Creating an Educational
App for Environmental Sustainability

Project Centre: Melbourne, Australia D-term 2015

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Abstract

The Centre for Education and Research in Environmental Strategies (CERES) provides education on sustaining limited resources such as food, water, and energy. We created The Chook, an interpretive mobile app, to enhance communication between CERES and its visitors by providing supplementary, educational information on CERES park features and environmental sustainability practices. By interviewing CERES experts, researching sustainable technologies, surveying visitors, and gathering user feedback, we generated and populated The Chook's content with the text, images, and audio files.

Acknowledgements

Our team would like to sincerely thank the following for their help and support throughout the project:

Executive Summary

By the year 2050, scientists expect that the global population will reach 8.9 billion (United Nations Department of Economic and Social Affairs- Population Division, 2004). As expected, "with a growing population, dramatically more food, water, and energy is needed" (Wharton IGEL, 2012). Education is a way to influence social change towards reducing our harsh impacts on the environment. It is argued that social and educational enterprises provide the means by which people can build awareness of local and global issues (CERES Strategic Direction, 2011).

The Centre for Education and Research in Environmental Strategies (CERES) is a non-profit, sustainability centre in East Brunswick, Melbourne, which received approximately 350,000 visitors last year. Several features in the CERES Environmental Park demonstrate innovative technologies and sustainable practices that conserve our most threatened resources: food, water, and energy. Currently, static signage is the only source of information visitors have as they explore the park. In order to improve communication and enhance visitor experience at CERES, our mission was to create an educational mobile app on environmental sustainability, called The Chook. Through research, we identified and generated educational content for The Chook in an effort to help CERES address the topics of food, water, and energy sustainability. To aid in the development of our educational app, we conducted three studies: an assessment of CERES park features, a survey of CERES visitors, and a survey of user feedback on The Chook.

The first study suggested that most of the park features were easy to locate. However, we found that some of the features were not as clear as they could be in communicating their purposes to the visitors. Therefore, we decided the content of the app should be an informational supplement among the features. Upon examining the remaining questions that we had after visiting each feature, we discovered that the most common question was how a

visitor could get involved or learn more. Therefore, we included information in The Chook that directly addressed these needs.

The responses to the visitor survey identified potential app users and how we could most effectively display educational content. Analysing their technology use habits indicated how successful our app would be upon release. Nearly 70% of participants with smartphones said they would be inclined to download The Chook. This suggested our app would be well received and utilised among park visitors who are comfortable with technology. Furthermore, the data on preferred learning methods indicated that to effectively educate our audience, various forms of media should be incorporated. The majority of participants were infrequent visitors. When analysing the data, we found that as frequency of visits decreased, the inclination to download The Chook increased. This supported our objective of having unfamiliar visitors utilise The Chook.

Our third study was a pilot investigation conducted to assess the content and usability of The Chook. We gathered nine volunteers who were unfamiliar with the educational content of CERES to ensure we used the correct target audience. Each volunteer was given a short quiz that tested prior knowledge on water, food, and energy sustainability topics. Next, the nine volunteers were divided into groups of three. One group toured CERES without The Chook, one group toured the park with The Chook, and the third group explored The Chook's content without touring CERES. After an hour, the participants completed a post-quiz identical to the pre-quiz. We scored the quizzes and then compared the results of the pre- and post-quizzes. Lastly, a user feedback post-assessment was offered to the six participants who had access to the app during the study. This assessment gauged participants' overall reactions to the app's content, detail, organisation, and aesthetics. The results of the user study showed that all three of our test groups improved their scores from the pre- to the post-quizzes. The first test group, which toured the park without The Chook, averaged a 13.9% improvement on the quiz. The second group, which toured the park with The Chook, improved their scores by an average of 27.7%. Lastly, the third test group that explored the app without access to the park, improved the most, increasing scores by 55.5%.

Although this is a small sample size, the results had positive implications and it provided the structure for further studies to be conducted with more participants. Both groups that used The Chook had significantly higher rates of improvement on their post quizzes. Additionally, all participants said they found educational value in the app. This suggests that The Chook met its purpose as an effective educational tool for the CERES Environmental Park.

The next development step for The Chook is enabling Bluetooth capabilities and executing a soft launch. CERES will have Bluetooth beacons around the park that link the physical feature locations to their virtual locations on The Chooks.

In summary, the adaptability of this mobile app will support CERES in its educational mission. As global environmental issues evolve, CERES will have a flexible tool capable of addressing the great challenges facing our global population. With The Chook, CERES can reach a larger audience, thereby promoting social change and educating their visitors about how to conserve our precious resources, both today and in the future.

Table of Contents

List of Figures

Introduction

By the year 2050, scientists expect that the global population will reach 8.9 billion. This is a 47% increase from 6.1 billion people in 2000 (United Nations Department of Economic and Social Affairs- Population Division, 2004). As expected, "with a growing population, dramatically more food, water, and energy is needed" (Wharton IGEL, 2012). Education is a way to influence social change towards reducing our harsh impacts on the environment. It is argued that social and educational enterprises provide the means by which people can build awareness of local and global issues (CERES Strategic Direction, 2011).

The Centre for Education and Research in Environmental Strategies (CERES) is a non-profit, sustainability centre in East Brunswick, Melbourne. Several features in the CERES Environmental Park demonstrate innovative technologies and sustainable practices that conserve some of the most threatened resources: food, water, and energy. CERES strives to cultivate a spirit of community while serving as Australia's largest deliverer of environmental education (CERES Community Environment Park, 2012).

CERES receives over 350,000 visitors per year (CERES Community Environment Park, 2012). Currently, static signage is the only source of information visitors have as they explore the park. According to the 2014 CERES Annual Report, a staff member typically answers a question every seven minutes to keep up with the visitors' informational demands. Recently, many organisations have begun using mobile apps and social media to communicate with large audiences (Pai et al., 2013). In order to improve communication and enhance visitor experience at CERES, our goal is to create an educational mobile app on environmental sustainability. To develop the framework of the app, titled The Chook, CERES contracted a commercial app design company to provide the software platform. Apple iOS will be the first platform to launch the app and it should be later released on Android devices. Through research, we identified and generated educational content for The Chook that reflected CERES's mission and how it would like to approach the topics of food, water, and energy sustainability.

Since CERES is an environmental park, there were concerns that mobile technologies might distract visitors from connecting with their environment. There is a potential "loss of self"

when people are too engaged in their electronic devices and ignore their physical surroundings (Robinson, 2015). Therefore, it became important to develop app content that keeps the visitors engaged with CERES' park features. We explored successful cases of social technology supplementing environmental education. For example, Project NOAH (Networked Organisms and Habitats) is an app used to explore wildlife and record sightings around the world. Users can upload photos of their sightings and begin conversation threads by commenting on each other's posts. In this way, nature connects people together and enables learning regardless of the user's physical location (Project NOAH, 2013).

The Kids Afield Project provides further evidence of technology encouraging connections to nature. Educators from The Harley School in Rochester, NY, developed the Kids Afield project in 2014 (Long, 2014). In this project, students explored nature and presented their findings with different types of media, such as photos, audio files, and videos. Students could then comment on each other's presentations. This exchange of information is an example of how learning, presenting, and discussing materials can facilitate a more personal connection to the educational setting without being limited to a classroom (North American Association of Environmental Education, 2014). Moreover, the educators found that using photography was the most successful way to deepen connections between people and the environment because it encouraged hybrid thinking (Long, 2014). Hybrid thinking is the blending of two typically independent concepts, such as nature and technology, which can lead to heightened knowledge retention and innovative thinking (TwinEngine, 2012). The use of multimedia enhances hybrid thinking. Utilising multimedia within mobile technologies is one way of effectively educating the masses (Pai et al., 2013). For example, the Metropolitan Museum of Art (The MET), which welcomed 6.2 million visitors in 2007, developed an app with different audio tours for adults and children (The Statistics Portal, 2013). The app also included pictures of the displays and supporting paragraphs of text. By separating the content into different forms of media, the MET app catered to a larger audience and varying learning styles (The MET App, n.d.).

After considering these successful strategies for educational technology, we studied CERES and its visitors. These studies enabled us to tailor the content of The Chook to the CERES'

experience. In Study 1, we assessed the CERES Environmental Park and its current forms of communication. In Study 2, we familiarised ourselves with the CERES visitors. Results from both previous studies formed the basis of Study 3, which finalised and tested a fully functioning prototype of The Chook.

Study 1: Self-Guided Tour and Park Assessment

CERES offers multiple resources and opportunities for visitors to learn about sustainability and engage in community programmes. Given the high volume of visitors, CERES staff members are not always available to guide or personally educate each individual. Thus, while on site, many visitors rely on the static signage to guide themselves through the park and learn about its features. In order to understand the type of content that should be included into an app, we conducted an observation study where we each took a self-guided tour and assessed features throughout the park.

Methods

Procedure

Each team member conducted an observation study in which he or she independently explored the CERES Environmental Park and assessed its features. As mentioned, we focused our attention on sustainable water, energy, and food practices as these three concepts will be presented in The Chook. Each team member conducted separate evaluations and the results were averaged between all four researchers. The interrater reliability was within acceptable limits indicating that there is some reliability among all four observations (Cronbach's α = .560). To navigate through the park, each researcher used a map of the facilities, shown in Figure 1, and directional signs on pathways. At each feature, the researcher evaluated: the difficulty of finding the location, the clarity of the purpose of the feature, the availability of resources at the feature, and the level of detail of the content presented at each feature. The features we studied were the Nursery, Community Plots, Learning Centre, Bike Shed, Merri Merri, Compost Site, Merri Table, Propagation Field, Chook Group, EcoHouse, aquaponics centre,

Resource Centre, Water Trail, Solar Cooling, Community Food Groups, Visitor Centre, Solar Thermal, Photovoltaics, Biogas, 2030 Trail, and Green Roofs.

Figure 1: Map of the CERES Environment Park (Courtesy of CERES, n.d.).

Variables

Location: After using the map to locate the features, each team member measured its difficulty to find on a 5-point Likert-type scale (1 = Very difficult to find; 5 = Very easy to find). The Location ratings for each feature, taken from all four of the members, were averaged to create a composite score.

Clarity: Once the feature was located, we rated how easy it was to understand the purpose of the feature. This was assessed on a 5-point Likert-type scale as well. A score of 1 meant the level of clarity at the feature, after reading nearby signs, was very low. A score of 5 meant that the purpose of the feature was clear and determined quickly. We also noted any residual questions we had after leaving the feature.

Availability: In addition to clarity and location, we were also interested in the Availability of resources to help visitors understand each feature. We, once more, used a 5-point Likert-type scale (1 = Little to no resources; 5 = Plenty of resources). We recorded the types of resources available at each feature, such as signs or nearby staff members.

Content: Finally, each researcher evaluated the content at the features. We focused mainly on the level of detail the content provided. The ratings were on a 5-point Likert-type scale (1 = Little to no detail; 5 = Very detailed).

Results

After each researcher completed the observation study, we compiled our notes and scores[1] for future reference, and began determining which features of the park The Chook should accentuate. Figure 2 is the map of CERES with a few examples of locations that will be included in the app. These examples show the residual questions and most significant scores from our evaluations. The significant scores were determined as the lowest scores that The Chook could improve upon.

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[1] A complete table of the features and their evaluations can be found in Appendix 1
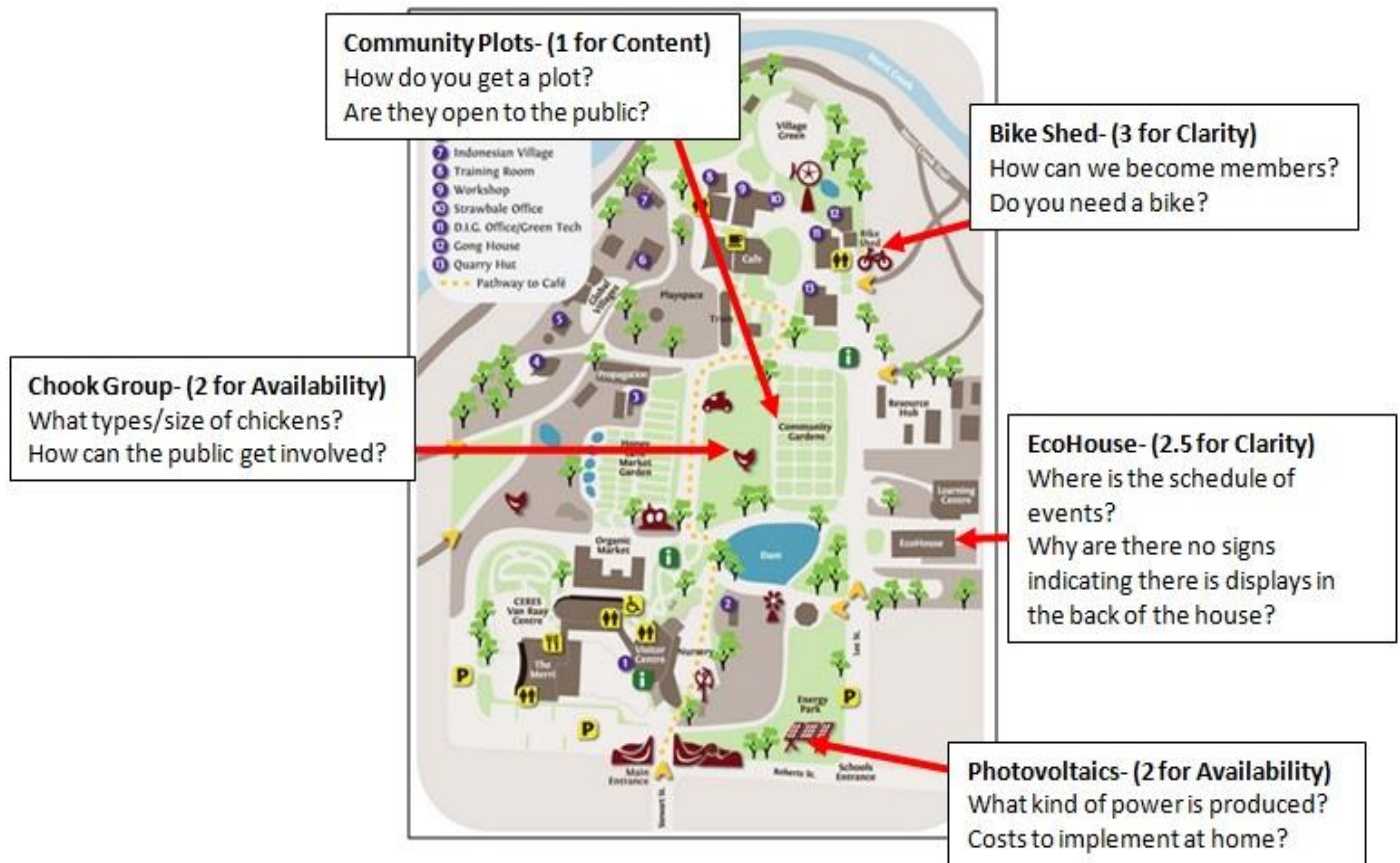
Figure 2: Map of CERES Environmental Park features with some examples of our relevant scores and gathered questions.

Location: The rating results for Location varied greatly from one feature to the next. For instance, the Nursery, Merri Table, and Visitor Centre all had the highest composite ratings, a score of 5, because they were located near the entrance with ample directional signage. Eight features, including the EcoHouse, Solar Cooling in the Energy Park, Community Food plots, Solar Thermal technologies, Photovoltaics, and the Biogas Digester, were all moderately difficult to find, and received 3s. Since these features align with our key selected themes (food, water, and energy), it was important to ensure that they could easily be found within The Chook.

Clarity: The Community Plots, Chook Group, EcoHouse, Aquaponics Centre, Water Trail, and Solar Cooling had low composite ratings (averaging 1 to 2.5) for Clarity. The remaining features had ratings equalling or exceeding 3. Five features were rated as 5 in this category: Visitor Centre, Learning Centre, Merri Merri Nature Path, Merri Table, and Propagation. Overall,

these results suggested that many of the features at CERES were relatively clear in their purpose, but there are a few features where the communication could be adapted to increase the clarity.

Availability: Compared to the other variables we tested, Availability scored lower results. Seven features had a rating below 3. The only resources supplying information for these features were small, stationary signs posted nearby. The Nursery, Bike Shed, Merri Table, and Visitor Centre were the only features that had staff members available to answer residual questions. The availability of resources scores influenced The Chook by determining what, or who, the visitors should be referred to for finding more information.

Content: Content ratings were above 3 for all of the features we assessed except for the Community Plots, Water Trail, and Community Food Groups. We found that most of the signs we examined were fairly detailed and provided interesting information, as well as supporting graphics. However, the features with a score of 3 or less have room for improvement. The level of detail of each feature helped indicate which features could use more descriptive information in The Chook.

Discussion

The results from our observation study suggested that most features are quite easy to find. However, we found that some of the features, although easy to locate, were not as clear as they could be in communicating their purposes to the visitors. Therefore, we decided the content of the app should be an informational supplement among the features.

Upon examining the remaining questions that we had after visiting each feature, we discovered that the most common question was how a visitor could get involved or learn more. Therefore, we decided to include a section in The Chook to directly address these questions. For example, we provided suggestions to visitors on how they can apply sustainable practices in their daily lives, how they can join CERES site groups, and what other resources they can explore to continue learning. To conclude our first study, we ultimately created a list of features, sorted by overarching themes as seen in Figure 3. Once we were familiar with the park

features, we were equipped to evaluate how the visitors preferred to interact with the features we assessed.

Welcome:
Get Connected
Village Green
Visitor Centre

Water:
CERES Van Raay Centre: Water
Dam: Biodiversity
Dam: Water Management
EcoHouse: Appliances
EcoHouse: Pavements
EcoHouse: Rain Gardens
EcoHouse: Wicking Beds
Lee St. Rain Gardens
Lee Street
Merri Creek Revegetation
Toilets
Water Monitoring

Energy:
Battery Turbine
Bike Shed
Biogas Digester
CERES Van Raay Centre: Energy
EcoHouse: Energy
Electric Charge Station
Energy Metering
Energy Park Entrance
Flexible Photovoltaics
Monocrystalline Photovoltaics
Solar Thermal
Swift Turbine
Vertical Axis Turbine
Wind Pump

Food:
Aquaponics
Community Gardens
Community Kitchen
Fair Food
Food Forest
Honey Lane Market Gardens
Merri Creek Market Gardens
Merri Table
Nursery
Organic Market
Propagation
The Bee Group
The Chook Group
Worm Farm

Figure 3: List of Objects sorted by Collections.

Study 2: Identifying and Analysing Visitor Experiences at CERES

The Chook is intended to connect visitors to the CERES Environmental Park. Following Study 1, we were familiar with the park, but we still needed to become familiar with the needs and interest of the visitors. Therefore, in Study 2 we investigated the visitor experience more directly. Specifically, we developed a survey to understand visitors' preferred learning methods, the features they were most likely to visit, and the online media platforms they were using to connect to CERES. The survey was offered to park visitors, CERES' Facebook page followers, and CERES Newsletter recipients. The findings from Study 2 provided insight into visitors' preferences among park features and their likelihood to use educational technology, such as The Chook.

Methods

Participants

Two hundred and twenty three individuals (152 female, 67 male, 4 did not report) participated in our survey either during their visit to CERES Environmental Park or through a link provided on the CERES Facebook page and the newsletter. All participants gave informed consent prior to taking the survey. There were 20 participants in the age range of 18-24 years old, 106 participants were 25-44 years old, 81 participants were 45-64 years old, and 15 participants were of age 65 and older. One person did not report his/her age.

Procedure

We conducted this research study by creating an electronic survey which we distributed in three ways. First, we created a post for the CERES Facebook page, see Appendix 2, inviting followers to take the survey with the link we provided. Second, a small paragraph, similar to the Facebook post, was included in the electronic CERES monthly newsletter. Third, we collected responses by personally approaching visitors with a tablet and having volunteers complete the questions. We approached CERES visitors both during the week and the weekend. Overall, our survey assessed five variables: Familiarity, Purpose, Technology Use, Learning Methods, and Demographics.

Variables

Familiarity: Four questions established how familiar the participants were with CERES. Our questions assessed how often visitors came to CERES, how they found out about it, and if they held a CERES membership. These questions were all in multiple-choice format. We also asked the visitors how, if at all, they were connected to CERES through social media (check all that apply: CERES website, Facebook, Twitter, Instagram, or Other).

Purpose: Five questions in our survey addressed the purpose of the participant's visit. We asked them to rate five different features and activities at CERES: the Market or Merri Table, the Bike Shed, the Nursery, attending a festival, and just exploring. These questions were

posed in the form of a 10 point Likert-type scale (1 = Least likely to visit for that purpose; 10 = Most likely to visit for that purpose).

Technology Use: We were interested in examining the potential usage of The Chook. We asked participants, on a 5-point Likert-Type scale, how easy it was for them to download new apps (1 = Very easily; 5 = Very difficult). Additionally, participants responded "yes" or "no" to two more technology questions: if they had a smart phone and if they would be inclined to download an educational app about CERES.

Learning Methods: We also assessed participant's preferred learning methods. Specifically, participants were given a list of 5 possible learning methods: reading, looking at pictures, watching a video, hands on activities, and other. They selected, checking all that applied, which learning methods they personally preferred.

Demographics: Age and gender was gathered as well. Age was assessed using the standard age categories (PGA Group, 2014); however, we modified our categories to start at age 18 since we did not include minors in our sample. Therefore the age categories were: 18-24, 25-44, 45-64, and 65+.

Results

After the surveying process was closed, we gathered the responses and began breaking down the data. We performed analyses and searched for trends based on each variable. These results indicated what type of content should be included in The Chook to meet the visitors' informational demands.

Familiarity: Figure 4 shows that of the 223 participants surveyed, 35.2% rarely visit, or were first time visitors to the park. Only 4.6% of the participants were daily visitors.
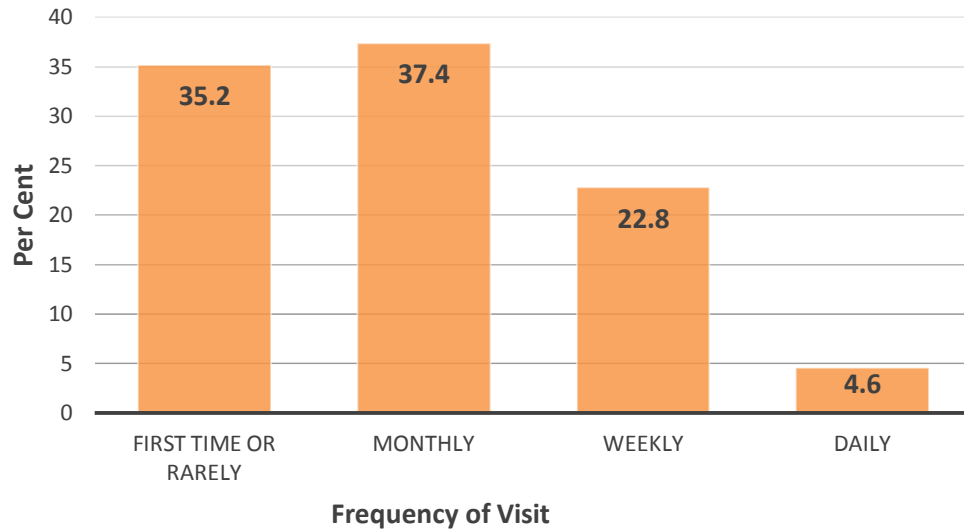
Figure 4: Per cent distribution of visitor frequency of the park.

As seen in Figure 5, nearly half (48.1%) of the participants were familiar with the CERES website. Additionally, 37.7% follow CERES on its Facebook page. Only a small percentage of participants follow CERES on Instagram or Twitter (8.2% and 5.1%, respectively).
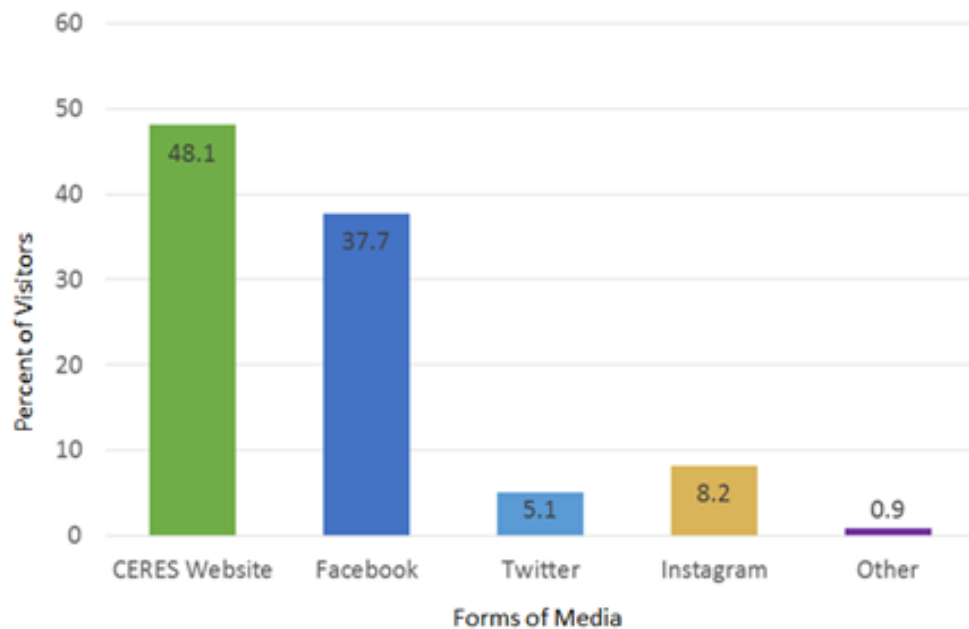
Figure 5: Media connections among CERES visitors.

Purpose: The mean rankings of the visitors' purposes of visit are shown in Figure 6. The Nursery was the most popular location visited by participants, with a mean rating of 7.63 out of

10. The Market or Merri Table was a close second, scoring an average rating of 7.17. The Bike Shed was the only location with a drastically different rating of 3.09.
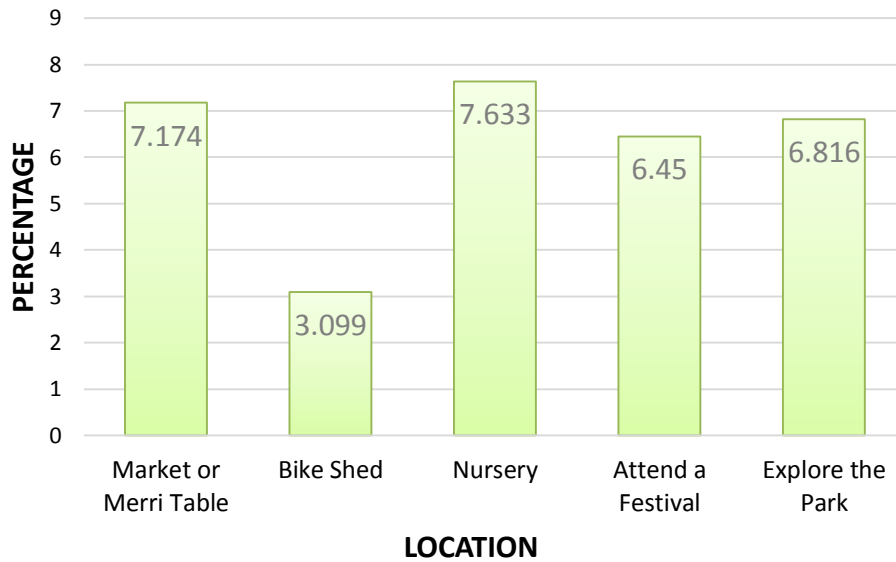
Figure 6: Mean ratings for likelihood of visiting various park features at CERES Environmental Park.

Technology Use: We found that out of the 223 people who responded to our survey, 57.4% own smart phones. Our survey determined that 82% of participants, when asked how easy was it to download an app, said it was very easy for them. We also found that 69.9% of all Study 2 participants were inclined to download The Chook. After searching for trends in the data regarding visitor frequency, we saw that as the frequency of visits decreased, the inclination to download the app increased, as depicted in Figure 7.
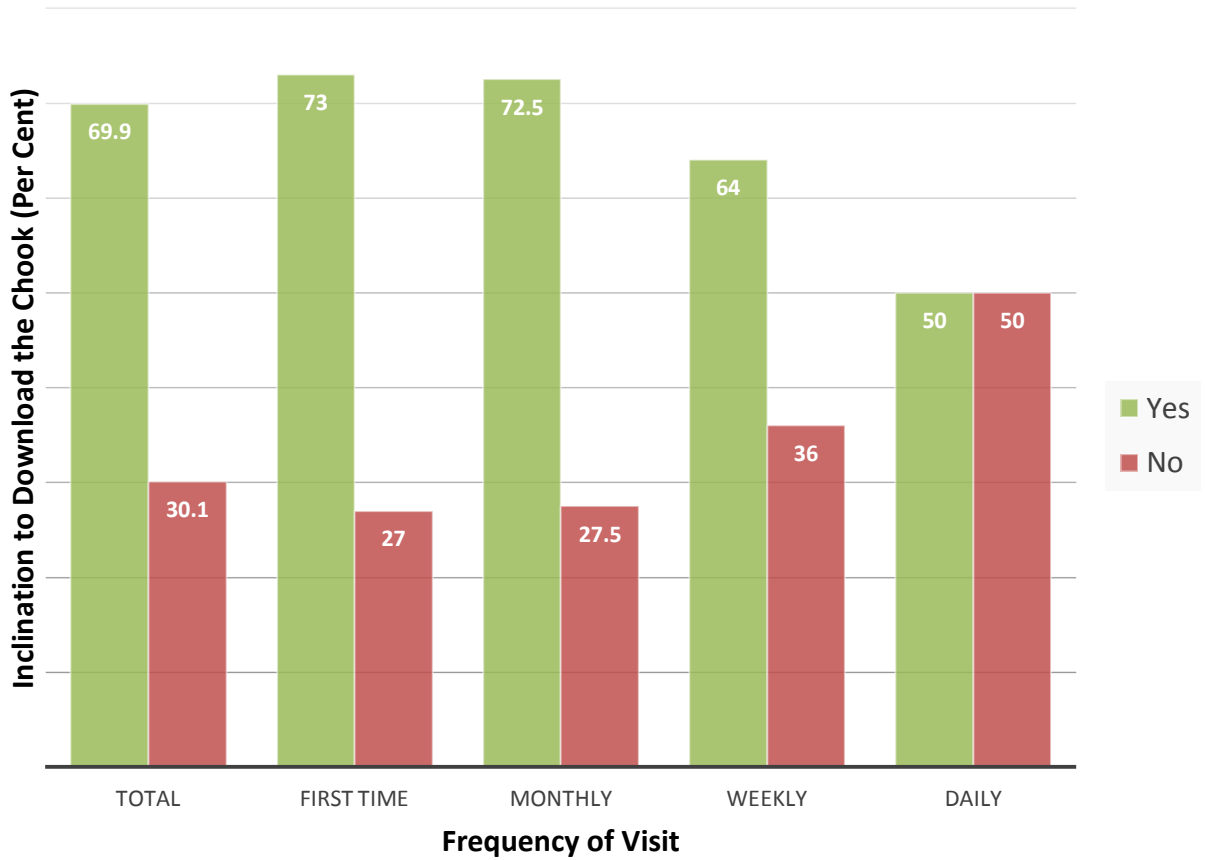
Figure 7: Inclination to download The Chook increases as the frequency of visit decreases.

Learning Methods: We found a wide distribution of learning preferences. Reading, Pictures, and Hands On had similar results of 29.8%, 21.1%, and 31.1%, respectively. Somewhat surprisingly, only 15.4% of participants prefer to learn by watching a video. Figure 8 shows a breakdown of these results.
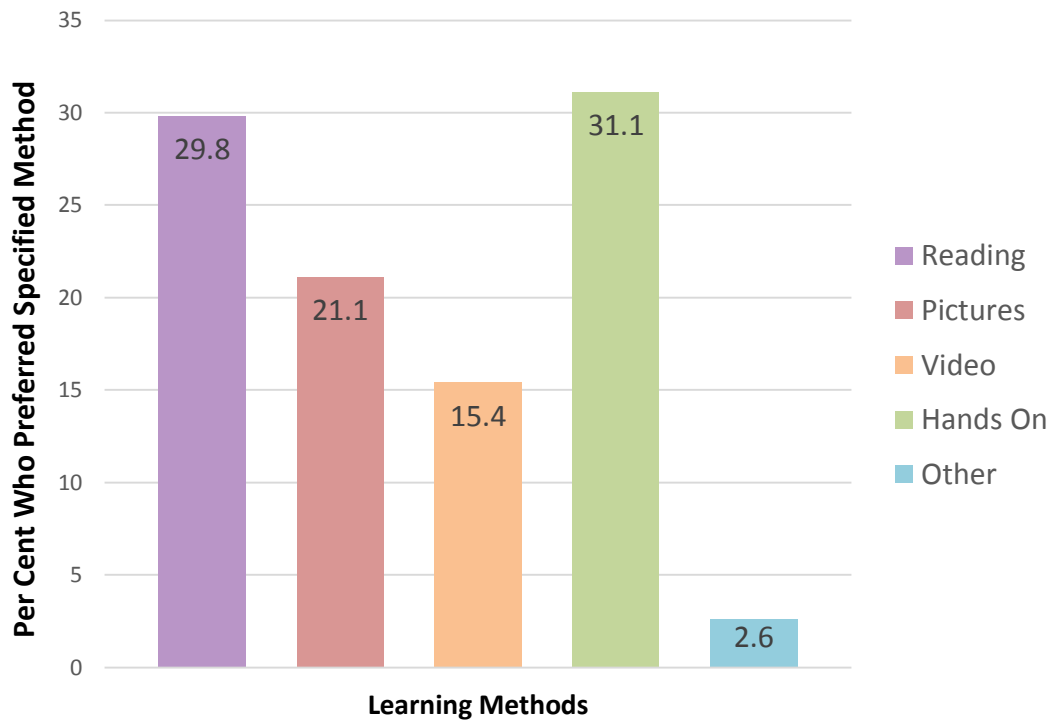
Figure 8: Per cent breakdown of visitor learning preferences.

Discussion

The responses to each variable influenced the content we generated for The Chook. Analysing familiarity helped us tailor our content to the visitors' needs. For example, a large portion of the visitors are aware of the CERES website, but not many follow CERES on social media. Therefore, we included a section in The Chook that encourages users to get connected with CERES' various social media accounts. This, in turn, should expand CERES' audience as it continues its mission to influence social change towards reducing our environmental impacts. Moreover, since the majority of the visitors were infrequent or first-time visitors, we included introductory information about CERES.

Using the likeliness of visitors to visit certain features, we were able to highlight underutilised areas of the park. For example, because the Bike Shed did not receive much attention, we included hours of operation, how people can get more involved, and highlighted

unknown facts that might interest the visitors. Furthermore, by including the most popular features in The Chook, such as the Nursery, we catered to the visitors' interests as well.

Analysing the Technology Use variable indicated how successful our app could be upon release. Since only 57.4% of participants had a smartphone, this reduced the potential audience of app users. However, nearly 70% of those potential users said they would be inclined to download The Chook. This suggests our app should be well received and utilised among park visitors who are familiar with technology.

The responses to preferred learning methods indicated that we needed to incorporate various forms of communication to suit the visitors. Since Hands On was the most preferred learning method, we encouraged visitors to get involved with different CERES activities and made suggestions on how they can apply the information into their own lives. The majority of The Chook's content takes the form of text and images, supported by sound files to satisfy those who are auditory learners. Since watching videos was the least preferred learning method, we did not include them in the app. However, videos could be included in future developments of The Chook.

Study 2 revealed the characteristics of potential app users and the type of content they preferred. With an accurate portrayal of our potential user demographic, we were better informed as we developed the content for the app. Specifically, it guided us while generating and refining texts, images, and audio recordings in Study 3.

Study 3: Populating and Testing The Chook

Our ultimate project goal was to bring a fully developed educational app to fruition using the initial framework developed by CERES' commercial contractor Art Processors[2]. Art Processors implemented their proprietary software, Enso Mobile, to structure The Chook's user interface. The Hamburger Layout was the selected design. This interface layout derives its "sandwich" name from having three easily accessible layers from anywhere on the app

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[2] Art Processors has approved the use of their name in this report.

(Washington, 2014). In particular, there is a broad help menu on the right view screen, options for exploring the bulk of app content in the middle view screen, and individual features with specific tabs on the left view screen. These layers of information provide the user with varying choices of detail for the particular park feature they intend to explore. This approach allows for creative organisation of broad content, while still having the most detailed information readily available for users. With unilateral screen sliding, Hamburger app navigation preserves uniformity and maintains user friendliness with the ease of a single thumb (Washington, 2014).

Populating The Chook

In Study 1, we found that the current signage could be improved. Our results from Study 2 revealed the fact that most visitors were generally unfamiliar with the park, and that the majority of visitors with smartphones would be inclined to use The Chook. These combined results influenced the type of information we included and how we decided to organise it. The Chook's purpose is to educate visitors on environmental sustainability and encourage them to explore various features of the park, especially those relating to water, food, and energy. In The Chook, these three themes are organised separately and referred to as Collections. All relevant features, referred to as Objects in the app, were sorted into appropriate Collections. Then, each Object's specific content was layered into five potential tabs: *Overview*, *Thoughts*, *Curious?*, *Oops*, and *Media*. Figure 9 shows the conceptual flow of content layering within The Chook.
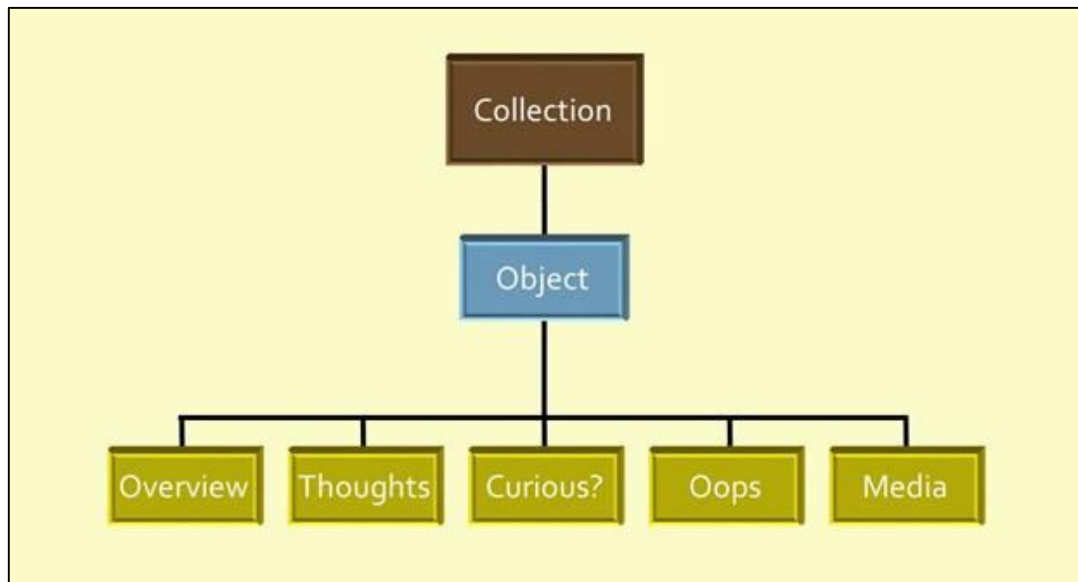
Figure 9: Overall layering and content organisation of The Chook into Collections, Objects, and Tabs.

Because most visitors came to CERES infrequently, we decided to include a summary of each Object in the *Overview* tab for visitors looking to become briefly familiar with the park features. The *Overview* section of the Visitor Centre Object describes CERES' mission and a brief history of the park. The tab *Thoughts* is a unique portion of the app that asks provoking questions to inspire critical thinking, personal reflection, and conversation among visitors.

The *Curious?* section contains details for visitors who wish to further explore the features or participate in CERES programmes. The language in this section is slightly more technical that the *Overview* section. Results of Study 1 showed that the most common question was "How can I get involved?" Therefore, within the *Curious?* section, we included suggestions of how users can incorporate sustainability practices into their own lives or sign up for CERES programmes.

CERES readily admits that not all green efforts result in successful outcomes. Consequently, the *Oops* tab was included since we decided one of the best ways to learn is by investigating past mistakes. The *Oops* section was populated with a number of stories about previous shortcomings. For example, CERES attempted to operate a mushroom growing

enterprise, but maintaining it became too expensive and laborious; it was subsequently cancelled. Certain park Objects, like the Visitor Centre, did not have any *Oops* content. On the app screen, tabs are only displayed if they were populated with content.

Finally, since the results of Study 2 showed that users prefer to learn from varying forms of media, we included the *Media* tab. Within this tab, users can find audio segments of CERES staff members providing extra details on particular features. To acquire these audio segments, we conducted interviews with 11 experts, each specializing in different fields, and recorded their input on various food, water, and energy topics. Prior to the interview process, we obtained signed consent forms from each interviewee in an effort to gain permission to use their audio recordings. Once the interview was concluded, we debriefed each interviewee about the purpose of the discussion and obtained post-release forms (see Appendix 3). Interview recordings were then cropped and enhanced in a sound editing program, enabling us to include the processed audio clips as *Media* items.

Once we completed gathering and generating all educational text, images, and audio, we archived the information. The content archive became the final product before populating The Chook. Our team had a meeting with the Art Processors[+] design team to learn how to update the app's framework. This meeting covered information such as how to open and edit pages of the app, the file compatibility requirements, and the process for integrating social media links or share features. We were introduced to the Content Management System (CMS) and were given a tutorial on how to transfer our collected content into appropriate sections of the app. The CMS allowed us to organise all the information into different Collections, Objects, and tabs. Figure 10 depicts one of the park Objects as it would be viewed by an app user.
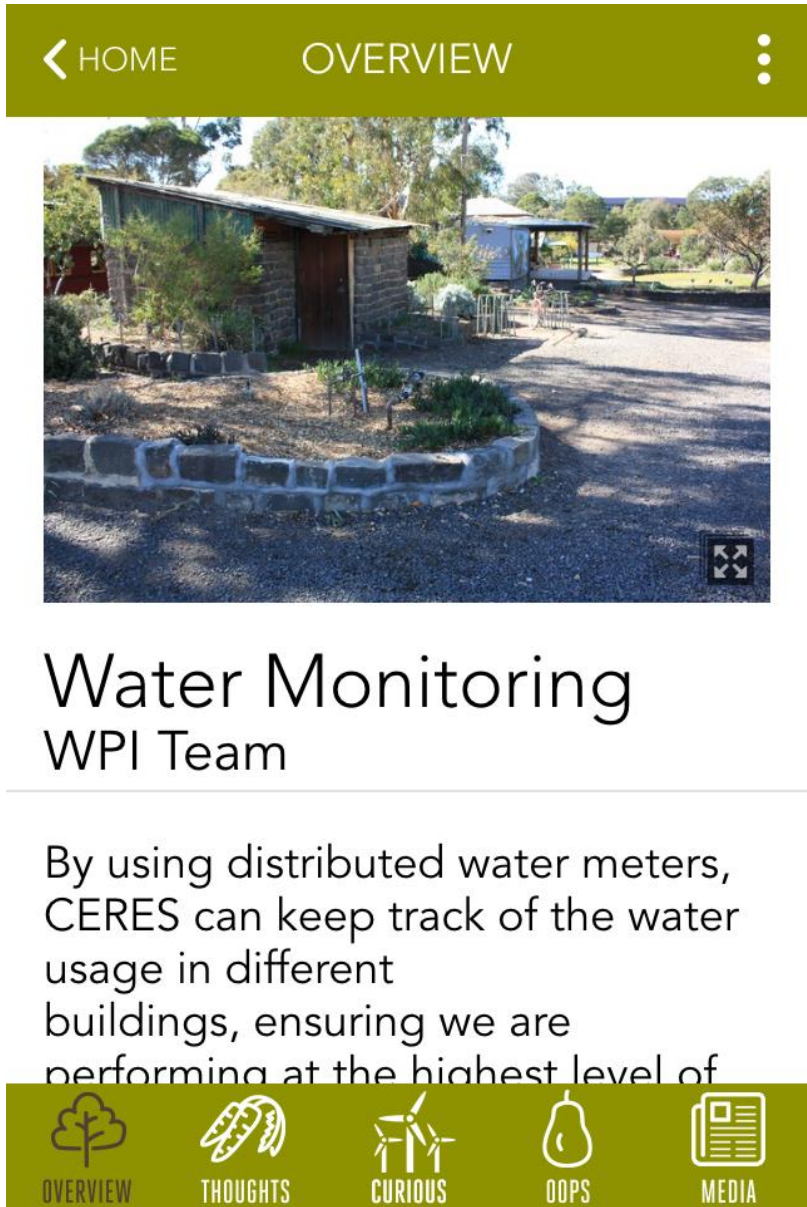
Figure 10: Screenshots of an Object with all five tabs in The Chook.

Once The Chook was fully populated with text, images, and audios, we proceeded to obtain user feedback on the educational content we created; it led us to the second aspect of Study 3: a user study.

Methods for the User Study

A pilot user study was conducted to assess the content and usability of The Chook. We gathered volunteers who were unfamiliar with the educational content of CERES to ensure we

used an unbiased target audience for The Chook. Nine participants were available. We assigned each participant a number, one through nine, to maintain anonymity. Although this is a small sample size, it provided an initial assessment that could be built upon with more participants in a future study. The two variables we assessed in this study were Educational Value and Usability.

Educational Value: Each participant was given a short, ten question quiz that tested prior knowledge on water, food, and energy sustainability topics. These questions did not test any previous knowledge on CERES itself. For example, participants were asked "What are swales?" and "What are the required components for a biogas generator?" All of the questions were multiple choice and the participants were instructed not to guess if they did not know the answer. The full quiz can be found in Appendix 5. Each user received 15 minutes to complete the quiz with no external resources allowed. Quizzes were labelled with the participants' numbers and collected after completion.

Once the pre-quiz was completed, the nine volunteers were divided evenly into three groups. Three participants toured the park as ordinary visitors, without the app, using only current signage. Three other participants were provided Apple devices and asked to tour CERES using The Chook. The remaining third of the participants stayed in a room, without access to the park, and explored The Chook by itself. All participants were instructed to explore individually and not speak to each other during the study. Sixty minutes were allocated for exploration. At the end of the hour, the participants returned to the original room where they took the pre-quiz.

To conclude the study, all nine participants completed a post-quiz identical to the pre-quiz. Each user was again given 15 minutes to complete the quiz. All quizzes were labelled using the participants' corresponding numbers. Our team scored the quizzes with an answer key and recorded the number of correct, incorrect, and omitted answers for each participant. We then compared the results of the pre- and post-quizzes.

Usability: A user feedback post-assessment was offered to the participants who had access to the app during Study 3. This assessment gauged participants' overall reactions to the app's content, organisation, and aesthetics. Participants were allowed to privately write yes or no and free-responses to questions such as if they enjoyed using the app, if it was easy to navigate, if any objects were hard to find or seemed misplaced, and if the images throughout the app accurately reflected the content within. We also asked users for their opinions on the level of detail included in the content. The post-assessment questions can be found in Appendix 5.

Results from User Study

Educational Value: The graded pre and post quizzes were matched by number and compared. All three test groups improved their scores from the before to the after quizzes. The first test group toured the park as current visitors would, without The Chook. Touring CERES without the app resulted in an average of 13.9% improvement on the quiz. The second group toured the park with The Chook and had greater improvement than the first group, improving by an average of 27.7%. Lastly, the third test group that explored the app without access to the park improved the most. These participants had an average of 55.5% improvement between quizzes. Figure 11 summarizes the amount of improvement in each groups' scores.
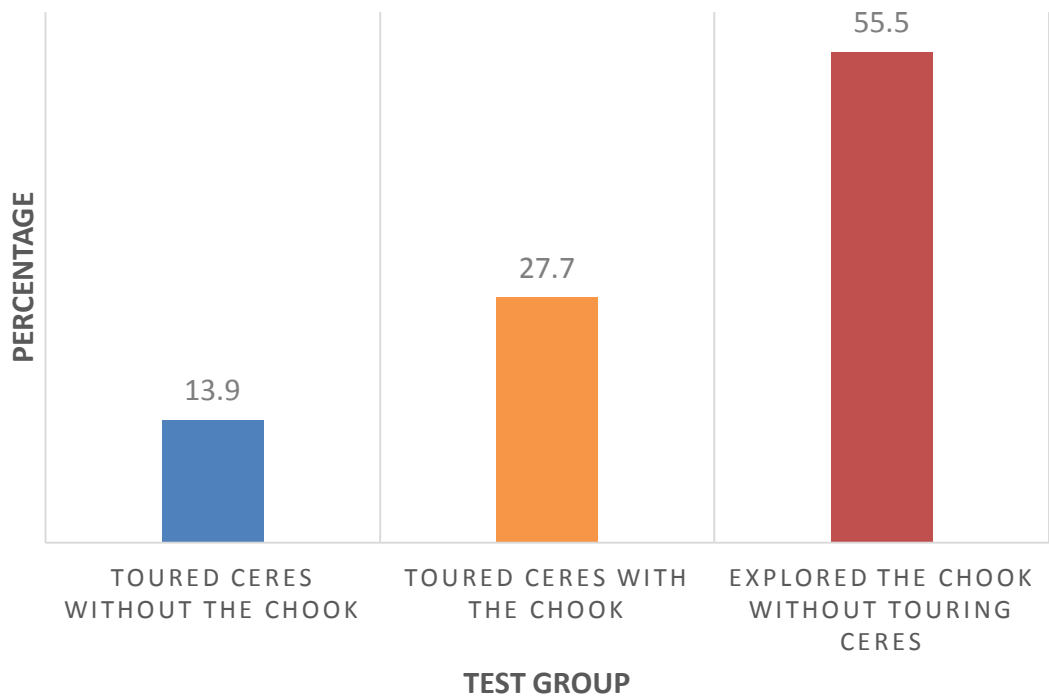
Figure 11: Comparison of quiz score improvement between study groups.

In our user feedback post assessment, all participants who had access to the app answered "yes, the app has high educational value". One participant said the Objects were very informative and had good descriptions. Another participant said the app had a good amount of information and he or she enjoyed learning new things. However, a different user said they would have liked more information on some of the Objects with smaller descriptions. A participant specifically mentioned the Bike Shed as a feature that could use more detail. When asked, "What is one fact about sustainability that really stuck with you from The Chook?" responses included how to build a rain garden, how solar energy was used in Australia, and how to protect farm animals from predators.

Usability: The question "What are your overall impressions of the app?" yielded positive feedback. One participant said it was user-friendly and the inclusion of audio was useful. Another user enjoyed the *Oops* section. All of the participants who took our post assessment answered "yes" to the questions, "Did you find the organisation of the app easy to navigate?"

and "Did you enjoy using the app?" However, when asked if the icon images and titles accurately reflected the content within their section, 66% of participants answered "no". One participant voiced that the Media tab should be called "Audio" instead and another stated that the *Curious?* and *Thoughts* icons were misleading.

Since the app had not yet been connected to the location devices around the park – which link the virtual features on the app to their physical features on site – all 44 Objects were viewed by users in an alphabetical list. Therefore, a few participants posed concerns about the Objects' order of appearance. When asked what about how The Chook could be improved, users said location capabilities need to be implemented and the park map should be easier to view so that Objects could be found more simply.

Discussion of User Study

Although this was a small pilot study, the results nonetheless were encouraging. Both groups that used The Chook exhibit higher rates of improvement on their post quizzes. Participants with The Chook during their tour of CERES averaged 14.8% higher compared to those without it. Additionally, all participants said they found educational value in the app. This suggests that The Chook met its purpose and can be an effective educational tool for the CERES Environmental Park.

The group that studied the app alone had higher rates of improvement compared to those who explored CERES with the app. We hypothesise that this variation occurred because all participants in the user study were allotted sixty minutes of exploration, regardless of what group they were assigned. Since participants who toured CERES had to locate and walk to each feature, they may not have been able to read through all Objects of The Chook, thereby missing answers to the quiz. Those who sat alone with the app potentially had an hour of constantly reading details without distraction or taking time between each Object. We recommend that future studies provide more time for park explorers and include a larger time lapse, perhaps several days, between using the app and taking the post quiz in order to test true knowledge retention.

The majority of usability concerns stemmed from navigating through the app. This was a symptom of all 44 Objects being presented in a single list and the map of the park being difficult to find. We recommend that the CERES map is placed as a sidebar menu option in order for users to pull it up with one swipe. In the future, Bluetooth beacons will be installed which will display Objects by their proximity to the user. This will allow users to be aware of their options, but still explore CERES freely without feeling guided throughout the park.

Several users stated that the icons within The Chook could more accurately reflect the content they represented. Therefore, we developed suggested icon designs seen in Figure 12 that CERES could use in a future upgrade of the user interface. However, we suggest conducting a more in-depth user study of the aesthetics before proceeding with any changes.
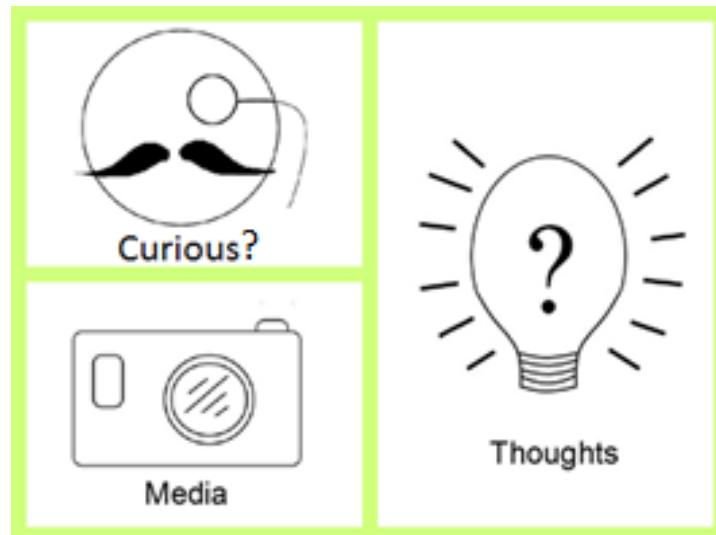

Figure 12: Suggested tab icons for Curious, Media, and Thoughts.

As already mentioned, we recommend that this study is repeated with a larger sample size in order to yield more reliable results.

Conclusion

The supply of global resources, such as food, water, and energy, is becoming increasingly strained as the human population increases. It is important to educate society on how these resources can be conserved and how to one can find ways to protect the planet that sustains us. The Chook is an educational tool that CERES can use to improve communication to their visitors as they explore the features of the park. By assessing the features of the park, surveying visitors, and interviewing CERES staff members, we were able to identify and generate all relevant information for our app project. We successfully populated The Chook with educational content on how CERES can effectively sensitise its visitors to the global issues of food, water, and energy conservation. Furthermore, it is hoped that our developed app will become an important tool for CERES to reach beyond its traditional park visitors to an even broader audience in an effort to provide much needed education about the protection and preservation of our environment.

Deliverables

The Chook is a complete prototype that can be uploaded to Apple mobile devices. It contains information on 44 different features around the CERES Environmental Park. The app educates visitors on innovative methods to conserve water, food, and energy and utilises multimedia to support different learning styles. We provided supplementary documents, a content archive and instruction manual, to continue managing The Chook after our project is completed.

The archive is a comprehensive collection of files on the CERES server that hosts all text, images, and audio files. The file naming convention we used is included; this enables easy file searches, additions and retrievals, while maintaining organisational uniformity. Our archive provides a streamlined way for a person unfamiliar with CERES to see what is in the app without using a mobile device, such as a researcher completing a future project.

The instruction manual is a simplified document for anyone at CERES to operate the CMS, edit The Chook, and trouble shoot technical issues that may arise. The CMS can be

managed on any CERES computer; we decided to include instructions on how to upload, edit, and instantly publish content to The Chook. Anyone with access to the CMS can perform these tasks without contacting a commercial technology provider, thus enabling CERES to take full ownership of its app.

Future Work

The next step for The Chook would be to enable Bluetooth capabilities and then proceed with a so-called a soft launch, i.e., the release of the app to a limited audience. CERES will have Bluetooth beacons around the park that link the locations of the physical features to the locations of the virtual Objects on The Chook's map. Once the beacons have been installed and connected to the CERES server, the app will be ready for the soft launch. For this soft launch, a shareable beta link will be created. The link can be distributed by CERES staff and recipients will be able to download The Chook to their Apple devices for further testing. Once CERES decides The Chook is ready for the public, Art Processors will submit The Chook to the App Store for review. Once approved, it will be available for download on devices running on iOS7 and later versions.

There are additional ways The Chook's development could continue. From Study 1, we recognised additional opportunities for The Chook to enhance various CERES features. However, certain features that could use improvement fell outside the scope of our project and consequently were not included. Therefore, we recommend adding other Collections or Objects such as the Aboriginal Trail, the Learning Centre, or a wildlife tour. In Study 2, we found that a small portion of visitors preferred learning by watching videos. Accordingly, we suggest CERES staff members film activities, such as creating a worm farm, and include it under the Media tab. Some participants in the final user study expressed interest in the founding of CERES and upcoming events. Therefore, we further recommend that The Chook should include content on CERES' history and its establishment, weekly events, upcoming workshops, or annual festivals. With these updates, CERES could potentially attract a wider audience, thereby expanding society's awareness of environmental issues and innovative solutions. As global environmental issues evolve, CERES needs to adapt in order to address the great challenges facing our

population. The adaptability of The Chook will be able to support CERES as it adjusts to global demands. With The Chook, CERES can reach a larger audience, thereby promoting social change and educating its visitors about how to conserve our precious resources, both now and in the future.

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Appendix

Appendix 1: Results from Initial Park Assessment

Table A1 tabulates the results from Study 1. Each feature of the park was rated on a 5 point Likert-type scale based on the categories listed in each column's label.

Table A1: Results of the Self-Guided Tour and Park Assessment (Study 1)

Exhibition/Potential Station	Difficulty to find	Apparency of what you should do there	Availability of resources	What was your resource?	Questions unanswered	Amount of detail
Nursery	5	3	3.5	staff and signs	What can/can't you buy (as opposed to borrow)? Where do the plants come from? Best plants to grow each condition/type? Easiest things to grow as beginner?	3.5
Community Plots	4	1	1	none	Are we supposed to be here? How do we get one? Who do we talk to about it?	1
Learning Center	4	5	3	Signs, window posts	Some events didn't have schedules, when is the next one?	3.5
Bike Shed	4	3	3	staff - busy usually	Do we need our own bike? How do we start? Times it is open?	3
Merri Merri	1	5	4	Sign	Is this a tour trail? Where is the beginning?	5
Compost	2	3	4	Sign	Can anyone use it? Why is it important to compost? How can I implement composting? What are some smaller scale uses of soil? Are there any limitations for proper use?	4
Cafe	5	5	5	signs and staff	When are the hours? Are there events here?	3
Propogation	4	5	4	Sign	How do I participate in propogating seeds? What is the definition of propogation? Where can I get seeds?	3
Chook Group	4.5	2.5	2	Sign	How do I get involved with groups? What are the types of chicken, flock size, etc?	3.5
Eco House	3	2.5	3	Sign	Where is th schedule of events? We didn't know we could go around the back to where all the technology displays are.	5 (for signs in back of house)
Aquaponics	4	2	3.5	sign	Where do the plants come from? How do you set up the small scale worm system it describes? What is a warm system? Can I see the aquaponics system? What is being grown?	4
Resource Center	4	4	1	none	How can I attend a speaker here?	5
Water Trail	3	2	2	Sign	What is/where is the water trail? Is this a functioning cycle? How can I use storm water in my house?	2
Solar Cooling	3	2	2	Sign	How can I use this? Can it be used in an entire home or one room?	4
Community Food Groups	3.5	none	3	Sign	How do you get involved? What days/times do they meet? What plants are growing?	2
Visitor Centre	5	5	4	Staff and signs - however, there are many entrances, so these might not be apparent to some visitors	none	5
Solar Thermal	3	3	3	Small sign	Small cookers for boiling tea water?	4
Photovoltaics	3	3	2	Sign	How much are they? Why aren't we using these?	3
Biogas	3	3	2	Sign	How can the remaining 40% of the landfill waste be accessed?	3
2030 Trail	3	3	5	Signs	What can you do noiw to stop it?	5
Green Roofs	4	none	3	Small sign, behind visitor path	Are there any residential green roof opportuinites?	4

Appendix 2: The Visitor Survey Facebook Post

Figure A1 shows the post made on the CERES Facebook page introducing The Chook app and encouraging followers to participate in our survey for Study 2.

Figure A1: CERES survey and The Chook Facebook Post

Appendix 3: Survey Questions

Below is the CERES Visitor Survey we conducted in Study 2. It was carried out through a Google survey and administered via Facebook, the CERES Newsletter, and in person on a tablet.

How often do you come to CERES?

○ This is my first time!

○ Weekly

○ Monthly

○ Other: [   ]

How did you find out about CERES?

○ CERES Website

○ Social Media

○ Newsletter or other ad

○ Friends or family

○ Other: [   ]

Do you have a CERES membership?

○ Yes

○ No

How likely are you to visit CERES to shop at the Market or Cafe?

	1	2	3	4	5	6	7	8	9	10	
Least Likely	○	○	○	○	○	○	○	○	○	○	Most Likely

How likely are you to visit CERES to visit the Bike Shed?

	1	2	3	4	5	6	7	8	9	10	
Least Likely	○	○	○	○	○	○	○	○	○	○	Most Likely

How likely are you to visit CERES to visit the Nursery?

	1	2	3	4	5	6	7	8	9	10	
Least Likely	○	○	○	○	○	○	○	○	○	○	Most Likely

How likely are you to visit CERES to attend a festival?

	1	2	3	4	5	6	7	8	9	10	
Least Likely	○	○	○	○	○	○	○	○	○	○	Most Likely

How likely are you to visit CERES to explore the park?

	1	2	3	4	5	6	7	8	9	10	
Least Likely	○	○	○	○	○	○	○	○	○	○	Most Likely

What is your age?

- ○ 18-24
- ○ 25-44
- ○ 45-64
- ○ Over 65
- ○ Prefer not to answer

What is your gender?

- ○ Male
- ○ Female
- ○ Prefer not to answer

Do you have a smartphone?

    ○   Yes

    ○   No

If you have a smartphone, how easy is it for you to download new apps?

	1	2	3	4	5	
Very hard - I rarely download apps	○	○	○	○	○	Very easy - I frequently download apps

If there was an interpretive app for CERES, would you be inclined to download and use it during your visit?

    ○   Yes

    ○   No

How do you prefer to learn?

Check all that apply

☐   Reading

☐   Looking at pictures

☐   Watching a video

☐   Hands on activities

☐   Other: [　　　　　]

Are you connected to any of the following CERES media?

Check all that apply

☐   CERES website - www.ceres.org.au

☐   Facebook - CERES Environment Park

☐   Twitter - @ceresbrunswick

☐   Instagram - ceresbrunswick

Appendix 4: Audio Consent Forms

The following forms are the consent and post consent forms for the recording of audio during the expert interview process in Study 3.

Recording of Audio Consent Form

We would like to record audio during this interview; by agreeing to have this interview recorded, you recognize that there may be risks presented from your identity being disclosed in any published report or presentations founded in this research project and agree to these risks.

	YES	**NO**
I agree to have audio recorded in this interview	☐	☐
Information on my identity, including name and position, may be published in a report or related presentations	☐	☐

_____   _____

Participant Signature   Date

_____

Printed Name

Post Recorded Audio Consent Form

Thank you for participating in our interview; have gained important insights from this process. We would like you to reflect on the interview and reconfirm your consent to the use of any audio recorded; by agreeing to the use of the audio, you recognize that there may be risks presented from your identity and opinions being disclosed in any published report or presentations founded in this research project and agree to these risks.

	YES	**NO**
I agree to allow the use of the audio recorded in this interview	☐	☐

_____   _____
              Participant Signature   Date

_____
              Printed Name

Appendix 5: User Group Questions

Below are the questions of the quiz offered as a part of the user study in Study 3 and the user feedback post assessment.

Pre and Post Quiz

What is your number?

Which turbine is best for a place with sporadic wind patterns, where the gearbox needs to be accessed from the ground?
- ○ Wind Pump
- ○ Traditional Turbine
- ○ Vertical axis Turbine
- ○ Horizontal axis Turbine

What are the required components for a biogas generator?
- ○ Biowaste, worms, soil, microorganisms
- ○ Water, worms, natural gas, heat
- ○ Biowaste, natural gas, soil, water
- ○ Biowaste, heat, microorganisms, water

What are ways to mitigate the negative effects of urban runoff?
- ☐ Swales
- ☐ Impervious Pavements
- ☐ Rain Gardens
- ☐ Sewers to Rivers
- ☐ Root zone Filtration
- ☐ Roadways

What are some challenges with maintaining pervious pavements?
- ○ Water from site is lost too quickly
- ○ Pests build nests within the pavement matrix
- ○ Leaves clog pores and pavement cracks
- ○ A pavement cleanser must be washed up weekly

What are some sustainable design features that can be built into your home?
- ○ Doubled glazed windows
- ○ Keeping thermal mass outside the home
- ○ Having more insulation in walls rather than ceiling and floor
- ○ All of the above

Which city is trying to ban cars by 2050?

○ Amsterdam

○ Paris

○ Prague

○ Venice

What kind of pests threaten seedlings?

○ Birds

○ Insects

○ Rats

○ All of the Above

What are food miles?

○ The distance food goes from production to point of sale

○ The number of miles that food will go in a biogas car

○ The length of food at a large farm

○ The distance food goes from production to consumption

What fish is most commonly used for aquaponics?

○ Flounder

○ Herring

○ Tilapia

○ Mackrel

What are swales?

○ Pots used to hold Propagating seeds

○ Low points in land to allow rainwater filtering

○ A bird common to CERES

○ Small bumps that grow on Chicken feet

User Feedback Post Assessment

- What are your overall impression of the app?

- Did you enjoy using the app? **Yes or No**
    - If yes, what was your favourite part?

    - If no, what could be improved?

- Did you find the organisation of the app easy to navigate? **Yes or No**
    - If no, what made it difficult or how can it be improved?

- As a visitor of CERES, do you think this app has high educational value? **Yes or No**
    - If no, what would make it more educational?

- Which, if any, items did you think had too much or too little detail?

- Were there any items in the app that were particularly hard to find or misplaced?

- Did the icon images and titles accurately reflect the content within their section? **Yes or No**
    - If not, which ones do you think should be changed?

        - What is one fact about sustainability that really stuck with you from The Chook?