in visitors scanning a few codes and then losing interest in scanning all of the codes on the wall.

3. The third interactive app idea is the "Virtual Tank" app. The virtual tank idea is a game in which the visitor starts out with an empty virtual "tank" that they can fill up with coral and fish. In order to add coral and fish to their virtual tank, visitors have to scan a QR code on the coral wall. The QR codes will be on the glass of the coral wall where different types of coral and fish usually reside. Once the visitor scans a QR code, a screen will pop up with information about a certain type of coral or fish. Users will then have to answer a question correctly in order to add the species of coral or fish to their tank. The interactivity portion of the app is strongly highlighted in this design because users will have to be moving around, scanning QR codes on the tank, and answering questions about the coral and fish. The visitor will have a feeling of accomplishment as they fill in their virtual tank. We feel this is the best option because visitors will be more enticed to learn about the coral tank as they want to get the satisfaction of filling their tank. Even though this is the option we think will be best for engaging visitors, it is likely to be the most difficult to develop and may not be the most feasible option.

Figure 7: On the left is the home screen for the first interactive idea the "Explore Our Coral Map". The middle is the home screen for the second interactive idea the "Explore Our Coral Wall". The screen on the right shows the third and final interactive idea the "Virtual Tank"

3.3 Building and Testing Educational Application for Coral Wall

This section highlights our results from building part of the app in Swiftic and testing the app with focus groups. The Swiftic app contains the information from the first result, as well as a form to help the LRF gain information demographics about who is coming to visit the coral wall. An "About Us" screen was also added to the app to help guests better understand what the LRF's mission is, as well as to promote their social media pages.
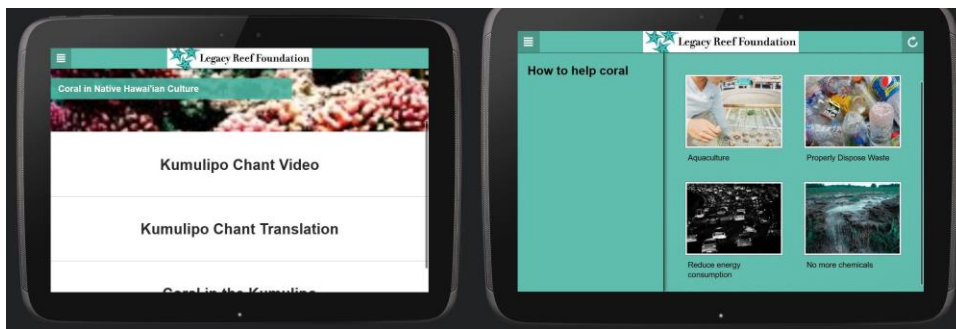
Figure 8: The screen on the left is the "Coral in Hawaiian Culture" screen where guests can listen and read about the Kumulipo chant and how coral are connected to the chant. The screen on the right is the "How to Help Coral" screen where guests can learn how they can help protect coral reefs.

The screen on the left in figure 8 is what appears when the visitor clicks on "Coral in Hawaiian Culture" on the app's initial page. The visitor can click on any of these three buttons and it will bring them to either the YouTube video of the Kumulipo chant, the English translation of the chant, or further explanation on what the Kumulipo means and details about how the chant relates to coral. This is different from the corresponding sections on the storyboard because of the limitations of Swiftic; we were not able to embed these features into the Swiftic app as we wanted to do, and clicking on the links takes users out of the app.

The screen on the right in figure 8 displays what people see when they click on "How to Help Coral". The visitor can see images and text depicting four different ways to help coral and can click on each one to learn more. This is different from the storyboard because there is no general information on the main page to entice the visitor to read more due to the developing

limitations of Swiftic. Another difference is we were unable to add the social media links shown on the storyboard which was the main interactive component for this part of the app. These missing pieces are due to the restrictions of using Swiftic as an app building software. To see all screens that the app includes and how they differ from the storyboard, see Appendix H.

We held a total of four focus groups with individuals who agreed to give us feedback about the app. On February 20th, we introduced the app to a group of eight WPI students. These students lacked knowledge on coral reefs but were proficient in using mobile apps. On February 26th, we travelled to the charter school, WHEA (West Hawaiian Explorations Academy) to test the app with a group of five high school students. These five students were working on a major research project about coral reefs for school at the time of the focus group and had significant knowledge on that subject, as well as on how to use mobile apps. On February 25th and 26th, two separate groups of professional divers associated with the LRF tested out the app as well. These two groups were very knowledgeable on coral reefs but were inexperienced in using mobile apps.

All four focus groups were productive and beneficial for us in the feedback they gave. All groups had similar thoughts, providing feedback that the app contained important information about coral reefs and was educational. All four groups, however, also talked about how the information displayed was too long or too in depth and could bore potential guests of the LRF. Some of the feedback from the WPI students was that the information should be displayed in small paragraphs rather than bullet points or long paragraphs. The WPI students also gave feedback saying the pictures and colors of the app could be better to grab the attention of the user. The WHEA students gave feedback to display the information in a way that catches the eye of the user, for example making an infographic. In figure 9 is an example of an infographic that could be used within the Swiftic app. The WHEA students gave the suggestion to address proper reef etiquette regarding tourists' interactions with coral reefs.

Figure 9: This is an infographic explaining 4 ways that tourists of Hawai'i can show proper reef etiquette. This is an example of an infographic that can be used in the Swiftic application and be a template for future infographics made by the LRF.

The two diver focus groups provided the feedback that the information included in the app was, at times, too in depth and should become more broad. Some pieces of information in the app were very complex, and the divers thought that guests could become confused when reading it. Another piece of feedback from the divers was to get rid of the raw materials section in the "Importance of Coral" section, as Hawai'i does not use coral for jewelry, and most people do not practice proper coral collection techniques which require obtaining a permit. The notes from the focus groups can be found in Appendix I.

3.4 Establish Plans for Future Development of Application

This section highlights our plan for how the LRF can improve their app once we have finished the project. The instructions cover topics from how to edit an existing feature within the app using Swiftic to how to analyze the data collected from the Google form within the app, so the LRF can understand the demographics of guests visiting their coral wall exhibit. For the full guide on how to improve the section see Appendix J.

After sitting down with Susanne Otero, we identified the most important criteria for freelance app developers and software development companies. We had a discussion with the LRF and told them that for creating this app alone, it would be an economically smart decision to initially hire a freelance developer. During our research, we observed that the cost of projects worked by freelancers was much lower than the minimum cost the LRF would have to pay in order for a software company to create their app. If the coral wall and app are successful, then the LRF should consider switching to a company as they expand and need multiple developers to work on a number of exhibit apps. To view the full tables as well as the tables of the top candidates for both freelance developers and app building companies described in this section, see Appendix K.

The main criteria for freelance developers is jobs worked, job success rate, average feedback, and hourly rate. The required number of jobs worked was decided to be more than 20 because that was the average number of jobs worked. Having more than 20 jobs worked put that developer at the above average range which we and Susanne Otero felt was sufficient. The average job success rate was 90%, so we decided a developer with a success rate above 90% would be sufficient in that category as well. The same reasoning goes for the average feedback category. We did not filter the rate per hour when finding the top four freelance developers. This

is because Susanne wanted us to use the three initial filters to ensure the quality of a freelance developer's work, and then see how much it would cost to hire someone who met the desired criteria.

The first category we identified as a top criteria for a software development company is a focus on mobile app development. We determined having a company focus 50% or more on developing mobile apps was satisfactory because that meant the majority of their work or at least half, was mobile app development orientated. Choosing a greater percentage than 50% would significantly limit the companies we could recommend before even taking the other criteria into consideration. The next category was an educational focus. While this is important for the educational app, we decided that we would not set a filter for this criteria, and instead see what results we obtained from the other filters. The number of reviews was filtered to be greater than 30 to ensure there was enough feedback from previous customers of the company to help determine customer satisfaction and success. All companies on Clutch had reviews well above 4.70 stars and general comments that were not helpful when comparing the companies. Thus, it was more important to see how many clients the company had worked for because the reviews for all companies were indistinguishable. Clutch also listed each company's minimum contract size for development work. The minimum project size was kept to be under $10,000 because as a non-profit organization, Susanne said the LRF could not initially afford more than that. She also voiced that the LRF would want to see the company's quality of work before spending more than $10,000.

4.0 Synthesis and Recommendations

This chapter highlights the overall progression of the project, where the project stands as we leave the LRF, and what steps the LRF should take next to complete the creation of the coral wall app.

4.1 Synthesis

We made significant progress during the past seven weeks towards creating an app for the LRF that guests can use while visiting the coral wall. The final version of the app, however, has yet to be developed. The weakest result of our project is the Swiftic app that we created. The inability to create an interactive app using Swiftic prevents the app from being a long-term solution for the LRF. Because of the information we collected, the LRF has the necessary content and design they need for the coral wall app. In addition, we were able to provide the LRF with three strong sets of interactive storyboards, displaying ways the app can be connected to the coral wall and providing a design for future development of the app. The LRF's mission centers around educating people to induce positive change in the way they interact with coral reefs. Providing three different storyboard options allows the LRF to decide which design will best help them achieve their goal of education and be implemented in the final app.

The LRF can take a few steps once we are finished with our IQP. The first is to conduct more screening on the freelance developers we have identified in the filtered table in appendix K. This screening process may include reaching out to each individual freelancer and explaining to them the goal of the coral wall app. Once the LRF has found a candidate that they are confident with, they should consider hiring that freelancer to create a new app. This app should include one of the three interactive ideas we storyboarded that could not be included in the Swiftic app. The reason for creating a new app instead of having the freelancer edit the Swiftic app is because the Swiftic software is so limited that it does not have the capabilities to build the interactive ideas for the coral wall exhibit. Once the new app is created by the freelance developer, the LRF should conduct another set of focus groups. This will allow the LRF to receive feedback on the interactive components of the new app and have the freelance developer make alterations to the new app based on the results of the second set of focus groups.

If the coral wall is installed and ready for visitors to see before the final application is ready, the LRF can still use the Swiftic app that we created as a placeholder. Although the

Swiftic app has very little interactivity, guests can still gain valuable knowledge about coral reefs. A new app developed by a professional freelancer is needed in order for guests to have an app that is connected to the coral wall, opposed to an app that simply has general information about how to help coral reefs. Once the final app is complete and ready to be used with the coral wall, it can be swapped out with the Swiftic app. This will allow LRF visitors to use an app that is connected to the coral wall tank they are visiting.

4.2 Recommendations

As an outcome of our work, we have identified a number of specific recommendations for how the app and the coral wall can best be used to help the LRF further its educational outreach goals.

Recommendation 1: Collect data on educational effectiveness of final application

The first recommendation is to have the interactive portion of the app collect data on how effectively visitors are learning the information about coral. All three interactive components that we storyboarded include a quiz portion where the guests answer a question about coral or fish based on the information they just learned. We recommend that the LRF coordinate with their software developer to ensure that visitors' responses can be collected from the app to provide data on their knowledge about coral reefs. This data can help the LRF understand whether or not guests are effectively learning the information about the corals, and provide insight into how they can change the app to improve guest learning. For example, if the data shows that guests are taking one to two tries to correctly answer questions, then that might indicate that guests are effectively learning about the coral and fish. If the data shows that app users are taking three or more tries to answer a question correctly, then the LRF might infer that app users are not learning the information effectively. Based on the data, the LRF can understand what interactive components or content areas are most effective in the app. The LRF can then change the app accordingly, so information on all coral and fish is conveyed in an effective way.

Recommendation 2: Include incentives for LRF visitors to encourage participation

The second major recommendation is to include raffle giveaways into the interactive portions of the final application. The idea is to have opportunities on the quiz portions of the interactive app for the LRF visitor to enter an email or post to social media to be entered into a raffle giveaway. The main purpose of these raffles is to increase the participation of visitors within the app. The main motivator for this idea is that visitors will want to be entered in the

raffle, but in order to be entered, they would have to complete the quiz in the app. We are aware that guests may just keep guessing in order to complete the quiz and be entered into the raffle. However, we believe guests will be more likely to learn about coral reefs if they were to guess and complete the quiz, rather than only answer part of the quiz and then not finish the whole quiz. As a startup, nonprofit organization, the LRF may not use this idea for the initial launch of the coral wall. However, if the coral wall is a big success and the LRF decides to expand, then implementing the raffle could become a possibility.

One raffle we thought could work was to have the guests enter their email for a chance to win a free LRF T-shirt or sticker once they complete their quiz. After some period of time, a month for example, the LRF can pick one of the emails during the time period as the winner of the free prize and notify them.

Another raffle follows the same concept as giving away a free T-shirt or sticker, but instead of entering an email, the guest has to post some sort of social media saying they visited the LRF. This social media post can be an Instagram picture of them at the coral wall exhibit and include the LRF as the location, or a tweet where they have to say they were at the LRF and use a hashtag like "#myLRFvisit". These social media posts will promote the LRF and help the organization become more renown for their work. After a certain time period, the LRF can search the social media platform they decide for either the LRF location or the hashtag and pick a post from that time period as the winner.

Apart from the main benefit of including a raffle which is to increase the participation of LRF guests to complete quizzes and possibly be more likely to learn how to help coral, there are possibly extra benefits that could arise from implementing a raffle giveaway. One extra benefit is the giveaway could raise the local profile of the LRF and attract more visitors. If someone who has not visited the LRF sees someone wearing an LRF T-shirt, they may want to know more about who the LRF is and visit their website or go see the coral wall tank.

Recommendation 3: New ways to connect to old guests and intrigue new guests to visit

Our final recommendation is that the LRF should implement a few changes that are intended to keep visitors connected to the organization, as well as intriguing new visitors to come visit the LRF. Keeping old guests connected can help grow the LRF profile because if the LRF can have past guests want to come back, then they can bring friends who may not have visited before. One way the LRF can stay connected to past guests is if they send out monthly and

yearly emails highlighting updates to the coral wall and app. These updates can range from new coral being added, to the app having a new interactive activity. The email can close with the LRF telling the past guest to come check out the new changes at the coral wall.

One way we thought the LRF could intrigue new visitors to come in is by having a live video stream of the coral wall playing on the home screen of the LRF website. When someone who has not visited the LRF hears about the organization, either from someone who has visited or by seeing a t-shirt possibly from the giveaway explained above, the first thing they will want to do is go look at the LRF's website. If the first thing that someone sees on the LRF website is a live stream of the coral wall tank, they will become interested and possibly want to go visit the coral wall. This idea can also keep past guests connected because old guests who have already been on the LRF website know about the coral wall live stream. If an old guest were to go back to the LRF website to see the coral live stream, and they saw a new fish or a different type of coral, they may want to go back to the LRF to see the new organism in person.

4.3 Conclusion

One of the LRF's three major objectives is to educate people of all ages on how we depend on the ocean and its coral reefs. Finding unique ways to encourage the general public to understand why coral reefs are important is significant to the LRF's future success. Their coral wall exhibit is designed to attract visitors to come and visit the LRF. By incorporating an interactive app to guide visitors through the exhibit and effectively teach guests how to protect coral, the LRF will ensure their coral wall exhibit is engaging and will be one step closer to achieving their desired mission as an organization.

Our work has involved devising a plan that the LRF can use to create this final application through the interactive storyboards we designed and the final freelance developer table we composed. Our efforts as a team have also provided the LRF with a Swiftic app that can provide guests with basic knowledge while the final app is being built. We documented ideas that could be used in the future to help improve the final app and increase the LRF's engagement with its guests. We are confident that by following the steps we outlined for the LRF, the coral wall and interactive app that is connected to the exhibit will be successful. We hope that our work over the past two months will help the LRF get closer to achieving their educational mission as a non-profit organization and expanding their profile.

References

Aquarium Domain. (2020). Aquarium Domain | Freshwater and marine aquarium hobby online resource and community Retrieved from http://aquariumdomain.com/

Albertazzi D, Ferreira MGG, Forcellini FA. A wide view on gamification. *Technology, Knowledge and Learning*. 2019;24(2):191-202. https://doi.org/10.1007/s10758-018-9374-z.

Babich, N. (2017, October 25). The role of storyboarding in UX design. Retrieved December 1st, 2019, from https://www.smashingmagazine.com/2017/10/storyboarding-ux-design/.

Barbier, E., Hacker, S., Kennedy, C., Koch, E., Stier, A., & Silliman, B. (2011). The value of estuarine and coastal ecosystem services. *Ecological Monographs, 81*(2), 169-193. www.jstor.org/stable/23047554

Barnes, R.D. (1987). Invertebrate zoology. Fort Worth, TX: Harcourt Brace Jovanovich College Publishers.

Bell, P. (2009). Learning science in informal environments, people, places, and pursuits. Washington, DC: National Academies Press.

Brander, L., & van Beukering, P. (2013). The total economic value of U.S. coral reefs. Retrieved from https://data.nodc.noaa.gov/coris/library/NOAA/CRCP/other/other_crcp_publications/TEV_US_Coral_Reefs_Literature_Review_2013.pdf

Coral Reef Alliance. (2019). Coral Reef Alliance | Saving the world's coral Reefs. https://coral.org/

Division of Aquatic Resources. (2015, August 15). Coral and live rock rules of Hawaii. Retrieved from https://dlnr.hawaii.gov/dar/habitat/coral-reefs/coral-and-live-rock-laws-of-hawaii/

Ferrario F., Beck M., Storlazzi C., Micheli F., Shepard C., & Airoldi L. (2014). The effectiveness of coral reefs for coastal hazard risk reduction and adaptation. Nature Communications, 5(1), 3794. https://doi.org/10.1038/ncomms4794

Frieler, K., M. Meinshausen, A. Goll , M. Mengel , K. Lebek, S. D. Donner and O. Hoegh-Guldberg. (2012). Limiting global warming to 2°C is unlikely to save most coral reefs. *Nature Climate Change*. *3*(2), 165–170. https://www.nature.com/articles/nclimate1674.pdf

Georgia Aquarium. (2020). Georgia Aquarium | Experience the world beneath the waves. Retrieved from https://www.georgiaaquarium.org/

Gilliam, D. S. (n.d.). Establishment and maintenance of a coral nursery | National Coral Reef Institute Research. https://cnso.nova.edu/ncri/research/establishment-maintenance-coral-nursery.html

Hoegh-Guldberg, O., Mumby, P., Hooten, A., Steneck, R., Greenfield, P., Gomez, E., et al. (2007). Coral reefs under rapid climate change and ocean acidification. *Science, 318*(5857), 1737-1742. www.jstor.org/stable/20051804

Hughes, T. P. (1994). Catastrophes, phase shifts, and large-scale degradation of a carribean coral reef. *Science, 265*(5178), 1547.

Justinmind. (2017). User personas, scenarios, user stories and storyboards: what's the difference? Retrieved from https://uxplanet.org/user-personas-scenarios-user-stories-and-storyboards-whats-the-difference-cf00315f0799

Kamehameha Schools. (2020). Admissions and program enrollment Kamehameha schools. Retrieved from https://apps.ksbe.edu/admissions/

Kravec, N. (2018, February 27). Before reefs become deserts: keeping coral healthy in Hawaii | Stanford News. Retrieved from https://news.stanford.edu/2018/03/01/reefs-become-deserts-keeping-coral-healthy-hawaii/

Lalli, C.M. and Parsons T. R. (1995). Biological Oceanography: an introduction. Oxford, UK: Butterworth-Heinemann Ltd. pp. 220-233.

Legacy Reef Foundation. (2019, October 22). Home - legacy reef foundation. https://legacyreeffoundation.org/

Levinton, J.S. (1995). Marine biology: function, biodiversity, ecology. New York: Oxford University Press, Inc. pp. 306-319.

Lutfi A., Daisuke T., Hai X. L., Tai C. T., Kok B. T., Chin Soon L. Ng, Caranzo Cabaitan P., Loke M. C. & Tiancheng S.. (2017). In situ nurseries enhance coral transplant growth in sedimented waters. *Marine Biology Research*. Retrieved from https://www.tandfonline.com/doi/full/10.1080/17451000.2017.1307988

Maunder, J. (2017, April 1). Gamifying museums pt 2. - Aardman and the American Museum of Natural History on the dos and don'ts. Blooloop. Retrieved from https://blooloop.com/features/gamification-museums-aardman-amnh/

National Oceanic and Atmospheric Administration. (2019). Coral reef ecosystems | National
    Oceanic and Atmospheric Administration. Retrieved from
    https://www.noaa.gov/education/resource-collections/marine-life-education-
    resources/coral-reef-ecosystems

NOAA Office for Coastal Management. (2019, July 8). Coral reefs. Retrieved from
    https://coast.noaa.gov/states/fast-facts/coral-reefs.html

Rennie, L., & McClafferty, T. (1995). Using visits to interactive science and technology centers,
    museums, aquaria, and zoos to promote learning in science. *Journal of Science Teacher
    Education*, 6(4), 175-185. https://www.jstor.org/stable/43156044.

Rogers, C. S. (2019). Immediate effects of hurricanes on a diverse coral/mangrove ecosystem in
    the U.S. Virgin Islands and the potential for recovery. *Diversity*, *11*(8),
    130.http://dx.doi.org/10.3390/d11080130

Rozendaal, M., Vermeeren, A., Issidorides, D. (2018). Using mobile technologies to capture the
    visitor experience. Pp. 239-258 in Museum Experience Design. Vermeeren, A., Calvi, L.
    Sabiescu, A. Crowds, eds. Springer. Retrieved from
    https://link.springer.com/content/pdf/10.1007%2F978-3-319-58550-5_12.pdf

Seale, C. (2012). Researching society and culture(4th ed.). Sage Publications Retrieved from
    https://books.google.com/books?hl=en&lr=&id=uhBCvNlypL4C&oi=fnd&pg=PA181&
    dq=advantages+and+disadvantages+of+interviews+and+surveys&ots=bEYU_1hV4D&si
    g=AKJGLbrwU8F-AdX63PcygTtNK50#v=onepage&q&f=false

Spalding, M. D., Brumbaugh, R. D., & Landis, E. (2016). Atlas of ocean wealth. Retrieved from
    https://oceanwealth.org/wp-content/uploads/2016/07/Atlas_of_Ocean_Wealth.pdf

Sumich, J.L. (1996). An introduction to the biology of marine life. Dubuque, IA: Wm. C. Brown.
    pp. 255-269.

United States Environmental Protection Agency. (2019, September 5). Coral reefs | US EPA.
    Retrieved from https://www.epa.gov/coral-reef

Waikiki Aquarium. (2020). Waikiki aquarium. Retrieved from
    https://www.waikikiaquarium.org/

Wilkinson, C. (2004). Status of coral reefs of the world: 2004 (Volume 1). Retrieved from
    http://www.icriforum.org/sites/default/files/scr2004v1-all.pdf

Appendix A: Content Outline for Application supplied by the LRF

![Legacy Reef Foundation logo]

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Content outline for

Coral Education Center educational app

The app should be a flexible product, allowing us to expand the content with time

It may be that the final product will have three versions of the content, one for each age group: non-reader/early readers, school children and adults.   However, we should start with a pilot version and that could be targeted to only one group for now.

The following outline could be used as follows: the higher-level sections (in black) can be covered in the pilot with the subsections(in other colors) serving as a guide of what could be included in updates of the content.

1) Coral and its place in Hawaiian creation story and in today's Hawaiian traditions regarding our relationship with the ocean.   Then add if time/resources permit…
    a) Excerpts from chants in both Hawaiian and translated to English

b) Link to a YouTube short video of chant performance or other cultural activity directly related to coral.

c) Examples of rules in place during the Hawaiian kingdom that promote respectful and sustainable ways to enjoy the natural resources: fishing permitted at certain times for certain species when they are spawning, avoiding fish that are too small, or females that may be pregnant. Etc. We need to consult with local lore experts for this material,

2) Coral ecosystem importance – intersection of western science with Hawaiian ancient knowledge. Food security for many coastal communities. Then add if time/resources permit…

a) Herbivores role in coral health

b) Examples of sustainable commercial fishing

c) Graphic examples of contamination – microplastics in the coral?

d) Are there any newspaper articles or other published data addressing food security, mass migration etc that may result from a decline of the reef?

e) The 5 corals one is more likely to encounter snorkeling in Hawai'i.   Each with one to three interesting facts

f) Coral reproduction – types

3) Current situation, threats. Current situation globally and then in Hawai'i specifically. Threats globally, and explaining which of the stressors are more at play in Hawai'i

4) Our role in mitigating, delaying, repairing.   Reuse, reduce, recycle, with emphasis in reducing.

a) Ways to reduce : use Social Media? to share and promote solutions and ideas that reduce use of any material.

b) LRF role in conservation and restoration and its role in food security for coastal communities.

c) Donate, adopt a coral, participate, share in social media , ask for government support for programs like ours– Ways YOU can help

d) Examples of aquaculture of corals, ornamental and consumable fish– controversial?

e) Link to papers explaining challenge of scaling up and community support

Appendix B: Interview about Cultural Significance of Coral Reefs to Hawaiʻi

We are a team of students from Worcester Polytechnic Institute in Massachusetts. We are conducting interviews with you to learn more about the connection historically and culturally Hawaiʻi has with its coral reefs. This is a collaborative project with the Legacy Reef Foundation. Our goal is to build an interactive application to help educate visitors of the coral wall exhibit and your insights will be extremely useful. Your participation in this interview is voluntary and you may opt out at any time. If you would like, we would be happy to include your comments as anonymous. If interested, a copy of our results can be provided at the conclusion of the study

- How were the native Hawaiian communities on the islands connected to the reefs?
- Are local communities connected in the same way now?
- What does the Kumulipo creation chant mean in terms of coral and its connection to the creation of the Hawaiian islands?
- How did the Kumulipo creation chant play into the view of coral in Hawaiʻi in the past?
- Are there other significant coral chants that are important in Hawaiian history?
- Besides chants, are there any legends or stories that talk about coral and their connection to Hawaiʻi?
- Are people in local communities as in touch with the history of coral in Hawaiʻi as much as in the past?
- What are people in the Hawaiian community currently doing to help preserve the reefs?

Interview with JennyRose Coney

Jenny (J): Hello.

Noah (N): Hi Jenny, My name is Noah.

Team LRF: I am Danya, I am Haley, Kevin.

N: Alright so we are a group from WPI working with the Legacy Reef Foundation building the application to go with their coral reef exhibit, do we have permission to record this interview?

J: Yeah sure, go ahead.

N: And then I just have to read this preamble I guess, asking you some questions that we are required to. We are a team of students from Worcester Polytechnic Institute in Massachusetts. We are conducting this interview with you to learn more about the connection historically and culturally Hawaiʻi has with its coral reefs. This is a collaborative project with the Legacy Reef Foundation. Our goal is to build an interactive application to help educate visitors of the coral wall exhibit and your insights will be extremely useful. Your participation in this interview is voluntary and you may opt out at any time. If you would like, we would be happy to include your comments as anonymous. If interested, a copy of our results can be provided at the conclusion of the study. Do we have your permission to record this interview for our record?

J: Yes.

N: Alright, awesome. Alright so our first question that we have for you is how are the native Hawaiian communities on the island connected to coral and the reefs?

J: Okay, so present day Hawaiian people you know we fish a lot and fish are connected to corals and ecosystems, so once the corals start to suffer it really affects the whole ecosystem so that affects fishing and things like that. In a more broader sense, coral is technically the common ancestor of all Hawaiians according to Kumulipo which is like our origin chant. I guess a good comparison would be the story of Adam and Eve in the Bible.

N: Alright, so do you still think that most local communities still feel that connection with the Kumulipo and with the coral today?

J: Oh yeah, one hundred percent. Anyone who has their head screwed on straight really feels the connection- it is there.

Danya (D): Going off of that, what does the Kumulipo creation chant mean in terms of coral and its connection with the creation of the Hawaiian islands?

J: Yeah so the Hawaiian islands, they were- this all like you know myths story-type things- but they are pulled out of the ocean by Maui. So coral, it was the first living thing. It was the first thing to come out of the darkness, so it is directly related to the creation of the Hawaiian islands.

D: How did the kumulipo creation chant play into the view of coral in Hawai'i in the past?

J: In ancient Hawai'i- Hawaiian people are extremely spiritual- so coral is viewed as an ancestor or a deity. So, very important and very sacred.

Haley (H): Are there any other significant coral chants that are popular in Hawaiian history or relevant at all?

J: I would say the most relevant is the kumulipo. It is pretty much the chant of all chants for us, so that is something I would focus on. And I can send you guys some links about the kumulipo and stuff like that.

H: What are people in the Hawaiian community currently doing to help preserve the reefs?

J: Well yeah there is alot going on. The Legacy Reef Foundation is a big one. The Kohala Center as well, their main focus is agriculture but their ocean-based stuff is also very important. On an individual level, just communities, overfishing and regulation and stuff like that and just being conscious is an integral part of our culture but is just becoming emphasized I guess you could say.

N: My only other question is do you know of any other legends or stories that talk about coral and how they connect to the people of Hawai'i and the island of Hawai'i.

J: You know, not off the top of my head, but I know they exist, so I will do some further research and I will send that over as well.

N: I think that is everything we really wanted to ask from you. It has been very helpful having this conversation. I appreciate you taking the time.

J: Yeah, no problem.

H: Do you actually know of any good YouTube videos of the Kumulipo chant?

J: Yeah, yeah, I think it is like a two thousand line chant. It is extremely long but it is really beautiful to listen to. I will send over some links.

Team LRF: Thank you so much. Bye.

Interview with Professor Puniwai

Kevin (K): ([00:04](underline))

Can you hear us?

Professor Puniwai (P): ([00:06](underline))

Uh yep. Sorry. Just put it on my speakers.

Haley (H)3: ([00:20](underline))

How are you doing?

P: ([00:21](underline))

Hi. So are you guys in Kona right now?

Noah (N): ([00:24](underline))

Well we are in Hilo right now? Yeah, we are traveling out to Kona Monday.

P: ([00:32](underline))

Right. It is a nice overcast day. Not too hot at base, huh?

Danya (D): ([00:36](underline))

Yeah.

N: ([00:39](underline))

My name is Noah. I am Danya. I am Kevin. I am Haley. Um, so we are students from, WPI, doing a project with the legacy reef foundation. Um, so do we have your permission to record this interview for our record. Awesome. Okay.

P: ([00:59](underline))

Do you want to record it through zoom or are you going to use something else?

N: (<u>01:02</u>)

We just have our phone next to the computer using voice memos

P: (<u>01:06</u>)

cause I can just press the record button and you could have the entire audio and video file. Oh,

P: (<u>01:19</u>)

no, it just started

N: (<u>01:20</u>)

I have to read this paragraph with some questions. So we are a team of students from Worcester Polytechnic Institute in Massachusetts. We are conducting this interview with you to learn more about the connection historically and culturally Hawai'i has with the coral reefs. This is a collaborative project with the legacy lead foundation. Our goal is to build an interactive application to help educate visitors of the coral wall exhibit. And your insights will be extremely useful. Your participation in this interview is voluntary and you may opt out at any time if you would like, we would be happy to include your comments as anonymous. If interested. A copy of our results can be provided at the conclusion of this study. Do we have your permission to record this interview for our record?

P: (<u>02:07</u>)

Yes, I agree.

N: (<u>02:09</u>)

All right, so, uh, the first question we had is, um, how are the native Hawaiian communities on the Island connected to coral Reese?

P: (<u>02:28</u>)

I think it is hard to focus on the communities on this Island.

K: (02:33)

Alright.

P: (02:34)

I think we have to just go back to the worldview of how,

P: (02:39)

Kanaka Maoli kind of understand coral reefs as part of their genealogy. And then, so I do not know if you want like the broad overview first and then narrow it down or just kind of the general,

K: (02:52)

yeah, I think broader than narrowing it down is better information wise. Cause we are asking a couple of people like all the same questions. So the answers are kind of more general so far.

P: (03:10)

Yeah, because I do not think, I mean people have specific connections to their particular reads, but the general idea and understanding I think is much larger. Have you read the paper that McKinney Greg and Lucas wrote on the significance of corals to, um, in ethnobotany of coral reefs? So chapter in a book and there is a book called the ethnobiology of coral reefs and I think they do a really good, um, summary to start. Um, so I would have to kind of look in there, um, kind of look up that article. Let me see. I have, I can get you that thinking a little bit. I had my students read it last week.

P: (04:06)

I think they go back to your coral reef being, you know, the first living creature that was created as part of the kumu lipo. And so when you go back to the Kumulipo as our creation story, it talks about how we as a people are all created, um, and are born from the rest of these and how we are related to all the rest of the creatures on our islands. I want to share with you the, um, this is the title of the book, the ethnobiology of corals and core Corby's by narci and price. Hmm. And then, um, so I think I have teens that they write about corals from very multiple, um, traditional

perspectives. So chapter seven, my head CLA, um, was written by Makani, Lucas and John. So I think that is also a good thing to cite. You are looking for these significance.

P: (05:17)

I think it is hard for people to understand the significance of a coral reef if you do not really understand the significance of your genealogies and how the creation story really sets up the foundation for how you relate to other creatures. Um, so that term, you know, more than human are our coral friends or core religions, our tree, you know, the tree people, the fish people when we call them that think it shows you how we do not think of it as just another living thing that exists that you love, but how you are related to that living thing and how it is life and its significance is related to your significance on this, on this earth. Um, so when I think of how Hawaiians think of coral reefs, they might not understand the biology and how it functions or be able to identify the various different species. Cause most, you know, most people who dive or fish or are connected to the ocean, they recognize the function and the life that that reefs provide.

P: (06:28)

But it does not mean they are going to know each individual species cause the significance is in the life of the entire organism. It is an entire reef as a whole. Um, and so that interconnectivity in that relationship exists. Um, because you, you know, the whole family, you know, you do not just say, I am going to love this cousin more than this cousin. Like you are seeing them as all relatives of yourself and knowing that their function is to exist and live and because they exist in life, everyone else can exist in. Um, and I feel like the community pool is really telling us that the functioning of coral because that is the opening of the creation story is set on that intertidal restage is that we realize how important to our islands these areas are. And we go through that life cycle. So, but we talk about that life cycle of these reefs and how they change through time. Um, but we recognize in the beginning, you know, the life that they provided.

N: (07:30)

Okay. Um, another question I have that is pretty similar is do you think that local communities were more connected with coral and felt a better connection back in the day? Or do you think

that, um, communities still feel as connected with the coral today as they would have been in the past?

P: (07:49)

And you mean communities as in people who live on this Island?

N: (07:52)

Yeah. People from the Island.

P: (07:56)

yeah, cause I think there is such a variety. I cannot say that correctly, but there is such a diversity of communities on our islands now that I would not, I would not be able to like, guess of how they interact with the coral reefs. Um, but there are many people who do not even understand what life underneath the ocean looks like. And so no, I do not think they have that connection. Um, I think the connection in the past was strong because we relied on it for our survival and because we related to them as family and as we forget that connection. Um, I think right now there is a time of trying to reconnect and that is just a normal life. Right. And families, sometimes you already close and then you kind of move away for a little while or you forget how important that connection to your grandma was and then you come back to it.

P: (08:49)

And so I think right now we are in that part of the cycle where we are coming back to how important those relationships are because we did not think of as that in parts and in our life. Um, just like we do in our own families and you forget how much you need your mom and then, you know, you go out and you mess up and you come home. And that is what we are doing right now. I think a lot of people were thinking that, Oh, their relationship to it was cute. They needed it to survive, but now we do not need it to survive. We can go buy food at the store and we can, you know, ship in our stuff. Um, and then now we are coming again back to the next realization that we cannot do that. We need to hold you back, um, and build those relationships again.

P: (<u>09:23</u>)

So I think the relationships are kind of cyclical. Um, and it was definitely something that they are tied to before. But I think I would not downplay the significance it plays on communities now. I think, you know, some people, their worldviews are different and so in their world view, they still might have coral reefs as a significant part of their cultural view, but it might be an economic view. So they might really believe that economics that they read saying we need coral reefs to act as a short break. We need coral reefs to protect their shorelines. And so they will value it in that regard. It is a different sort of value, but I am not seeing it any less. It is just part of their review on how significant that reef is to them. Um, and the same goes to, you know, tour operators, tourists. Um, it is hard to say what a tourist's perspective or significance of the reef is cause we did not have tourists in the past. And so, um, yeah, I do not know. It is hard to, I would not want to talk for other communities, but the communities that have continued their ties to reefs, I feel like it is just as strong as it was in the past.

N: (<u>10:33</u>)

Um, another question. Um, so we have heard about the kumulipo chant, um, but we kind of want to know what it means in terms of coral and like its connection to the creation of the Hawaiʻi islands.

P: (<u>10:50</u>)

Say that last part again. So you said you have kind of been introduced to the kumulipo, but you want to know more about the names of coral or,

N: (<u>10:57</u>)

no, just how it relates to coral and like how it relates to the creation of the islands here.

P: (<u>11:07</u>)

So the kumulipo is not a, it is not a creation chat about the Island. It is the variation in chance about the people. Um, and by people, I mean like more than people, so more than humans and humans, but it, and it might have a small part, a small section of it that talks about our islands in particular. But the channel itself is more talking about the connections, the relationships that

humans have to all of these different creatures that live here and phenomena. Um, and so a coral is that first part of the creation story. It is the first thing that is birthed. Have you guys seen a version of the Kumulipo

K: (11:51)
We have read a little bit but we are not really sure like what it really means

P: (11:57)
Okay. Um, have you guys read others sort of creation stories?

K: (12:03)
No, that was actually one of our other questions later on. It was if you know of any other chants or stories or legends about like the creation of like coral and people around Hawaiʻi

P: (12:15)
Well I just want to increase your stories in general. Like have you guys done a little bit of, that is how you understand how things are significant to people is you read their creation stories.

K: (12:24)
Yeah. Okay.

P: (12:26)
So that is kind of what I do in some of my classes. It is hard to understand the significance of the community. People if you do not realize the significance of the creation story of other people's. And so, you know, you can go back to the, well, you can go back to Greece, you can, you know, we know the mythology. Some of Greek mythology, right? Those are their creation stories. And in their gods you can see what is important to them. So if you read the creation chant of the Chinese and go, um, then you will understand some parts about the Chinese people. And so, then the same thing is the Bible is a creation story for Christians, right?

P: (<u>13:09</u>)

And in that, in the beginning of these trends usually are the things that are the most important. Cause that is what was created for us. And so when you read these creation chants, you kind of understand how they look at the world and how their cultures, um, organized around it in a bit. Um, and so when you are like the Norse mythology, you know, the cow is a really big part of their other mythology. And so they needed a lot of sustenance. The cow was that in China. Um, it was from the aid that they were born in, um, Alaska, some of the peoples, um, they were born from the sea. And so in Hawaiʻi, our creation chance starts with the heavens. Um, having all this cataclysmic change and then from the heavens, um, creating all this tribulus in energy, the first thing that was born was the coral.

P: (<u>14:04</u>)

And so that means it was born. It was birthed. Um, it was separated from the rest of creation. And so that coral was the first thing that was born. And then after the coral polyp itself, so first the coral polyp was born and then after the coral polyp, then the reefs were born. And so they recognize the individual coral and then the reefs pop up. The long corals, although those corals are the different types of reefs that came from that individual birthing. And then after the coral was born. And then we have a lot of the invertebrates that live along the intertidal reef that were born after them. And then it goes on and on and on, you know, up to birds and flying things. And then man does not come about until the eighth era of the kumulipo so way down the line. And so that is how we understand that these are our ancestors and, sort of how you relate to them to different creatures in the community will be connected to where they were born along that spectrum. And so things that were born in the very beginning are of the highest status. And that is the kind of way I read it is that those first, even though they were named, you know, they kind of named them, Oh, there is the, I do not know how many, do you guys know Marine invertebrates?

P: (<u>15:37</u>)

Okay. So at names like the comers and the sea stars and the sea urchins. Um, and nowadays, not everyone might know what it is, but I have been trying to teach you, but like that is the first bar. That is the foundation that needs to exist before everything else could happen. And so after that

foundation of invertebrates, then we have some fish, then we had sharks, then we had plants and vines and crawling things and flying things. It is all of those came after. So the creation story tells you who was the birth, just like in your genealogy. Who was born next, next, next. Thousands of lines of who was born first, second, third, fourth. But the first to be born. Um, well the night was born first. Um, have you guys been to the local Mokupapapa discovery center and Hilo yet?

K: (16:35)
No, we have actually never heard of that.

P: (16:38)
Oh, okay. You guys need to see that in Hilo. Toda i's a Friday. They are open today. It is free. It is in downtown Hilo, right at the loop. Okay, so it is NOAA. So now the NOAA outreach, um, visit center. And so they have, you can hear the kumulipo being chanted, you can see it on the wall and it is still, it is dual in Hawaiian language and in English as well. So it is a really neat display that kind of is trying to showcase to visitors the importance of our reefs and showcasing the Northwest and wearing items. Cause those are all, all our older coral reefs. Um, and how important they are to us.

K: (17:19)
Oh great. Thank you.

P: (17:20)
Yeah, I would say that is a good place to go.

K: (17:22)
All right, so like I am just linking them, reword this question all of a sudden. So we talked about the kumulipo. Is that probably the most significant creation chant for Hawaiʻi or are there a couple of other ones that might be maybe not as significant or well known but also culturally important I guess. I do not know.

P: (<u>17:52</u>)

So I guess every creation chant is talking about the creation of you know, something in the book of cartoons. So the Kumulipo is the creation chat that was written down for Kua Koula cause he was King and he was trying to show his rank of importance so that that chant is specific to the kuawa. And then there are other creation chants that might be particular about a place. And so you will hear some stories about how the islands were born and who they were born to. And so that one is, it is a piece of the kumulipo, but it is trying to showcase the burdening of the chiefs and the islands. And so they will have different reasons for different creation chants. Um, so there are other creations chants.

P: (<u>18:40</u>)

Um, I will put, most of them will be, of course, things that are written down are the people who have the power to write them down, right? So most of the things that are written down in the creation, chants of the ease of the chiefs and they are trying to fight for power by telling you, you know, how significant they are and who they are related to. I do not think coral is a big part of most of those chants because to connect yourself to the creation of the earth, you have to have really big money, right? You have to be a chief of the highest esteem to trace your lineage all the way back to the creation of this. Um, so most normal or you know, common people would not have those kinds of chants in their, in their stories.

P: (<u>19:28</u>)

Um, but there are different stories Hina is the God is, he now is sort of connected with coral. And so if you, if you try to learn a little bit more of how we envision the world, our gods are not people that are deified. Our gods are elements. They are environmental processes that we gave a name to. So it is not that we said he, Hina is a female, she is a female entity, but her energies, her functions all have to do with breathing. They have to do with the cycles of the moon. They have to do with procreation. And so the goddess of the intertidal area is equivalent to the core reef ends, all the functions the coral reef has. So if you beat a story about Hina that talks about how she is the reef and what is happening to her is what is happening on that reef. And so there is lots of difference, stories that exist that is high in that intertidal area to her functions.

P: (<u>20:30</u>)

So Hina is also the goddess of the moon, the Mahina. And we know that the, the Mahina, the moon regulates our tides, right? So the moon is related to other intertidal stuff and all the corals, they will, they will spawn based on moon cycles, you know, their based on the moon and the tides and they can only grow and start to in depth based on, you know, their condition. So that is all of Hina's function. So it is not quite a creation stories, but our stories are about about the importance of our intertidal areas. And in our reefs, in general, Hina and Kanaloa, both are kind of ocean deities. Um, so it is something that not much has been written a lot about trying to switch how, when things are written down by a missionary and how they would talk about a God versus how we would talk about our God in our sense. So our gods are these all powerful elements in the universe that has a name, but it does not mean we are deifying like a person or mad. So yeah, I do not, I think the common people and versions of the Kumulipo, there is not just one, but versions of the Kumulipo are the base source.

K: (<u>21:49</u>)

Yeah. Um, so just another question we have is, um, do you know what people in the Hawaiian community are currently doing to help preserve the reefs?

P: (<u>22:02</u>)

Like on the personal basis or how by individuals have like gathered and form groups and

P: (<u>22:11</u>)

know, there is a lot of efforts going on. So I guess I am trying to see where you want the,

K: (<u>22:15</u>)

well I would say both as an individual level. Like what would you say? Like the average person who lives on an Island is doing to help preserve reefs. And then like what, like groups or like what, like events that have happened to also help them?

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P: (22:35)

Oh, there is, there is a, there is a plethora of nonprofits that I think are trying to help our oceans. And so I think again, the reef is just part of our holistic understanding of the ocean. So there's, we might not say we are preserving the reef, but all our actions to Malama ina and take care of our Island. We know what impact the reef. And so you cannot take care of a reef by focusing on the reef. You have to take care of the reef by focusing on the health of the entire Island. Um, and so in that regard, there is, you know, hundreds and hundreds of jobs in this Island from alumni know that people understand we need to, you know, reforest we need to get rid of our invasive species that cause different, um,

K: (23:19)

okay.

P: (23:20)

Cause different effects on our landscape that will affect the reef. Um, because the reef itself is fine. It is what we are doing to the reef. So we need to change human actions. Um, so most of the people that I know are, you know, they are trying to understand fishing pressure. They are trying to understand different chemical pollutants, nonpoint source pollutants, freshwater runoff, um, chemical pollutants in freshwater streams. Um, so a lot of people are definitely worried about the impacts of things going into our aquifers and our water table that then goes out to the rapes. I mean, I think most people who are connected to this place for time are very concerned. I cannot say about people who moved here because they love the beauty of Hawaiʻi. I think that it is different and those people care for this place in a different way than the people who care for this, I know is one that feeds them. So I think most people in Hawaiʻi are very cognizant of what they put on the landscape and are trying to make sure that the impact we have on the land is minimal so that our oceans can, can survive and be healthy again.

K: (24:31)

Right.

P: (24:31)

I do not know, there is so many community groups. I cannot really talk about any particular one.

K: (24:38)

Um, I think that was all of our questions, so thank you. Very informative.

P: (24:45)

Yeah. Well, I enjoy it. Yeah. I think the Mokupapapa is a great place to start before you head out to Kona. And I know our reefs are different than Hilo side. Um, but I think we understand them in ways that people do not quite understand just because they are not like a nice coral reef that Kona has, where you can snorkel for hours. I mean, the people here still are really connected to them and the reefs are different. We have big bouldery coastlines, we have steep drop-offs. We have all these different environments, but we treasure them just the same as the Kona people will treasure their nice Sandy beaches and shallow coral reefs. Enjoy.

K: (25:20)

Thank you so much.

P: (25:23)

Okay. Have a great day.

K: (25:24)

You too.

Appendix C: Weighted Decision Matrix for App Development Software

		Software Options							
		Swiftic		**Appy Pie**		**AppMakr**		**Appery**	
Criteria	**Weight**	**Rating**	**Score**	**Rating**	**Score**	**Rating**	**Score**	**Rating**	**Score**
Cost	0.8	4	3.2	2	1.6	5	4	1	0.8
Ease of Alterations	1.0	5	5	3	3	3	3	2	2
User-Friendliness	0.7	5	3.5	4	2.8	4	2.8	2	1.4
Collaboration	0.5	4	2	2	1	4	2	5	2.5
Total Score			**13.7**		**8.4**		**11.8**		**6.7**
Rank		**1**		**3**		**2**		**4**	

This is the final weighted decision matrix we completed and ultimately used as a tool to decide on the app development software we would create our application with. We chose to use Swiftic because of the matrix results.

Appendix D: Focus Group Questions for Testing Application

We are a team of students from Worcester Polytechnic Institute in Massachusetts. We are conducting interviews with you to learn more on how we can improve the application on the coral wall exhibit just tested. This is a collaborative project with the Legacy Reef Foundation. Our goal is to build an interactive application to help educate visitors of the coral wall exhibit, and your insights will be extremely useful. The coral wall is a 16-ft tank that features multiple types of coral and fish. The goal of the exhibit is to teach visitors more about coral reefs, and why they are important, in an interactive way. Your participation in this interview is voluntary and you may opt out at any time. If you would like, we would be happy to include your comments as anonymous. If interested, a copy of our results can be provided at the conclusion of the study.

- Overall did you find this application informative?
- If you were visiting the LRF's planned coral tank, would you use the app as you were looking at the tank? If not, why not?
- Did you feel engaged with the application while using it? If not, where in the application did you not feel engaged?
- What parts of the Coral Biology section did you learn the most about?
- What parts of the Coral Biology section do you think could use more improvement?
- What parts of the Coral Importance section did you learn the most about?
- What parts of the Coral Importance section do you think could use more improvement?
- What parts of the Coral in Hawaiian Culture section did you learn the most about?
- What parts of the Coral in Hawaiian Culture section do you think could use more improvement?
- What parts of the Threats to Coral section did you learn the most about?
- What parts of the Threats to Coral section do you think could use more improvement?
- What parts of the How to Help Coral section did you learn the most about?
- What parts of the How to Help Coral section do you think could use more improvement?
- Are there any other suggestions you have that could improve the application?

Appendix E: Document Containing all Information Included in the Application

This document contains all information in every section and subsection of the Educational Application for the Legacy Reef Foundation.

Coral Biology

Most Common Coral

All of the information in this section is from the Division of Aquatic Resources (2015) and personal communication with Andrea Ehlers.

Antler Coral

(*Pocillopora grandis*)

- Colonies have thick pipe-like branches that resemble moose antlers
- Can be found between 35 and 150 feet deep
- Colonies have a brown color that is typically darker than other coral

Finger Coral

 (*Porites compressa*)

- Finger like branching and shallow snowflake-shaped calices
- Common in wave-protected areas like bays or deeper reef slopes in depths up to 150 feet
- Color ranges from light brown to light yellowish-green

Lobe Coral

(*Porites lobata*)

- Produces massive forms on the reef ranging from the intertidal zone to depths up to 180 feet
- Calices have snowflake appearance and are shallow and flush to the surface
- Range in color from yellowish-green to brown, and sometimes blue

Rice Coral

(*Montipora* capitata)

- Calices are found in between rice like projections on the surface of the coral
- Common on lower reef slopes below the wave surge up to 150 feet deep
- In sunlit reefs the the Rice coral will grow into branch-like coral where in shaded reefs the rice coral grow into a plate-like coral

- Color ranges from brown with white tips to a more creamier color

Cauliflower Coral

(*Pocillopora meandrina*)

- Most common coral on Hawaii
- Found at depths up to 150 feet deep
- Cauliflower shaped heads about 10 to 20 inches in diameter
- Color range from brown to pink

Coral Anatomy

All of the information in this section is from Barnes (1987), Levington (1995), Summich (1996), Coral Reef Alliance (2019), and personal communication with Andrea Ehlers.

Coral reefs are a colony of growing coral. Although coral represent plants or rocks they are classified as animals. Coral are colonial organisms, meaning corals are made up of hundreds of individual organisms called coral polyps. The majority of the coral polyps body is made up of a stomach that is lined with digestive filaments. The polyp has one opening called the mouth, the coral takes in food and expels waste through its mouth. Surrounding the mouth of the coral polyps there are tentacles, these tentacles are used for defence, for capturing food, and for keeping debris away.

90% of a coral's diet comes from the zooxanthellae, a micro algae that lives within the coral. The zooxanthellae perform photosynthesis and the coral polyp takes that energy and uses it as food. The other 10% of a coral's diet is based on small fish. To capture food the polyp have stinging cells on their tentacles called nematocysts. Nematocysts deliver toxins to prey that can be lethal, the prey of coral polyps can be microscopic animals such as zooplankton or even small fish.

How/Where Coral Grow

All information in this section is from Barnes (1987), Coral Reef Alliance (2019), Lalli & Parsons (1995) and personal communication with Andrea Ehlers.

Corals can reproduce asexually and sexually. In asexual reproduction, new clonal polyps bud off from parent polyps to expand or begin new colonies. This occurs when the parent polyp reaches

a certain size and divides. This process continues throughout the animal's life. Coral larvae are either fertilized within the body of a polyp or in the water, through a process called spawning. In some areas, mass coral spawning events occur one specific night per year and scientists can predict when this will happen.

Coral reefs are created when coral polyps secrete calcium carbonate ($CaCO^3$). Coral polyps secrete the calcium carbonate by the bottom portion of the polyp. The coral polyp rests on a base and when calcium carbonate is secreted the polyp creates a new base and the polyp is elevated. This process of secreting calcium carbonate can cause the coral polyps to grow anywhere from 1 to 10 millimeters.

Coral can only grow in specific environments. Most coral can only grow in oceans where the temperature does not drop below 18°C. Coral grow optimally in temperatures between 23°C and 29°C, some coral can grow at 40°C for short periods of time. Coral also needs salty water to grow, salt levels between 32 and 42 parts per thousand are best for coral growth. The water also needs to be clear so that light can reach the coral. Most coral reefs are restricted to the euphotic zone, which is where light can penetrate to a depth of 70 meters.

Fish in Coral Reefs

All information in this section is from Aquarium Domain (2020), Georgia Aquarium (2020), Waikiki Aquarium (2020), and personal communication with Andrea Ehlers.

Yellow Tang

Yellow Tang are identified by their bright yellow color and their long snout. They feed on the algae in reefs which helps the coral from being overtaken by algae. You can see Yellow Tang swimming singly or in small groups in the crevices of the reef

Achilles Tang

The Achilles Tang is identified by the dark body and bright orange patch on their tail. They eat algae which helps the coral not be overtaken by algae and slow coral growth. Achilles Tang can be found in shallower water by reefs where the water moves quicker.

Arc-Eye Hawkfish

The Arc-Eye Hawkfish can display colors ranging from olive green to a bright reddish brown. They are known for their dark rings that extend behind their eyes. They eat shrimp, crab, and other small crustaceans, as well as small fish. You can find Arc-Eye Hawkfish perched on the edge of coral heads or rocks.

Chromis Vanderbilti

The Chromis Vanderbilti is identified by their bright yellow lower body and dark blue spots. They eat zooplankton that are near the surface of the water above reefs. You can see Chromis Vanderbilti in large schools feeding above the reef or hiding in the reef's rocks.

Flame Angelfish

The Flame Angelfish can be identified by its bright reddish-orange color and their black stripes. They feed on algae that can slow the growth of coral. They also eat small crustaceans like krill. You can find Flame Angelfish swimming singly in and out of the rocks of the coral reef.

Importance of Coral

Shoreline Protection

All information in this section is from Barbier et al. (2011), Ferrario et al. (2014), NOAA Office for Coastal Management (2019), Spalding, Brumbaugh, & Landis (2016) and personal communication with Andrea Ehlers, Bill Coney, Susanne Otero, and Captain Neil Elliot.

Coral reefs provide risk reduction assistance in preventing an estimated $94 million per year in significant flood damage. This is because 97% of a wave's energy is absorbed by a healthy coral reef, serving as a buffer for shorelines from storms, waves, and currents. This prevents property damage, loss of life, and erosion. Humans who live near the coast need coral reefs because they provide protection from severe storms like tsunamis and hurricanes. Coral reefs also protect marine life in between the shore and the reef.

Tourism

All information in this section is from Barbier et al. (2011) and personal communication with Andrea Ehlers, Bill Coney, Susanne Otero, and Captain Neil Elliot.

Coral reef services in the United States bring in a total economic value of $3.4 billion per year. Coral Reefs provide revenue from recreational activities such as SCUBA diving, snorkeling, tours, and sports fishing. Hawai`i earns about $50-60 million per year from about 100 diving operations alone.

Raw Materials

All information in this section is from Barbier et al. (2011) and personal communication with Andrea Ehlers, Bill Coney, Susanne Otero, and Captain Neil Elliot.

Coral reefs are beneficial in the numerous raw materials they provide us with. One example is raw material in the form of limestone which is used in cement and road building. Another form of raw material usage from coral reefs is for jewelry making.

Fishing

All information in this section is from National Oceanic and Atmospheric Administration (2019), United States Environmental Protection Agency (2019), Wilkinson (2004) and personal communication with Andrea Ehlers, Bill Coney, Susanne Otero, and Captain Neil Elliot.

Over 500 million people across the world depend on coral reefs (Wilkinson, 2004). According to the National Marine Fisheries Services, in 2001 the United States, alone, estimated that U.S. coral reef fisheries were valued at $100 million annually and recreational fishing from coral reefs was valued at an additional $100 million annually (United States Environmental Protection Agency, 2019). Coral reefs serve as a habitat for about one fourth of all marine species, as they are found in, on, or around the reefs. This vast biodiversity that relies on coral reefs adds to their importance (National Oceanic and Atmospheric Administration, 2019). Hawaiian people depend on coral reefs for fishing because it ensures them with food and jobs.

Threats to Coral Reefs

Ocean Acidification

All information in this section is from Hoegh-Guldberg et al. (2007) and personal communication with Andrea Ehlers.

Ocean acidification is due to the absorption of carbon dioxide from the atmosphere into the ocean lowering the pH of the water. Climate change is something that has increased the rate of CO_2 entering the ocean. Ocean acidification can cause coral to grow at a slower rate, with a lower density, making it more prone to storms and waves which will damage the coral.

Coral Bleaching

All information in this is from Frieler et al. (2012), United States Environmental Protection Agency (2019) and personal communication with Andrea Ehlers.

Coral bleaching occurs when zooxanthellae, which is a plant cell that grows in coral, dies, causing coral to lose its color. Over time if the zooxanthellae does not grow back, the coral can die. In some cases, it takes coral one to two decades to go back to its pre-bleaching state.

Overfishing

All information in this section is from Hughes (1994) and personal communication with Andrea Ehlers.

Current fishing techniques damage the coral and cause undesired fish to be caught and discarded. When there is a decreased amount of plant-eating fish living in coral reefs, algae are able to be grown without being eaten. An overgrowth of algae has the ability to slow down the growth of coral and even kill them. Also with smaller fish no longer living in the reefs, larger predators like sharks will leave the reefs as well.

Pollution

All information in this section is from United States Environmental Protection Agency (2019) and personal communication with Andrea Ehlers.

Pollution from the land is quite dangerous to the ocean and its coral reefs. Pollution includes sedimentation, nutrients (nitrogen and phosphorus), pathogens from sewage, runoff, stormwater,

toxic metals or chemicals, and then trash from microplastics. The main effect of pollution is disease that can slow the growth of coral and even kill them.

Recreational Threats

All information in this section is from the United States Environmental Protection Agency (2019) and personal communication with Andrea Ehlers.

Recreational threats include the use of sunscreens which include harmful chemical ingredients that damage coral reefs. Recreational scuba diving and snorkeling also pose a threat to coral reefs as divers can accidentally kick a coral reef, or get too close and damage it. Other forms of recreational use that can damage reefs are: hitting a reef with an anchor, and improperly gathering coral to sell as jewelry.

Severe Storms

All information in this section is from Rogers (2019) and personal communication with Andrea Ehlers.

Severe storms are another local threat to coral reefs. Storms such as hurricanes can destroy coral reefs. After major hurricanes such as Irma and Maria, coral reefs in the U.S. Virgin Islands were totaled. It is almost impossible to rebuild coral reefs after severe storms.

How Can We Help Coral

Aquaculture

All information in this section is from Gilliam (n.d.), Lutfi et al (2017), Legacy Reef Foundation (2019) and personal communication with Andrea Ehlers, Bill Coney, Susanne Otero and Sandra Romer.

Aquaculture is the process of growing an organism in a tank and then, once healthy, moving it back into the wild. Coral that have broken off from the reef, from a storm or anchor, and can still grow are called "coral of opportunity". Groups like the Legacy Reef Foundation take coral of opportunity and grow them in labs.

Properly Dispose of Waste

All information in this section is from the United States Environmental Protection Agency (2019), Legacy Reef Foundation (2019) and personal communication with Andrea Ehlers, Bill Coney, Susanne Otero and Sandra Romer.

Reduce, Reuse, Recycle is a good motto to live by to help properly throw things out. Disposing of waste, especially plastic improperly can be very bad for the environment. Plastics will break down and turn into microplastic which can harm animals on land and in the water including coral.

Reduce Energy

All information in this section is from the United States Environmental Protection Agency (2019), Legacy Reef Foundation (2019) and personal communication with Andrea Ehlers, Bill Coney, Susanne Otero and Sandra Romer.

Reducing the amount of energy you use can reduce the amount of heat and CO2 you emit. Driving cars and other vehicles emit a lot of gasses. It is better to walk or ride a bike if you can. You should also reduce the amount of energy you use in your home by: turning off the lights when you are not there, do not keep the heat on or A/C on if you do not need it.

No More Chemicals

All information in this section is from the United States Environmental Protection Agency (2019), Legacy Reef Foundation (2019) and personal communication with Andrea Ehlers, Bill Coney, Susanne Otero and Sandra Romer.

Fertilizers that are nitrogen and phosphorus rich are dangerous to coral. It is better to use more organic fertilizers and prevent run off that may contain other chemicals and dangerous metals. It is also important to start using reef safe sunscreen. Sunscreen containing ONLY zinc or titanium as their main active ingredient is safe for coral reefs.

Coral in Hawaiian Culture

Kumulipo Chant and Translation

All information in this section was provided to us by JennyRose Coney.

O ke au i kahuli wela ka honua

At the time when the earth became hot

O ke au i kahuli lole ka lani

At the time when the heavens turned about

O ke au i kuka'iaka ka la

At the time when the sun was darkened

E ho'omalamalama i ka malama

To cause the moon to shine

O ke au o Makali'i ka po

The time of the rise of the Pleiades

O ka walewale ho'okumu honua ia

The slime, this was the source of the earth

O ke kumu o ka lipo, i lipo ai

The source of the darkness that made darkness

O ke kumu o ka Po, i po ai

The source of the night that made night

O ka lipolipo, o ka lipolipo

The intense darkness, the deep darkness

O ka lipo o ka la, o ka lipo o ka po

Darkness of the sun, darkness of the night

Po wale ho--ʻi

Nothing but night

Hanau ka po

The night gave birth

Hanau Kumulipo i ka po, he kane

Born was Kumulipo in the night, a male

Hanau Poʻele i ka po, he wahine

Born was Poʻele in the night, a female

Hanau ka ʻUku-koʻakoʻa, hanau kana, he ʻAkoʻakoʻa, puka

Born was the coral polyp, born was the coral, came forth

Kumulipo Video

https://www.youtube.com/watch?v=p_CzHSx_GhM

Coral in the Kumulipo

All information provided in this section is from personal communication with JennyRose Coney and Professor Noelani Puniwai.

What does "Kumulipo" mean?

Kumulipo is translated into "Beginning-in-deep-darkness" in English.

What is the Kumulipo?

The Kumulipo is a Hawaiian creation or origin chant.The Kumulipo consists of over 2000 lines that explain the origin of Hawaiians and offers insight into their values as people in early and

modern times. Through the Kumulipo, early Hawaiian culture, political structure, way of life, and mythology are all explained.

Insight into the importance of coral in Hawaiʻian culture:

The Kumulipo says that the first thing pulled up from the depths of the ocean by Maui was coral. From coral grew all the marine life around the coral. Then, the islands were created, and all the plants, animals, and people of Hawaiʻi were then created. The creation of the Hawaiian islands is directly related to coral. Coral is essentially the common ancestor of all Hawaiians according to the Kumulipo.

Appendix F: Original Storyboards for Application

A description for what the LRF visitor sees and how she can interact with the application can be seen underneath each picture. Parts of the screens circled in red show a button that the LRF visitor can click to direct them to another screen.

On this screen, we included different buttons with different information. Here, there is a button for "About Us", "Coral Ecology", "Importance of Coral Reefs", "Threats to Coral", "How to Help Coral", "Coral in Hawaiian Culture", and "Our Coral Wall". The reason for using buttons is that they are very easy to comprehend what information you are about to learn more about; also it added a small part of interactivity by having the visitor expand a section by clicking a topic.

Shown above is the "About Us" screen. The "About Us" screen includes information about the LRF, with their mission and objective, as well as the LRF's social media links.
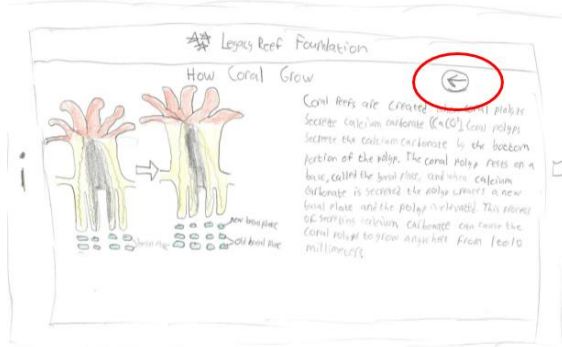
Shown above is the "Coral Ecology" screen. There are five buttons named "Basic Anatomy", "Reproduction", "Where Coral Grow", "How Coral Eat", and "How Coral Grow". A user of the application is able to click on any of these five buttons, where she will be taken to a new screen with information based on the button she clicked. For example, if the user wants to learn more about how coral grow, she would click on the "How Coral Grow" button and go to the screen with more information about that topic.

Shown above is the "Importance of Coral Reefs" screen and the screens associated with it. Users have the option to click on a "branch" which has the options of "Tourism", "Fishing", "Raw Materials", and "Shoreline Protection". If the user picks on "Shoreline Protection", then she is brought to another screen displaying an image of an example of shoreline protection as well as multiple facts about shoreline protection.

Legacy Reef Foundation
click on any of the items below to learn about the threats to coral reefs

LRF visitor clicks to learn about the threats to coral reefs. She is brought to this screen where there is a...

Legacy Reef Foundation
Bleaching
Threat Type: Global

Coral bleaching happens when zooxanthellae, which is a plant cell that grows in corals dies, causing coral to lose its color. Over time if the zooxanthellae doesn't grow back, the coral can die. In some cases, it takes coral decades to go back to its pre-bleaching state.
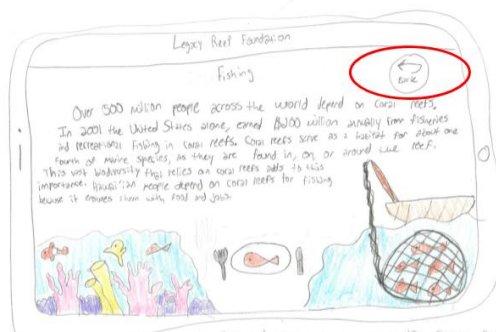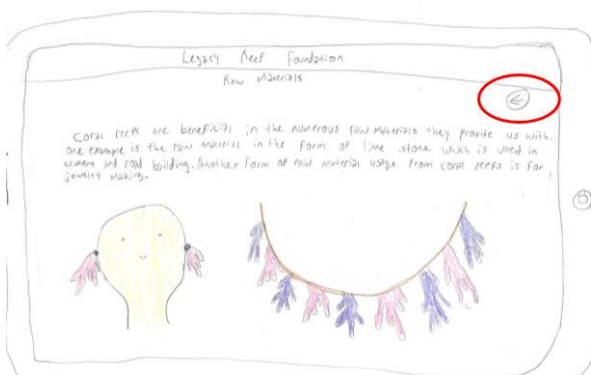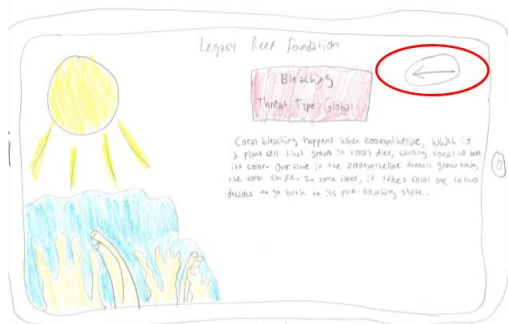
LRF visitor Sally clicked on the item that indicated bleaching. She is brought to this screen where facts about coral bleaching are given and how bleaching affects coral reefs.

back button

Legacy Reef Foundation
Ocean Acidification
Threat Type: Global

Ocean acidification is due to the absorption of carbon dioxide from the atmosphere into the ocean lowering the pH of the water. Climate change is something that has increased the rate of CO_2 entering the ocean. Ocean acidification can cause coral to grow at a slower rate, with a lower density, making it prone to storms and waves which will damage the coral.

LRF visitor Sally selected the car item in the landscape on the initial "Threats to Coral" screen. The car symbolized the ocean acidification threat, and multiple facts about ocean acidification are shown.

Legacy Reef Foundation
Recreational Use
Threat Type: Local

Recreational threats include the use of sunscreens which include harmful chemicals, sometimes damage coral reefs. Recreational scuba diving and snorkeling are a risk to coral reefs as divers can accidentally hit a coral reef or get to the coral damaging it. Other forms of recreational use this area damage reefs are hitting a reef with an anchor, and individuals gathering coral to sell as jewelry.

LRF visitor Sally clicks on the recreational use button and is brought to this screen. Once she is done with this screen she can return to the threats here to history the Pref screen.

63
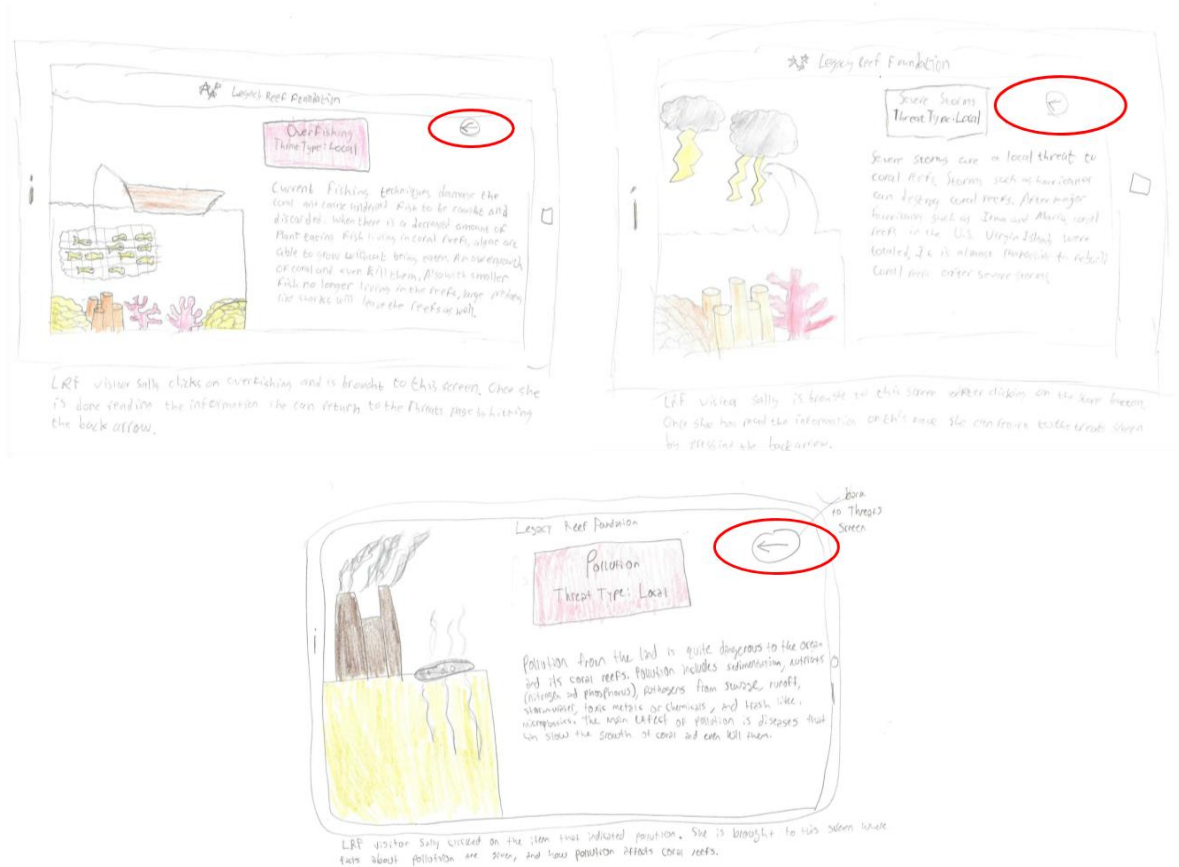
Shown above is the "Threats to Coral" screen where a landscape with multiple items is shown. There is a sun, car, sewer, anchor, fishing net, and a storm. These items all represent the many threats to coral reefs. A user can click on any one of these items which will bring her to the item's screen with more information on the threat. For example if the user clicks on the fishing net, it brings her to the "Overfishing" threat screen where facts about overfishing are displayed as well as what "threat type" overfishing is. A user has the option to go back to the main screen where she can click on another threat.

Shown above is the "How to Help Coral" screen which is similar in design to the "Threats to Coral" screen. The main screen displays different types of objects that represent

ways that people can help preserve coral. For example if the user clicks on the "sunscreen" object, it takes her to another screen with facts about the harmful ingredients in sunscreen and what visitors can do instead to help coral reefs.
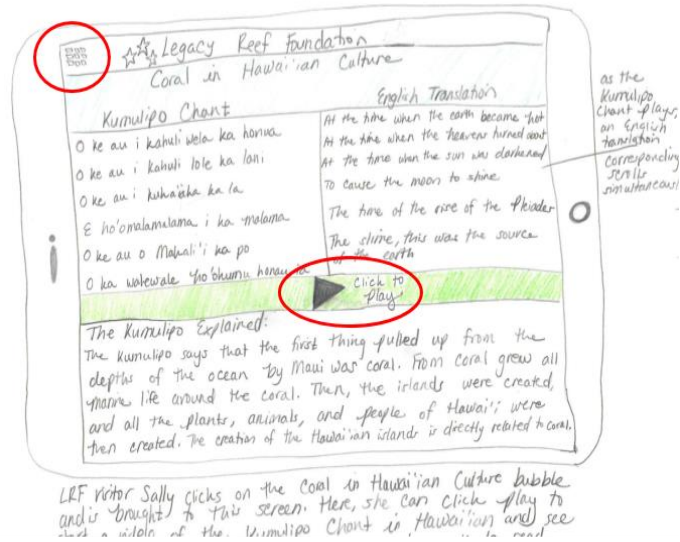
Shown above is the "Coral in Hawaiian Culture" screen. The "Coral in Hawaiian Culture" screen includes general information about the Kumulipo and how coral are connected to the Kumulipo chant to engage the visitor in wanting to learn more. The visitor then has the chance to click on a video where she can listen to the chant or on buttons underneath the video that have a translation of the chant to English. The interactivity comes from the video, instead of just reading, the guest has the chance to listen to the chant which will make the visitor want to know more about it and what the chant means.
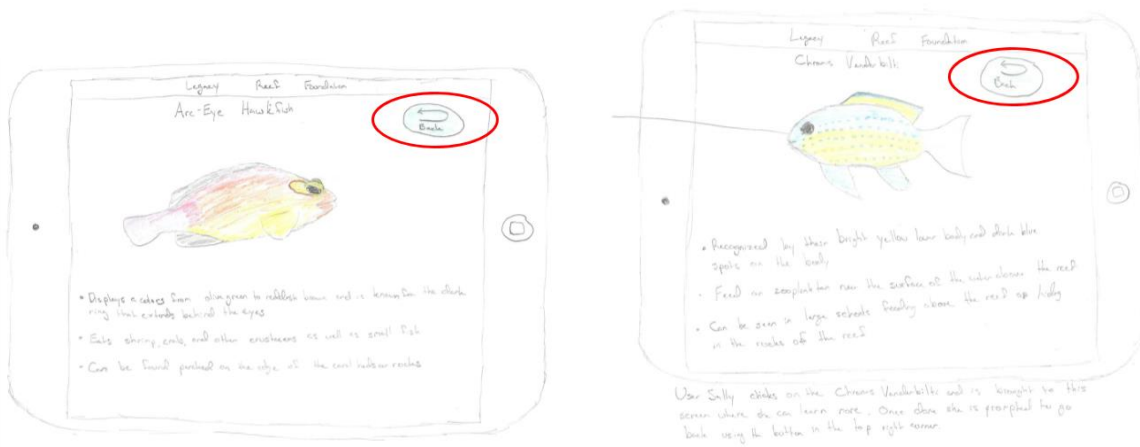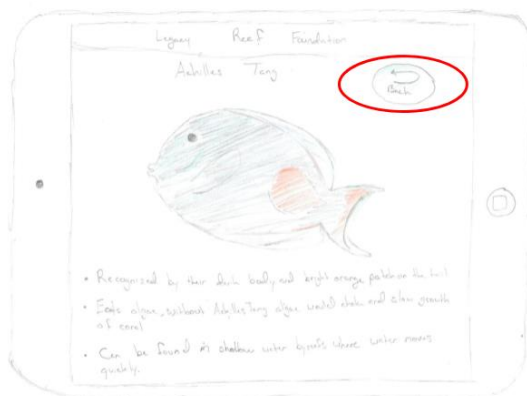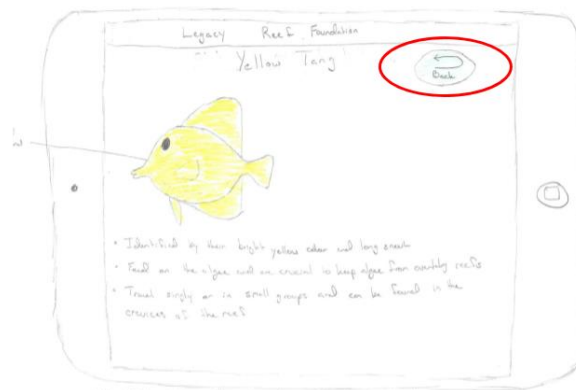
These storyboards are based on some of the interactive design ideas which are more explained in Appendix G. These screens show the two options that a user would be able to see if she were to use the "Explore Our Coral Map" interactive design idea or scanned a QR code towards the top of the screen where the fish reside. These screens show the different types of fish in the coral tank that will be displayed.

Cauliflower Coral screen:

★★ Legacy Reef Foundation

CAULIFLOWER CORAL
(Pocillopora Meandrina)

- Most common coral in Hawaii
- Found at depths up to 150 feet depth
- Cauliflower shaped heads about 10 to 20 inches in diameter
- Color range from brown to pink
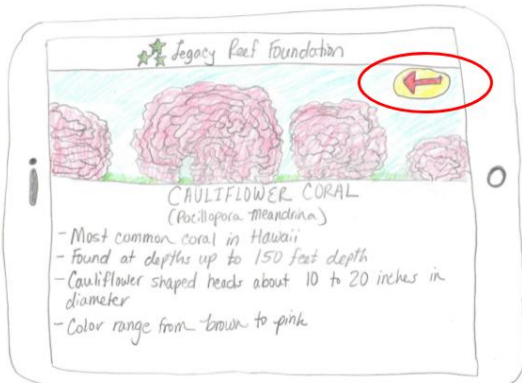
LRF Visitor Sally clicks on Cauliflower Coral from the Most Common Coral in Hawai'i page and is brought to this screen. Here, different [facts about the coral will be displayed along with an image of the Coral]

Finger Coral screen:

★★ Legacy Reef Foundation

FINGER CORAL
(Porites Compressa)

- Finger like branching and shallow snowflake-shaped calices
- Common in wave-protected areas like bays or deeper reef slopes in depths up to 150 feet
- Color ranges from light brown to light yellowish-green
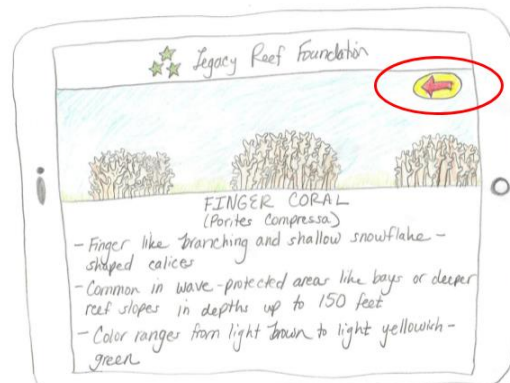
LRF Visitor Sally clicks on Finger Coral from the Most Common Coral in Hawai'i page and is brought to this screen. Here, different facts about [the coral will be displayed along with an image of the]

Lobe Coral screen:

★★★ Legacy Reef Foundation

LOBE CORAL
(Porites lobata)

- Produces massive forms on the reef ranging from the intertidal zone to depths up to 180 feet
- Calices have snowflake appearance and are shallow and flush to the surface
- Range in color from yellowish-green to brown and sometimes blue
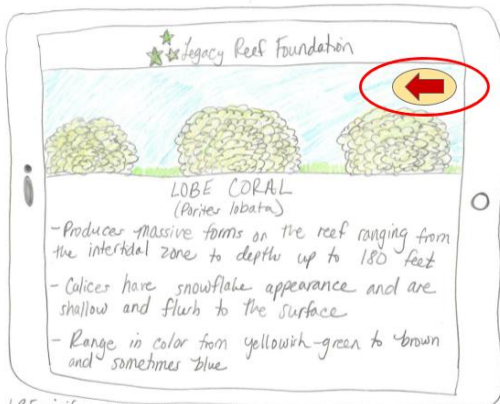
LRF Visitor Sally clicks on Lobe Coral from the Most Common Coral in Hawai'i page and is brought to this screen. Here, different [facts about the coral...]

Rice Coral screen:

★★★ Legacy Reef Foundation

RICE CORAL
(Montipora Capitata)

- Calices are found in between rice like projections on the surface of the Coral
- Common on lower reef slopes below the wave surge up to 150 feet deep
- In sunlit reefs the colonies will grow into branch-like coral and in shaded reefs the colonies will grow into plate-like coral
- Color ranges from brown with white tips to a cream color
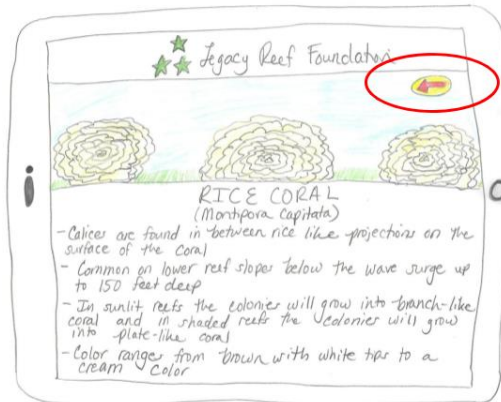
LRF visitor Sally clicks on Rice Coral from the Most Common Coral in Hawai'i page and is brought to this screen. Here, different [facts about the coral will be displayed along with an image of the coral]

Antler Coral screen:

★★ Legacy Reef Foundation

ANTLER CORAL
(Pocillopora Grandis)

- Colonies have thick pipe-like branches that resemble moose antlers
- Can be found between 35 and 150 feet deep
- Colonies have a brown color that is typically darker than other coral
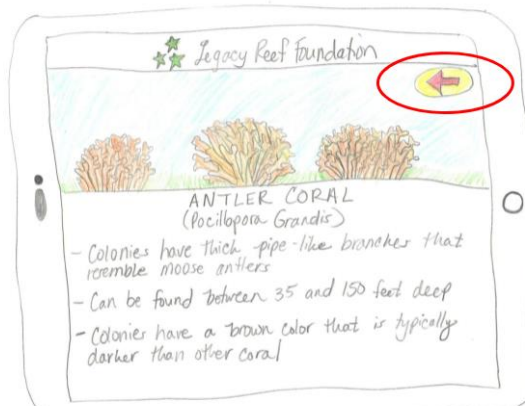
LRF Visitor Sally clicks on Antler Coral from the Most Common Coral in Hawai'i page and is brought to this screen. Here, [different facts about the coral will be displayed along with an image]

These storyboards are based on some of the interactive design ideas, which are explained further in Appendix G. These screens show the two options that a user would be able to see if she

was to use the "Explore Our Coral Map" interactive design idea. These screens show the different types of coral in the tank, with more information on each type of coral.

Appendix G: Storyboards for Interactive Portion

       A description for what the LRF visitor sees and how she can interact with the application can be seen underneath each picture. Parts of the screens circled in red show a button that the LRF visitor can click to direct them to another screen.

1. **Explore Our Coral Map Application**

       The main screen of the application shows a birds-eye view of the coral wall, where multiple types of coral are displayed. The visitor can click on the images of the five corals to learn more about the coral. There is a "Explore our Fish" button that the visitor can click on to view all of the fish in the coral wall. The interactive portion of this screen is that visitors can follow along the coral wall with the application's aerial view map, creating a direct connection to the coral wall.
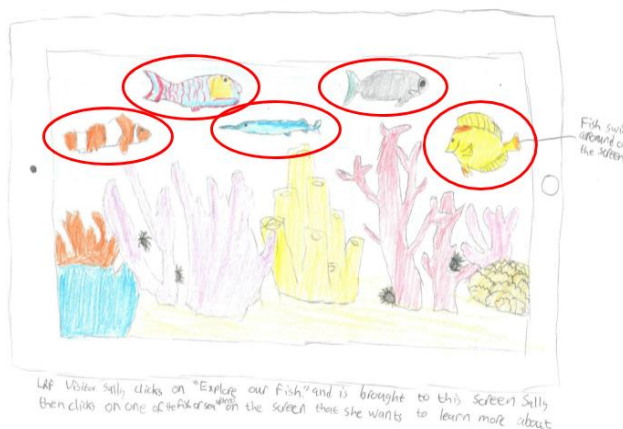
       This screen shows a virtual coral wall where all of the fish are moving around. The visitor can click on any of the fish to be brought to a screen to learn more about the fish that was

selected. The animated fish are interactive as it may excite the user as she can see the fish moving around both in the tank and in the application.
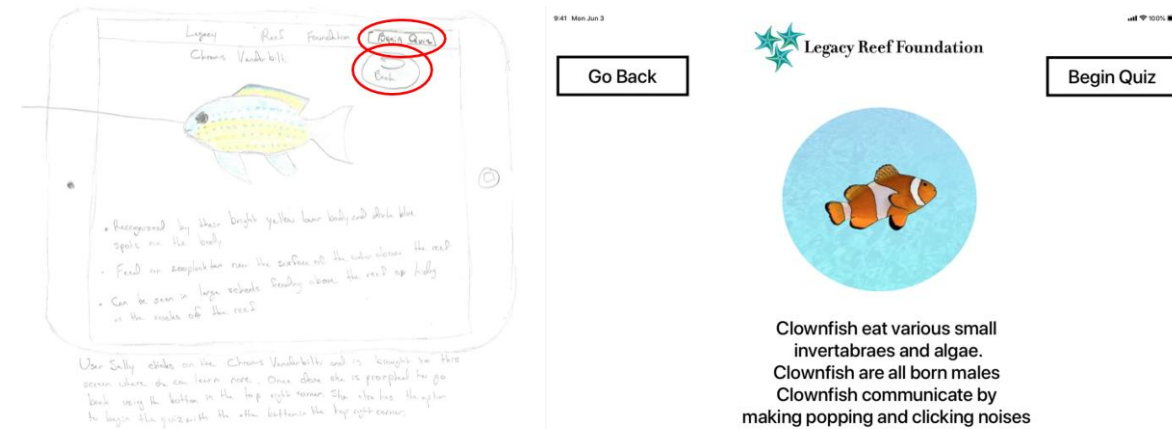
This screen shows the specific type of fish that the user selected and is shown multiple facts about the fish. This portion is not as interactive as it is given many facts about the fish without really having a portion of learning that may be "fun" but it does give the user a lot of information about the tank.

2. **Explore Our Coral Wall QR Code Application**
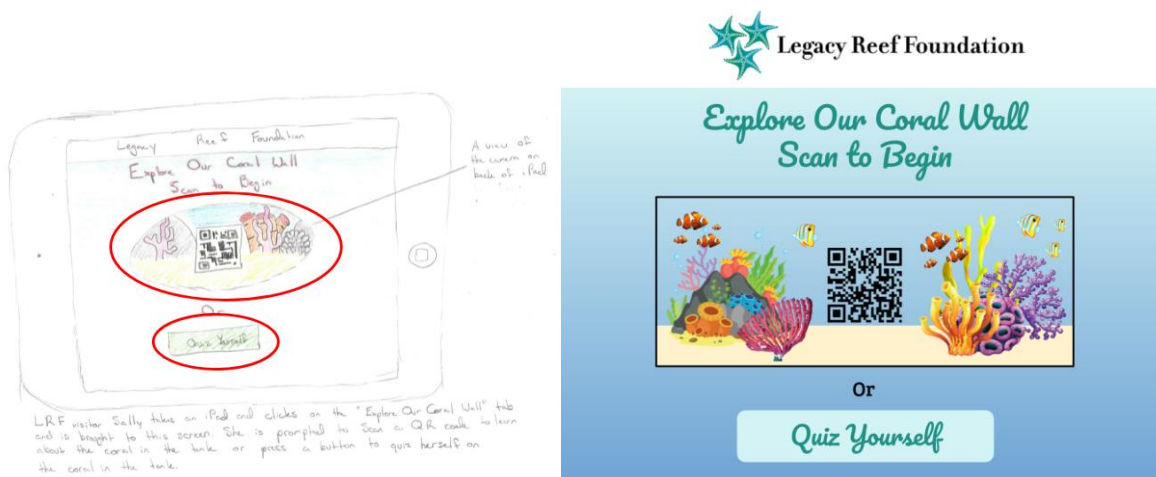
This screen prompts the user to scan a QR code on the coral wall to learn more about the coral in the tank or the user has the option to press a button to quiz themselves about the coral in the tank. The QR codes offer the user interactivity as she can look at the coral wall and pick

which QR code she wants to scan. Having the option to quiz themselves also gives the LRF a way to measure how much the visitors may be learning.
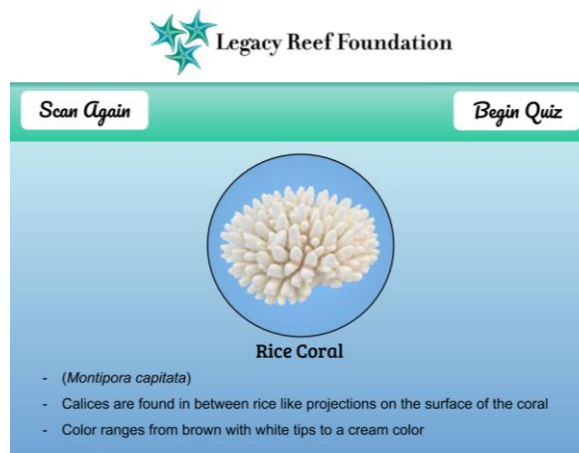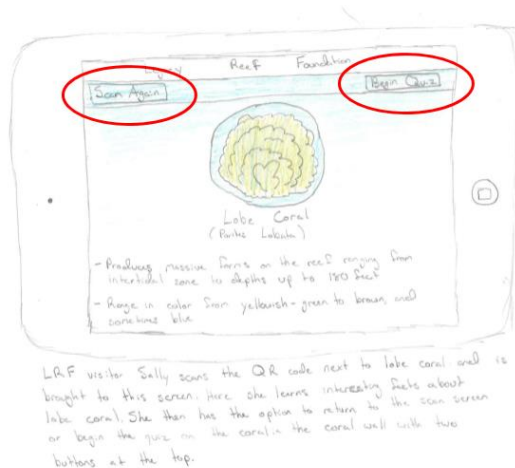
The visitor scans the QR code next to the lobe coral and is brought to this screen. Here the visitor can learn interesting facts about lobe coral. The visitor has the option to return to the scan screen or begin the quiz on the coral, with the two buttons at the top. This gives the user an interactive portion as she can look at the coral wall and pick what she wants to learn about. Getting the multiple facts about whatever she scans is important so that the user can quiz themselves which would be a measure of how much they learned.
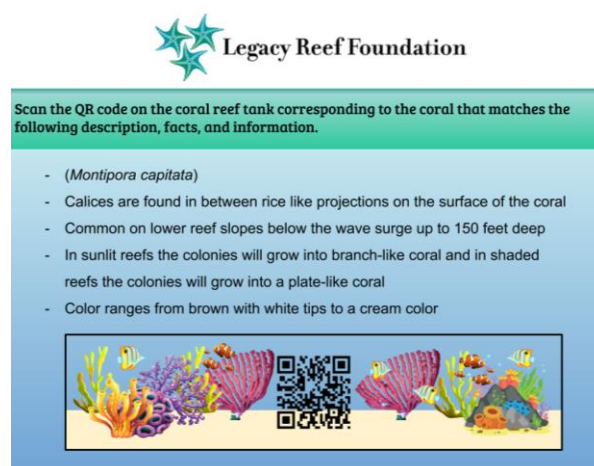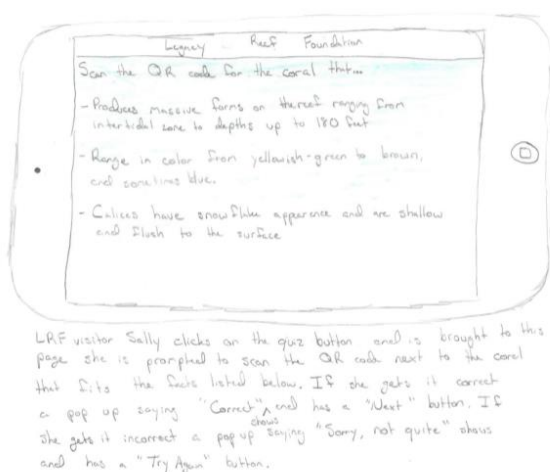
The visitor clicks on the quiz button and is brought to this page where she is prompted to scan the QR code next to the coral that fits the facts listed below. If she gets it correct, a pop up

saying "correct" shows and has a "next" button. If she gets it incorrect, a pop up saying "Sorry, not quite" shows and has a "Try Again" button.

3. **Virtual Tank Application**
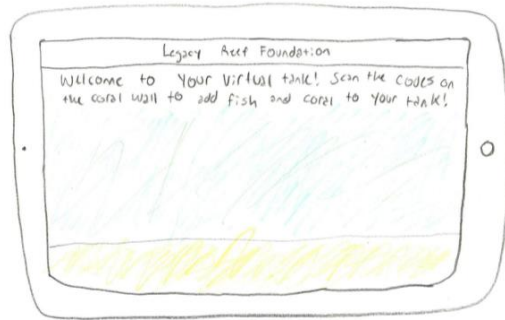
The visitor is brought to a screen that displays an empty virtual tank. The visitor is then prompted to scan QR codes on the coral wall to add items like coral and fish to their virtual tank. This acts like a "game" and the user is excited and wants to fill up her tank so she can see all of the items that can be added.

The visitor scans the QR code for the rice coral and is given multiple facts about rice coral. In order to add rice coral to her virtual tank, she has to answer a question about rice coral that was stated in the facts that were given. If she answers correctly, rice coral is added to her tank. If she answers incorrectly, she is prompted to try again. This is a great way that highlights interactivity as the user scanning the codes on the coral wall is a good incentive. Asking the visitor questions about what she read about is another great way to measure how the visitor is learning.

The visitor answered the question correctly and was able to add rice coral to her virtual tank. This gets the user excited to answer more questions correctly to add more coral and fish to her tank.
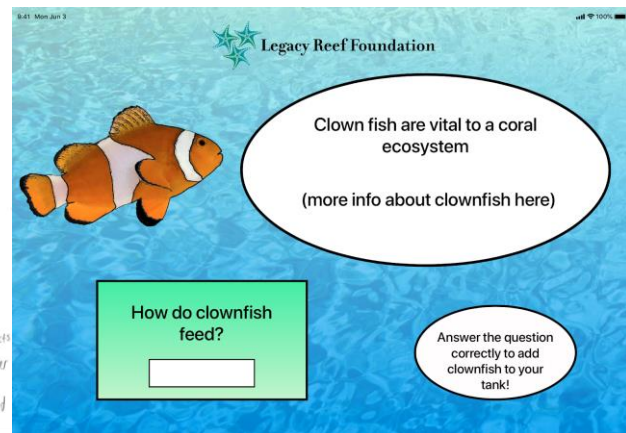
The visitor can repeat the process above for the fish in the tank as well as the other coral in the tank. The QR codes for the fish can be found on the glass of coral wall tank, higher than the QR codes for the coral and close to where the visitor is most likely to find that specific fish.
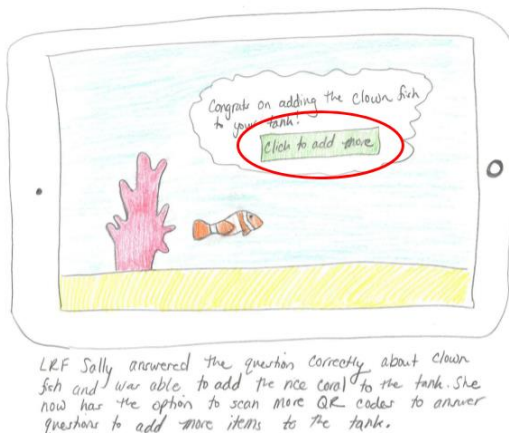
Once the visitor gets the questions correct and adds the fish to her virtual tank she can see the fish just added and the coral she already added. The visitor can then keep on scanning QR codes and answering questions about all of the species, in order to keep adding coral and fish to her virtual tank. This adds interactivity because the guest can physically see the progress she is making in filling her virtual tank with the fish and coral she chooses.
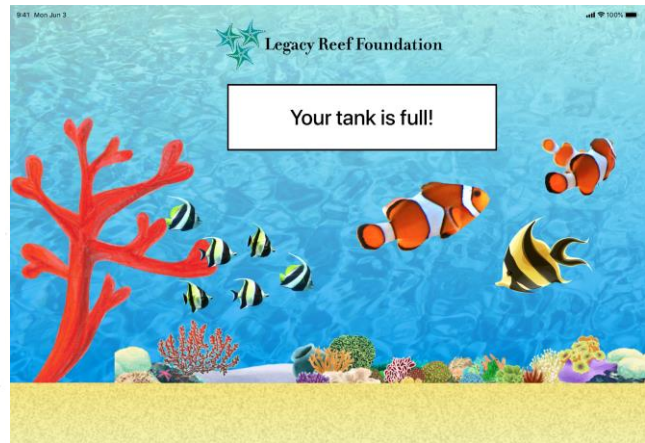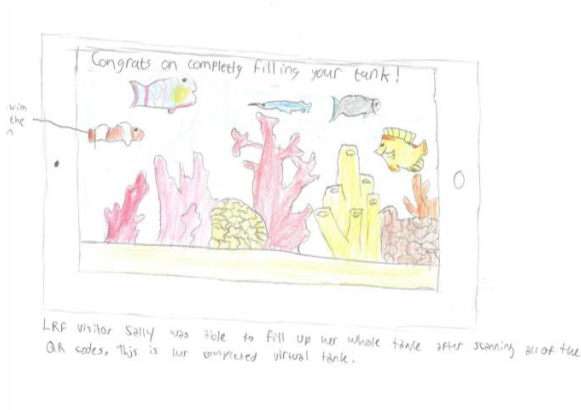
The user was able to fill up her entire tank by answering questions correctly. The fish and coral are animated here.

Appendix H: Screenshots of Swiftic Application

Descriptions of what the visitor sees for each screen and how she can interact with each screen can be seen below each picture or set of pictures.
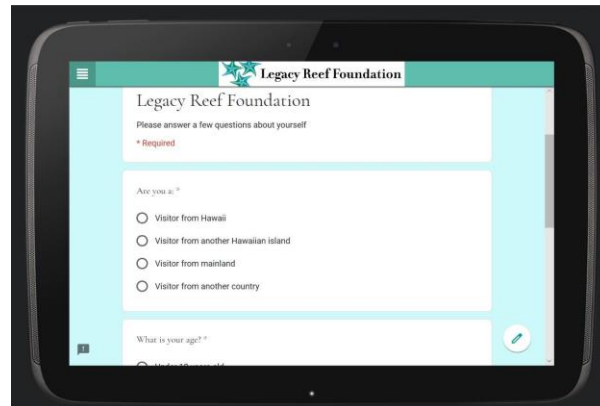
This screen shows the visitor information form that the LRF will use to gather data on how many people are visiting the coral wall. This form includes three questions asking about where the visitor is from, how old the visitor is, and how many times she has visited the LRF. This was originally not included in the storyboard, but the LRF wanted to include it in the application so they could better understand the demographic of their visitors.

This screen is shown when the visitor clicks on the "About Us". This screen includes where the LRF is located, the phone number to contact the LRF, and the links to the LRF's website and Facebook. It also includes a section with the LRF's mission statement and current projects the LRF is working on. This was not originally included in the storyboard but, as a group, we thought this would be a great way for visitors to get a better understanding of who the LRF is. Also this screen promotes their social media pages.
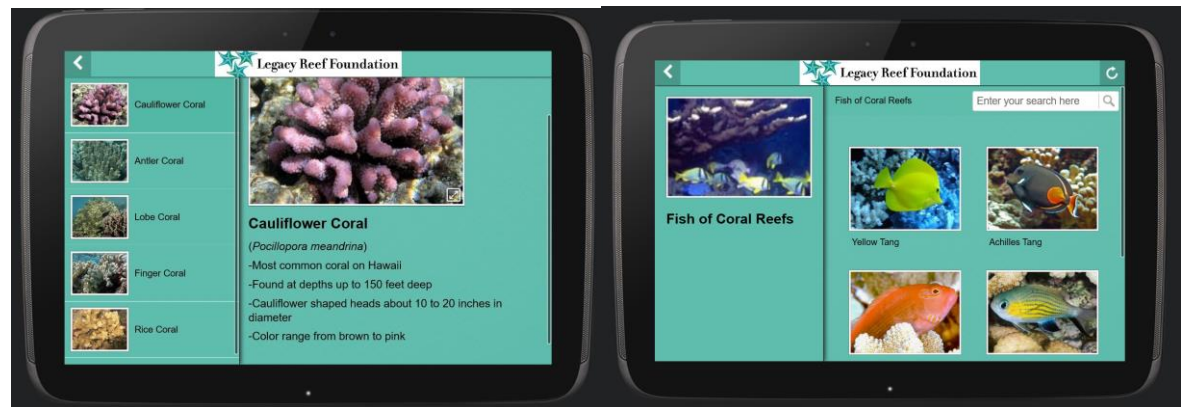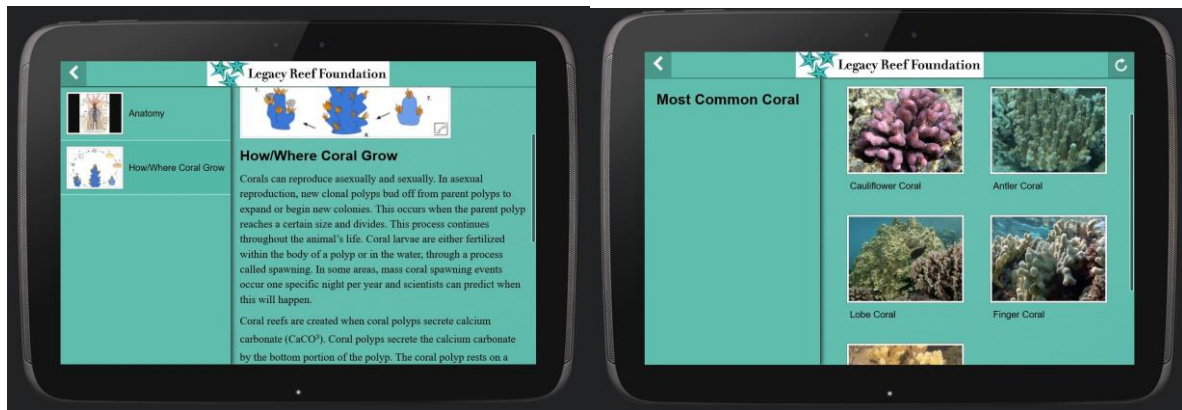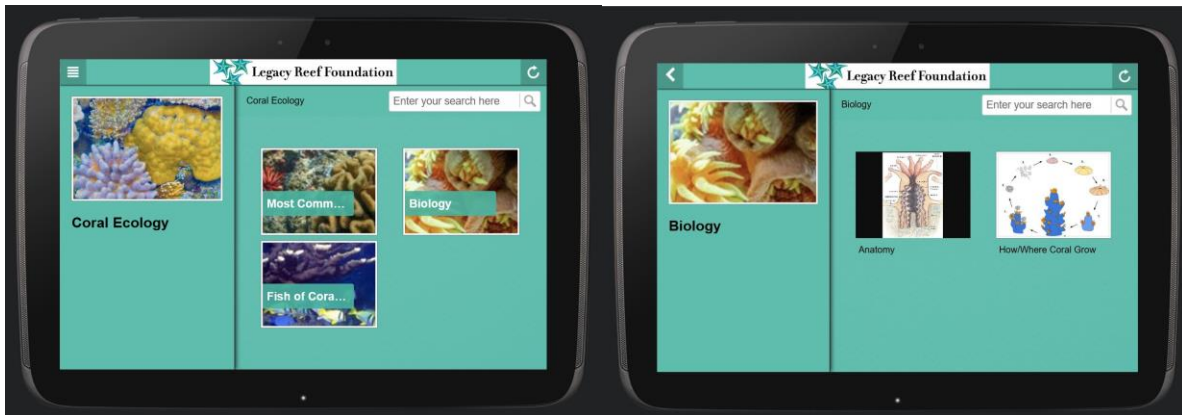
These screens show the section on "Coral Ecology". The visitor has the options to learn either about the most common coral or the biology of coral. If she clicks on "Most Common Coral", she is brought to pictures of five coral; the visitor can click on one of the coral to learn more about. If she clicks on "Biology", she can decide whether she wants to learn more about the anatomy of a coral or how and where she can find coral growing. This is different from the storyboard because all the information, all common coral and information on the biology of coral, was originally all going to be on one page. In the application, the visitor has to click many buttons to learn about a specific coral which may cause the visitor to become disinterested. This is due to restrictions that Swiftic has as an application developing software.
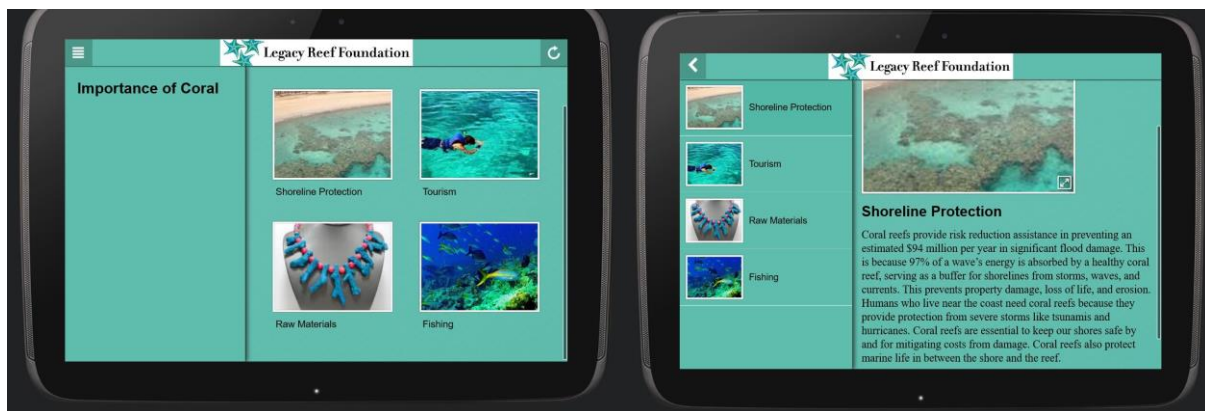
These screens show up when the visitor clicks on "Importance of Coral Reefs". The visitor is shown how coral reefs are important in so many ways, and clicks on one of the ways to learn more about it. This was added as the team thought that if the visitors of the LRF learned how important coral reefs were to communities all over the world, then it would entice them to want to be more proactive in helping coral.
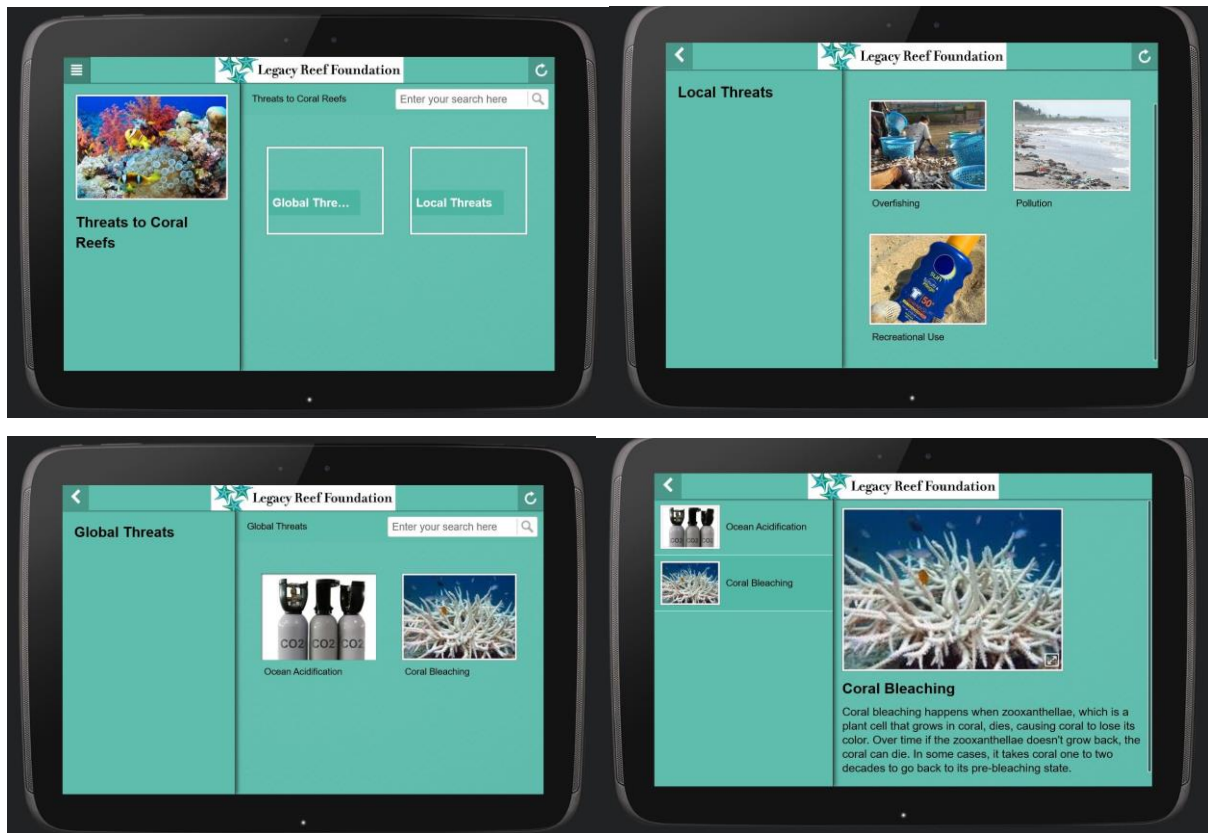
These screens show up when the visitor clicks on "Threats to Coral". The visitor has the options of clicking on local threats, and then clicking one of the local threats to learn more about a specific local threat. The visitor can also do the same for global threats and learn about the two main threats that affect coral all over the world. These screens were very similar to that created on the storyboard as there was intended to be less interactivity for the threats. The only difference is that there are multiple buttons that need to be pressed to learn about a specific threat, local or global.
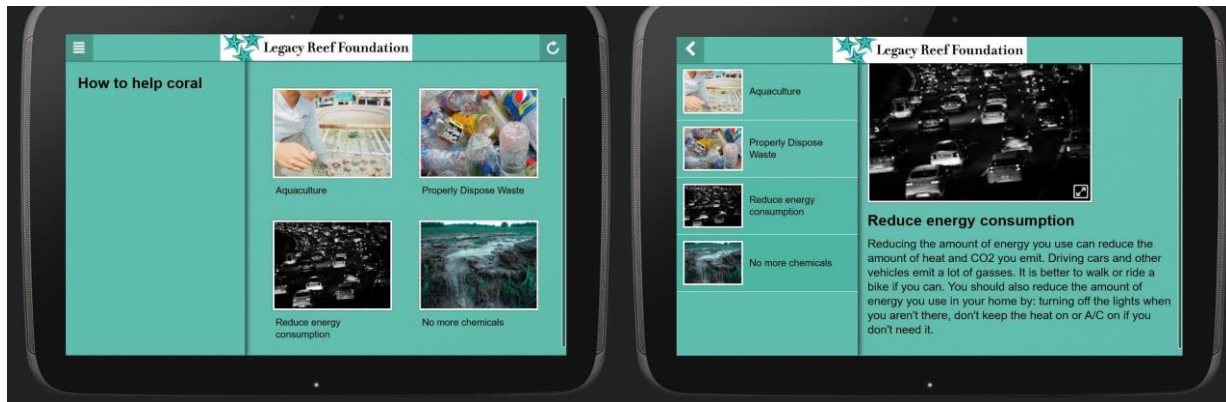
These screens display what people see when they click on "How to Help Coral". The visitor can see the different ways to help coral and click on each one to learn more. This is different from the storyboard because there is no general information on the main page to entice the visitor to read more. These missing pieces are due to the restrictions of Swiftic as an app building software as well as the time constraint of only being able to work on this application for seven weeks.
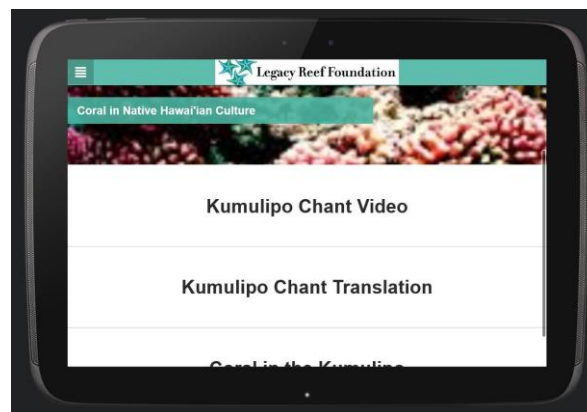
This screen shows up when the visitor clicks on "Coral in Hawaiian Culture". The visitor can click on either of these three buttons and it will bring her to either the YouTube video of the Kumulipo chant, the English translation of the chant, or corals relation to the chant. This is different to the storyboard because instead of everything being built into the application, we had to use links that took the visitor from the application to documents and YouTube to learn more about the Kumulipo chant. These links are not a long term solution as they redirect visitors out of the application and to continue learning they must go back into the application.

Appendix I: Focus Group Summaries

   Below shows comments and suggestions recorded from each of the four focus groups that tested the Swiftic application. The groups scanned QR codes that brought them to a website that acted as a demo of the application. Comments made by the groups as they used the application were recorded and placed in the corresponding section after the focus groups were complete. After each group was done using the application, each group was asked the 14 questions from Appendix D. Due to time constraints some groups were not able to answer all 14 questions. At the bottom of each section is a summary of the overall conclusions made from the focus group responses.

1. Overall did you find this application informative?

Focus Group	Response	Additional Comments/Suggestions
WPI	Yes	● Info too long to read, boring
WHEA	Yes	● Info is good & straight forward
SCUBA Divers Focus Group 1 (Feb. 25)	Yes	● User-friendly ● Good colors & photos
SCUBA Divers Focus Group 2 (Feb. 26)	Yes	● Really good stuff in the app

Summary:

Overall, from the focus groups we concluded the application is informative. Reasons for this include the responses we received saying:

- Information for the most part is good
- At times information is too in depth and can become boring

2. If you were visiting the LRF's planned coral tank, would you use the app as you were looking at the tank? If not, why not?

Focus Group	Response	Additional Comments/Suggestions
WPI	Use only the tank	- Add audio to info on tank - Just want to look at tank & not read
WHEA	Would use app with tank	Would not use app by itself
SCUBA Divers Focus Group 1 (Feb. 25)	Rather have a tour guide speak to visitors than use an app	- Talk in person, then refer to app - App may not work best for older visitors
SCUBA Divers Focus Group 2 (Feb. 26)	No response recorded	

Summary:

Overall, from the focus groups we concluded age and level of interest are two major factors in whether or not a person would use the application while looking at the tank.

- **College students:** would mainly focus on the tank because they have more interest in the visual of it instead of reading through an app
- **High school students:** would use the app with the tank
- **Older adults:** would prefer a tour guide speak to them about the tank exhibit over using an app

3. Did you feel engaged with the application while using it? If not, where in the application did you not feel engaged?

Focus Group	Response	Additional Comments/Suggestions
WPI	No	- Too much reading & clicking - Need more pictures
WHEA	Straight forward	Colors are bland
SCUBA Divers Focus Group 1 (Feb. 25)	No response recorded	
SCUBA Divers Focus Group 2 (Feb. 26)	No response recorded	

Summary:

Overall, from the focus groups we concluded the application was straight forward but not very engaging. Reasons for this include:

- Too much clicking
- Not enough pictures
- Bland colors

4. Section: **Coral Biology**

Focus Group	Learned Most About	Needs Improvement
WPI	Coral anatomy	Animations to show how

	diagram	- corals grow over time - Break up text - Add more pictures - More infographic-like
WHEA	Info on how deep coral can be found	- Common coral instead of "most common coral" - Wording change of represent to "resemble" in anatomy section - Add bullets to how and where section - Shorter text - Numbered with pictures
SCUBA Divers Focus Group 1 (Feb. 25)	Coral ecology slide	- More pictures of different coral - Cauliflower coral may need to change cus its been 80-90% lost - Add in how much each species has been affected - More fish and how to identify each species - Add info about codependency between fish and coral - Connect everything more - Simplify info- less text, more pictures - Stress coral is a living animal

		• Stress coral is more complex
SCUBA Divers Focus Group 2 (Feb. 26)	Nice photos	• See mainly lobe or finger coral • Lost over 80% of cauliflower coral over the past 5 years • Arc eye hawkfish will eat other fish • Black fin or Agile Chromis is very popular and will do well in aquarium • Flame fish is very rare and hard to keep alive • Achilles tang are rare

Summary:

Overall, from the focus groups we concluded the positive aspects of the "Coral Biology" section include:

• The section on coral ecology and coral anatomy was the most informative slide

Overall, from the focus groups we concluded the aspects of the "Coral Biology" section that need improvement include:

• Use more pictures and less words to display information
• Have pictures throughout the screens to break up the text
• Talk about how each type of coral was affected by the latest bleaching in Hawai'i
• Include more common fish that can be found in ocean and aquariums

5. Section: **Coral Importance**

Focus Group	Learned Most About	Needs Improvement
WPI	Shoreline protection	• More/better pictures

		• Add in comparison of shoreline with reefs vs. shorelines without reefs • More infographic-like
WHEA	Shoreline protection	• More bullets, less paragraphs
SCUBA Divers Focus Group 1 (Feb. 25)	No response recorded	• Tourism- not completely fitting to coral importance • Get rid of jewelry and necklace picture • Enhance images • Simplify info • Hawai'i does not use coral for manufacturing • Focus more on: shoreline protection, overfishing, nursery and habitat • White sand actually comes from fish who eat from the coral (parrot fish poop)
SCUBA Divers Focus Group 2 (Feb. 26)	No response recorded	• Coral reefs do not protect much about Tsunamis

		● The very bad storms can be really damaging to reefs

Summary:

Overall, from the focus groups we concluded the positive aspects of the "Coral Importance" section include:

- Shoreline protection was the most informative slide

Overall, from the focus groups we concluded the aspects of the "Coral Importance" section that need improvement include:

- Information should be displayed using less text and more pictures
- Focus less on tourism and more one shoreline protection, habitat for marine life, and hotspots for fishing

6. Section: **Coral in Hawaiian Culture**

Focus Group	Learned Most About	Needs Improvement
WPI	The Hawaiian and English translation	● It should not take you out of the app ● Too much writing ● Chant translation and video should be on same screen ● Most people will not want to watch the video ● Video will be hard to hear if too many people are playing it

		on different devices
WHEA	No response recorded	• The word "Hawaiian" does not contain an 'okina between the two i's • It should not take you out of the app
SCUBA Divers Focus Group 1 (Feb. 25)	No response recorded	• Took too long to load • Do pronunciation of the chant in the beginning • Maybe have chant playing outside of the application- more like a part of the exhibit • Have some say Hawaiian phrase then English translation • Have a local video made to put in application instead of a YouTube video
SCUBA Divers Focus Group 2 (Feb. 26)	Short and informative	No response recorded

Summary:

Overall, from the focus groups we concluded the positive aspects of the "Coral in Hawaiian Culture" section include:

- Short and informative
- Hawaiian and English translations

Overall, from the focus groups we concluded the aspects of the "Coral in Hawaiian Culture" section that need improvement include:

- If the video is in the app, it should be embedded within the app instead of a link to YouTube
- The Kumulipo chant should play out loud while the Hawaiian and English written translations appear on the screen
- A local video of the Kumulipo made just for the LRF would be a better alternative than the YouTube video
- The video could be better if it were displayed on a screen near the exhibit rather than on the app, so everyone can watch at the same time- prevents multiple videos playing at once

7. Section: **Threats to Coral**

Focus Group	Learned Most About	Needs Improvement
WPI	Local threats	- Add more global threats- looks weird that there are only two - Put all threats on one page with different subheadings for local and global - Too much writing
WHEA	No response recorded	- Include specific chemical ingredients in sunscreen that are harmful - Add invasive species section - Add rise in water

		• temperatures/global warming section • Add section about tourism being a major threat and why

SCUBA Divers Focus Group 1 (Feb. 25)	No response recorded	• Add section about rise in temperatures
		• Include specific pollutants (i.e. specific chemicals that are harmful to reefs such as in sunscreen)
		    ○ More detail on sunscreens, not all sunscreens are harmful, (using zinc oxide vs other chemical)
		• Add section about jewelry use being harmful
		• All threats should be general/do not distinguish between global and local
		• Fishing is controversial
		    ○ Address destructive fishing techniques rather than local fishing
		        ■ Drudging
		        ■ Ghost nets
		• Add section about decreasing wild life on the reefs
		• Add section about aquarium trade

		● Change recreational use to recreational threats

SCUBA Divers Focus Group 2 (Feb. 26)	No response recorded	● Name the chemicals that are damaging in the sunscreens
		● Zooxanthellae should also be called microalgae
		● Fertilizers can cause a bloom of algae
		    ○ Add on to kill or slow growth
		    ○ Too much algae blocks the sun
		● Overfishing may not be true as a threat to corals/ not enough evidence
		● Ocean acidification is more of a theory/ the evidence that is there does not confirm it
		● Add in/ adopt the Hawaiian law in the text
		● Severe storms take out the coral and can change the habitat
		    ○ You can see more fish after the storm
		    ○ Severe storms could be good or bad

Summary:

Overall, from the focus groups we concluded the aspects of the "Threats to Coral" section that

need improvement include:

- Make the information less wordy and less in depth
- Make threats one general topic, do not separate into global and local threats
- When addressing harmful sunscreens, say the exact chemicals that harm coral
- A section about the rising water temperatures should be added
- Other sections to possible add include: Aquarium trade and invasive species

8. Section: **How to Help Coral**

Focus Group	Learned Most About	Needs Improvement
WPI	No more chemicals (funny title)	- Change "No more chemicals" title - Put more emphasis on corals in recycle page - Relate each section more to coral
WHEA	No response recorded	- Reef courtesy - Do not step on coral - Do not take it
SCUBA Divers Focus Group 1 (Feb. 25)	No response recorded	- For aquaculture, before clicking it was thought about eating fish and aquaculture - Talk about fish consumption if you are talking about fish - Add in section about energy consumption

		● Hitting the bullet points of climate change, but focus more on general environmental impact
		     ○ Cats are a problem in pollution of the ocean
		 ● Concentrate on things that affect coral directly
		     ○ Sewers are a problem
		 ● Many things are controversial problems, push for action rather than impossible problems
		 ● More specific information on what visitors can do while they are in Hawaii vs what they can do in their hometown
		     ○ Snorkeling on the reef, do not take things from the reef
		     ○ Encourage people first to cover up rather than using sunscreen
		     ○ Snorkeling in Hawaii is dangerous for first time snorkeling
		 ● Aquaculture is ambiguous
		     ○ Coral aquaculture/LRF aquaculture

SCUBA Divers Focus Group 2 (Feb. 26)	Aquaculture section is good	● Do not ignore other types of aquaculture

		● Name the chemicals that are damaging in the sunscreens

Summary:

Overall, from the focus groups we concluded the aspects of the "How to Help Coral" section that need improvement include:

- Each section needs to be more related to coral
- Adding in a "Reef Courtesy" section, infographic, or set of guidelines (especially for tourists) would be beneficial
- Add some clarity to aquaculture section- change title name to stray away from the thought that it is about eating fish
    - Provide further information on the LRF's role in aquaculture
    - Do not ignore other types of aquaculture
- Include a fish consumption section
- Include an energy consumption section
- Focus on climate change and even more on general environmental impact
    - Really concentrate on aspects that affect coral directly
        - Cats
        - Sewers
- Voice actions people can take, rather than controversial problems
- Offer specific information visitors to Hawaii can do to help coral
- Offer specific information on what people can do to help coral in their hometown (more general changes to their daily lives)
- Provide names of chemicals people should avoid when buying sunscreen

9. Other Suggestions and Recommendations:

Focus Group	Suggestions and Recommendations
WPI	● More interactive

	● More pictures/more exciting ● Make visitor form mandatory for using the app
WHEA	● The spacing is not all the same ● Include the instagram and the facebook ● Map does not load on about us ● Search box gives blank box in corner that does not serve a purpose ● Get better images ● Fish slides could use headers for each bullet ● Diet, appearance, habitat in the reaf ● People get distracted by full paragraphs ● People find it easier to take info in bullet points ● Expand images does not work for everyone
SCUBA Divers Focus Group 1 (Feb. 25)	● Not intuitive on how to get back to the home screen ● About us page needs more narrative, background on LRF and different projects they are doing ● Tourists have a limited time of engagement, the app will not keep attention to tourists and general visitors ● Put priority of topics in the application ● Going to get a mix of different people, some people may scan QR code, some people may not scan ● May need to tailor application to specific audience ● Maybe add Pono Pledge into the application or some pledge regarding coral reefs ○ LRF can be a part of the Pono Pledge ● Some people might look at a section and not another, which may lead to misinformation

	• Maybe have a webcam in the tank and having a way to view it on their phone after visiting, keeping it on their phone so they can use it in the future • Have more of an order on how people should click on each section in the app • Incorporate more sea life/shrimp/sea turtles/etc • Bulleted points of information are more helpful rather than a full narrative, more pictures, less text • Fix typos
SCUBA Divers Focus Group 2 (Feb. 26)	• Visitor form should not say visitor from Main Island • Looks great • We should be proud • Aiming app towards younger people could lead to more changes

Summary:

Overall, from the focus groups we concluded the aspects of the application in general that need improvement include:

- Make the information into bullets or infographics (less words), guests will get too bored if reading paragraphs
- Better images for sections are needed
- The topics in the application need to be prioritized or ordered so guests do not get misled or are not confused when reading about certain topics
- Give more background on the LRF: who they are, what is their mission, and what projects are they doing to reach that mission

Appendix J: Guide for Improvements for Education Application on Swiftic

The purpose of this document is to provide simple instructions on how to improve the application intended for the coral wall exhibit. If an improvement you want to include does not have instructions in this document you can go to the Swiftic Help Center located on their website: https://help.swiftic.com/hc/en-us/categories/200268542-Edit-My-App. Or you can email their support team at support@swiftic.com.

1 How to invite others to edit your application

1. On a laptop or computer, click on the "Sign In" button in the top right corner. You should be brought straight to your apps.
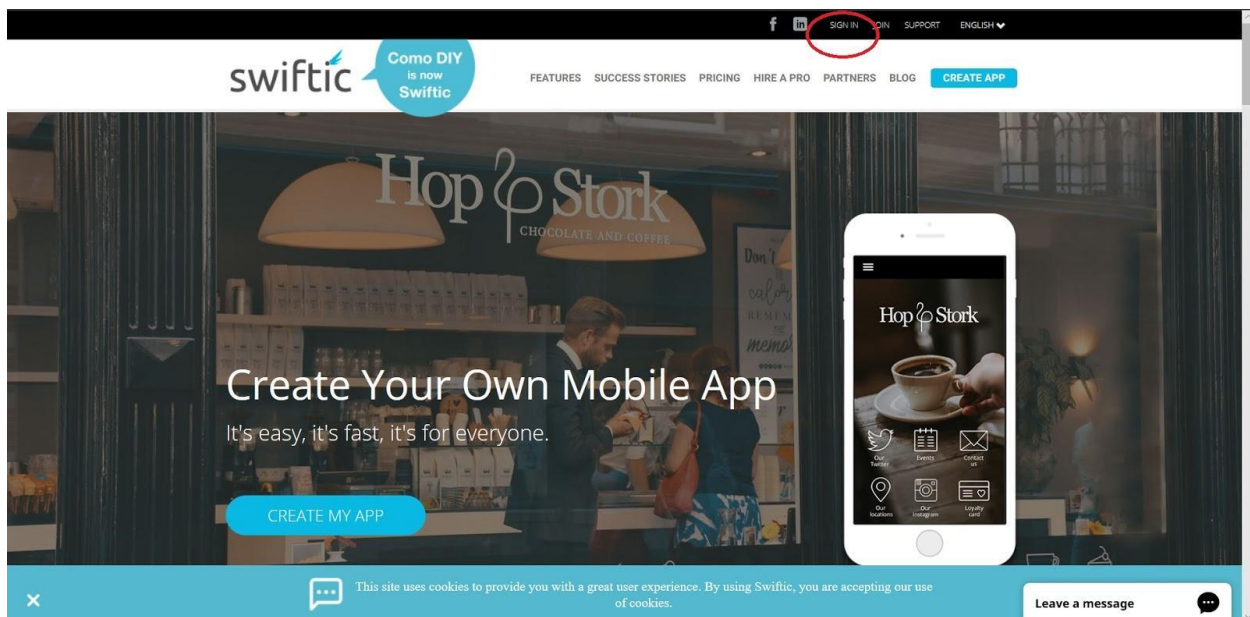
2. Go to the application named "Legacy Reef Foundation" and click "Invite" located on the left side of the bottom bar next to "Delete". DO NOT CLICK DELETE!
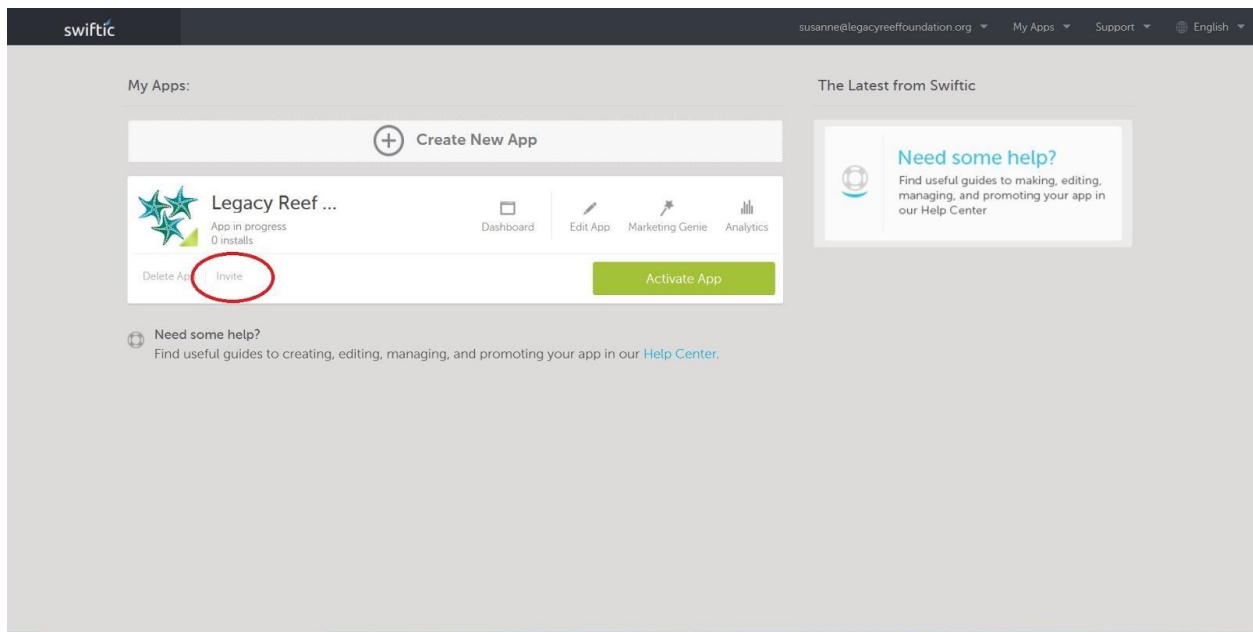
3. Type in the email address of the person you want to invite to edit the application. (Make sure they have an account on Swiftic)

4. Click on "Select Permission" and choose either "Developer" or "Editor".
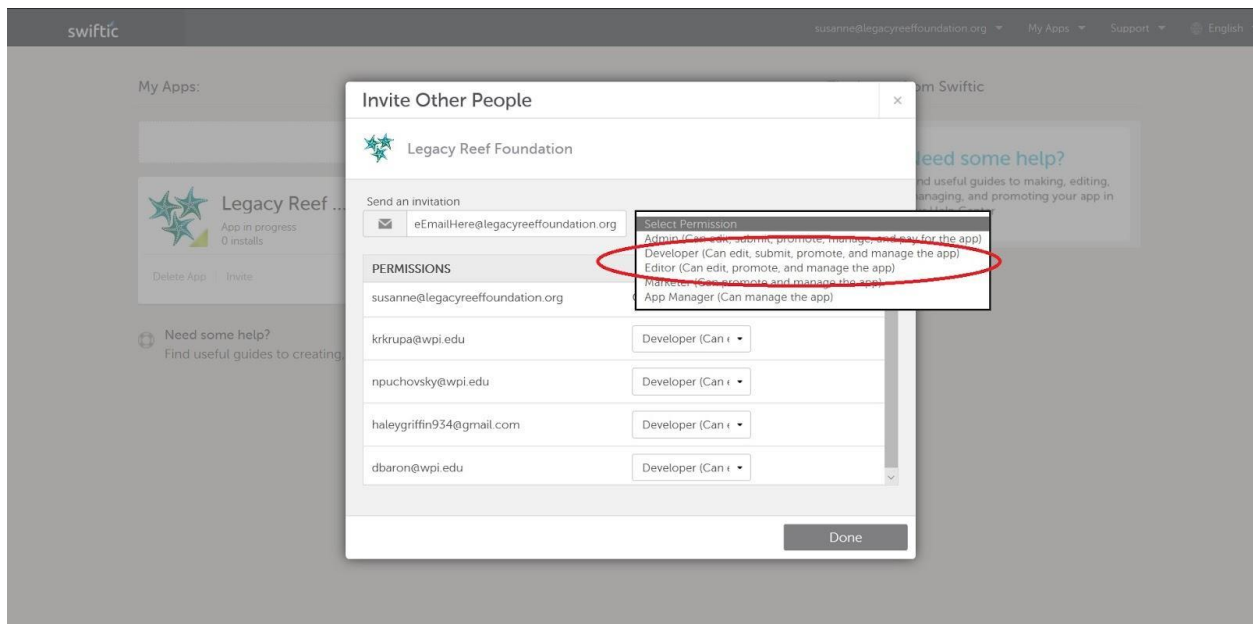
5. Click Send. The new editor should receive an email with an activation link.

2 How to remove others from editing your application

1. On a laptop or computer, hover the mouse over your email in the top right corner of the screen until the drop down menu appears. Click on "My Apps"
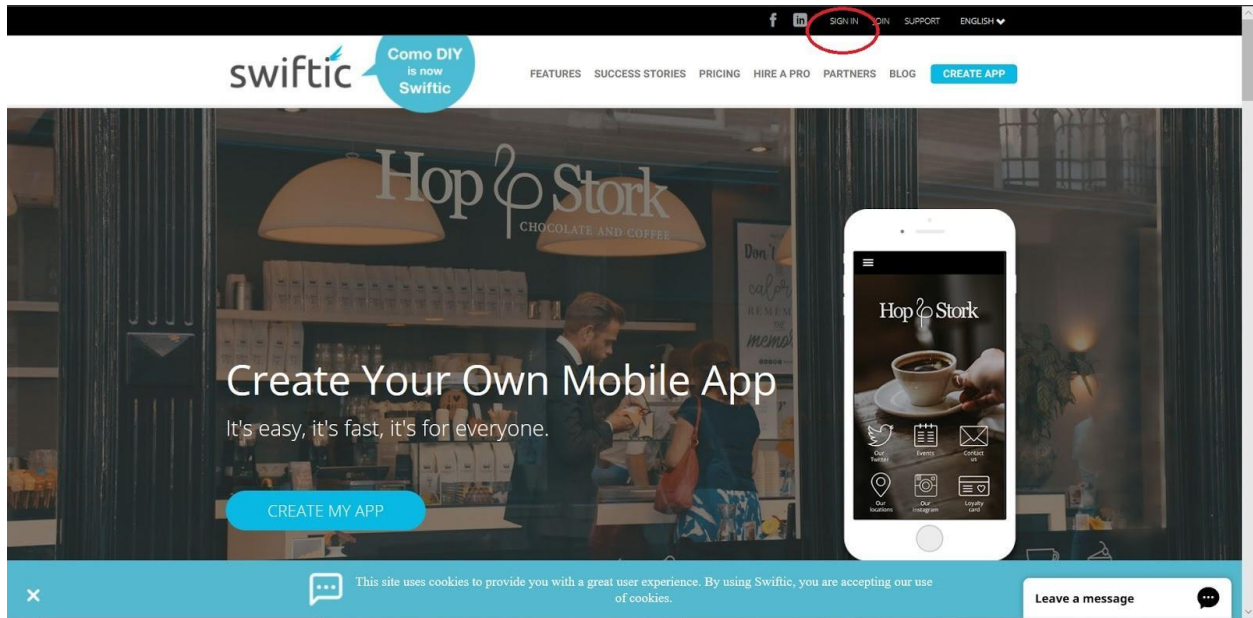
2. Go to the application named "Legacy Reef Foundation" and click "Invite" located on the left side of the bottom bar next to "Delete". DO NOT CLICK DELETE!
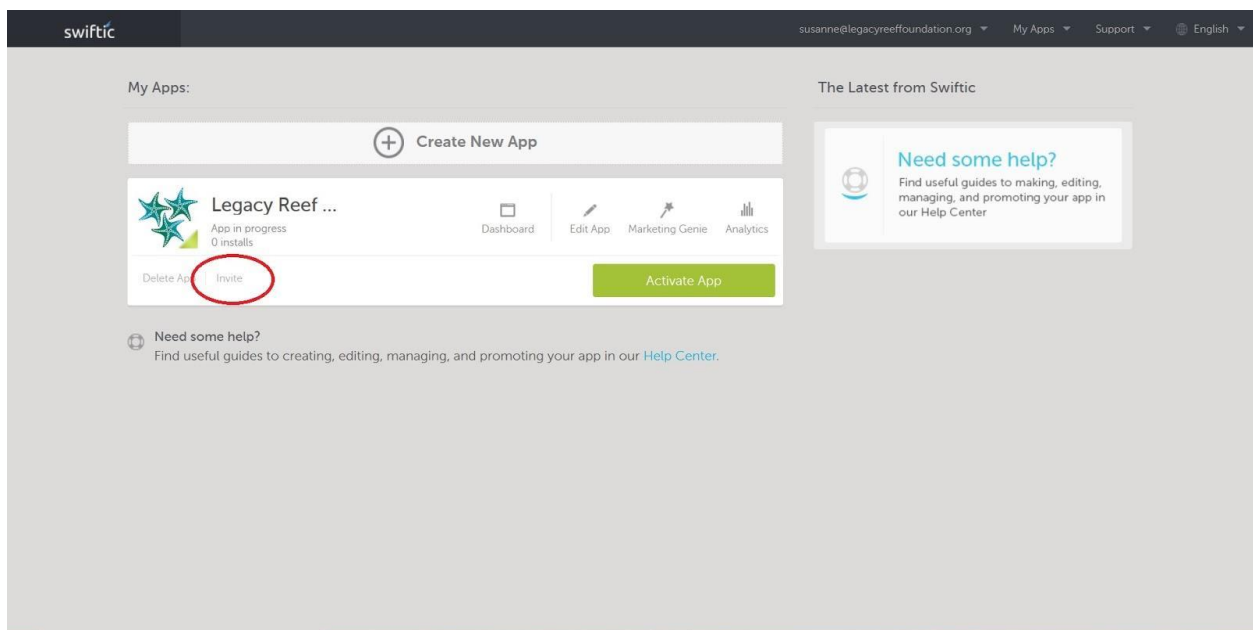
3. In the "PERMISSIONS" section hover the mouse over the email of the person you wish to remove from editing the app until an "x" appears on the far right side of their email.
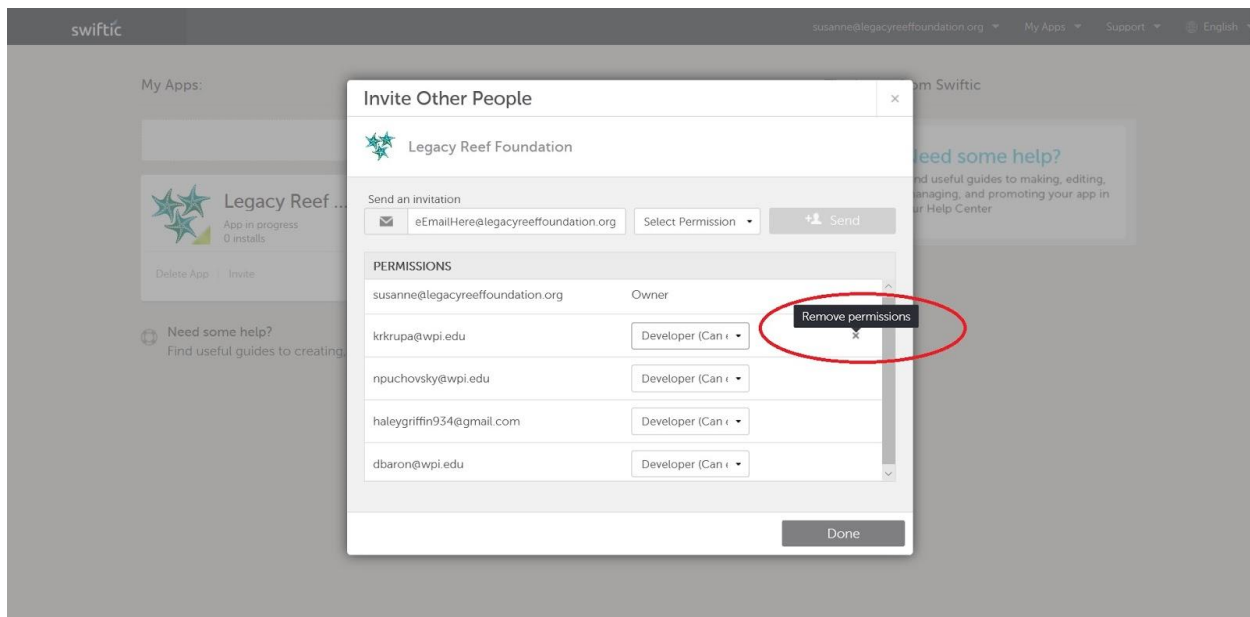
4. Click the "x" and click "Remove" on the tab that pops up after clicking on the "x".

3 How to create a new feature

1. On a laptop or computer, click "Edit App" on the application named "Legacy Reef Foundation" on the "My Apps" page on your Swiftic account.
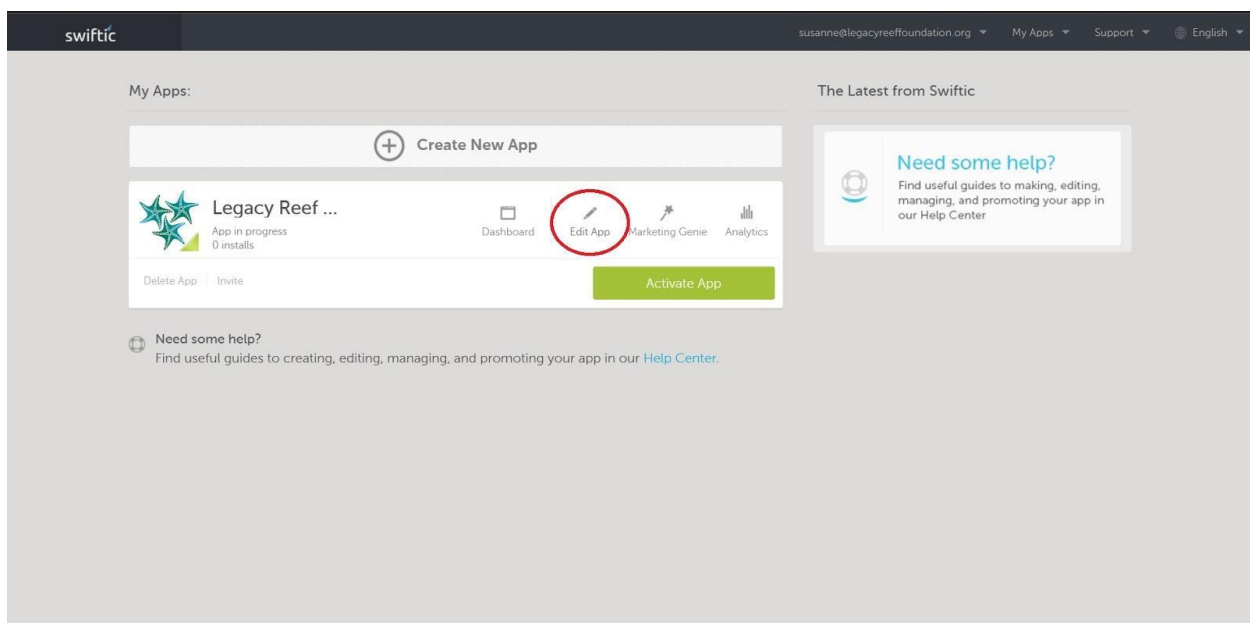
2. Go to the "App Features" page on the top of the screen, and click the "Add Feature" button on the bottom of the screen. Or, click the green plus sign in the top right corner.
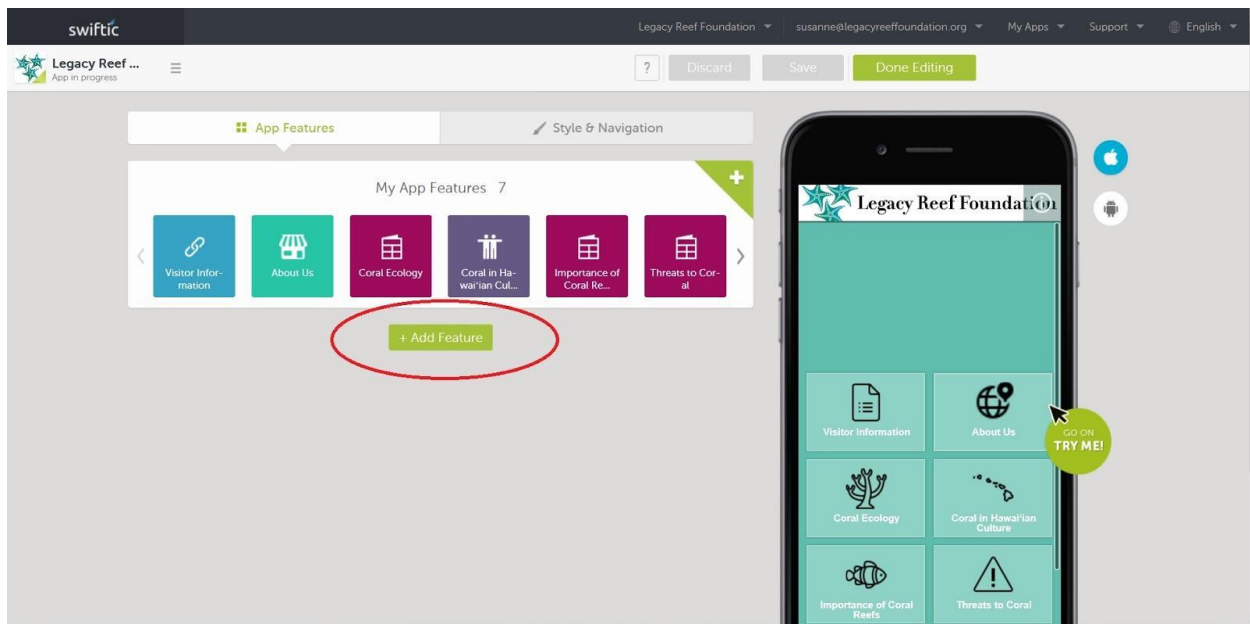
3. Click the "All Features" button in the top right corner, and choose which type of feature you want to create. (We mostly used the "Custom" and "Collection").
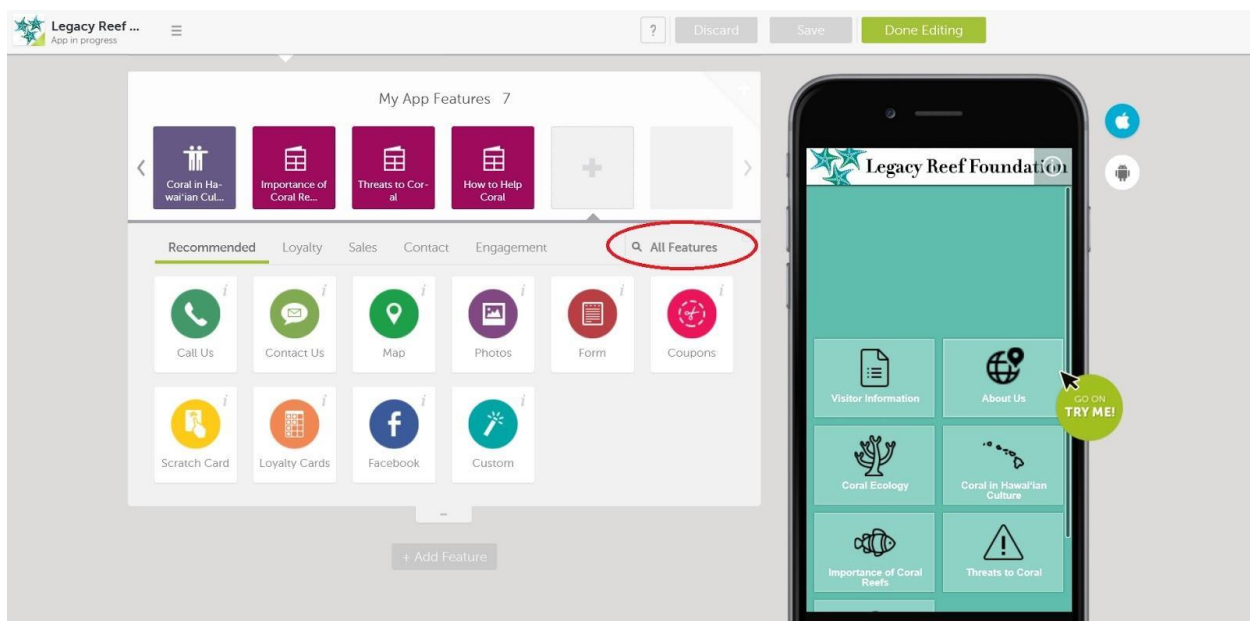
4. For further instructions on the "Custom" feature, follow 1.31. For further instructions on the "Collection" feature, follow 1.32.

3.1 How to create "Custom" features in the application

A custom feature is one that has the image below on the "My App Features" on the left side.

Coral

1. To edit this type of feature click on the image above in the "My App Features" using a laptop or computer.

2. The Title of this feature and icon that will appear on the application's home page can be edited by typing in the text box and clicking on the icon in that can be seen in the image below.

3. In the "Content" section type out any information you want to put into this section.
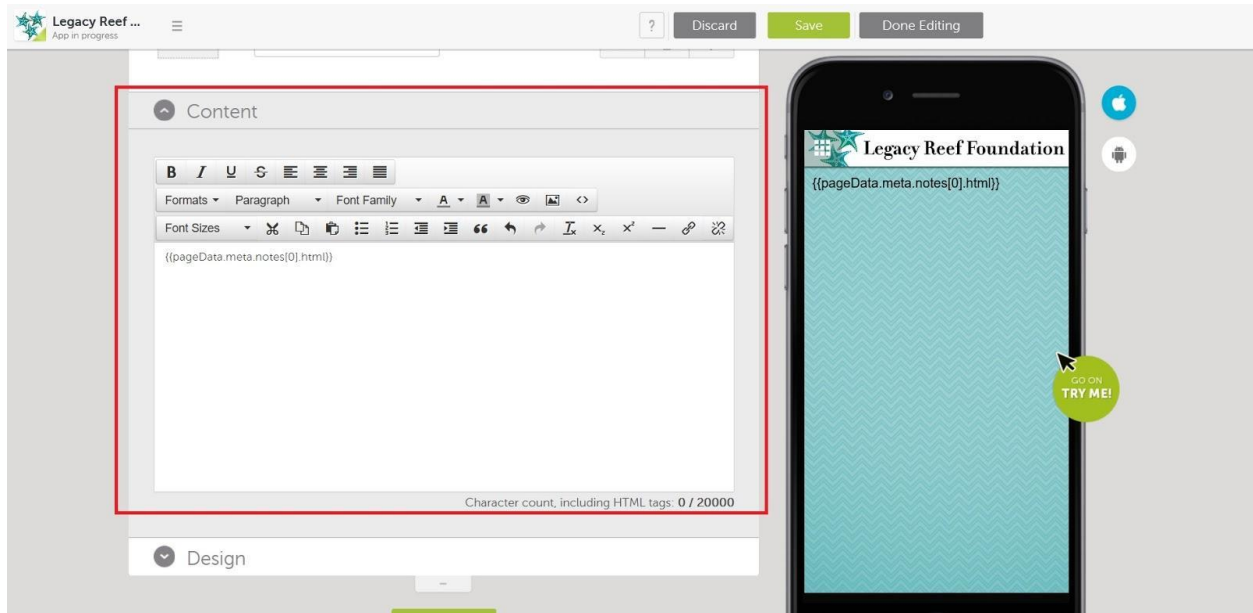
4. To add a picture copy an image and paste into the text box where desired.

5. To add a background picture or color to this feature click the down arrow next to "Design" located underneath the large text box.

6. Click the rectangle with a plus sign, and then click the bottom rectangle that is to the right of "For tablets".
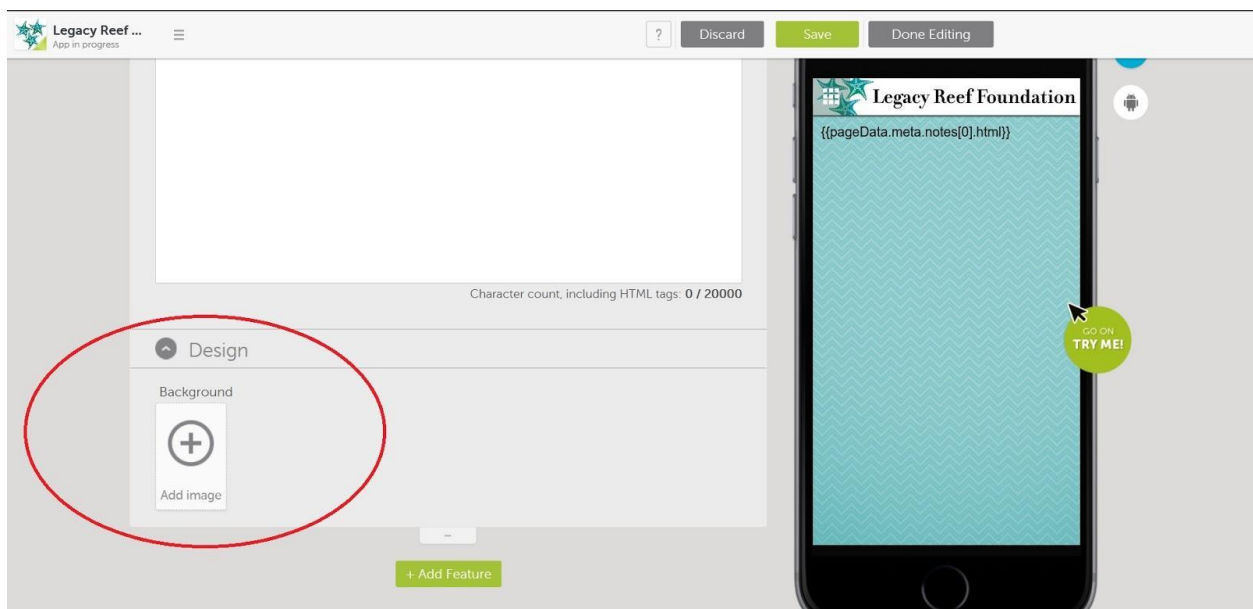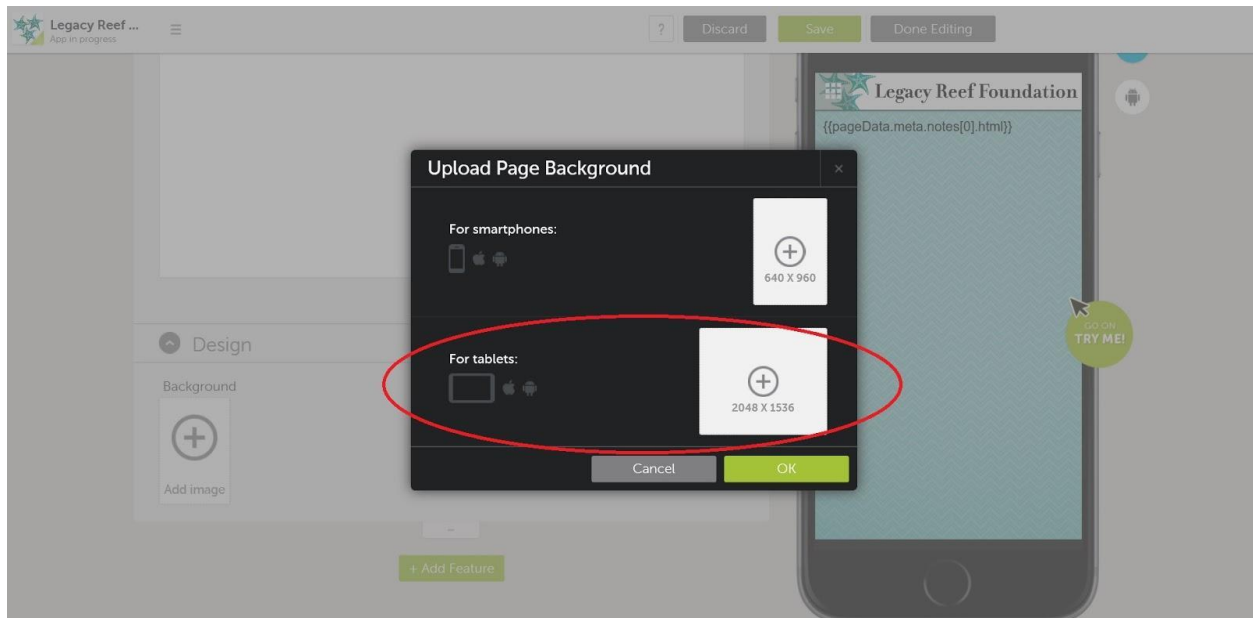
7. Select the image you want for your background, adjust the square on the "Source" until the "Preview" image is how you want it for the feature. Then click "OK".
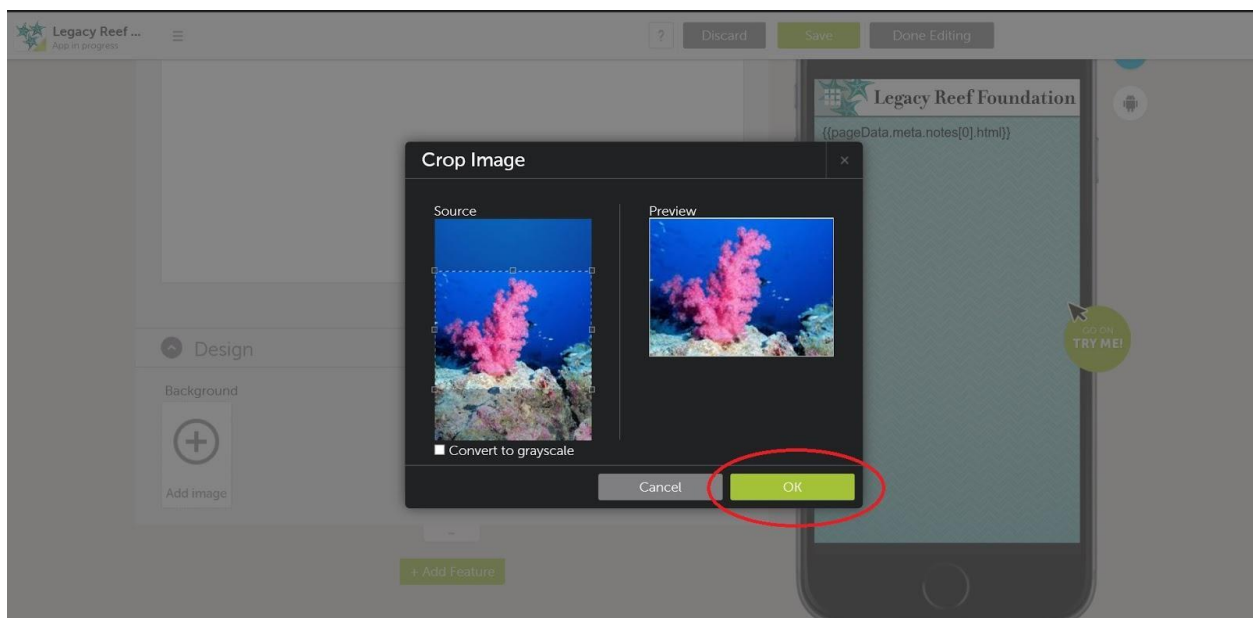
8. Click "Save" on the top bar before leaving the website.
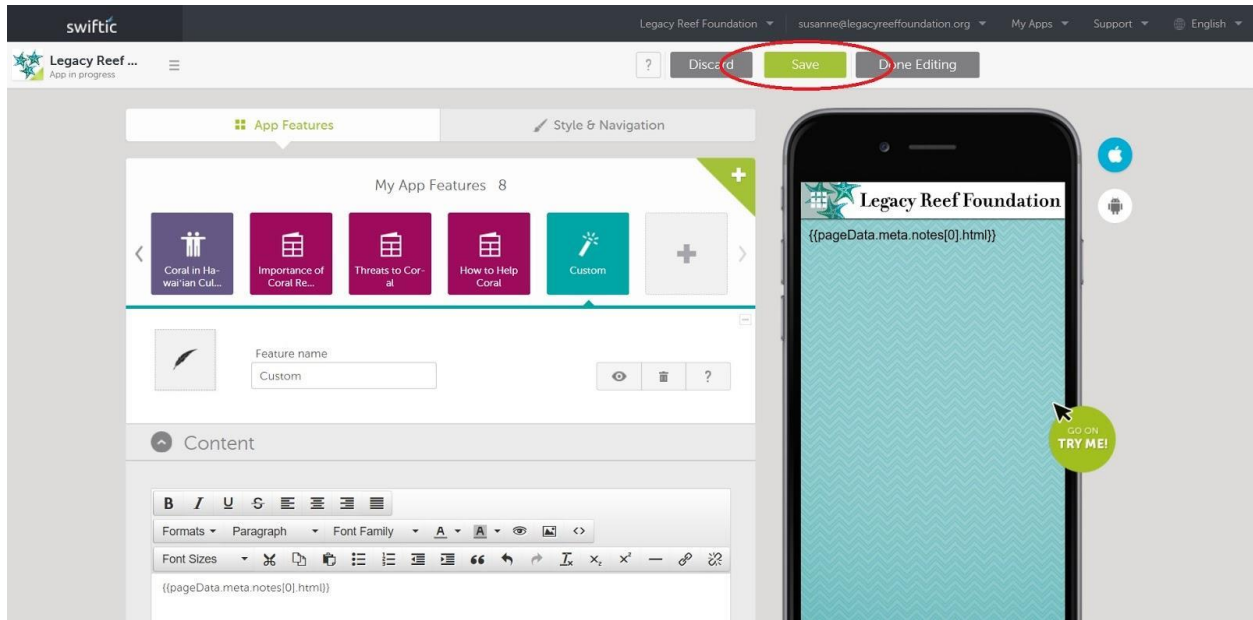
3.2 How to create "Collection" features in the application

A collection feature is one that has the image below on the "My App Features" on the left side.

1. To edit this type of feature click on the image above in the "My App Features" using a laptop or computer.

2. The Title of this feature and icon that will appear on the application's home page can be edited by typing in the text box and clicking on the icon in that can be seen in the image below.
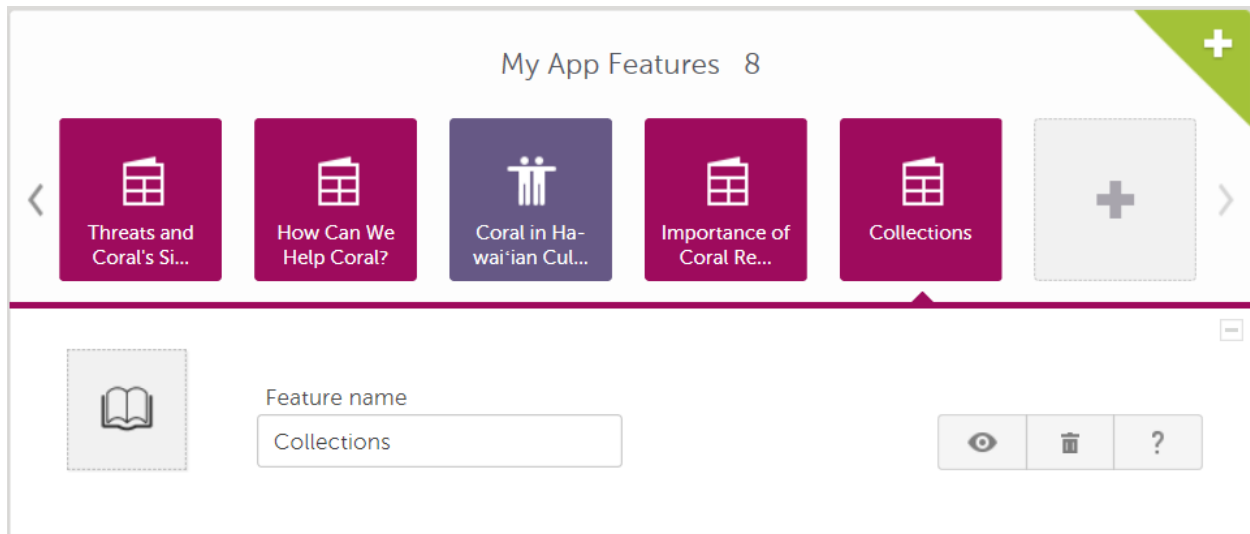
3. Click "Start New Catalog", and give the catalog the name you want to give it. Also if you want to give this catalog an image click the gray box and select the image you want for your background. Once done, click "Save" on the bottom of the pop up.
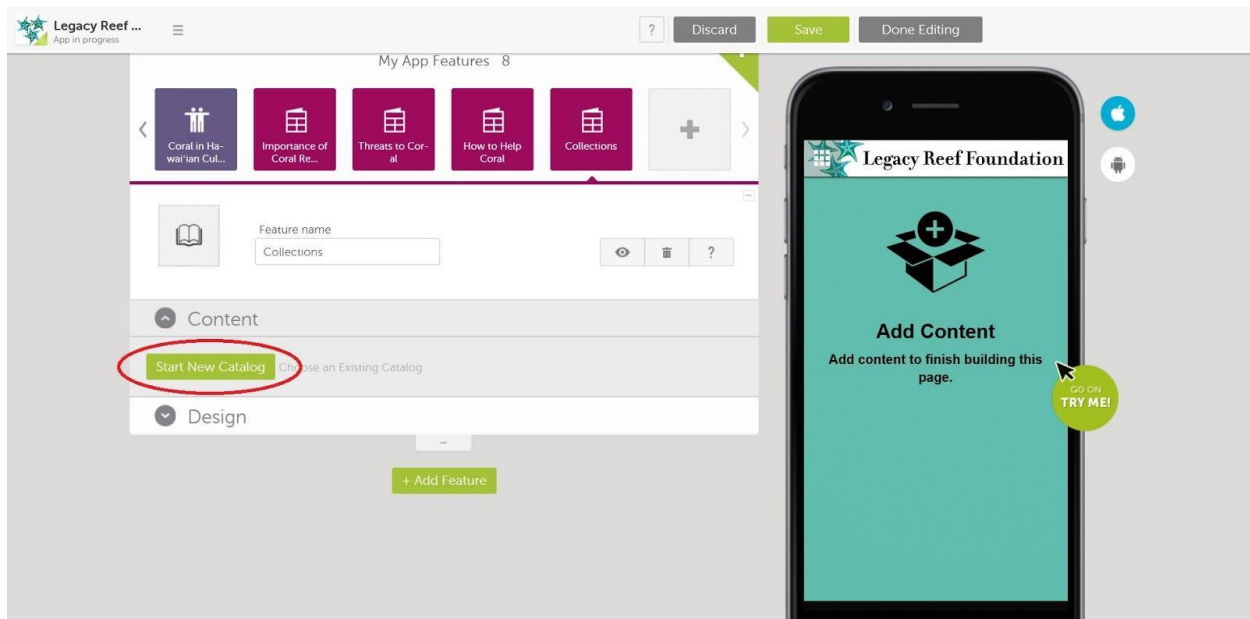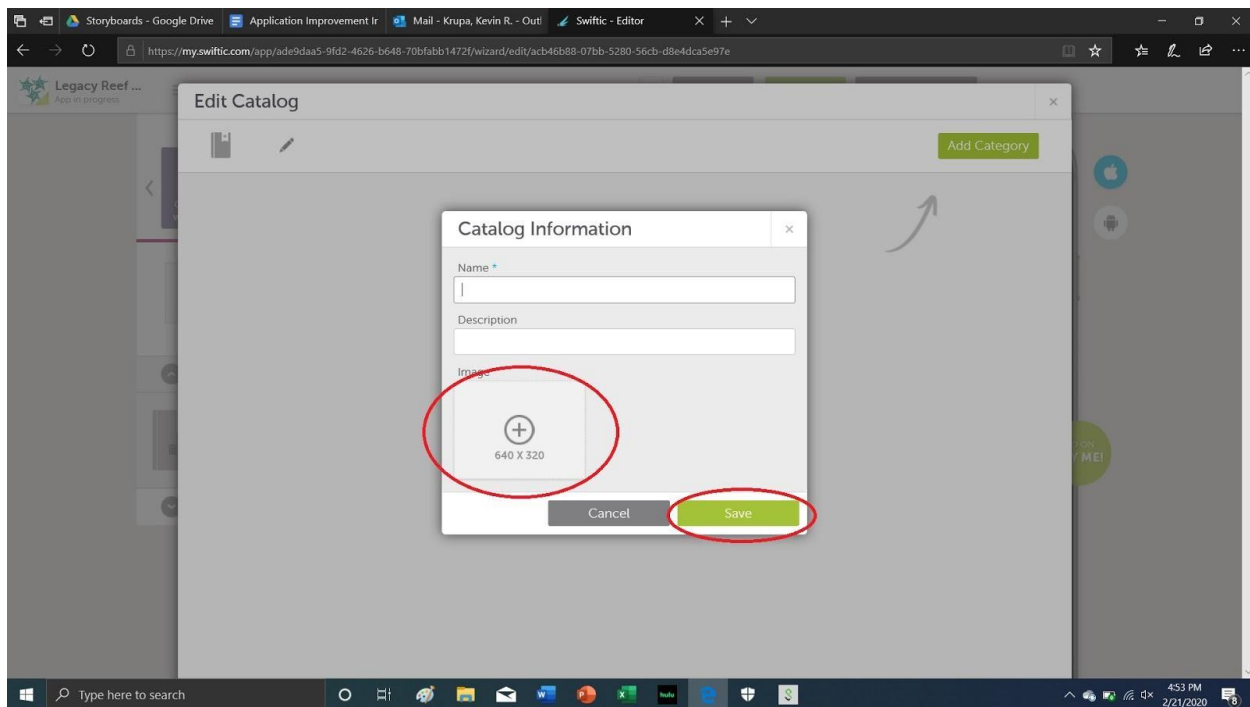
4. To add a category click the "Add Category" button in the top right corner and follow the same process as creating the catalog.
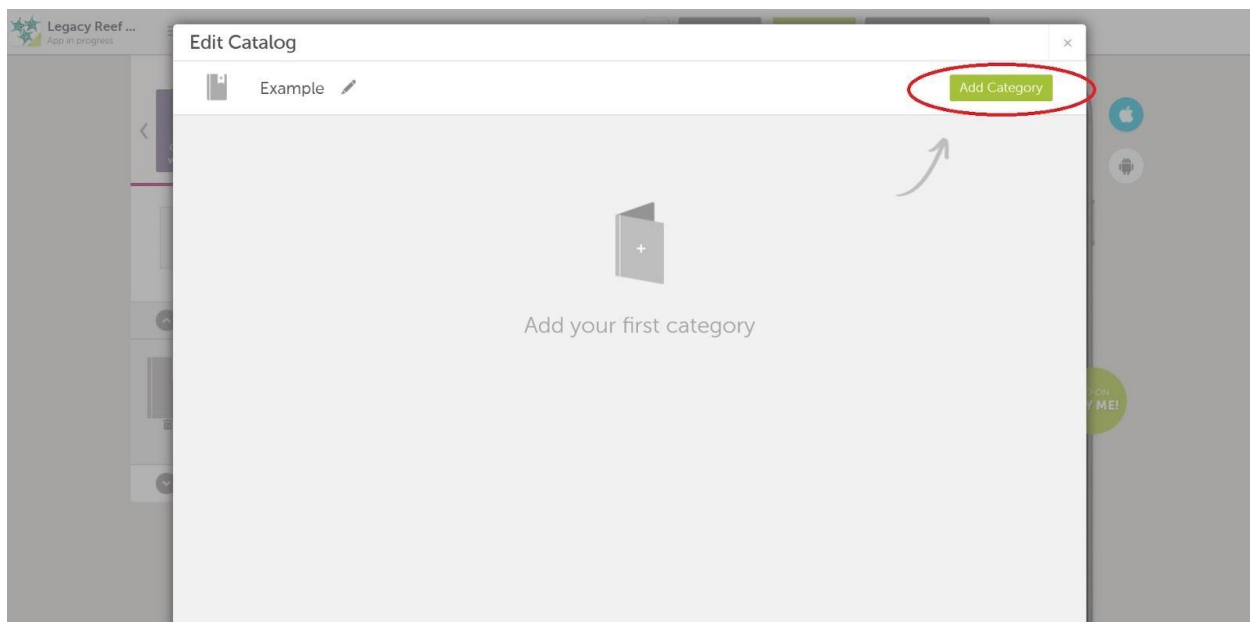
5. A category works as subsections for the feature, so if there are no subsections (ie. threats to coral have global and local threats) then only create one category.

6. Click on the category and in the top right corner click "Add Item"
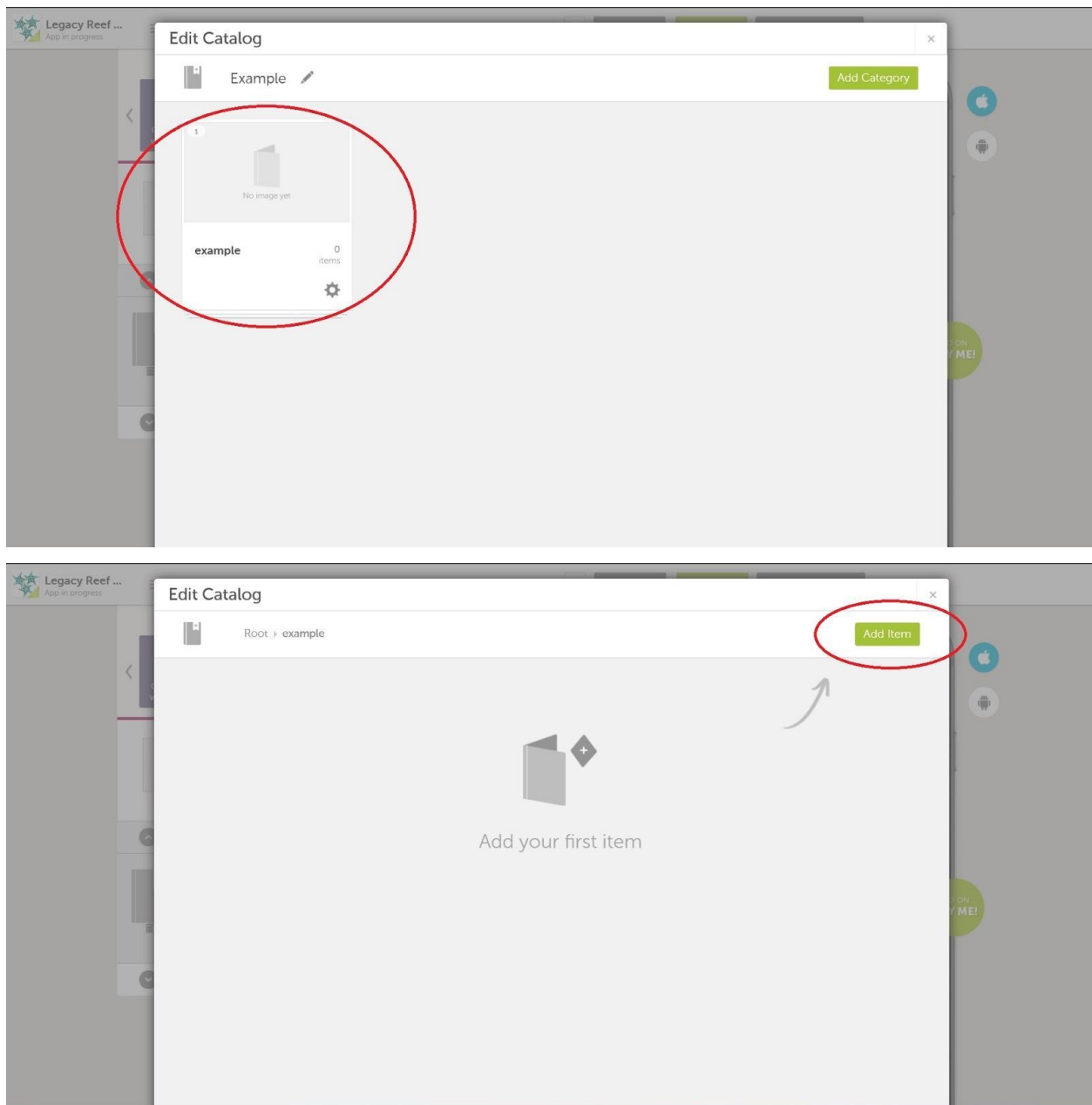
7. Type in the desired title for this piece of information in the "Title" box.
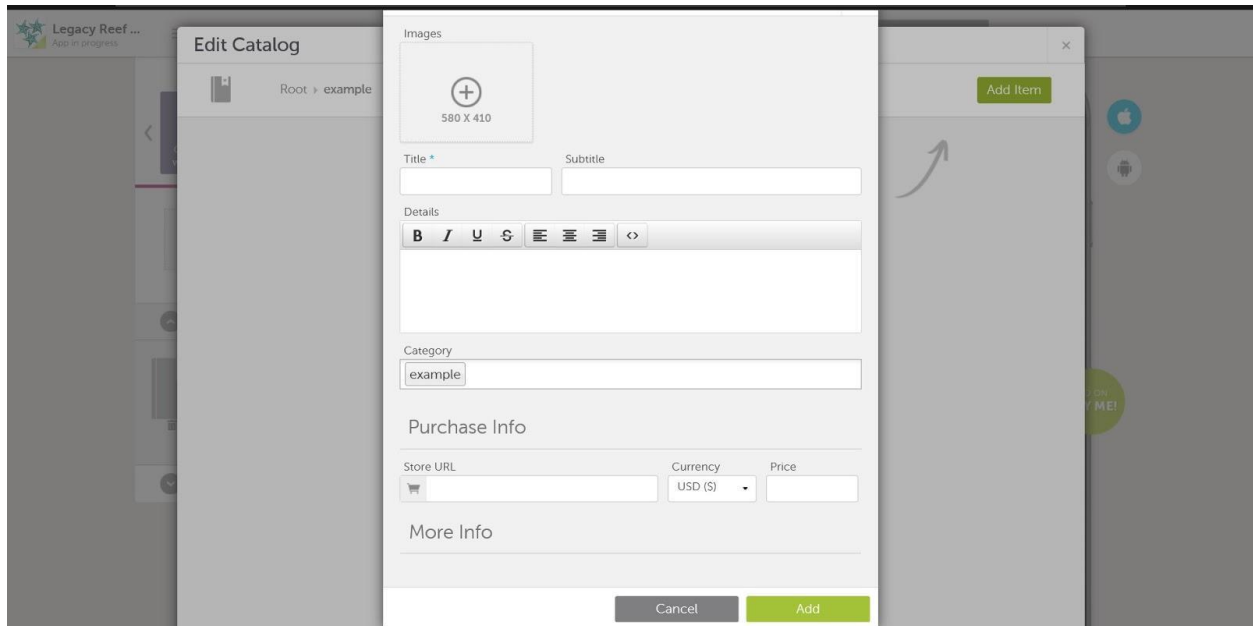
8. All information for this item can be typed out in the text box provided.

9. An image for this item can be added using the gray box at the top of the edit section.

10. Ignore the purchase info section.

11. Once done click "Add" and repeat steps 6-11 for as many pieces of information as needed.
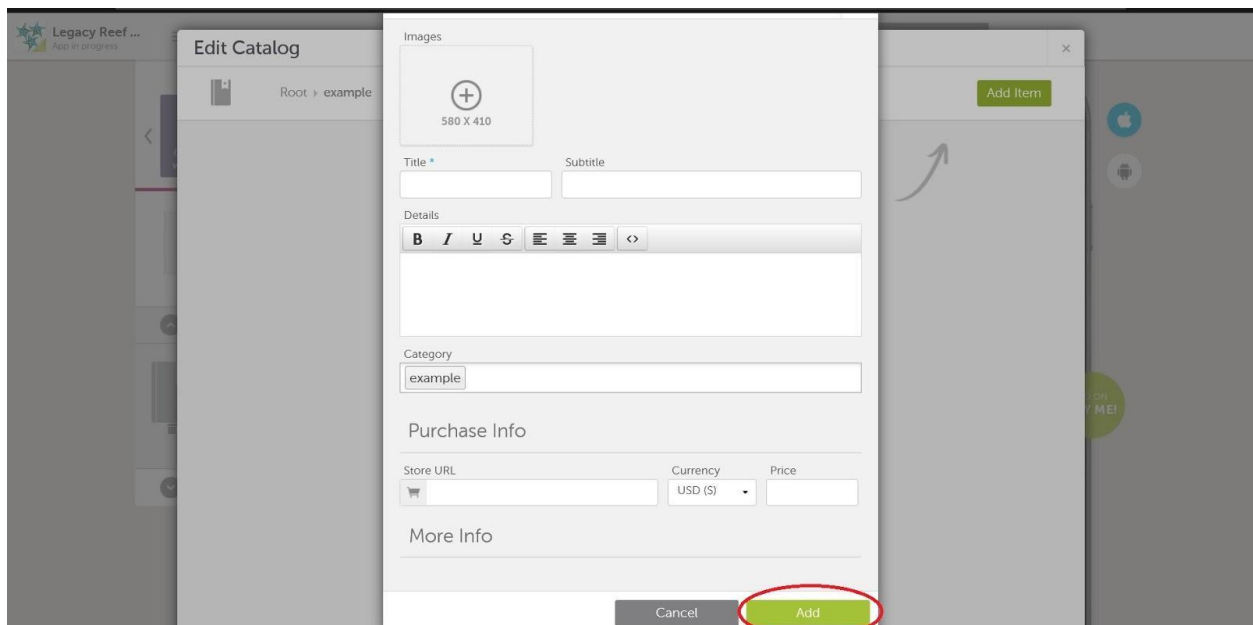
12. Click "Save" on the top bar before leaving the website.
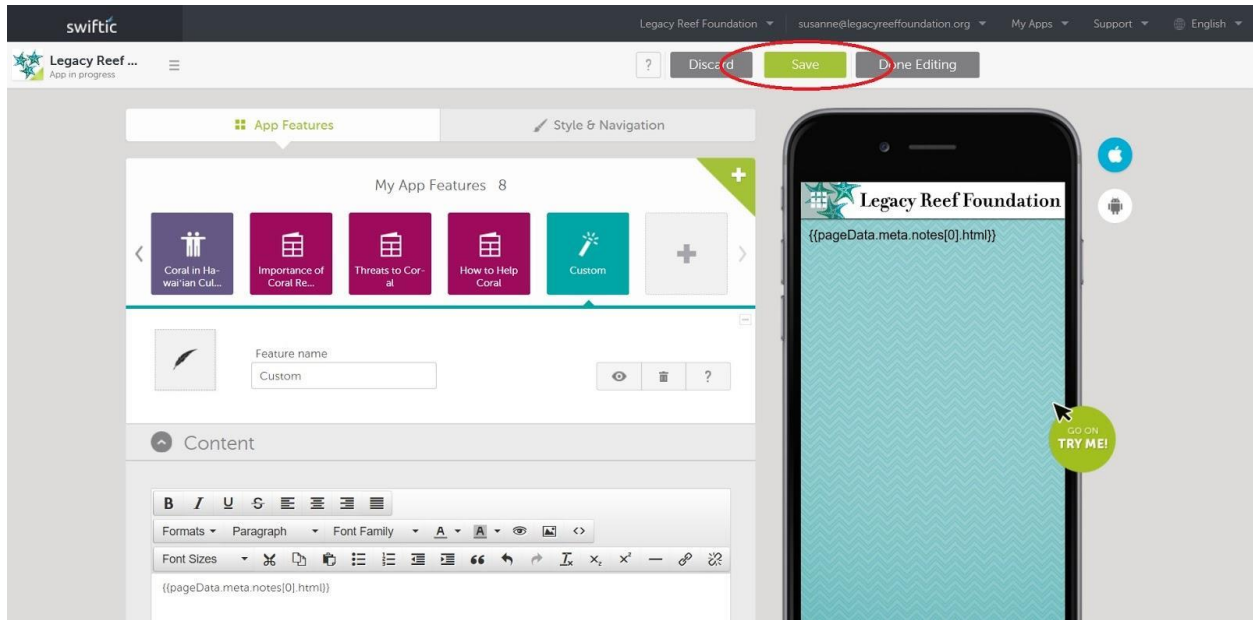
4 How to add to an existing feature

1. On a laptop or computer, click "Edit App" on the application named "Legacy Reef Foundation" on the "My Apps" page on your Swiftic account.
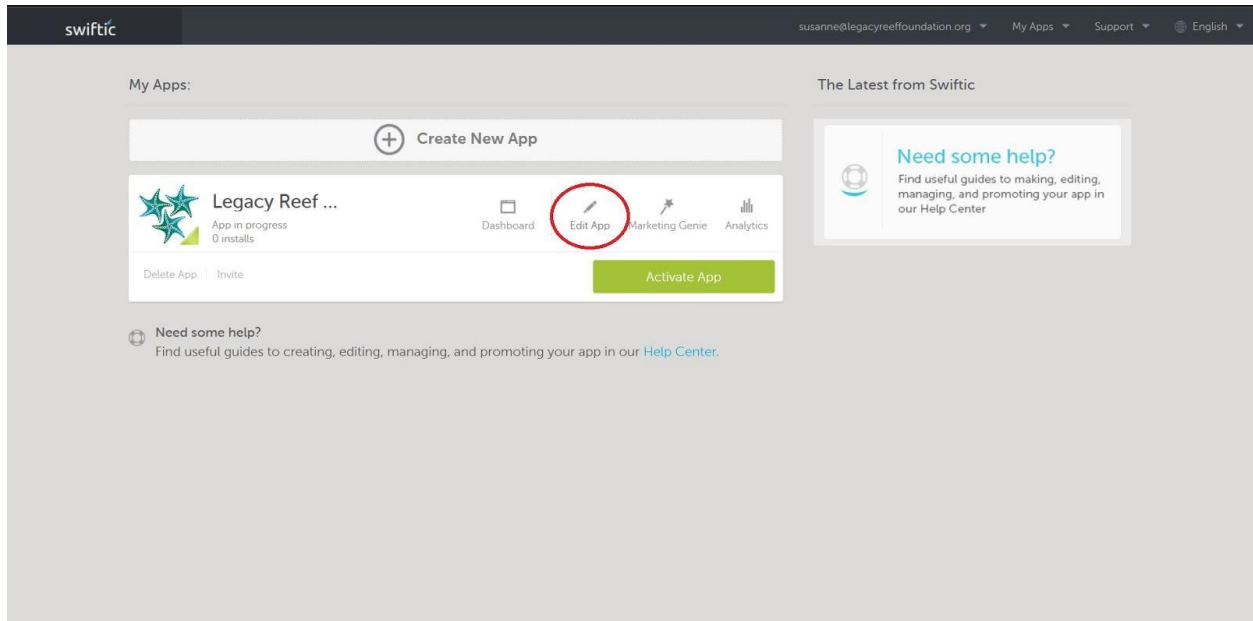
2. Go to the "App Features" page on the top of the screen, and click on the feature of the app you want to edit.
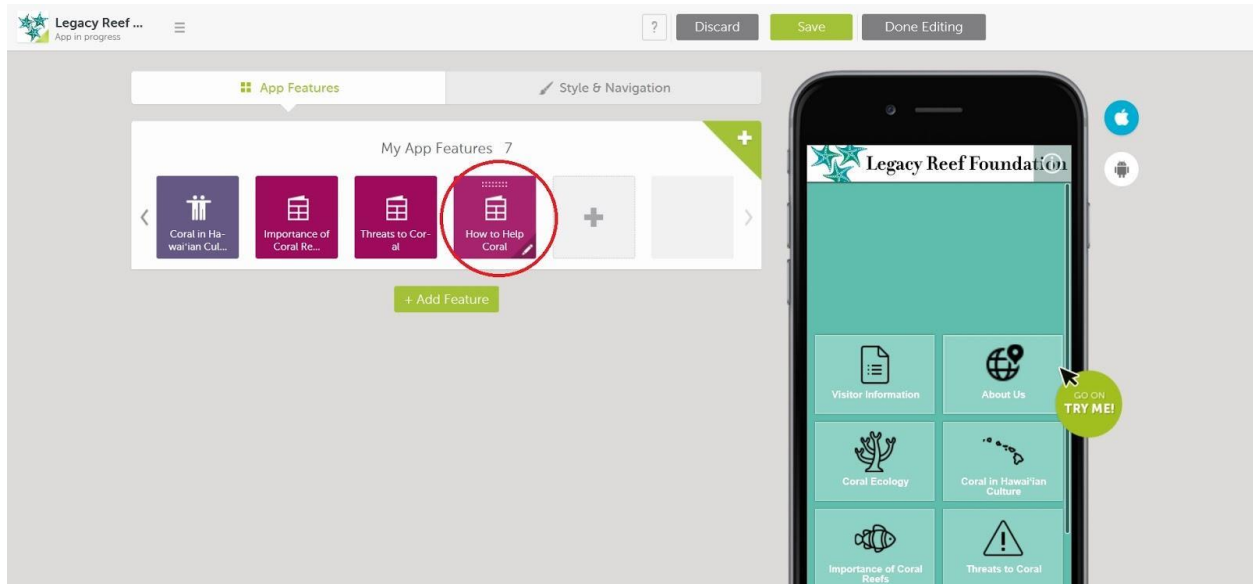
3. Click "Edit Catalog" in the content section.
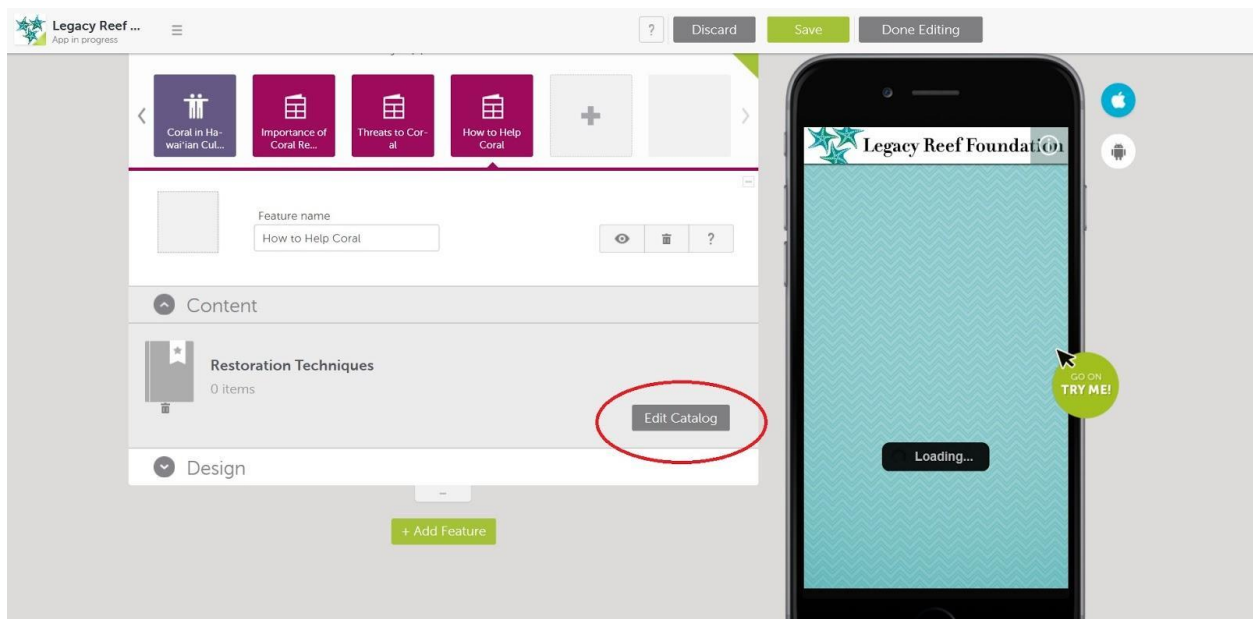
4. To add a new section to that feature click "Add Category".
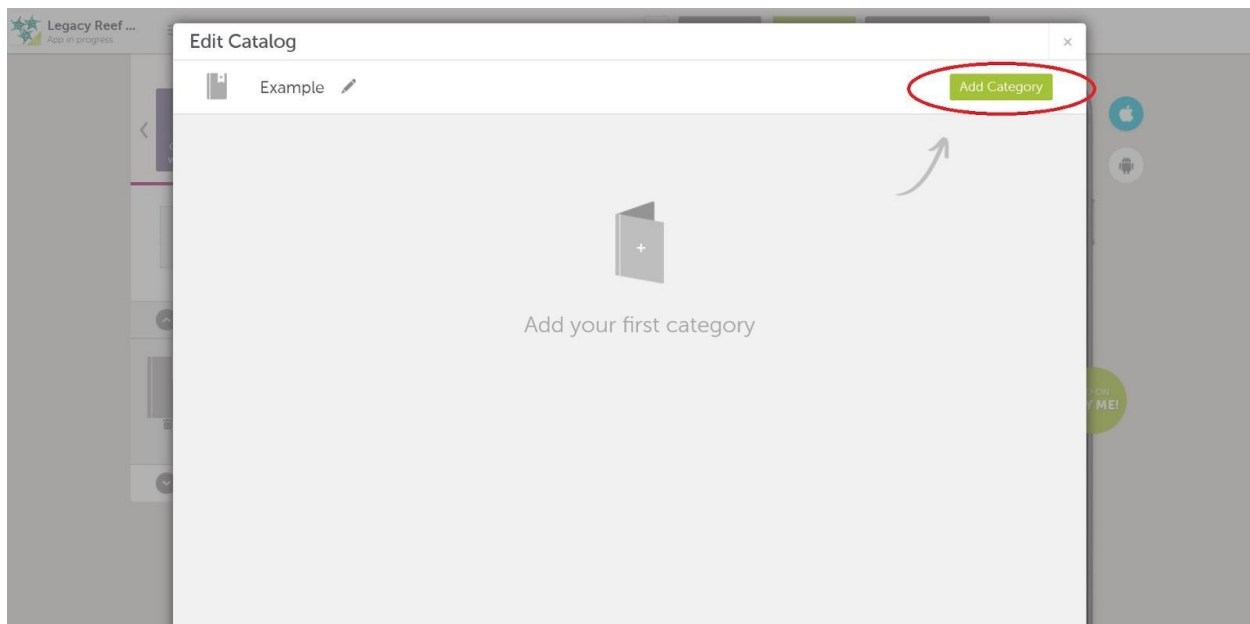
a. Type the Title for the new category
   i. If you want to give this section an image on the title screen of the app, add a picture to the "Thumbnail image"
   ii. If you want that section to have a picture once you are in the section, add a picture to the "Header image".
b. Click "Create Category".
c. Click "Add Item"
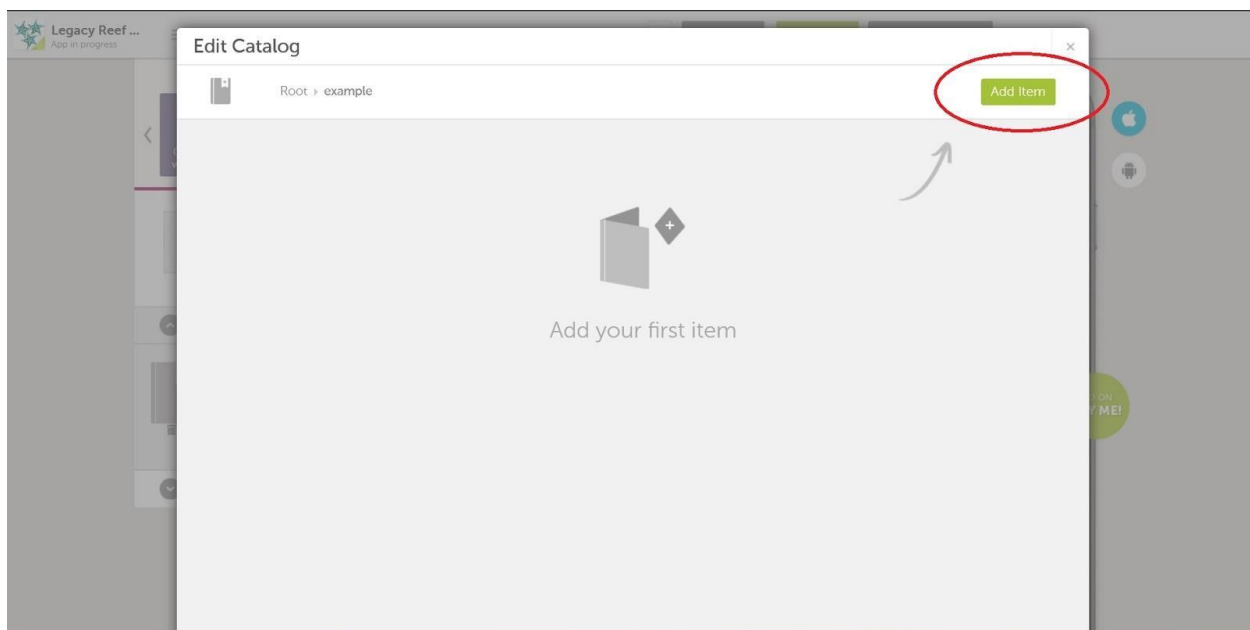
   i. Type in the title you want to have for that subsection.

      ii. Add any images you want to be apart of this subsection from your

         computer.

      iii. Type any information you want to add to this subsection in the textbox

6. To edit sections of the feature click the settings button in the bottom right corner of the section you want to edit; then click "Edit".
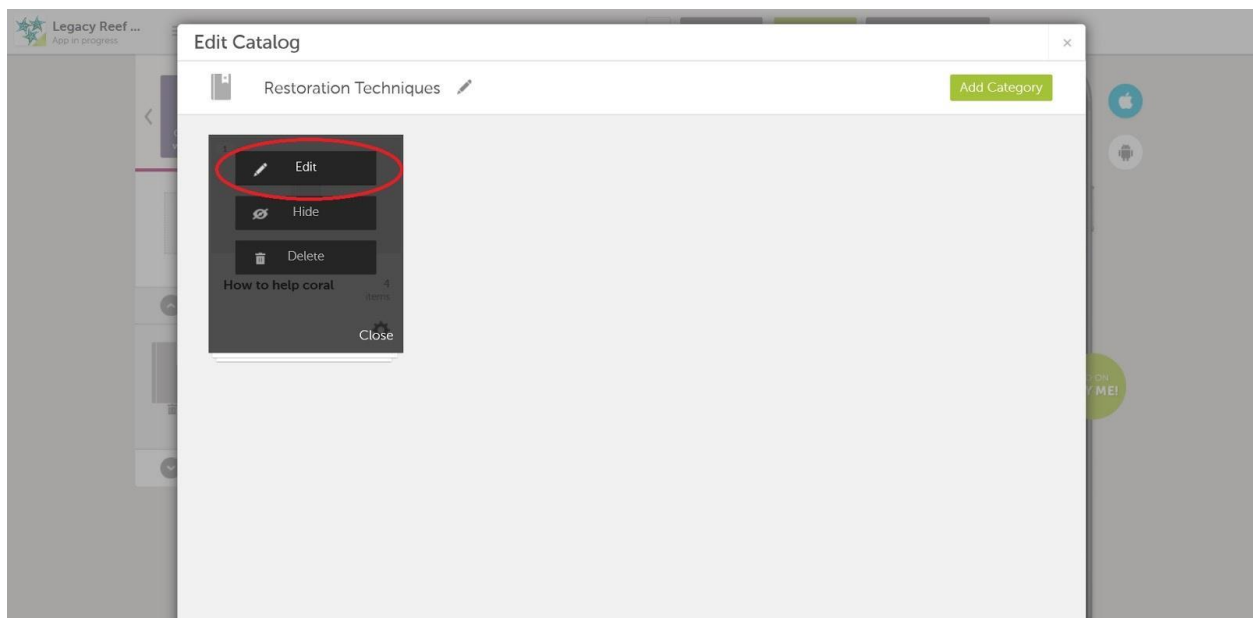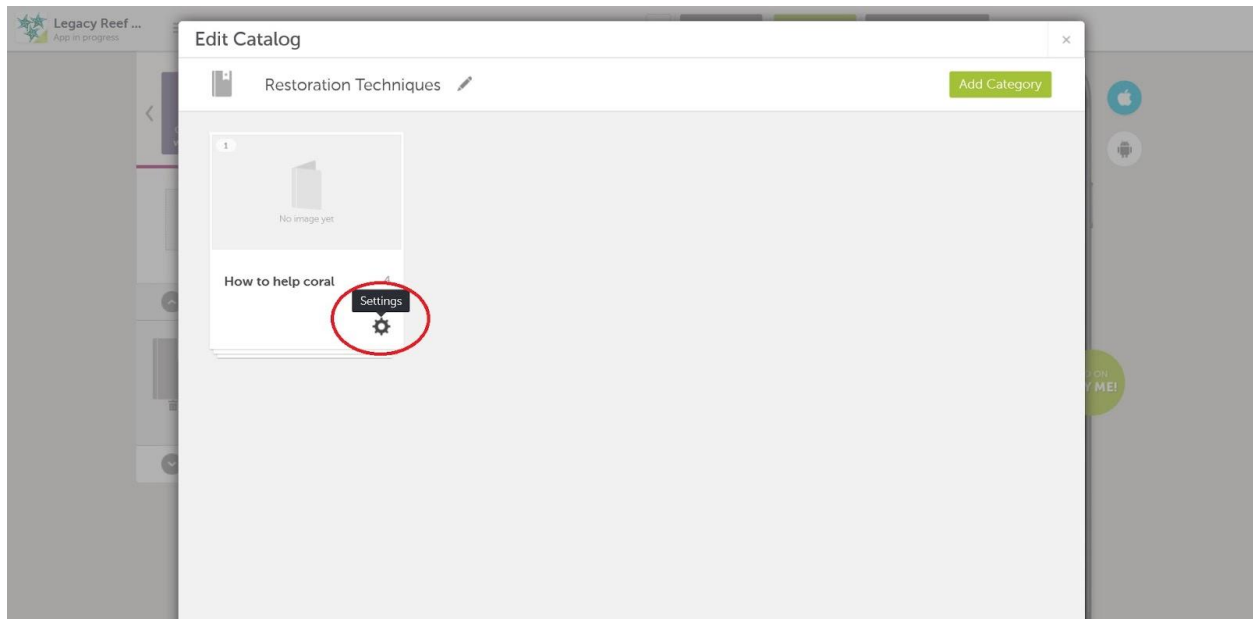
6. To edit subsections of a section click on the section the subsection is located in. Then, click on the subsection you want to edit and the edit window will appear.
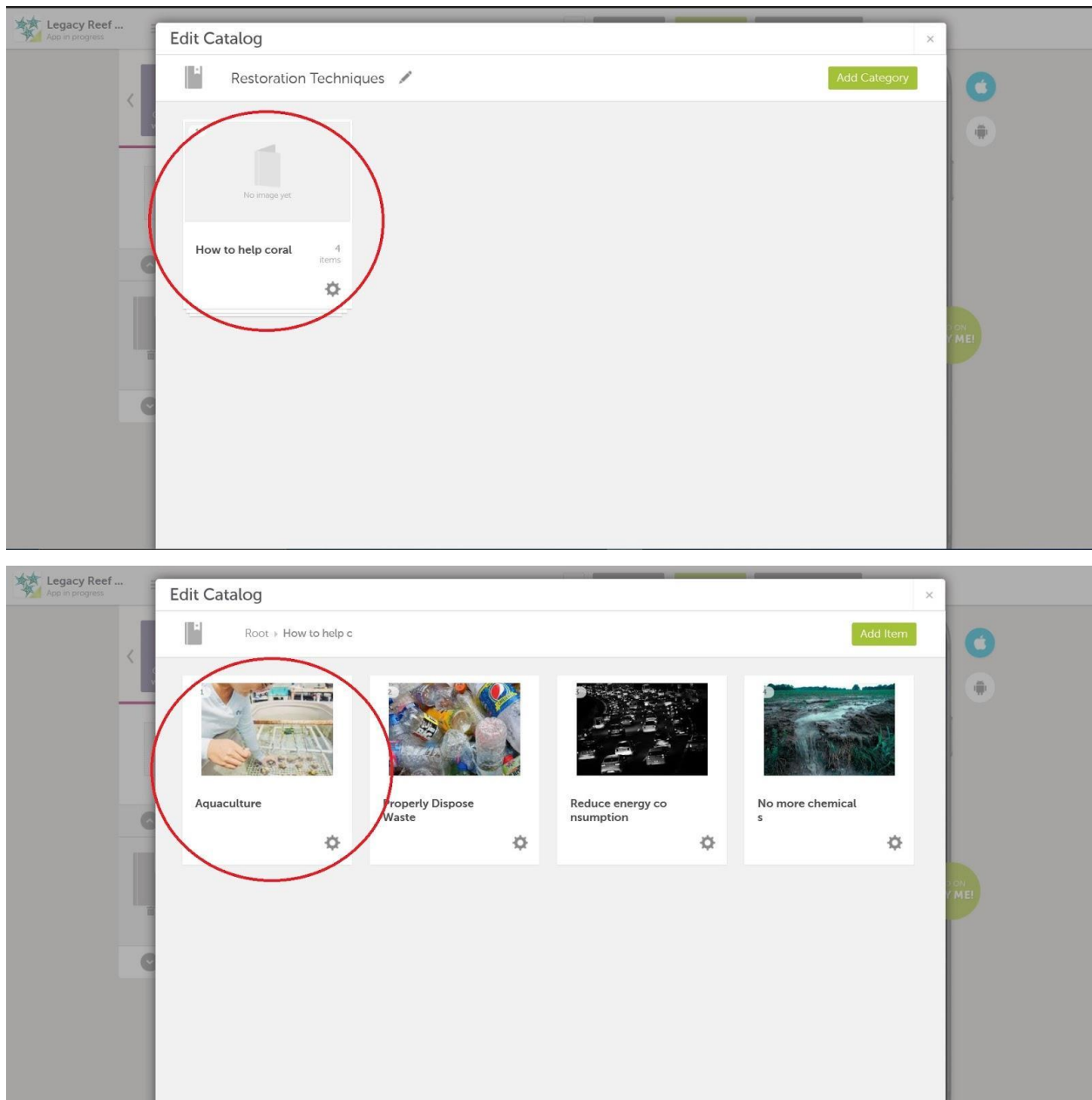
a. Click Save at the bottom once done editing.
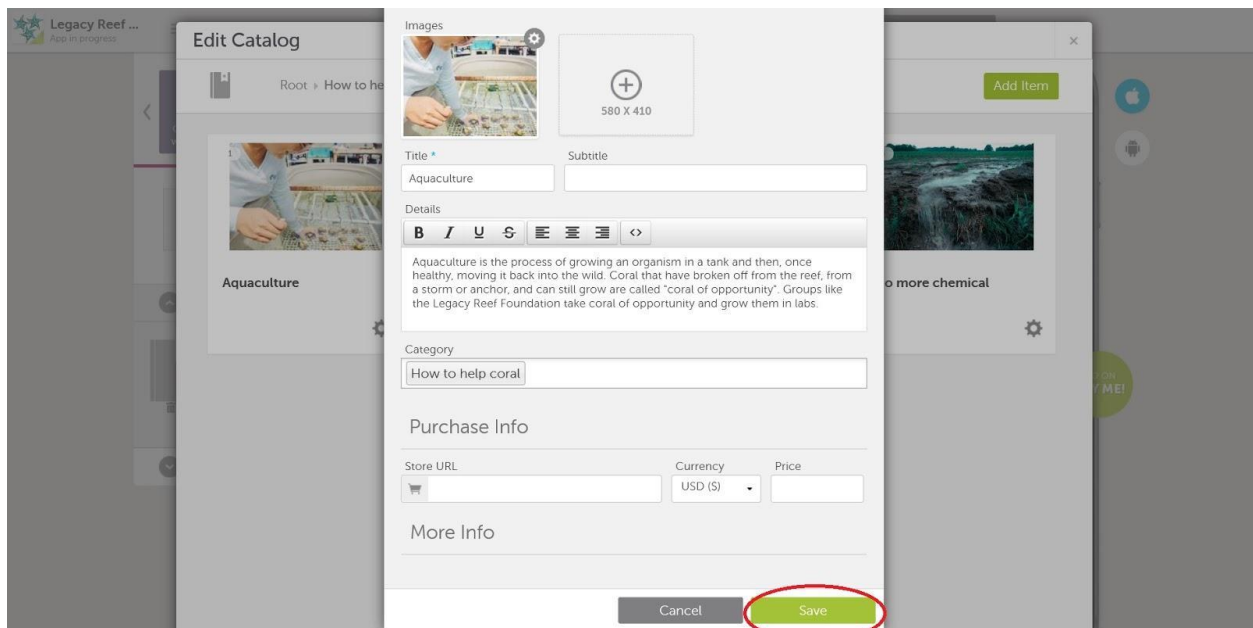
7. Click "Save" on the top bar before leaving the website.
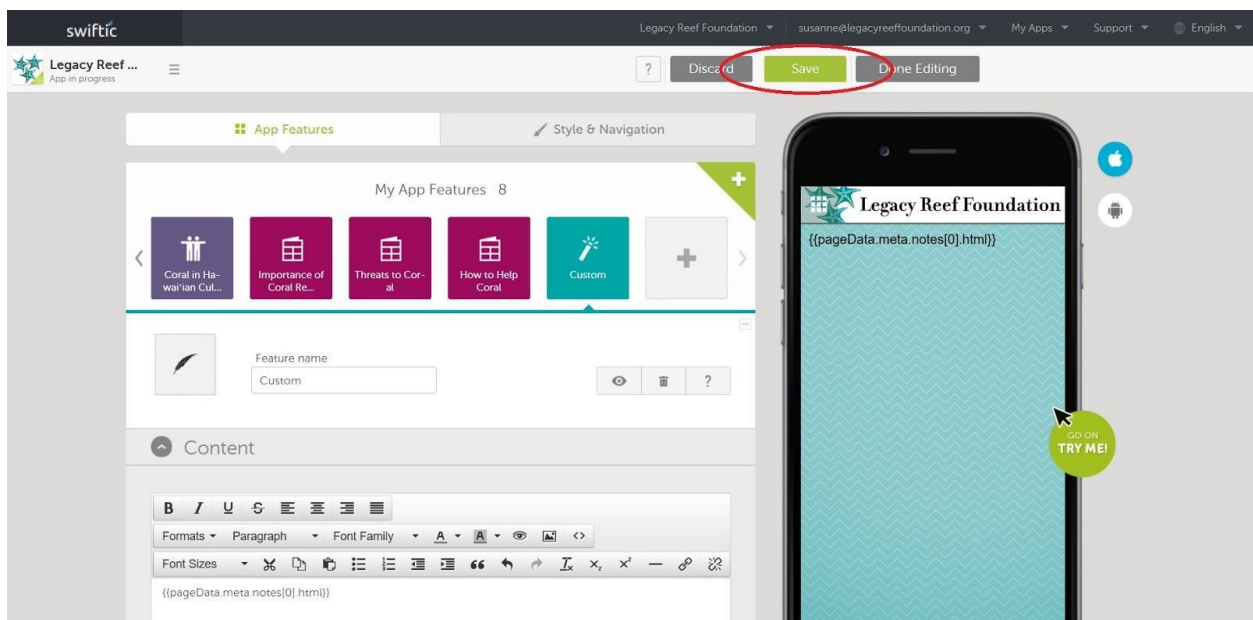
5 How to edit the "Coral in Hawaiian Culture" Feature of the Application

This feature is unique comparClick "Save" on the top bar before leaving the website.ed to the other features of the application as it is links that send the visitors to google docs or the youtube video of the Kumulipo chant. Steps 1-4 will be steps on how to edit the google docs containing

the information. Steps 5-13 will explain how to add new sections, or documents, to the culture feature within the application.

1. On a laptop or computer, sign into google drive.
2. Click on the "LRF Application" shared with you from us, and go to the folder titled "Coral in Hawaiian Culture"
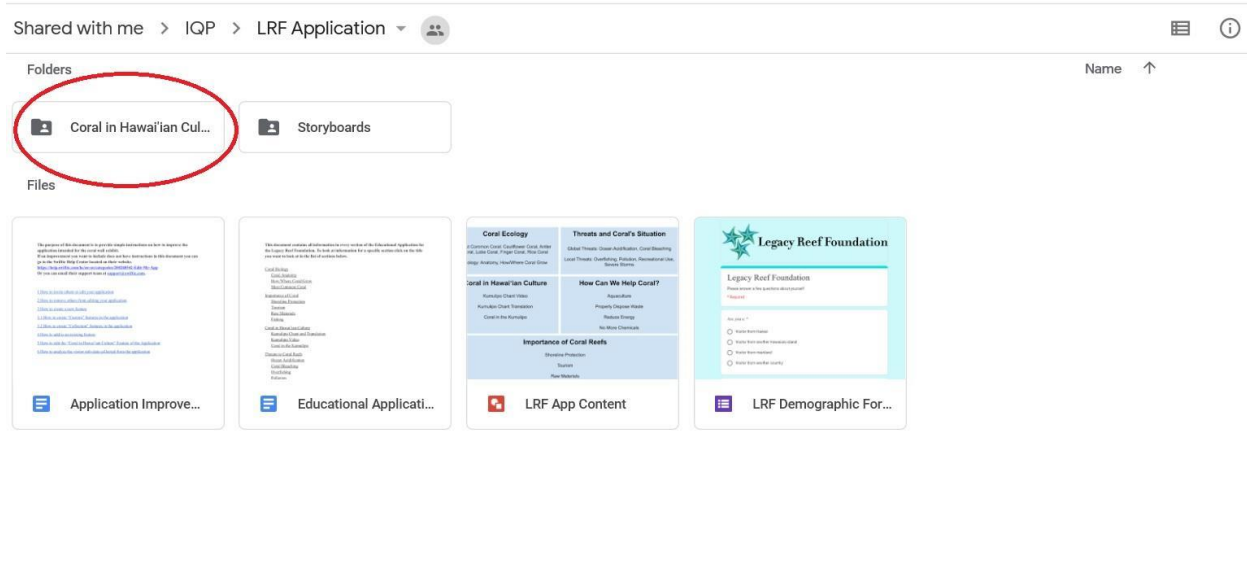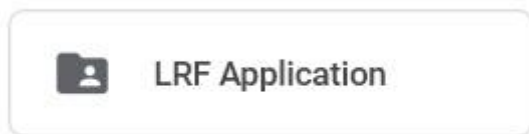
3. Click on the document you wish to edit and change/add any information as needed.

4. To add images go to "Insert", "Image", and "Upload from Computer"
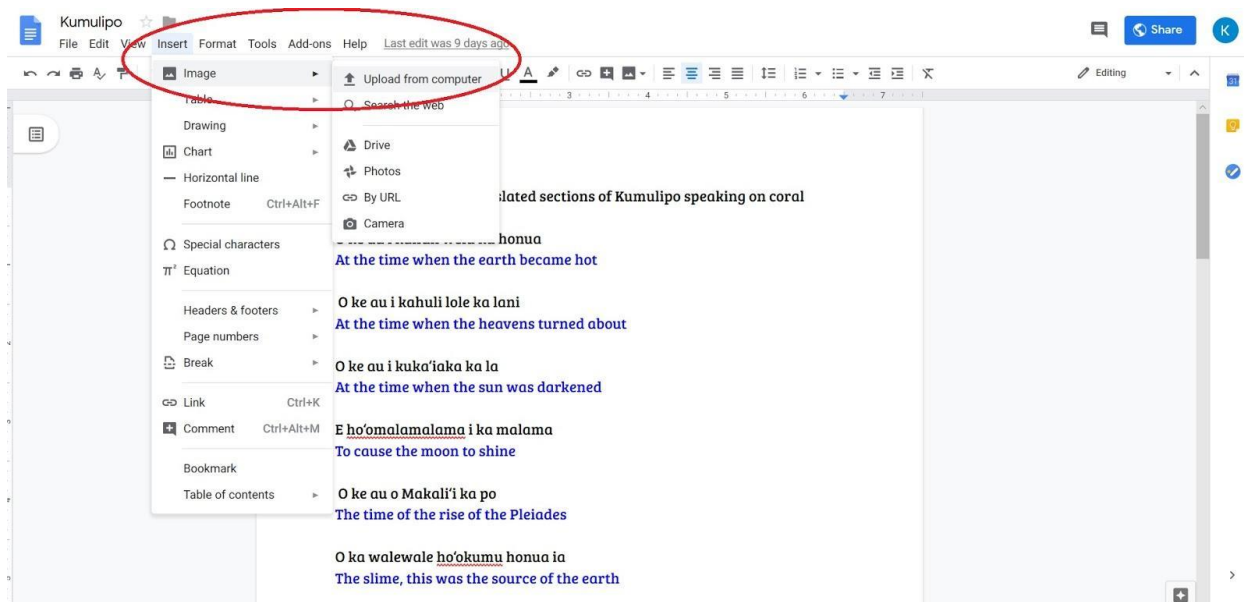
5. To add a new document or section to this feature click on the "Share" button in the top right corner of the document.
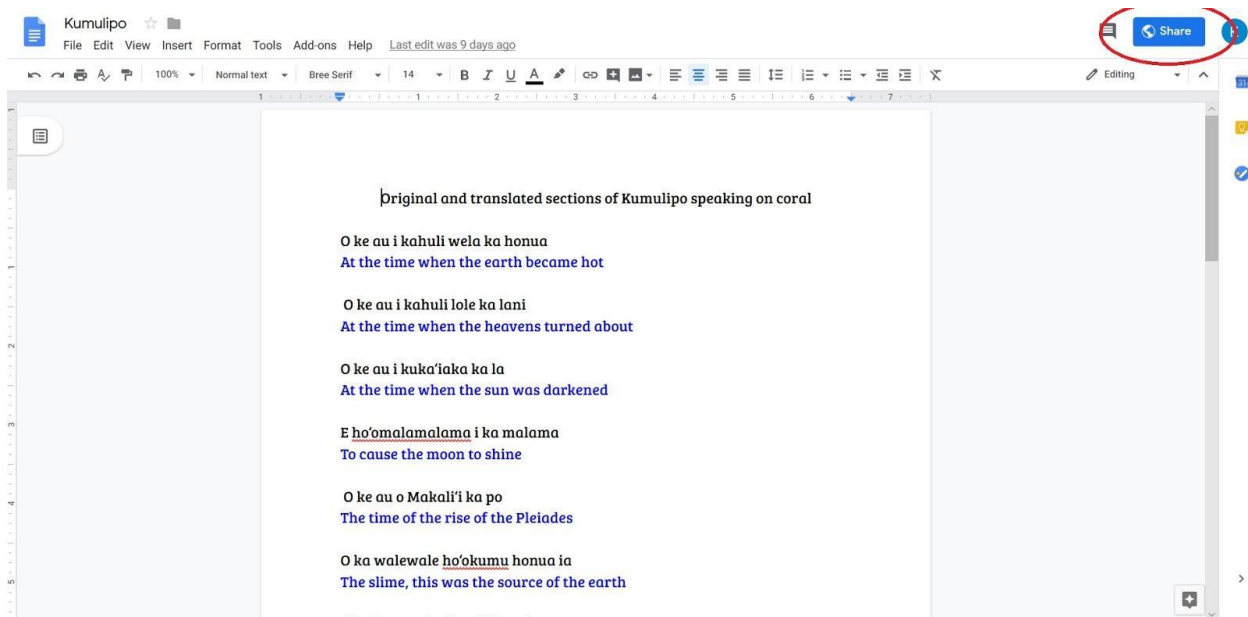
6. Click on the drop down bar above the shareable link and select "More…".
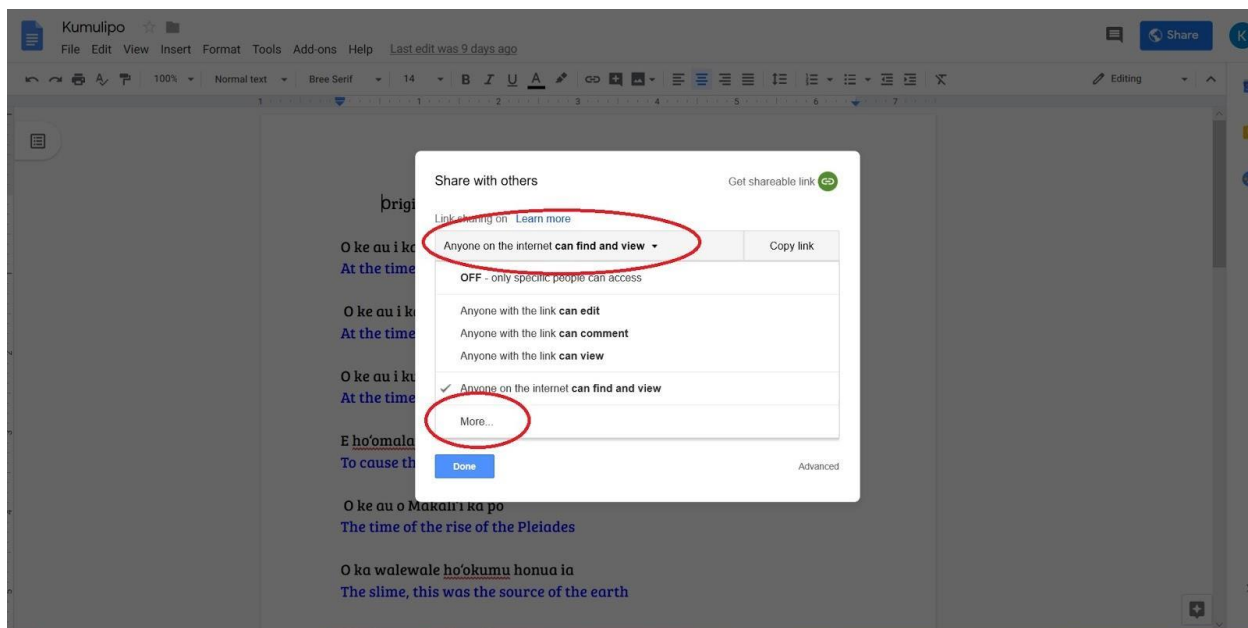
7. Make sure the "On-Public on Web" is selected and click "Save".
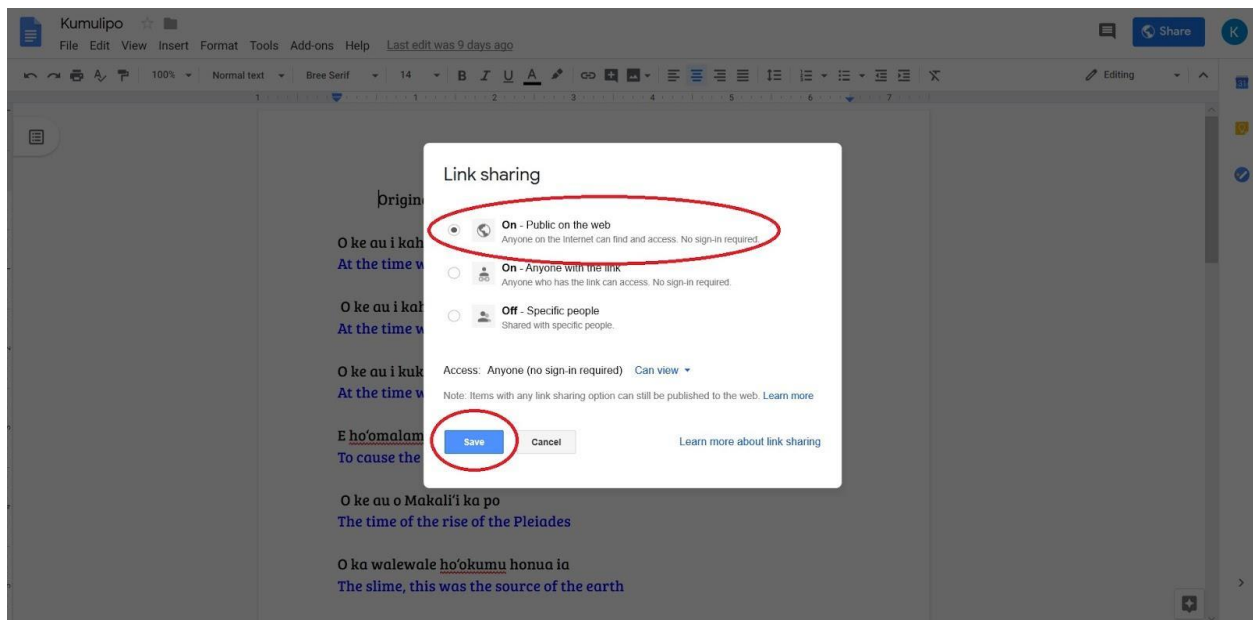
8. Then click "Copy Link" and go to Swiftic.
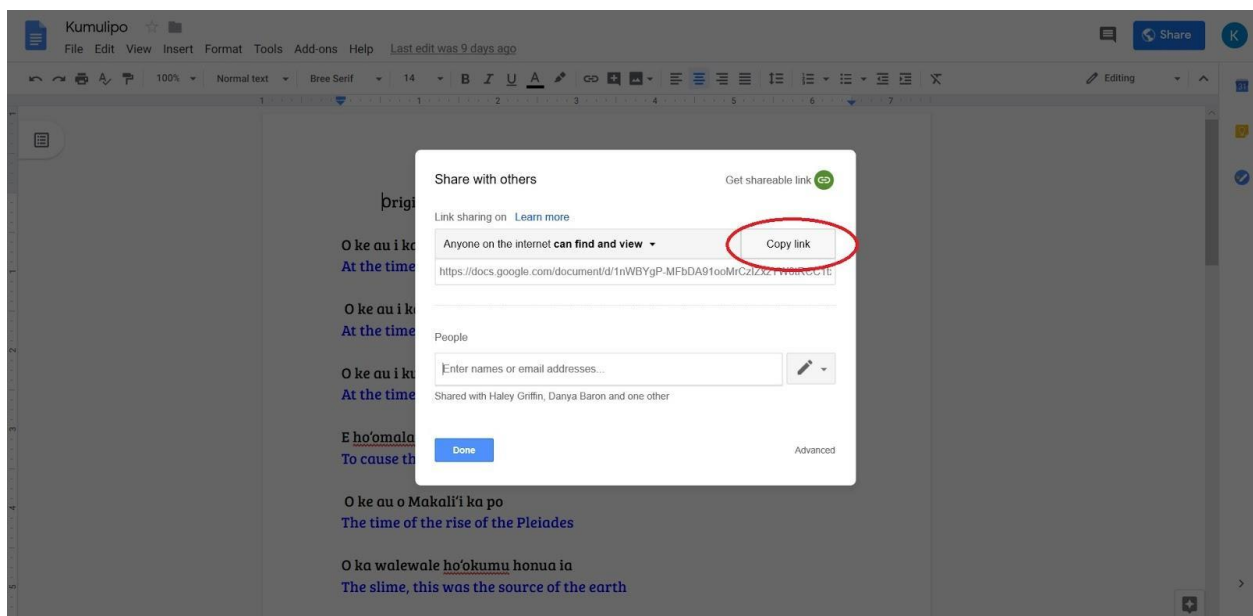
9. In Swiftic, click on the feature in "My App Features"titled "Coral in Hawaiian Culture".
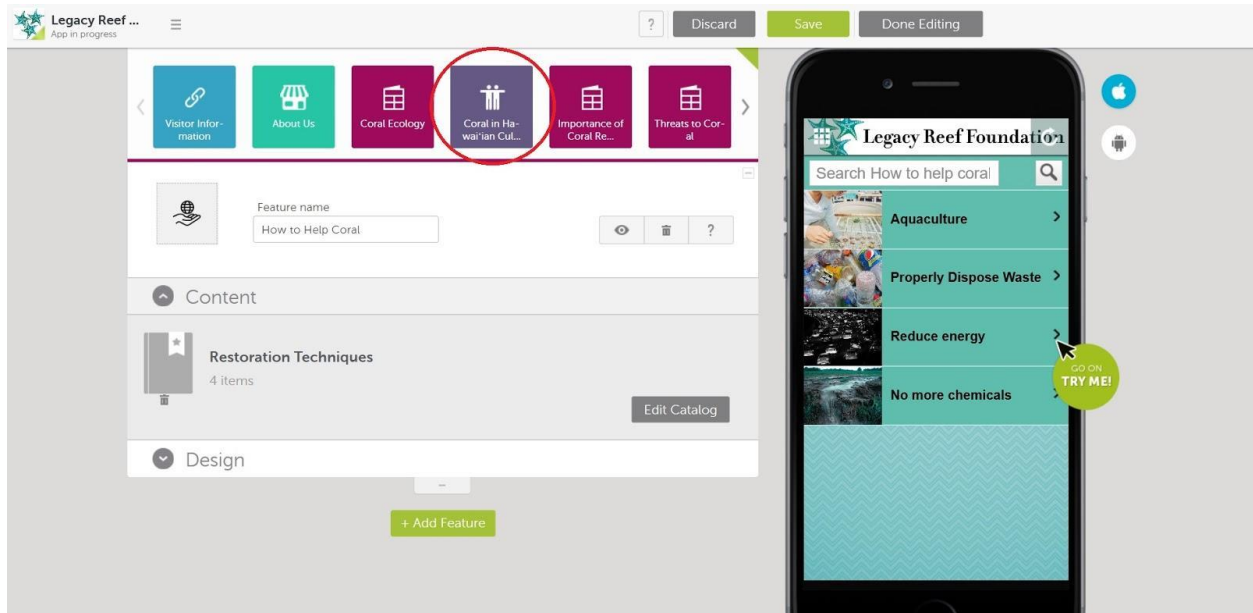
10. Go to the bottom of the "Content" section where it says "Add Link"
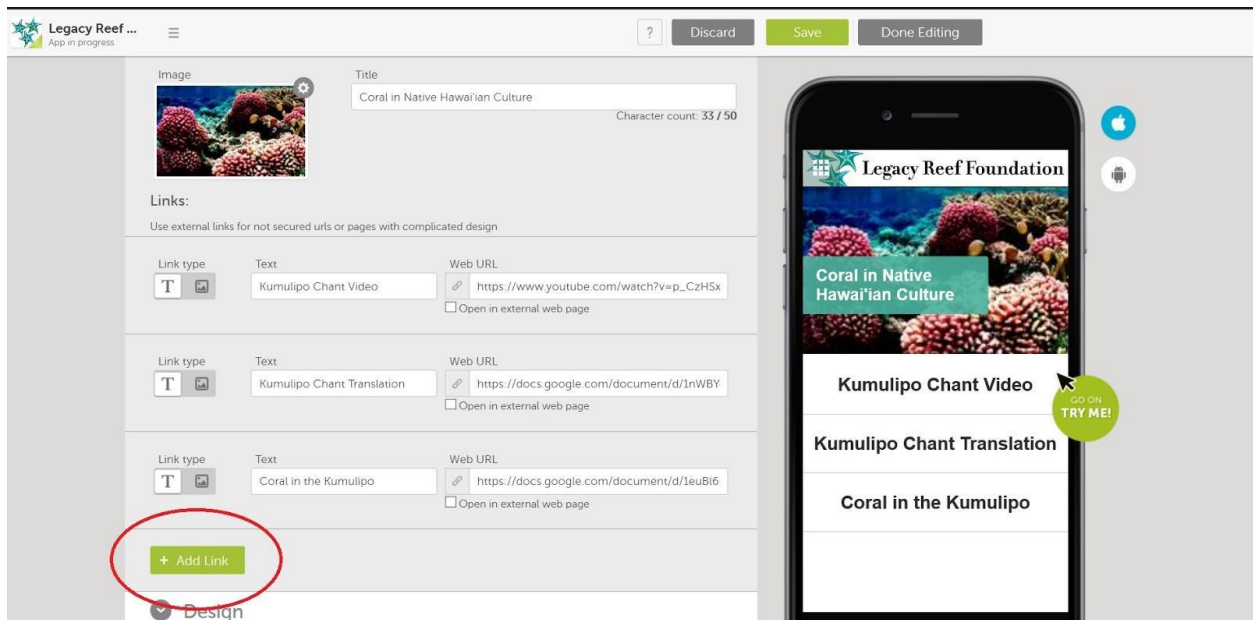
11. Under "Text" is the title for the new section. Paste the URL under "Web URL", then click Save on the top right of the page.
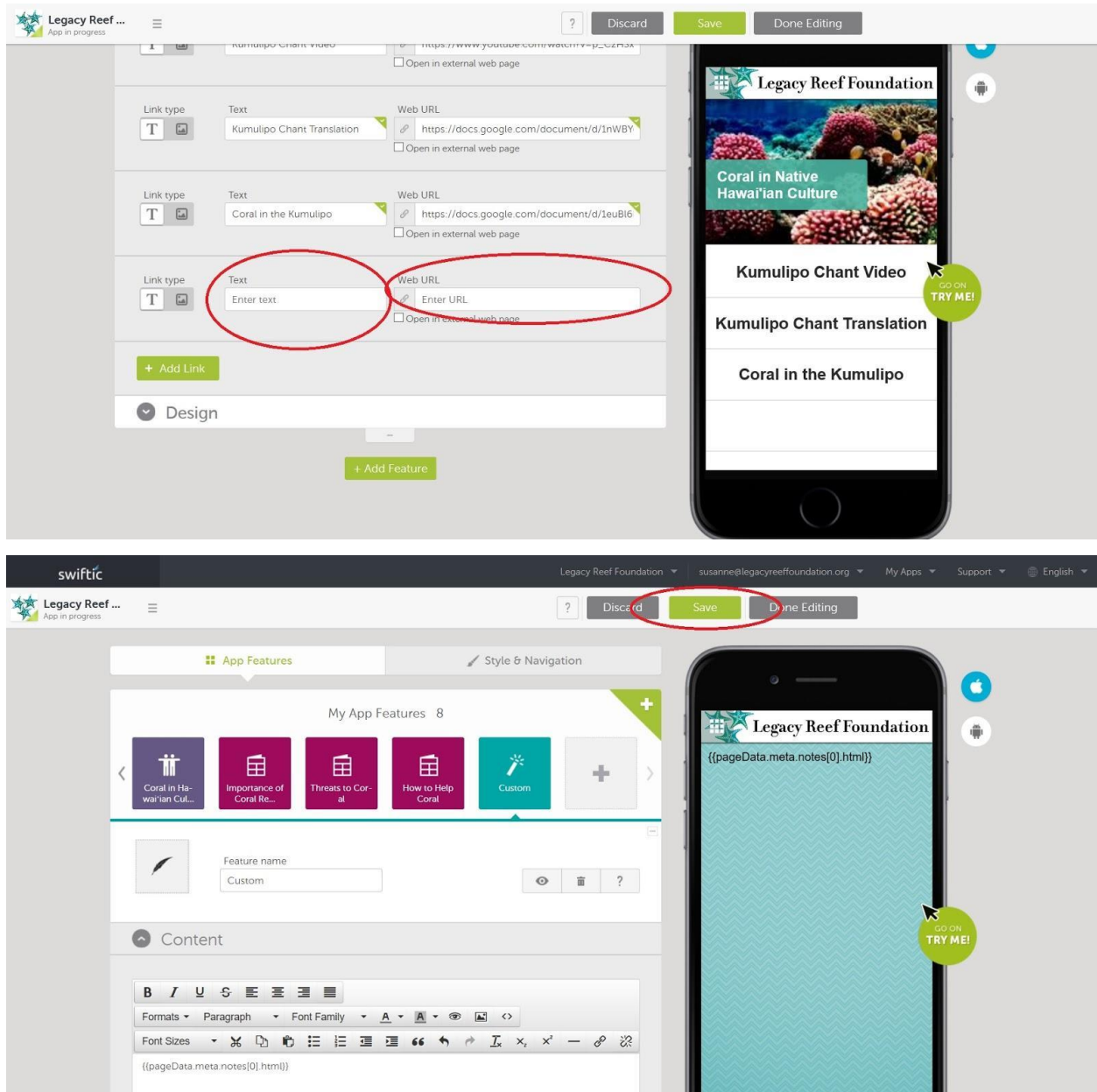
6 How to analyze the visitor info data collected from the application

1. On a laptop or computer, sign into google drive.
2. Go to the "LRF Application" folder that was shared with you.
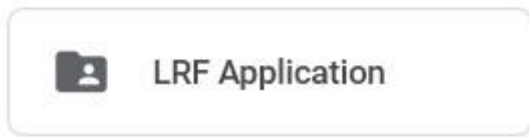
3. Open the "LRF Demographic Form".
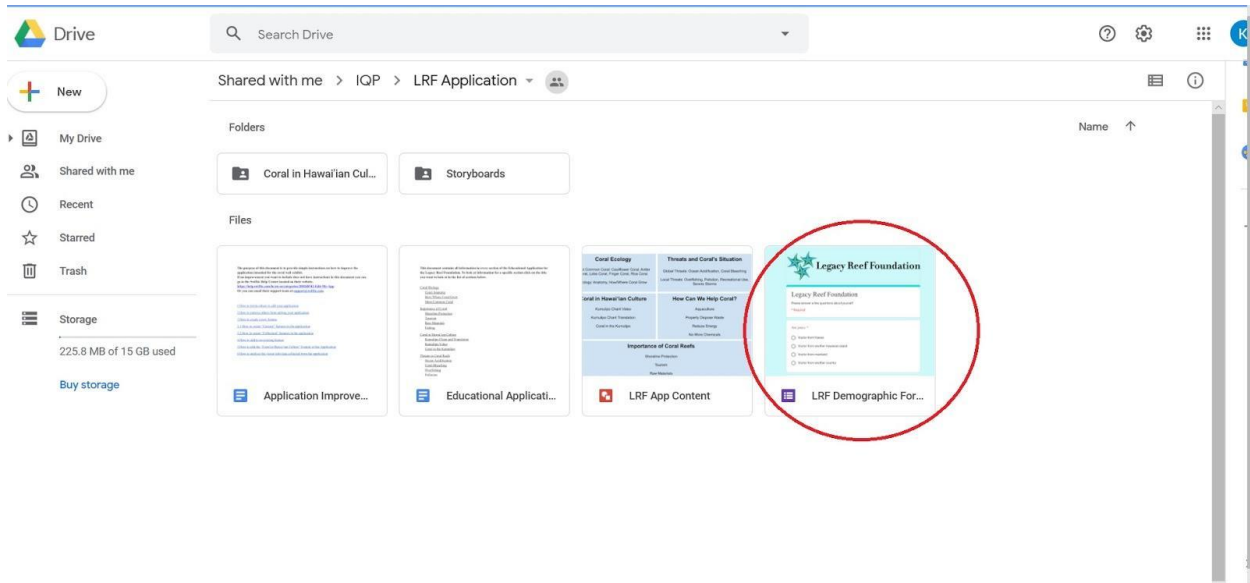
4. Click on "Responses" on the top of the page.
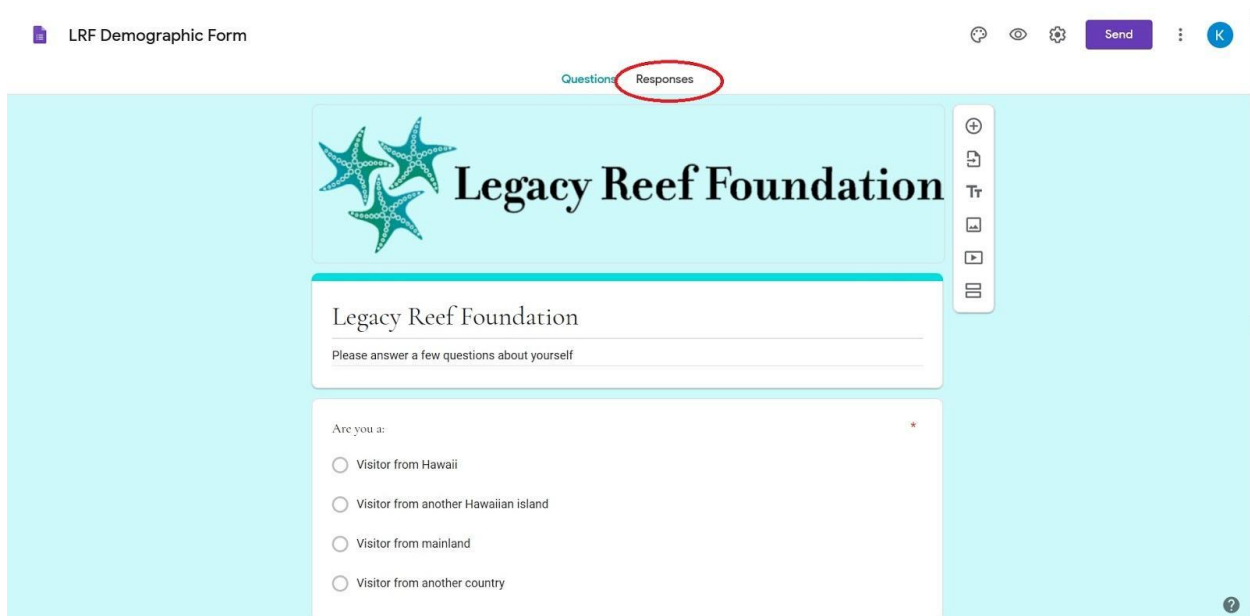
5. Graphs showing percent of responses for each question will appear.

6. If you want to further analyze the responses you can click on the green square in the top right corner to create a google spreadsheet.
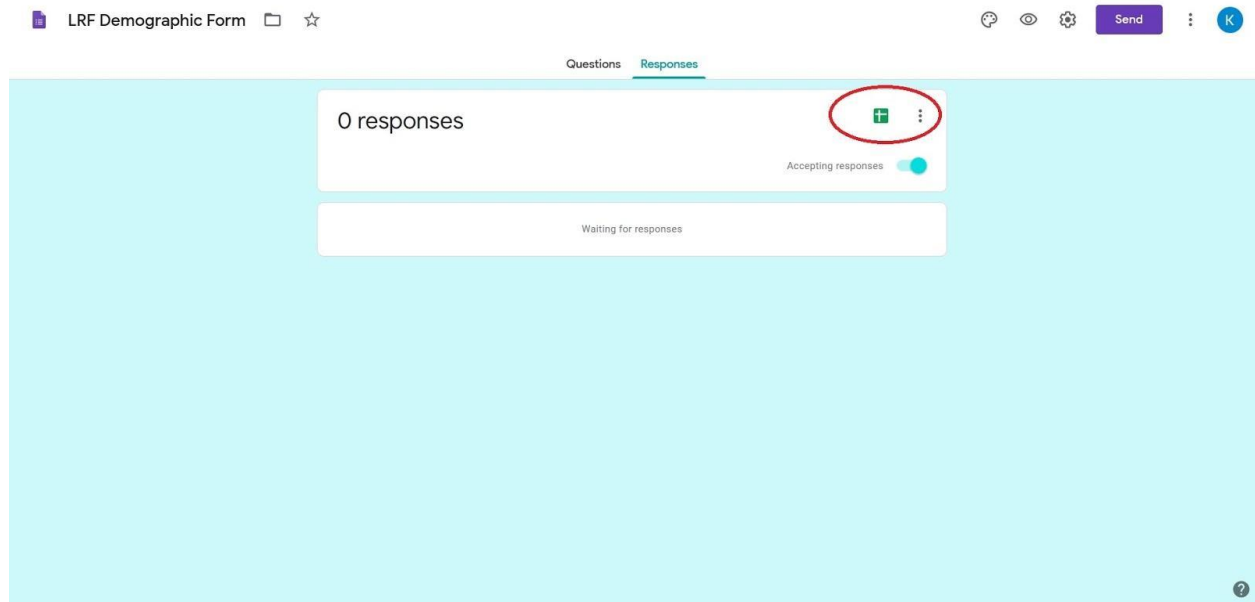
Appendix K: Tables of All Freelance Developers and App Development Companies

Table for freelance developers

Name	Location	Jobs Worked	Sucess Rate	Averge Star Feedback	iOS Development	Android Development	Availability (Response Time)	Cost/Hour	Profile Link
Doug R.	Celebration, FL	18	100.00%	5.00	Yes	Yes	<24 hours	$80.00	https://www.upwo
Erik L.	Vancouver, WA	1	92.00%	N/A	Yes	No	<24 hours	$67.99	https://www.upwo
J Aiden S.	Downey, CA	61	93.00%	4.87	Yes	Yes	<24 hours	$75.00	https://www.upwo
Brodie R.	Glendale, AZ	1	92.00%	N/A	Yes	Yes	<24 hours	$65.00	https://www.upwo
Bijal P.	Edison, NJ	44	94.00%	4.68	Yes	Yes	<24 hours	$20.00	https://www.upwo
Steven K.	Alpharetta, GA	32	99.00%	4.89	Yes	No	<24 hours	$80.00	https://www.upwo
Barton L.	Agoura Hills, CA	7	N/A	5.00	Yes	Yes	3+ days	$120.00	https://www.upwo
Emanuel A.	Salina, KS	15	97.00%	4.99	Yes	Yes	<24 hours	$65.00	https://www.upwo
Chuck D.	Winter Springs, FL	9	N/A	4.89	Yes	Yes	As needed	$50.00	https://www.upwo
Zach F.	Auburn, AL	22	75.00%	4.80	Yes	No	<24 hours	$120.00	https://www.upwo
Rehan H.	Chicago, IL	30	100.00%	4.99	Yes	Yes	<24 hours	$150.00	https://www.upwo
Michael Robert M.	Los Angeles, CA	34	100.00%	5.00	Yes	No	<24 hours	$85.00	https://www.upwo
Manuel C.	Guadalupe, CA	31	100.00%	4.90	Yes	Yes	<24 hours	$70.00	https://www.upwo
Gregg G.	Tuscon, AZ	36	100.00%	5.00	Yes	Yes	<24 hours	$115.00	https://www.upwo
Kerre D.	Carmel-By-The-Sea, CA	21	100.00%	4.98	Yes	Yes	3+ days	$45.00	https://www.upwo
Emmanuel I.	Prosper, TX	33	86.00%	5.00	Yes	Yes	<24 hours	$75.00	https://www.upwo
Emin O.	Miami, FL	32	100.00%	5.00	Yes	Yes	As needed	$100.00	https://www.upwo
Bhumik S.	Newark, CA	27	100.00%	4.92	Yes	Yes	<3 days	$55.00	https://www.upwo
Jerry E.	Temecula, CA	10	100.00%	4.97	Yes	Yes	<24 hours	$65.00	https://www.upwo
Andrew B.	Plymouth, MN	20	100.00%	4.99	Yes	Yes	<3 days	$120.00	https://www.upwo
Christopher C.	Springville, UT	14	94.00%	5.00	Yes	Yes	<24 hours	$80.00	https://www.upwo
Abinav K.	Berkeley, CA	0	N/A	N/A	N/A	N/A	As needed	$50.00	https://www.upwo
Anton A.	San Diego, CA	45	100.00%	4.99	Yes	Yes	<24 hours	$120.00	https://www.upwo
Brandon B.	Simi Valley, CA	6	97.00%	4.98	Yes	Yes	<24 hours	$60.00	https://www.upwo
Solomon R.	Ann Arbor, MI	0	N/A	N/A	Yes	No	Works <30 hours/week	$50.00	https://www.upwo
Stephen K.	Antioch, TN	0	N/A	N/A	N/A	N/A	Works <30 hours/week	$55.00	https://www.upwo
Solomon W.	Minneapolis, MN	29	100.00%	4.94	Yes	Yes	<24 hours	$70.00	https://www.upwo
Daniel D.	Durham, NC	1	N/A	5.00	Yes	Yes	Works >30 hours/week	$70.00	https://www.upwo
Ian S.	Charleston, SC	2	N/A	5.00	Yes	Yes	As needed	$80.00	https://www.upwo
Jason C.	Anna, TX	27	96.00%	4.90	No	Yes	Works <30 hours/week	$50.00	https://www.upwo
Austin B.	South Jordan, UT	3	N/A	5.00	Yes	No	Works <30 hours/week	$75.00	https://www.upwo
Christopher F.	Fredericktown, MO	36	N/A	3.33	Yes	Yes	Works >30 hours/week	$49.00	https://www.upwo
Mikhail R.	Boston, MA	13	75	4.49	No	Yes	Works >30 hours/week	$59.00	https://www.upwo
Yasha K.	Engelwood, CO	83	N/A	4.80	Yes	Yes	Instant	$39.00	https://www.peop
Nadim Hussein	Bay Minette, AL	143	N/A	5.00	Yes	Yes	<2 days	$30.00	https://www.peop
Harish Kumar	Tempe, AZ	15	NA	4.90	Yes	Yes	<1 day	$10.00	https://www.peop
Dawood Shahid	San Francisco, CA	2	N/A	5.00	Yes	Yes	within a few hours	$15.00	https://www.peop
Rafael Alvarado Emmanuelli	Virginia Beach, VA	4	N/A	3.70	Yes	Yes	Instant	$40.00	https://www.peop
Anastasiia Shynt	Los Angeles, CA	3	N/A	5.00	Yes	Yes	within a few hours	$40.00	https://www.peop
Derek Sanchez	Brownsville, TX	7	N/A	5.00	Yes	Yes	<1 day	$62.00	https://www.peop
Hassan Hamza	Los Angeles, CA	3	N/A	5.00	Yes	Yes	<1 day	$60.00	https://www.peop
James Mays	Louisville, KY	2	N/A	5.00	Yes	Yes	within a few hours	$55.00	https://www.peop
Sibtain Ali	Clarksburg, MD	1	N/A	5.00	Yes	Yes	Instant	$16.00	https://www.peop
Kamran Siraj	College Park, GA	3	N/A	4.30	Yes	Yes	<2 days	$26.00	https://www.peop
Panveet Singh	Washington, GA	5	N/A	5.00	Yes	Yes	Instant	$15.00	https://www.peop
Prateek Sharma	Albany, NY	3	N/A	4.30	Yes	Yes	within a few hours	$12.00	https://www.peop
Shahil Shah	Winona, MN	4	N/A	5.00	Yes	No	within a few hours	$25.00	https://www.peop
Steve Ryder	Columbus, OH	0	N/A	N/A	Yes	Yes	Instant	$22.00	https://www.peop
Krushang Sonar	Chicago, IL	8	N/A	4.70	No	Yes	Instant	$30.00	https://www.peop
Sanjay Rathod	Washington, GA	8	N/A	4.80	Yes	Yes	within a few hours	$10.00	https://www.peop
Lisa Albert	Sacramento, CA	0	N/A	N/A	Yes	Yes	Instant	$15.00	https://www.peop
Taylor Henry	Sacramento, CA	0	N/A	N/A	Yes	Yes	Instant	$15.00	https://www.peop

Table for application development companies

Name	Location	Link	Mobile App Development Focus	Education Focus	Min. Projcect Size	Avg. Hourly Rate Min	Avg. Hourly Rate Max	Number of Stars	Number of Reviews
10Pearls	San Francisco, Ca	https://10pearls.c	40%	10%	Undisclosed	Undisclosed	Undisclosed	4.8	13
AppSquadz	Ridgewood, NY	https://www.apps	64%	15%	$1,000	$25	$25	4.5	22
Arbisoft	McKinney, Tx	https://arbisoft.co	30%	30%	$10,000	$50	$99	4.9	9
ARKA Softwares	Dallas, Tx	https://www.arka	60%	15%	$5,000	$25	$25	4.8	30
Belitsoft	New York City, NY	https://belitsoft.c	10%	50%	$10,000	$25	$49	4.9	17
Blue Label Labs	New York City, NY	https://www.bluel	60%	10%	$75,000	$100	$149	4.8	36
Byteridge	Sunnyvale, Ca	https://byteridge.	50%	10%	$10,000	$25	$25	4.9	20
Cortina Productions	McLean, Va	https://www.corti							
Cubix	West Palm Beach, Fl	https://www.cubi	60%	10%	$10,000	$25	$49	4.9	22
Cuesum	Boston, Ma	https://cuseum.c							
Dev Technosys	Commerce, Ca	https://www.devt	35%	20%	$5,000	$25	$25	4.8	87
Digiryte	Manchester, UK	https://digiryte.co	50%	20%	$50,000	$50	$99	4.8	24
Diversido	Claymont, De	https://www.upw	50%	40%	$10,000	$25	$49	5	4
Dom & Tom	New York City, NY	https://domandto	50%	20%	$50,000	$150	$199	4.8	20
EnjoyTECH USA	New York City, NY	https://www.upw							
Five	New York City, NY	https://five.agenc	60%	15%	$10,000	$100	$149	4.9	27
hedgehog lab	Boston, Ma	https://www.hedg	100%	10%	$50,000	$100	$149	4.7	31
HubSpire	New York City, NY	https://www.hubs	60%	30%	$5,000	$25	$49	5	12
Impekable	San Francisco, Ca	https://impekable	50%	10%	$25,000	$150	$199	4.8	25
IndiaNIC	Beverly Hills, Ca	https://www.india							
Innofied Solution	Sunnyvale, Ca	https://www.inno	80%	90%	$10,000	$25	$49	4.8	28
Intuz	San Francisco, Ca	https://www.intuz	50%	25%	$10,000	$25	$49	4.7	38
iTechArt Group	New York City, NY	https://www.itech	30%	30%	$25,000	$25	$49	4.9	23
Keenethics	New York City, NY	https://keenethics	20%	40%	$5,000	$25	$49	5	11
Konstant Infosolutions	Palo Alto, Ca	https://www.kons	60%	20%	$5,000	$25	$25	4.8	85
Local Projects	New York City, NY	https://localproje							
Logicnext Inc.	Pasadena, Ca	https://www.upw							
Magora	London, UK	https://magora-s	60%	10%	$10,000	$50	$99	4.8	42
MerixStudio	New York City, NY	https://www.meri	20%	20%	$25,000	$50	$99	4.7	57
Modern Tribe	Minneapolis, Mn	https://tri.be/	15%	50%	$50,000	$150	$199	4.9	5
Mutual Mobile	Houston, Tx	https://mutualmo	60%	10%	$100,000	$150	$199	4.8	9
Net Solutions	Los Angeles, Ca	https://www.nets	35%	10%	$10,000	$25	$49	4.8	31
nomtek	Washington DC	https://www.nom	70%	35%	$50,000	$50	$99	4.9	22
OCSICO	San Jose, Ca	https://ocsico.co	20%			$25	$49	4.6	5
Octal IT Solution	Sarasota, Fl	https://www.octa	60%	20%	$10,000	$25	$49	4.8	74
Quovantis Technologies	Los Angeles, Ca	http://www.quova	25%	40%	$10,000	$25	$49	4.7	18
Quytech	Walnut, Ca	https://www.quyt	60%	10%	$10,000	$24	$49	4.7	20
Railway Men	San Francisco, Ca	https://railwayme	30%	30%	$10,000	$50	$99	4.9	29
Red Foundy	Chicago, Il	http://www.redfo	70%	10%	$25,000	$150	$199	4.8	19
RipenApps	Ontario, Ca	https://ripenapps	65%	15%	$5,000	$25	$25	5	22
Roofstrap	Hollywood, Ca	https://www.roots	20%	100%	$10,000	$100	$149	4.8	23
Space-O Technologies	Scottsdale, Az	https://www.spac	60%	10%	$25,000	$25	$49	4.7	32
Sparx IT Solutions	New York City, NY	https://www.spar	50%	20%	$5,000	$25	$25	5	23
Steelkiwi	Belmont, Ca	https://steelkiwi.c	30%	20%	$10,000	$25	$49	4.9	37
STRV	Venice, Ca	https://www.strv.	40%	10%	$50,000	$100	$149	4.9	19
Table XI	Chicago, Il	https://www.table	45%	20%	$75,000	$150	$199	4.9	41
TatvaSoft	Murphy, Tx	https://www.tatva	30%	15%	$10,000	$25	$25	4.8	15
TechAhead	Agoura Hills, Ca	https://www.tech	60%	10%	$25,000	$50	$99	4.7	44
Techugo	Dulles, Va	https://www.tech	49%	15%	$5,000	$25	$25	4.8	46
thoughtbot	Boston, Ma	https://thoughtbo	35%	20%	$25,000	$150	$199	4.9	16
Tintash	Raleigh, NC	https://www.tinta	60%	10%	$100,000	$50	$99	4.8	21
Toptal	San Francisco, Ca	https://www.topta	50%	20%	$25,000	$100	$149	4.6	7
TTT Studios	Vancouver, Ca	https://ttt.studio/	55%	15%	$50,000	$100	$149	5	18
Utility	New York City, NY	https://utilitynyc.c	60%	10%	$50,000	$100	$149	4.9	14
X2 Mobile	Wilmington, De	https://www.x2m	70%	80%	$25,000	$25	$49	5	7
Xicom	San Francisco, Ca	https://www.xicor	50%	10%	$10,000	$25	$49	4.7	27
Zoar Technology	Naples, FL	https://www.upw	50%	10%	$1,000	$50	$99	5	1

This table shows the top four freelance developers. The criteria that all freelance developers had to meet was, work more than 20 jobs, complete more than 90 percent of the jobs they have worked, and have an average feedback rating higher than 4.85 stars. The last column shows the cost per hour charged by each freelancer.

Name	Jobs Worked (>20 jobs)	Job Success Rate (>90%)	Average Feedback (>4.85)	Rate ($/hr)
Gregg G.	36	100%	5.00	$115.00
J Aiden S.	61	93%	4.87	$75.00
Michael Robert M.	34	100%	5.00	$85.00
Solomon W.	29	100%	4.94	$70.00

This table shows the top three software development companies. The criteria that all companies had to meet was, focus at least 50 percent of their work on developing software that is used for mobile apps and they have to have received at least 30 reviews. The percentage of how much the company focuses their work on education was also listed. The last two columns show the minimum price the LRF would pay in order for that specific company to work with the LRF, and the cost per hour for each software company.

Name	Mobile App Development Focus (>50%)	Education Focus	Number of Reviews (>30)	Min. Project Size
Intuz	50%	25%	38	$10,000
Konstant Infosolutions	60%	20%	85	$5,000
Octal IT Solutions	60%	20%	74	$10,000