

SANTA CLARA UNIVERSITY
DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

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Santé le Match

BE ACCEPTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

BACHELOR OF SCIENCE IN COMPUTER SCIENCE AND ENGINEERING

BACHELOR OF SCIENCE IN WEB DESIGN AND ENGINEERING



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Submitted in partial fulfillment of the requirements
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Bachelor of Science in Web Design and Engineering
School of Engineering
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ABSTRACT

In Senegal, many children are unaware of the importance of common hygiene practices due to limited health education on sanitation and personal hygiene. As a result, the repercussions of not following these practices are not clearly understood. This is an issue because some of the most common diseases in Senegal can be prevented through better sanitation practices and other basic preventative measures. Developing hygienic habits at a young age is critical—especially in a developing country such as Senegal. We have created a mobile application that educates and empowers children with the basic knowledge of WASH—water, sanitation, hygiene. Because Senegal often does not have reliable internet connectivity, our application will not rely on connectivity to function. Instead, users will only need to have the application installed on their technological device ahead of time in order to acquire full functionality of the application.

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Chapter 1

Introduction

1.1 Background

In Senegal, 41% of the children ages 4-8 are out of school and are not receiving any form of health education. Due to the lack of education on sanitation and personal hygiene, the repercussions of not following these practices are not clearly understood. By not washing your hands before meals, you increase your chances of exposure to many diseases such as bacterial diarrhea and hepatitis A, two diseases that are prominent throughout Senegal. These diseases can potentially be lethal, especially for children without proper access to medical treatment. This is an avoidable issue because some of the most common diseases in Senegal can be prevented through better sanitation practices and other basic preventative measures. Developing hygienic habits at a young age is critical—especially in a developing country such as Senegal. Most importantly, caring for oneself in these manners is beneficial for both physical and mental health. As we are in the midst of the COVID-19 pandemic, preventing illnesses from spreading is particularly crucial.

1.2 Current Solution

There is currently no existing solution in Senegal. Although there are health game applications in the United States, none have been implemented in Senegal, and the available applications do not provide a combination of gaming and health education. Most importantly, none of the applications are designed to target 4-8 year old Senegalese children as the primary consumer.

1.3 Proposed Solution

We aim to teach children in Senegal about health in a fun and innovative way with a team that consists of 3 senior computer engineers, 2 public health students, and 2 graphic designers. Our project entails a mobile application, similar to *Candyland*, that educates and empowers children with the basic knowledge of WASH—water, sanitation, hygiene. We have also incorporated basic facts on common preventable diseases and mental health tips. Because our target audience spans such a diverse age group, 4-8 years old, our game will be lesson-based, with increasing complexity as the children advance further through the game. To ensure that they are learning throughout the game, there are questions at each level or spot and the child must answer the question correctly to proceed to the following level or spot. Users will need to have the application installed on their mobile device ahead of time in order to acquire full functionality of the application.

We hope to integrate our game into the curriculum of local pre-primary and elementary schools throughout Senegal. As the project is still under development, we will most likely be passing on our prototype to future engineering students for further development and testing. By eventually integrating

our application into the education industry in Senegal, we hope that our application will become a major resource for Senegalese children to learn about proper hygiene.

Chapter 2

Requirements

2.1 Functional

2.1.1 Critical

- The application will provide education and information on the following
 - Basic and Sophisticated Hygiene
 - Common Diseases
 - Mental Health
 - Preventable Diseases
 - Physicians and Doctors
 - Sanitation Practices
 - Senegal Information and History
 - Science
 - Sustainability
 - Vitamins and Supplements
 - Ways to Prevent Sickness
- The application will allow users to learn at their own pace with level-based random questions
- The application will be interactive and include easy-to-understand modules with storylines for the children to follow

2.1.2 Recommended

- The application will allow users to save their progress in the board game
- The application will allow users to input their own data such as login name ID and password for machine learning purposes and game adaptability to the specific user
- The application will include a point system for engagement and entertainment purposes

2.2 Nonfunctional

- The application should have a simple, pleasant, and kid-friendly user interface that is easy to navigate and understand
- The application should be able to handle bugs and errors such as unintentional user mistakes in the game

2.3 Design Constraints

- The application must be low-cost and budget friendly
- The application must be a mobile application used on Androids
- The application must be done using the frontend engineering software language React Native Javascript
- The prototype application must be completed by May 2022

Chapter 3

Use Cases

The main use case for this mobile application is to obtain information and gain knowledge on sanitation practices, common diseases, basic hygiene, sustainability, vitamins and supplements, and ways to prevent sickness.

Users will be able to learn and understand the importance and basic knowledge of WASH—water, sanitation, hygiene. Additionally, users will be able to gain a sense of togetherness with the community by learning, playing, or discussing the questions with friends, family, and peers. Furthermore, there will be mental health tips and basic facts on common preventable diseases incorporated in the application.

As shown in Figure 3.1, some use cases for users would be to download the application, view and review the learning sections, interact with the boardgame, and answer the randomly generated quiz questions. Moreover, for the admin, our use cases would be to edit the quiz questions and learning sessions and update the modules, whether it means removing an entire lesson or changing the curriculum based on future testing.

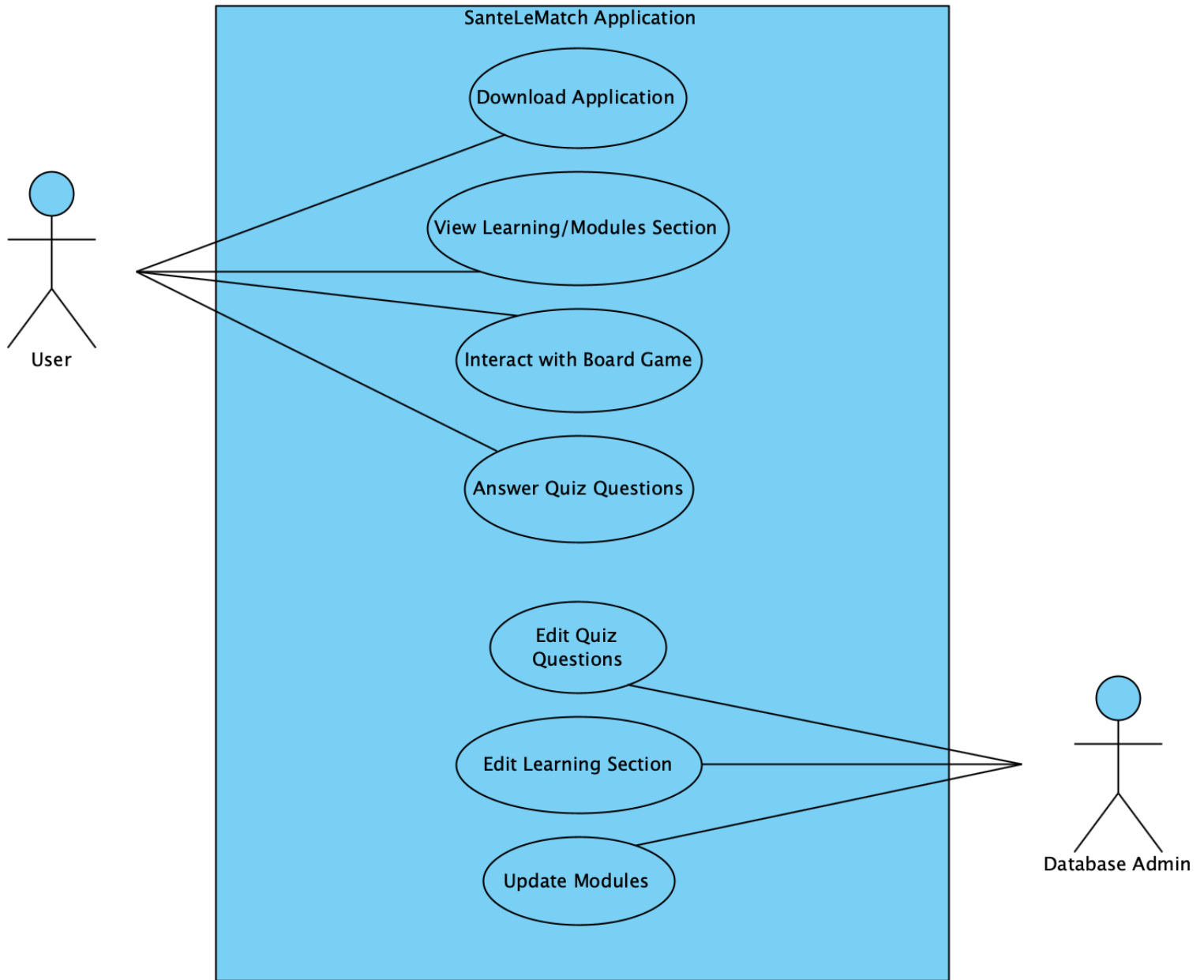


Figure 3.1
Use Case Diagram

Chapter 4

Activity Diagram

Below is the model of activity diagram for our application users:

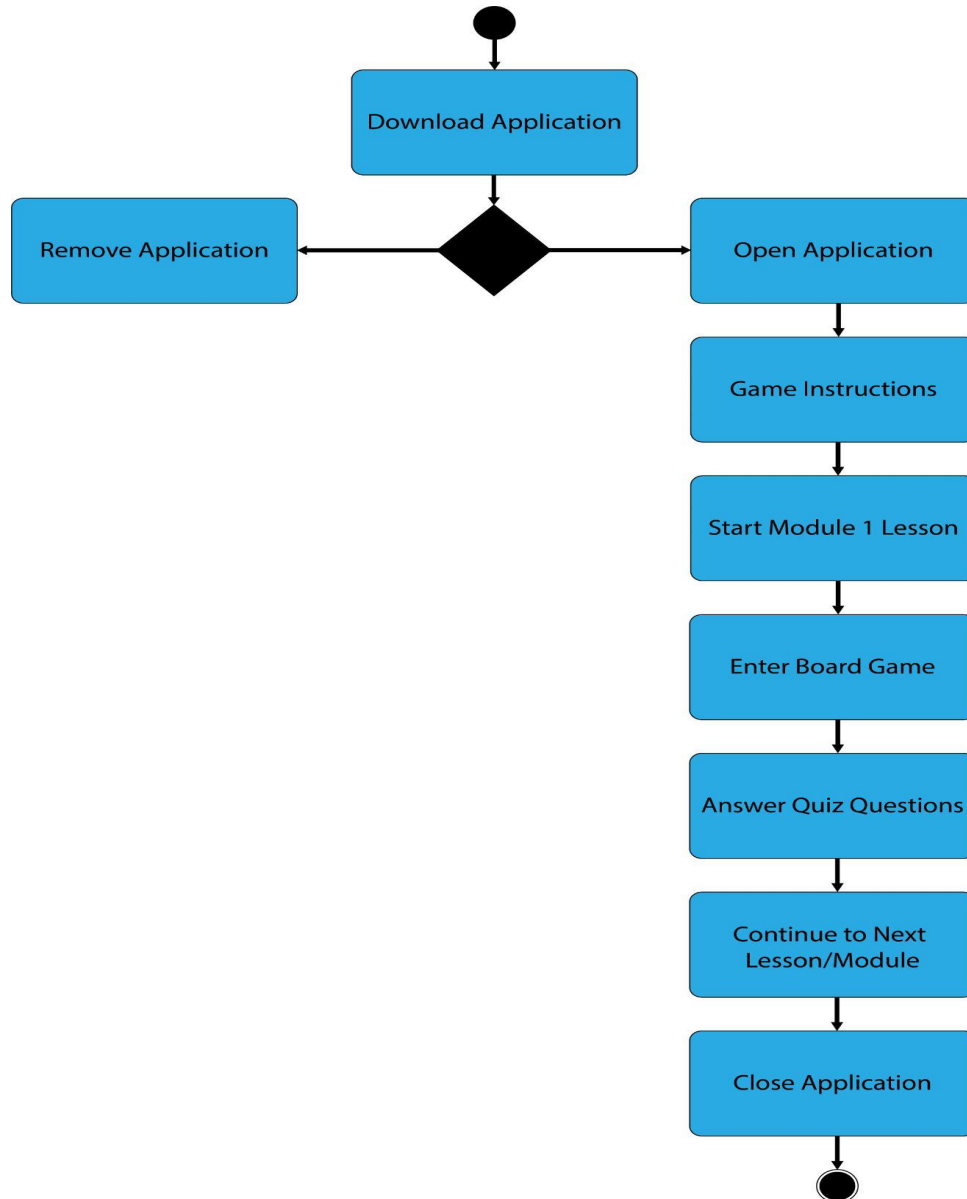


Figure 4.1
User Activity Diagram

Chapter 5

Conceptual Model

5.1 Proposed Solution

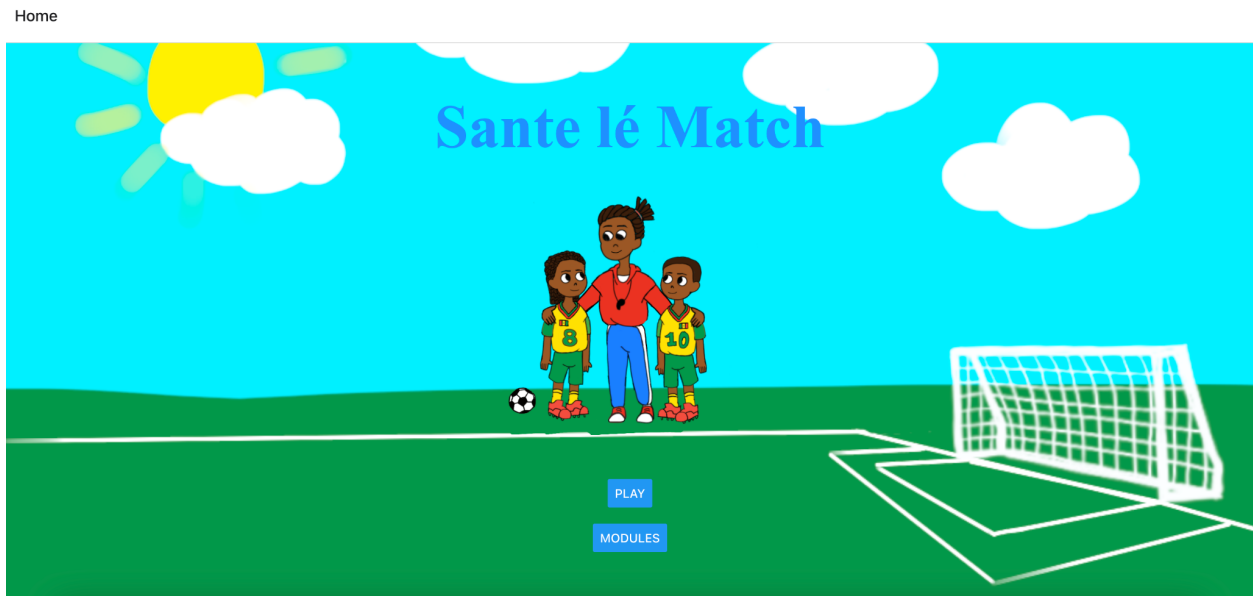


Figure 5.1
Home Screen

Upon entering Santé le Match, users will see the home screen of the application with a “PLAY” and “MODULES” button, shown above in Figure 5.1. Clicking on the “PLAY” button will lead the user to the game instructions screen, where they will be guided through the onboarding process of how the game works and what it is about. For each stage of progression in the game, users will be presented a set of curriculum slides featuring information on healthy hygiene and health habits. These slides will consist of plain text and simple graphics (primarily images and animated GIFs) and can be seen as part of our modules screen.

After completing the lesson/module slides, users can head to the main section of the game, which consists of a specific board game per lesson/module. Each of the board games have randomly generated questions specific to that lesson/module and are in the format of multiple choice. Users will have a choice to select between four answer choices, and depending on their response may either advance to the next board tile or remain in place.

Chapter 6

Architectural Diagram

For our architectural design, we decided to implement something simple in order to save time, money, and decrease room for potential errors. React Native Expo allows for everything to be done in the device. Our React JS code connects the JS Bundle, which bundles our code into an application for the client to play. The JS Bundle also connects to the bridge that permits the JavaScript and the Native modules to interact with each other, allowing the use of different JavaScript functions.

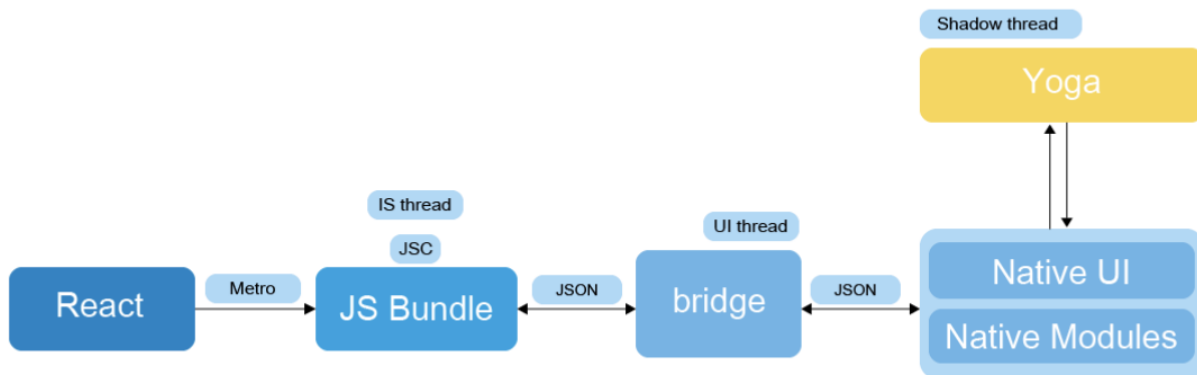


Figure 6.1
Architectural Diagram^[4]

Chapter 7

Design Rationale

7.1 User Interface

We chose to move forward with a simple and intuitive design that would make the game easily accessible and usable for users. Our target audience includes 4-8 year old children in Africa and anyone else interested in learning more about fundamental hygienic practices. Because of this, our mobile pages will be concise and simple to navigate. In order to cater our app more specifically to our younger target audience, we have decided to design the game stylistically similar to the western board game *Candyland*. We will also incorporate soccer as our main thematic elements to further assimilate our app with popular sports culture in Senegal.

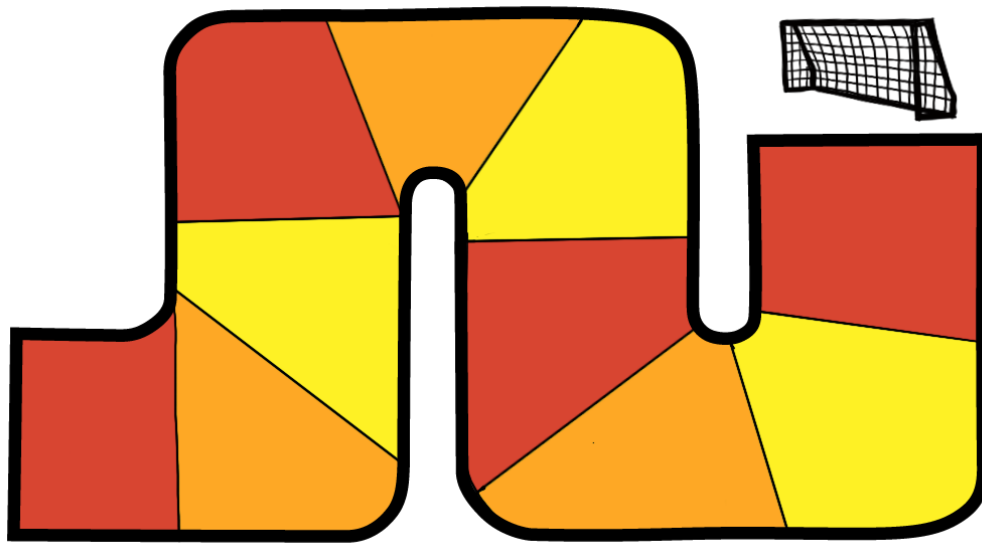


Figure 7.1
Board Game Design

7.2 Technologies Used

In terms of technologies used, we went ahead with React Native Expo which allows cross-platform usability between iOS and Android. For the purpose of our senior design project, we are planning to deploy it on the Android tablet. We also hope to implement an AWS database in the future as it is relatively simple to set up. This would ultimately allow the children to create accounts and therefore save their usernames, passwords, and progress.

Chapter 8

Test Plan

8.1 Interface Testing

We were not able to conduct usability testing on Santé le Match due to obstacles encountered and setbacks. Hence, usability testing would be done later in order to gain feedback from people prior to launching the application. Usability testing is critical to our development of the application so that we can get a holistic understanding of the user's pain points with the application and improve the overall user experience and design. Since our application is geared towards children in Africa we need to ensure that the application is simple to use and navigate, which would be achievable through usability testing.



Figure 8.1
Lesson One Graphic Interface

Chapter 9

Risk Analysis

Risk	Consequences	Probability	Severity	Impact	Mitigation
Delay in acquiring lesson plan/modules	Loss or productive time, development may take longer	0.3	8	2.4	Check in regularly with the Public Health (PH) students
Bugs	Application not working, may lead to delay in application launch	0.99	4	3.96	Write clean code, maintain consistency throughout development
Time	Application not completed on time	0.3	9	2.7	Create a timeline with milestones and set deliverables. Prioritize key features
Data Loss	Delay applications development	0.05	8	0.4	Utilize Git version control on GitHub to save work on version histories.

Chapter 10

Societal Issues

10.1 Ethics and Social

The purpose of our project is to provide access to educational information on personal hygiene and health for a community that does not have access to it. Since we are all human beings, we should all be treated equally and should all have access to the same information. It is within our capabilities to create a solution that can bring life-changing information to rural communities, and so we should uphold that. Specifically, as web developers and computer engineers, there would be additional emphasis on user privacy in websites and plagiarism in the creation of mobile apps. We believe both are extremely important in terms of respecting users and making safe improvements or advancements.

10.2 Political and Economic

Our system is economical because there is no cost to our system. Santa Clara University has already supplied tablets and React Native Expo allows any cost to be negligible. In addition, our application is free to develop and to distribute. We further do not anticipate any political impacts since our application will not affect the hierarchical structure of their political system.

10.3 Health, Safety, and Manufacturability

The educational benefit of our application will contribute to the livelihood and well being of populations in Senegal. Users would gain knowledge on sanitation practices, basic hygiene, sustainability, and ways to prevent sickness.

Moreover, in terms of user privacy, collecting data has been a hot topic when discussing what is ethical in engineering, as many companies use their app to track user behavior, violate personal privacy, and store the users' personal information secretly. Our application does not allow any of these unethical behaviors and we do not use CSS techniques to track user behavior. No data is collected and no data will be used for illegal purposes.

We consider accessibility to be a key impact in our app. Not only do we want our application to be technologically accessible, we also expect to have a cultural aspect to best fit the needs of the Senegal population. React Native Expo allows high accessibility and free manufacturability.

10.4 Sustainability and Environmental Impact

As engineers, we are obliged to consider the impact of using valuable resources and environmental impacts. The main primary impact would be the use of electricity to charge the tablets, which would be negligible since our client's schools have already used the tablets before.

In order to embody our obligations to sustainability and environmental impact as a team, we must place both the students and customers at the heart of our decision making. These decisions include the accessibility of the application, the architectural/system design, and user interface design based on their living conditions and cultural experiences.

10.5 Usability

With regards to usability, our team debated heavily on whether or not to include a database in our mobile application. Most importantly, we focused on a minimalist design which makes the game very simple and straightforward to play, as shown in Figure 10.1. Some of the reasons for implementing a database include enabling students to keep track of their progress and save where they left off within our mobile game. By saving their individual progress, this would allow students to focus on learning new material rather than re-learning content that they have already seen before.

On the contrary, due to time constraints and feasibility, not implementing a database would decrease the overall complexity of the app, as well as allow us to prioritize and focus on the more necessary features of the application. Also, by not having a database, this would allow for other schools in the area to use the application since the game would not require servers to enable the database. As a result, we collectively concluded to not include a database for usability and accessibility considerations.

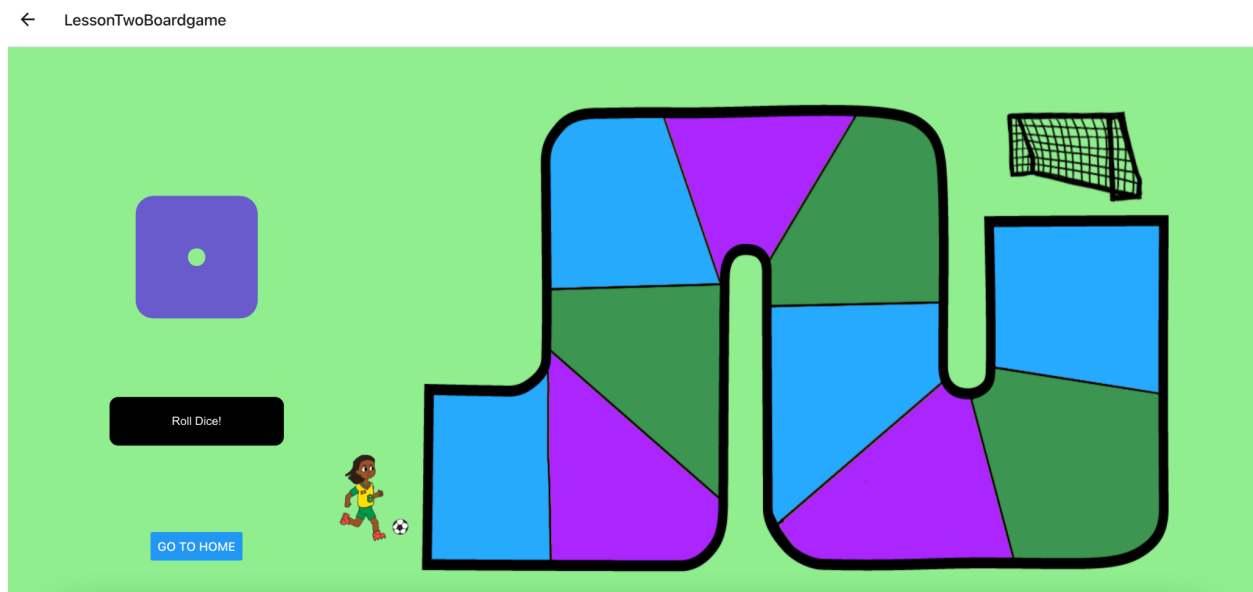


Figure 10.1
Lesson 2 Board Game

10.6 Lifelong Learning Compassion

We have an implied teacher-student relationship with our customers given that our goal is to holistically educate children in Senegal about sanitary habits, and to do so in a responsible and scientifically accurate way. We as a group developed this project because we wanted to pass on informative knowledge that has impacted ourselves in many ways. Above all, we feel like this project would be a lifelong learning experience for both our team and the children playing our game. Rather than having direct compassion on individuals, we want to focus on the different aspects of ensuring that we are actually providing a benefit to the 4-8 year old children in Senegal and making the learning tool enjoyable, not just for learning purposes.

Chapter 11

Conclusion

11.1 Obstacles Encountered & Setbacks

1	Working with New Technology - React Native Expo
2	Losing important team member (graphic designer)
3	All images and visual aspects delayed
4	Modules 2 and 3 delayed
5	Loss of time → Delay causing some initial ideas and aspects of prototype to be canceled

Figure 11.1
Encountered Obstacles and Setbacks

Throughout the entire process, we were met with a few obstacles and setbacks, with the first being that we were working with a completely new technology that no one in the engineering team had experience with before, so we really had to learn everything from scratch. This definitely proved to be difficult initially for us. The major obstacle we encountered was losing our one and only graphic designer midway through the project without any graphics or lessons done. As a result, all the images and visual aspects were delayed. Luckily, we were able to find and hire two new graphic designers to complete module 1, but this resulted in modules 2 and 3 being delayed. Ultimately, this loss of time and delay caused some of our initial ideas and aspects of our prototype to be canceled or put on hold.

11.2 Changes

With the obstacles and setbacks in mind, we had to make a few changes to our application. First and foremost, we did not implement our recommended functional requirements listed under section 2.1.2. This means that we do not have a point system or a login/logout credentials input for users to save their progress and hence, we are currently not implementing the database system. That being said, we will be passing our current application to a future engineering team to take over for them to implement these recommended requirements.

Moreover, we had to utilize whatever components and parts we had already, which was module 1. Thus the current application is tailored towards one single module. Finally, after our meeting with our client Magatte in early January, we learned that their schools have strong wifi and servers, so we fully expect wifi and data to not be a problem. In the case we want to deploy our application in other locations in Africa, we expect to pass our current prototype to another team for further development in terms of lack of connectivity.

11.3 Lessons Learned

Overall, this was a great learning experience and we wanted to share some key points and lessons learned throughout our entire design process.

1. Setbacks and obstacles are bound to happen, as it's part of the process, whether in our education or outside in the working force.
2. Design reports and requirements are very significant in making everything smooth. We found it helpful to have a design report to look back on whenever we ran into problems in order to keep us on track.
3. Change and work on one thing at a time. Initially, we attempted to debug our code all at once, which led to more errors and debugging, causing lack of progress. We eventually broke things down into smaller components and distributed our code into individual parts, allowing us to be more efficient.
4. Documentation and requirements are fluid. It is pivotal to learn that it is perfectly fine to change requirements if they are not working. Project documentation does not have to be strict or done a certain way, and it helps to have backup plans along the way.

Chapter 12

Current Application

12.1 UI/UX

For our current application, we have a bright color palette in order to help engage and help intrigue the children to keep playing the game, as shown in the figures below.

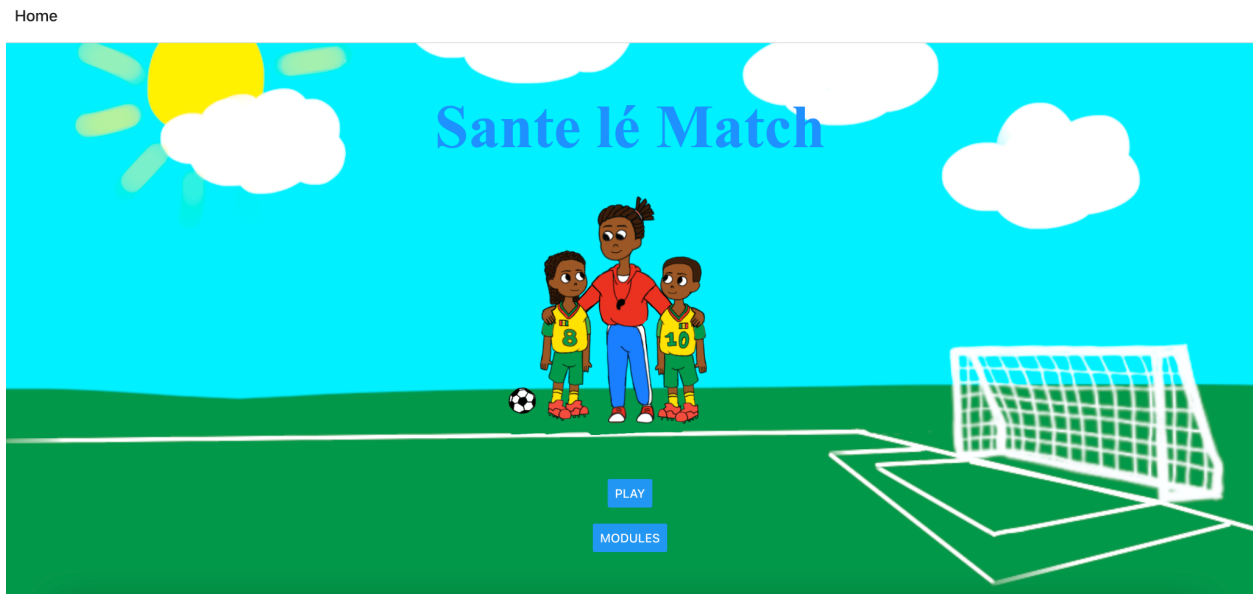


Figure 12.1
Landing Screen

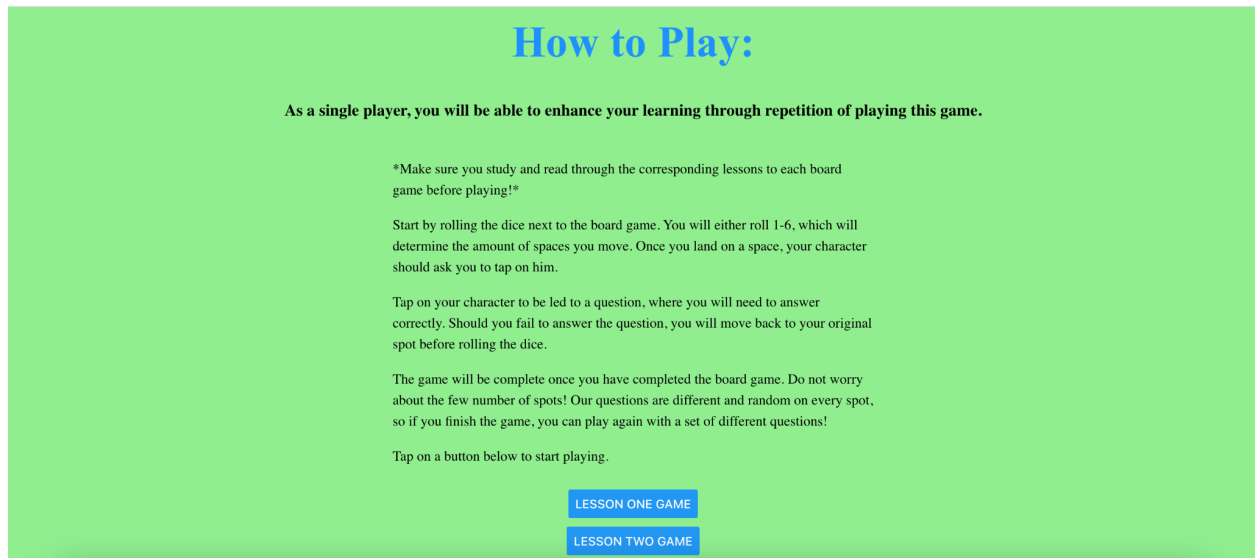


Figure 12.2
Game Instructions Screen

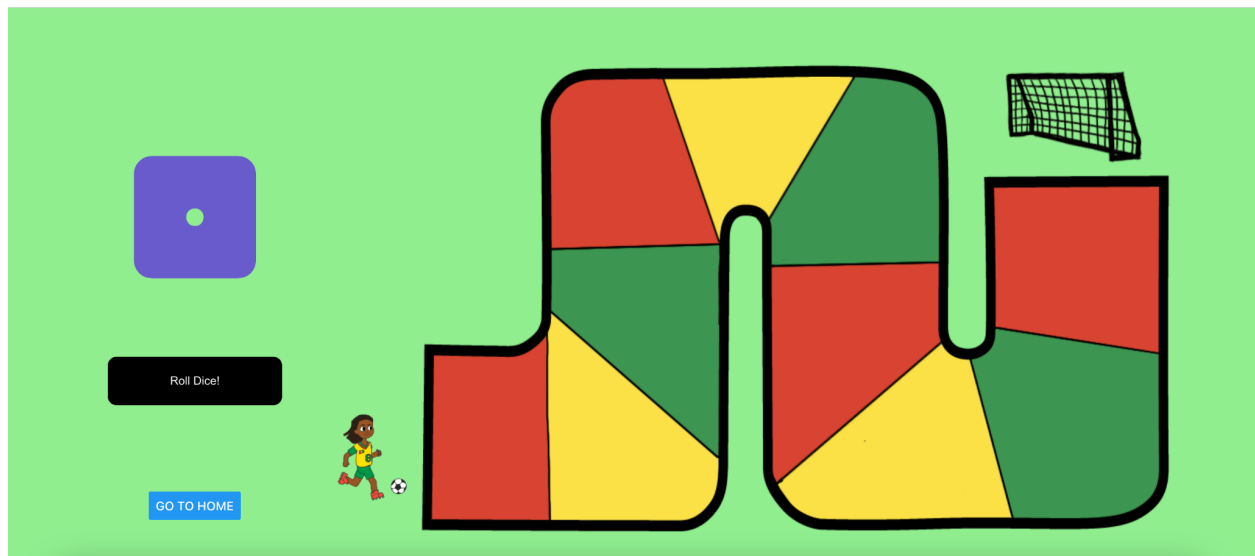


Figure 12.3
Lesson 1 Board Game

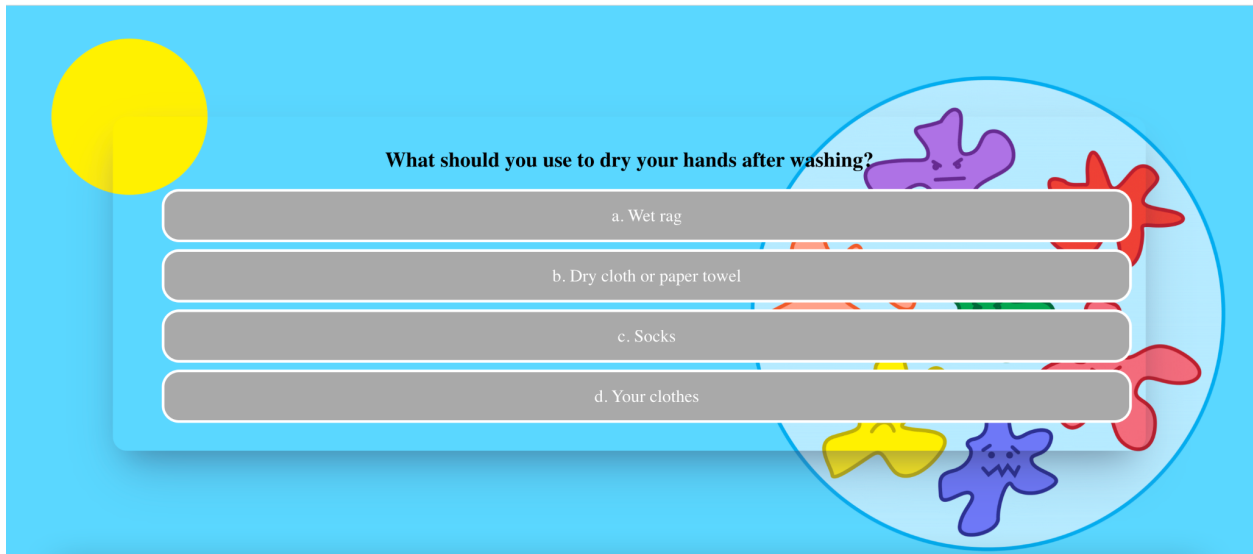


Figure 12.4
Questions Screen

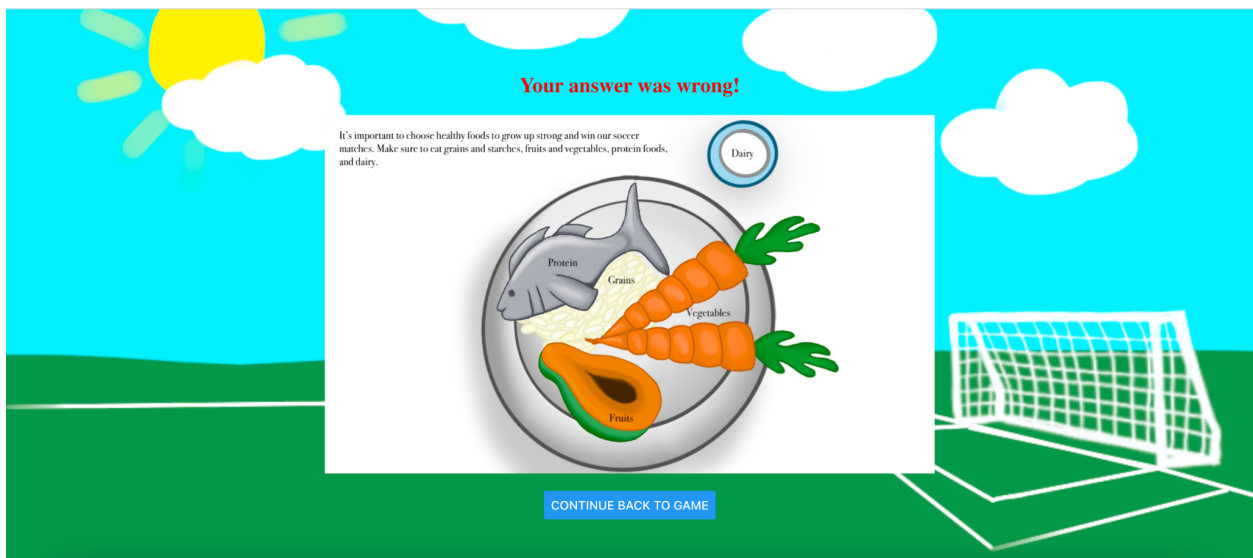


Figure 12.5
Wrong Answer Popup Screen

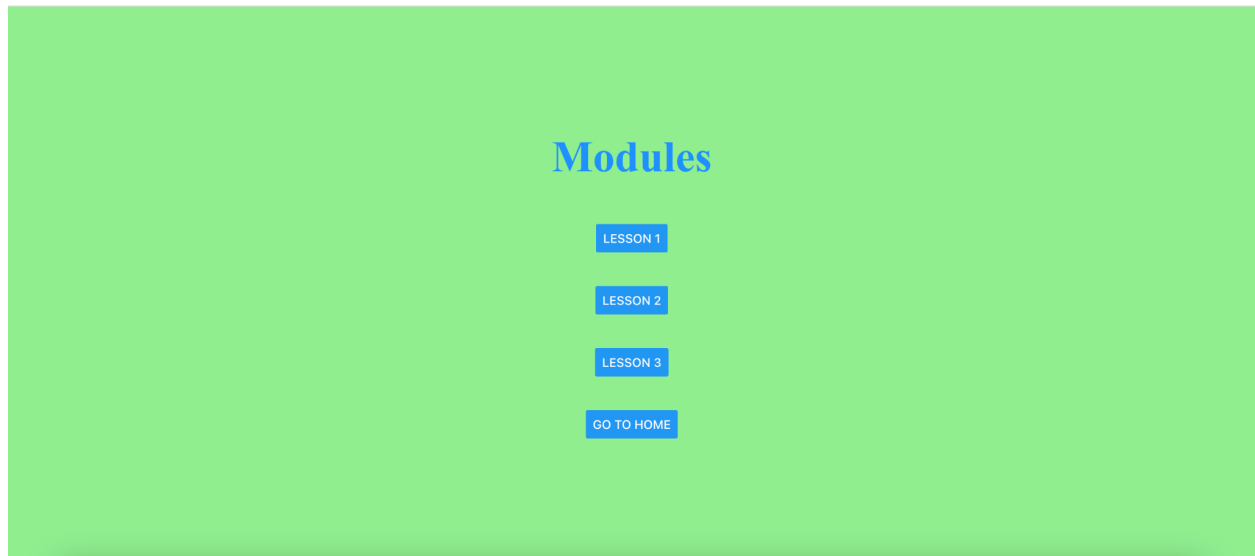


Figure 12.6
Modules Screen

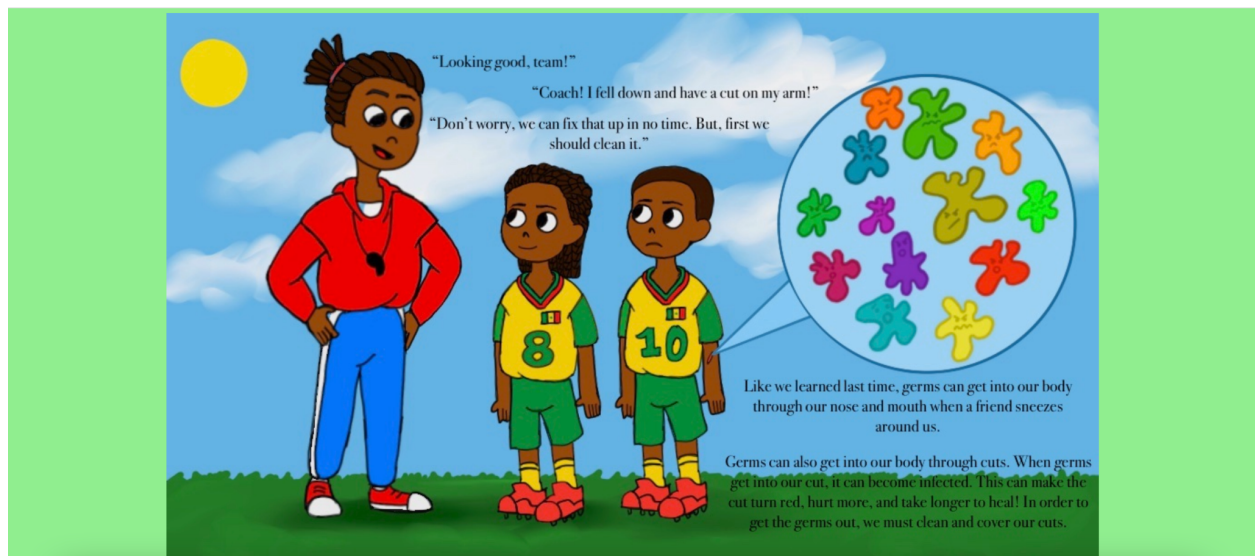


Figure 12.7
Module Graphic 1

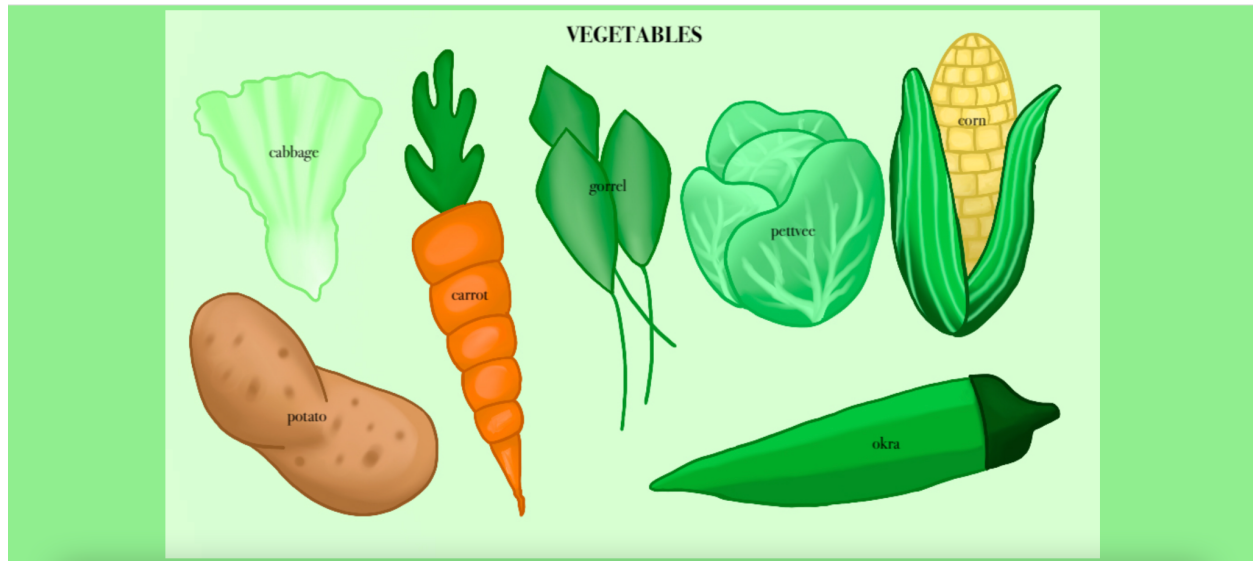


Figure 12.8
Module Graphic 2

12.2 Functionalities

When the application is opened, the home screen will be shown (Figure 11.1), where users can either click on the “PLAY” or “MODULES” button. Clicking on the “PLAY” button will lead the user to the game instructions screen (Figure 11.2). This is where the onboarding process occurs and users will have to read all the instructions to really understand what the app is about and how to play the game. We would also like to note that all our screens have a back button on the top left for users to go back to the previous screen should they unintentionally click on the wrong button or make a mistake.

Clicking on the “MODULES” button on the home screen will lead the user to the modules screen (Figure 11.6). All of our lessons are listed here and users can click into whichever lesson they desire to review and study. Furthermore, each lesson contains graphics designed by our 2 graphic designers (Figure 11.7 and Figure 11.8). The lessons are designed in sliding format and hold a storyline for children to have more interaction.

After the user finishes reviewing and studying the lesson, they can head back to the game instructions screen to choose the corresponding lesson board game they want to play. The board game screen is designed with the hierarchy of the dice being on the left and the lesson board game on the right (Figure 11.3). When the user rolls the dice, the soccer character will land on the corresponding spot they rolled and they will be guided to the questions screen to answer the randomly generated quiz question (Figure 11.4). Since our questions are generated randomly on every spot, users can play the game many times because they never know which question they will get. If the user gets the question correct, the soccer character will stay on the spot they rolled. However, if the user selects the incorrect answer, they will be guided to a wrong answer review screen to prompt them to review the slide again before returning back to the game (Figure 11.5). Our goal is to limit the number of times that the user answers the same question incorrectly.

12.3 Project Demo

Our current prototype application is still being further developed and has not been deployed yet. This is an exciting application and as a result, we have provided a link below to view a brief project demo of our current prototype. We ultimately hope to pass our current Santé le Match application off to future engineering teams in order to eventually deploy a more complete application in Senegal and possibly the entire African continent.

Project Demo Link: <https://youtu.be/VO2p7Iwhfz8>



Figure 12.9
Project Demo Video

Chapter 13

2021-2022 Project Timeline

13.1 Year-Long Timeline

September

- Meet as Group with Advisor
- Learn components of senior design needed for product

November

- Get information and research from EWH team
- Brainstorm and come up with application prototype design and name

January

- Develop initial application
- Senior Design practice presentations
- Meet with client to discuss scope and deliver our initial ideas

March

- Demo progress to EWH team & Advisor
- Continuing developing application

May

- Senior Design Conference 2022
- Start post-presentation report

October

- Learn more about Frugal Innovation Hub
- Apply for funding
- Meet with EWH team to discuss, brainstorm, and start planning

December

- Create rough conceptual model/prototype and app design using Figma Software
- Finish Design Report Draft & Final
- Learn React Native & more about database

February

- Demo progress to EWH team & Advisor
- Continuing developing application

April

- Demo progress to EWH team & Advisor
- Finish first application prototype

June

- Finish post-presentation report
- Demo prototype to client and pass on to future engineering team

Chapter 14

Further Plans

14.1 Next Steps

In order to fulfill our vision of a complete satisfying application, we have some next steps planned for Santé le Match before further deployment.

1. We plan on finishing a fully complete prototype application with all 3 modules included before our graduation.
2. We plan on demoing our current prototype application to our client before our graduation.
3. Our project will be passed on to an engineering team of graduate students to further develop our prototype by adding our recommended requirements such as a language option between French and English as well as login/logout credentials.
4. We plan to pass our project on to the future engineering team successfully for them to eventually implement our test plan and for development until the application is ready for deployment outside of school systems and to the public.

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Senior Design Report

Final Audit Report

2022-06-08

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