MEDtalk

Let Us Do The Talking!

Final Capstone Report

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Abstract

According to the 2018 Census, 67.3 million U.S. residents reported as non-English speakers who spoke a language other than English at home. These individuals typically struggle when communicating with others and expressing themselves, especially proposing as a challenge to healthcare systems in providing quality patient care. As language barriers are particularly prevalent in the hospital environment, patients who do not understand or speak English need a way to express their needs and communicate with their health care providers. Current methods to aid these patients include hospital-provided interpreters, patient television remotes, mobile translation apps, and augmentative/alternative communication apps. But, these solutions are not all-inclusive to patient needs, nor are they very reliable and accessible. Therefore, our solution, MEDtalk is a picture-based app that seamlessly expresses the needs and wants of non-English speaking patients to their medical personnel. The app is powered by text-to-speech technology, where pictures are associated with buttons to help non-speakers understand the action, without knowing any English. Our team has conducted substantial user and market research, and spent a lot of time building a brand that encompasses accessibility. With our design of the app, we have combined prevalent technologies such as text-to-speech and language translations, to develop a fully functioning user interface that is easy to use. Through these efforts, MEDtalk hopes to be the voice of non-English speaking patients and diminish that fear that is so very common in an unfamiliar hospital environment.

Background

The numbers of those classified as having limited proficiency in the English language continue to grow by at least a third every decade, establishing this group as one of the

fastest-growing segments in America [1]. Language barriers are a significant contributor to the gaps in universal health care. The most apparent factors are a longer length of stay, decreased understanding of their diagnosis and treatment plan, lower satisfaction with received care, and increased medication-related concerns [2]. In addition, the disconnect in communication between patients and their healthcare providers often leads these same patients to experience unfavorable events, which significantly lowers their quality of care. The impression of feeling neglected in the hospital environment is not uncommon for many non-English speaking patients. Such feelings are especially heightened during the discharge process and when doctors speak directly to patients regarding their condition.

Most important, however, is recognizing how many non-English speaking patients end up in the ER in need of urgent care, but cannot express their pain, how they feel, and when they want or need something from the provider. For example, a Chicago pediatric ER reported that compared to patients who had no problems communicating with their physicians, those who had limited proficiency in English had to stay approximately 28 minutes longer. In addition to that, on average, they also required an additional $41 worth of tests to find out what was wrong with them [3]. Again, such parameters result from the lack of essential communication between the two parties, which severely decrease patient satisfaction of care.

Furthermore, analyzing patient patterns in the recent COVID-19 pandemic reveals specific takeaways regarding this subject. Many individuals contracted the virus; however, it is interesting to note that patients with little to no English proficiency had a 35% greater chance of death. Their physicians noted particularly their inability to communicate with these patients to recognize their needs and concerns [4]. Patients report that there is nothing scarier than not

understanding your doctor or being able to express your concerns to them in a time of such uncertainty, which only adds to the intimidating environment.

In order to accurately obtain information regarding this topic, our team conducted a survey of our own, designed to understand the current issues of individuals suffering from these situations. The results of our study were eye-opening, as although over half of the individuals answered that they or their loved ones had been in the hospital recently, 81.6% of that group reported having some difficulty regarding communication in the hospital environment [5].

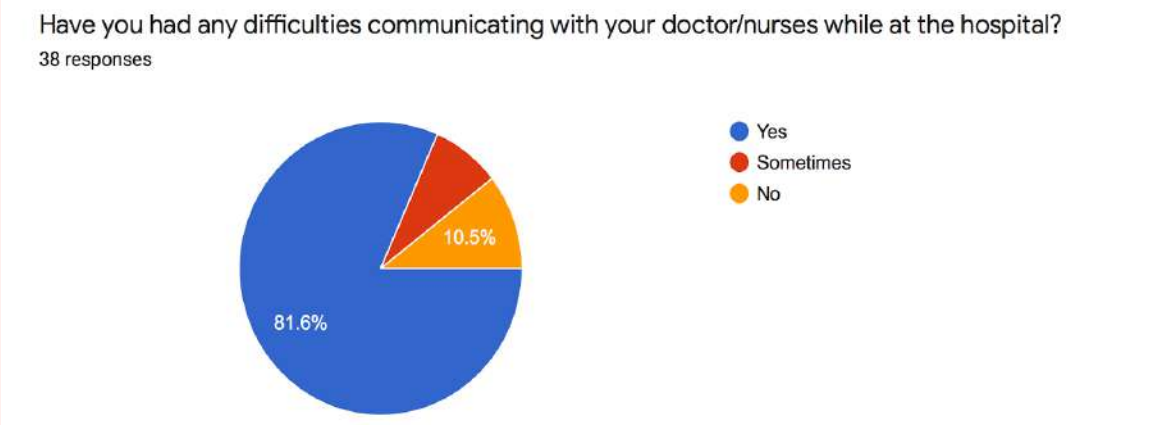

Figure 1: Survey Results of Difficulties in Hospitals

We also conducted 20 user interviews where we interviewed potential users who had recently been in the hospital. They conveyed that they felt scared and intimidated while making hospital visits because they not only had to worry about their potential diagnosis in question, but also about their language barriers posing a challenge. Such data signifies that hospital-based patients who have language barriers, both in understanding and speaking English, need a seamless way to communicate with medical personnel. Moreover, they need a simple and universal way to express themselves to their caretakers to ensure their needs are met. This is the only way to guarantee the utmost patient care and the quality of treatment.

Given the scope of this problem, a few current solutions are in place to guide patients through this process. For example, many hospitals provide interpreters who verbally translate information from medical personnel to the patient in the language of their understanding. These hospital interpreters are usually required to be fluent in an additional language besides English and comprehend medical terminologies [6]. Another piece of technology that attempts to aid patients in communicating in English is translating apps. Many popular translation tools can convert text from one language to the other; in this case, from the patient's native language to English. Finally, augmentative/alternative communication is another method of using pictures to help non-verbal or impaired individuals communicate. Furthermore, an indirect solution in place is the patient television remotes typically found attached to every patient's bed. While most of the functions are to operate the television, there is one button that the patient can press to call their attending nurse. This alerts the nurse to visit the patient's room to see what they may need or want. Finally, many AAC apps are available for download on the app store and can be used in someone's daily life to help them communicate their ideas.

Statement of the Problem

The issue of language barriers affecting the quality of healthcare is extremely severe as everyone is entitled to quality healthcare that they are satisfied with. Unfortunately for individuals who lack a proficiency in English, they are unable to often comprehend information or communicate in the hospital setting. This grows their intimidation towards hospitals and can even prevent them from wanting to visit the hospital in the future, and this level of neglect can cause many future issues to arise. Despite the presence of the current solutions as described above, an efficient method of communication between non-English speaking hospital patients

and their medical caretakers is yet to be delivered. These existing methods attempt to scratch the surface of a significant issue. But, they do not yet provide a technical solution that genuinely answers the ultimate need because they fail to be inclusive, reliable, and accessible to the user.

For instance, hospital interpreters are not a dependable long-term solution because they are not always available, especially when the patient requests them the most. This is due to the patients to interpreter ratio in most hospitals and an interpreter's inability to spend more than a few minutes with each patient. While state laws require hospitals to provide interpreters within several minutes, this is unfortunately not the case. Many users who had recently visited the hospital expressed that they often did not receive an interpreter in time. Furthermore, in our user survey, almost half of the sample size (48.6% to be precise) agreed that their interpreters were not always present when required [5]. Clinical data gathered on this matter further proved this limitation to be a concern at most public hospitals around the country [7].

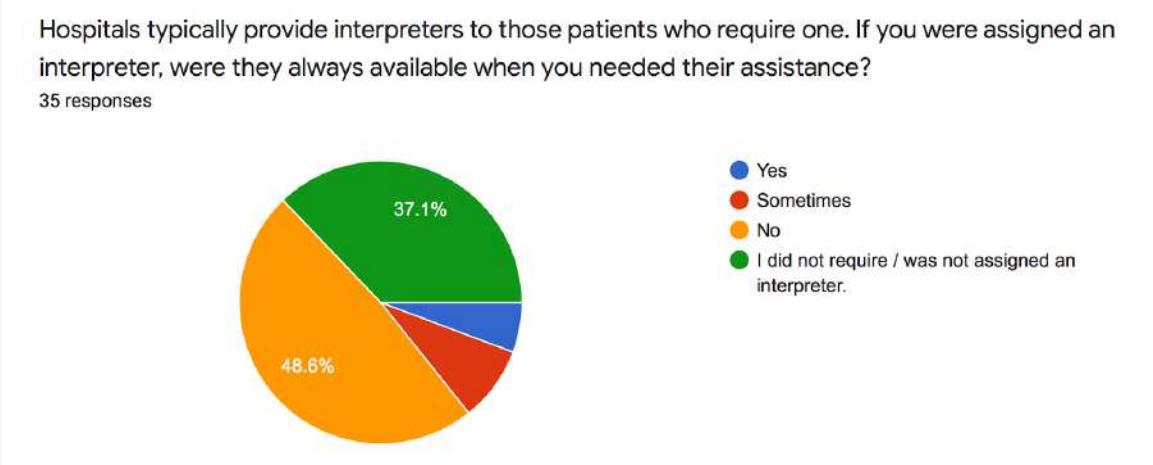

Figure 2: Survey Results of Interpreter Availability

Our conversation with New York Presbyterian Queens hospital highlighted these issues with interpreters. The doctors we spoke to emphasized that time is critical in hospitals, and unfortunately, interpreter services do not prioritize that. This causes doctors to wait extremely

long before they are able to help patients, especially in emergency rooms, where there are often dozens of visitors waiting. They mention how often the doctors have to use family members as translators in the event that an interpreter is unavailable, which is highly inconvenient because the family member may not be well versed in translating medical terminology.

Additionally, mobile translation services are not accessible or designed to serve non-English speaking patients because these patients usually have difficulty navigating complex technological applications. Such mobile applications also all require a stable connection to the internet, which may not always be accessible to users staying at the hospital. As a result, such machine translation tools are not user-friendly, and many patients that fall into this niche report inability to utilize them [8]. This data is critically supported by our survey results, once again, which details that almost 82% of those who partook in the survey answered that they do not use any mobile translation services due to various reasons [5].

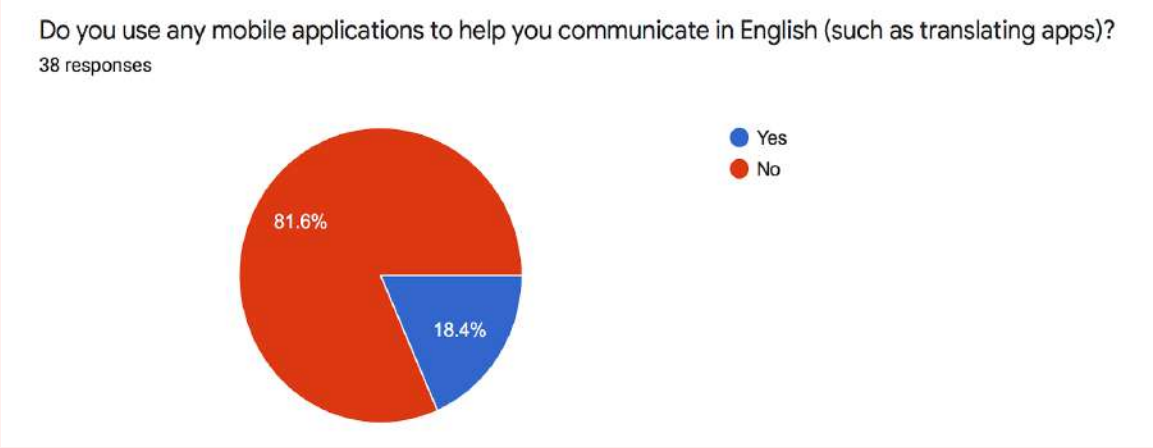

Figure 3: Survey Results of Mobile Translation Services Use

Furthermore, the hospital-provided television remote solution is not inclusive in addressing all patient needs, as their only beneficial function is the feature to alert the nurse. Once the nurse arrives, however, the patient then has to struggle to convey what they called them

for them. And thus, this proves itself to be an inefficient solution. The final solution: alternative and augmentative communication apps are also not capable of providing an adequate fix to this issue because they are more geared towards an educational purpose. They typically seek to help children, and are not suited for use in the hospital environment. Not to mention that many of these apps usually have a high price associated with them like Proloquo2Go, which costs $250.

Thus, we propose a simplistic yet effective solution to support non-English speaking hospital patients: MEDtalk. This picture-based tool allows patients to select images that verbalize their needs and express themselves to medical personnel. Then, the app takes that input and turns it into a verbal announcement that will be said aloud to relay the patient's message. It is our hope that MEDtalk will improve the quality of care received by patients with limited proficiency in English by enabling them to connect easily with those attending to them.

Rationale of Solutions

Therefore, MEDtalk is an excellent solution for hospital patients who have difficulty understanding and communicating in English. With the help of our mobile app, patients are able to communicate directly with doctors and nurses with the use of our pictorial style layout and text-to-speech functionality. The application features include many pre-added image icons that patients can press without needing to wait for an interpreter at the hospital. We have added basic conversational pages to express needs and food preferences, as well as conversation starters. The app even provides patients a way to show their pain, and even incorporates the use of different language for quick translations.

MEDtalk is also the perfect solution to the problem discussed above, as it manages to perfectly do what many of the existing technologies cannot. For example, unlike

hospital-provided interpreters, MEDtalk is always reliable and patients can depend on it to provide them assistance at all times. There is no additional wait time with the use of MEDtalk as the patient simply has to turn on their phone, or bedside device where MEDtalk is accessible. Additionally, in comparison to mobile translation apps and AAC apps, MEDtalk is far more dependable as it requires no internet connection. This is because we understand that access to the internet is not something that is always available at hospitals. Additionally, MEDtalk is also user-friendly and easy to use unlike Google Translate, as it features simple functions that are able to provide quick translations to numerous languages. Most importantly, MEDtalk is truly a unique solution because no other application specifically targets this user niche of non-English speaking patients in hospital-based environments.

	Hospital Interpreters *(direct)*	Google Translate *(direct)*	Hospital Remotes *(indirect)*	AAC Apps *(indirect)*	MEDtalk
Reliable				✘	✘
User - Friendly			✘		✘
Language Translations		✘			✘
Caters to this user group	✘				✘

Table 1: Comparison of MEDtalk and Other Solutions

All of the characteristics described above showcases why MEDtalk is the ideal solution for this issue that has long been ignored. These attributes will surely provide the application a potential leverage to dominate a new market. The competition may be relatively low for a while, giving us the upper hand in establishing ourselves as leaders in this niche. While keeping the

competition low, we can shift our focus to other functions like promotions and partnerships rather than just development. Our primary source of funding is partnerships with hospitals that are looking to integrate MEDtalk into their system. We will adopt the subscription based business model where hospitals purchase the MEDtalk license based on the quantity they are buying for. Then patients will receive access to the service either downloaded on their smartphone or on hospital bedside devices. Lastly, hospitals will continue to renew that subscription yearly to ensure we maintain a steady flow of revenue. It is our goal that through this model and extensive marketing from our partnering hospitals, we will grow MEDtalk to be the leading solution for individuals who face intimidation in hospitals due to language barriers.

Design and Development of Systems

We began our design with our user base in mind: hospital patients who have difficulty communicating with hospital staff due to language barriers. These people will usually be those who are non-tech savvy and many will be a part of the older generation of users. To reach our user base, we needed to make a product that is accessible. A smartphone is accessible to most Americans and will not require any additional hardware for our users or hospitals to implement; therefore, creating a mobile application was the best course of action [10].

To make our application more accessible, we did not implement a login system. Studies have shown that many people do not like creating online accounts due to the lengthy process of making an account and account fatigue when one has to remember many accounts and passwords [11]. Furthermore, user accounts are unnecessary to our app because many of our users will be one-time or short-term users. Not creating user profiles allows us to stay away from the collection of sensitive data and potentially violating HIPPA. We value privacy, and as user data is

not collected, there is no need for an internet connection, further making our app accessible. This gives us leverage over other mobile translating applications because they all require a stable connection to an internet source, which may not always be available in hospital-based settings. Eliminating such features ensures that our app infrastructure is simple and easy to use.

After asking a few potential users and observing how they interact with various mobile applications, we noted that we needed to have a UI system with simple to use mechanicals, minimal text on screen, and aesthetically pleasing icons for our app. Studies show that the elderly find it difficult to use mobile apps with complex mechanics that they are not used to (e.g., dropdowns and side menus) and symbols they are unfamiliar with. For example, the universal "play" icon for music and videos is simply a triangle to people unaware of its cultural significance [12]. Therefore, our app only uses buttons and scroll mechanics to view all options on a single page. The app will also feature a natural background color that is easy on the eyes and complements our logo color, incorporating our brand. However, we also created more background color modes to accommodate all user preferences. For further consistency, we only use these specified colors on the application: black, red, and white.

The main features of our application that will be discussed in the next few sections include: picture-based UI, text-to-speech integration, conversational pages, pain page, multiple language support, hospital requested pages (COVID FAQ and Routine Checklist), and additional background modes. These will be further discussed, as well as the technologies used.

1. Tech Stack

To create our application, we have used Android Studios, a unified environment for Android app development [14]. The benefit of using the Android Studio environment is because

it is all-inclusive of the many functions and technologies we need to code. For example, Android Studio has a built in text-to-speech feature that we used to allow all the buttons in our app to speak out loud [9]. Additionally, it also includes a language translation feature that allows us to seamlessly support translations as we've implemented in our app. Android Studios also supported the creation of a clean and easy to use user interface, which we were also able to make interactive through the use of animations. In addition to that, the main programming language we wrote the app in was Java as Android Studios supports the use of this language very seamlessly.

For collaboration and version control purposes, we used GitHub, which allowed each member to push out their changes to the private repository. This tool ensured that we were all able to collaborate together without interfering with each other's updates. Now that we have successfully finished the implementation of this app prototype, we have been looking into how to get this on the Google Play store. We hope to have it in the store by the end of summer as we believe it will help many individuals suffering from language barriers in the hospital.

Figure 4: Technology Stack Used

2. Picture - Based UI

Our app features a simple and easy to use user interface emphasizes user-friendliness and accessibility. This is accomplished through the predominant association of pictures with each

button to help non-English speakers understand the meaning, without having to know English. These universal icons represent the action described in the buttons, such as a knife and fork on a plate representing “food”, and a speech bubble to denote “common phrases”. The reason we have labeled each picture with one word is to avoid any confusion that may arise with people not understanding what the picture is conveying.

Figure 5: Picture-Based UI Being Shown in Main Page

While all pages of the app incorporate the use of these large picture-based buttons, the main page consists of a few categories that will unlock more options to perform the specified function. For example, the main categories shown in the main menu includes the “Food” page, “Needs” page, “Pain” page, “Common Phrases” page, a “COVID FAQ” page, and a “Routine Checklist” page. Additionally, we also have an emergency button where the device will play a pre-recorded computer voice “help” message out loud. This will alert nearby health professionals

such as emergency nurses that the patient needs urgent assistance. Most importantly, the entire app was designed by keeping the needs of our users in mind. And thus, we made sure to use large readable fonts and dark text colors throughout.

The picture-based UI was technically developed using Android Studio's AppCompatButton and ImageView class. The AppCompatButton class allowed us to place a button in the GUI of the application. Next, we gave the button characteristics such as size, color, border style, and added a text label. Then, using the ImageView class we placed the image into the GUI and placed this image over the button. The image's coordinates were assigned in respect to the button; therefore, if the button is moved, the image will also be moved. This allowed us to make copies of this button and use it throughout our app changing characteristics as needed.

```
<ImageView
    android:id="@+id/image_setting"
    android:layout_width="45dp"
    android:layout_height="45dp"
    app:layout_constraintBottom_toBottomOf="@+id/button_setting"
    app:layout_constraintEnd_toEndOf="@+id/button_setting"
    app:layout_constraintStart_toStartOf="@+id/button_setting"
    app:layout_constraintTop_toTopOf="@+id/button_setting"
    app:srcCompat="@drawable/setting" />

<androidx.appcompat.widget.AppCompatButton
    android:id="@+id/button_setting"
    android:layout_width="65dp"
    android:layout_height="65dp"
    android:background="@drawable/custom_buttons"
    android:contentDescription="Reset"
    android:textSize="34sp"
    app:layout_constraintStart_toStartOf="parent"
    app:layout_constraintTop_toTopOf="parent" />
```

Figure 6: Code Snippet of Picture-Based Buttons Creation

Our application UI is built using the ScrollView class. This allowed us to add more buttons than we can fit on one page. Users can access these buttons simply by scrolling down.

3. Conversational Pages

We have three major conversational pages which include a range of topics that may come up in a conversation between a hospital patient and the hospital staff. The first page is the “Food” page which allows patients to relay their food preferences and dietary restrictions. The options range from a number of foods and drinks, all that are easily accessible in the hospital environment. For example, if a patient would like to drink some “water” or eat an “apple”, they can press the picture associated with that action. They can also relay their dietary restrictions, such as if they can only eat Halal, or Kosher, or if they’re even on a vegetarian diet.

Figure 7: Food Page Options

The “Needs” page works similarly, however, it includes a range of different needs a patient may have. For example, they can press the “toilet” icon to verbalize that they want to go to the restroom, and then the attending nurse will help them fulfill that. Additionally, the

“Common Phrases” page provides patients with a list of communication starters for effective communication. This includes greetings, asking for the doctor, or relevant questions regarding discharge information. These options ensure that the patient never has to worry about what to say or how to say it, as MEDtalk’s conversational pages can help guide their conversations.

Figure 8: Needs Page (left) and Common Phrases Page (right)

4. Text-To-Speech Integration

Text-To-Speech is supported on all pages of the app, and when a button is pressed by the patient, its respective message is said out loud to nearby medical personnel. When a button like the “HELP” button is pressed by the patient, the app immediately takes that text input and turns it into speech.

Figure 9: Demonstration of Text-To-Speech on the "HELP" Button

The way we coded this is using Android Studio's TextToSpeech class. First, we called the class then set the language to English. Next, we gave it a String (the sentence that needed to be said out loud) and called the speak function. For each button of the pages, we entered the specific sentence that needed to be said out loud.

```
TTS = new TextToSpeech( context: this, i -> {
    if (i == TextToSpeech.SUCCESS) {
        if (langButton.getText().equals("English")) {
            TTS.setLanguage(Locale.US);
```

```
helpButton.setOnClickListener(view -> {
    if (langButton.getText().equals("English")) {
        TTS.speak( text: "I need help", TextToSpeech.QUEUE_FLUSH,  params: null,  utteranceId: null);
```

Figure 10: Code Snippet of Text-To-Speech Integration

5. Pain Page

The design of the "Pain" page is similar to the previous conversational pages presented. On the bottom half of the page, there are buttons for common hospital visit reasons that are similar in design to the "Food" and "Needs" page buttons. These options were obtained from a public medical database and showcased patterns in which visit reasonings were the most popular. The top half of the page, however, includes a few additional features: a full body diagram, a time indicator, and an emotional scale. The full body diagram is used by patients to pinpoint the exact

location of pain, and we have also added text-to-speech functionality within that page. This allows for each body part to be said out loud when the patient presses on it. The time indicator can be used alongside the visit reasons to show the duration of the pain. This can be in time intervals of hours, days, months, or years. Lastly, the emotion scale allows for patients to express how they are feeling, ranging from dark green (leftmost button) which means “great”, to dark red (rightmost button) which means “terrible”. Text-To-Speech functionality is also incorporated within the emotion scale, where each emotion is said out loud when scrolled through. Through the use of all these features on this page, patients are provided with a new and modern way of showing their pain, which will promote their health and well-being.

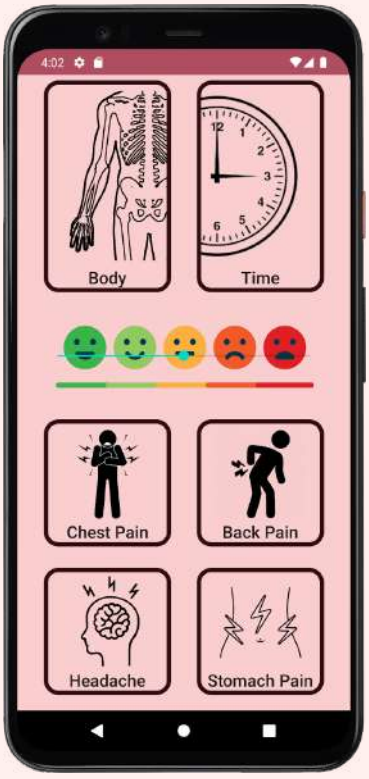

Figure 11: Pain Page Overview

The way each of these functions was coded in Android Studios, was that the full body diagram uses the OnTouchListener function in Android Studios to detect the X and Y

coordinates of the touch. We have assigned a specific radius coordinate to each body part. and so when the user presses a specific body part, the text-to-speech for that specific part is verbalized. For the emotion scale, we used the SeekBar class, where the characteristics such as background image was changed and the step count was changed to five. The time indicator feature followed a similar creation methodology as the previous conversational pages, as we mimicked that design.

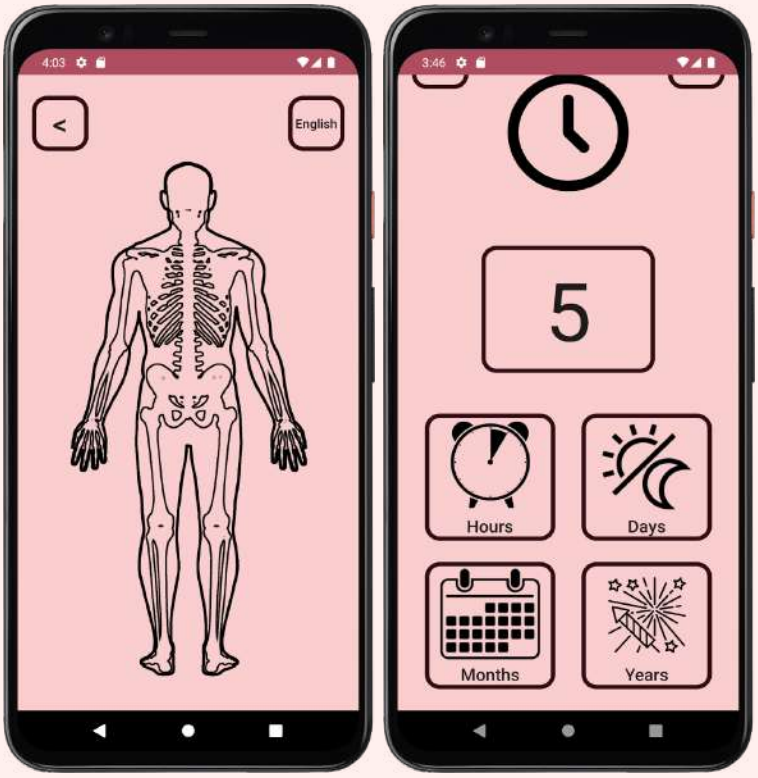

Figure 12: Full Body Diagram (left) and Time Indicator (right)

6. Additional Languages Support

We understand that despite the use of pictures, our users may still have a bit of difficulty understanding what each button means. This is why we support additional languages which allows users to understand what a button means before playing it out loud for nearby nurses. To make this as seamless as possible, we provided a language toggle switch that is on the top right

corner of every single page. This toggle switch allows users to switch back and forth between having the app in “English”, and a second language of their choosing. Pressing this switch will make the language change throughout all pages of the app, where the second language will be written inside the toggle button to signify that it is in use. It is important to remember that the second language must first be chosen in the app’s settings tab, where users can choose from Chinese, Korean, and Hindi. Due to time constraints of this project, our app currently only supports these languages and English. Through our user surveys and hospital research, we had identified these languages to be the most common in hospital patients. However, we are planning on adding even more languages as we continue to make enhancements to the app.

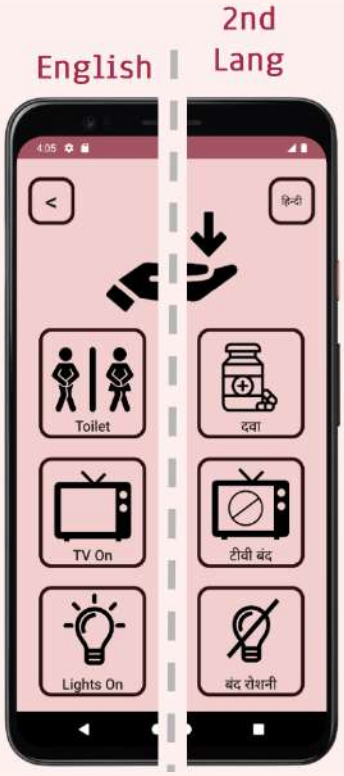

Figure 13: Translation to 2nd Language Where Toggle Switch is on Top Right Corner

From our user feedback, it was brought to our attention that some individuals may be able to speak a certain language, but not be able to read in it. For example, a certain individual may be able to speak Hindi, but unable to read in Hindi. This led us to realize that in our app, a distinction between speech and text language should be made. Thus, through the addition of another option in the settings menu, we separated the text and speech language.

Figure 14: Settings Menu With Speech and Text Language Separation

This option follows the previous option where the user selects a second language, and it asks whether the user would like to keep the text in English. If they choose “on”, then the text in all the pages will be in English, however, if they select “off”, then all the text will be in the chosen second language. The speech will still be in the second language chosen, no matter what the text selection is. These speech and text selections are then provided as an input to the toggle

switch, which will change the app based on these preferences. We did not provide the user more options for the text language besides English as our user research showed that patients either needed the text in their own language or English. Through this speech and text language separation, we allow users to customize the app to their liking.

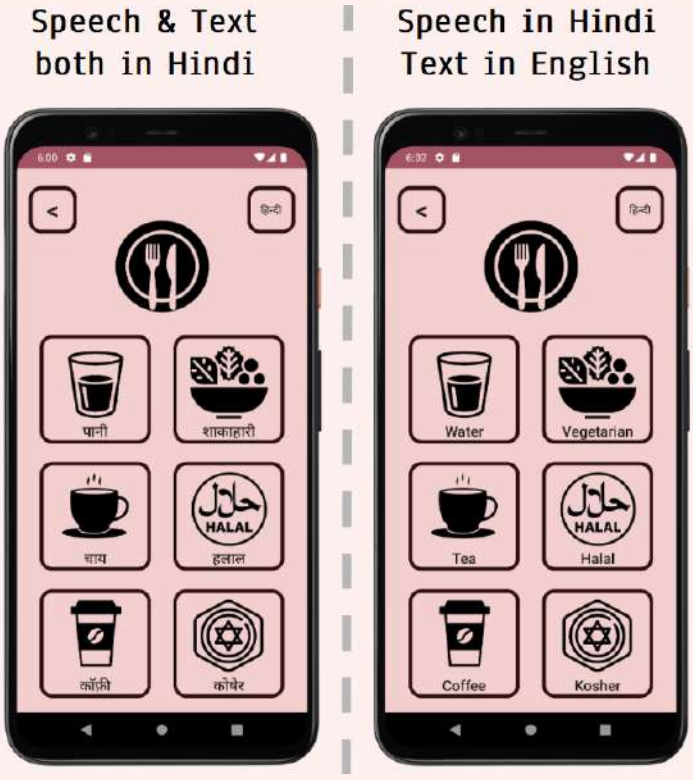

Figure 15: Speech and Text Language Separation Difference

In terms of technicality, the way we coded this function in our application is through Android Studio's Translation Editor. This allows each word or phrase that is in the app's pages to be displayed in both the default language (English) or any other language. To obtain the translated words and phrases, we utilized Google Translate and manually embedded the translations. This is because we could not afford the Google Translate API at this time.

Figure 16: Android Studio's Translation Editor

Additionally, in our code, if we changed our locale from English to another language, then both the text on the screen and the speech also changed to that specific language. This allowed us to control the way the pages were altered based on the text and speech selections.

```
TTS = new TextToSpeech( context: this, i -> {
    if (i == TextToSpeech.SUCCESS) {
        if (langButton.getText().equals("English")) {
            TTS.setLanguage(Locale.US);
        } else if (setting_locale.equals("zh")) {
            TTS.setLanguage(Locale.CHINESE);
        } else if (setting_locale.equals("ko")) {
            TTS.setLanguage(Locale.KOREAN);
        } else if (setting_locale.equals("hi")) {
            TTS.setLanguage(new Locale( language: "hi"));
        }
    }
});
```

Figure 17: Code Snippet for Language Toggle Switch

7. Hospital Requested Pages

We had presented it to a potential partner of ours, New York Presbyterian Queens and while they loved all the app features, they expressed their difficulty in conducting morning rounds. This is because their staff spent a lot of time asking basic routine questions. This

includes questions such as how the patient is feeling, if they had any bowel movement, or taken their medication. This takes a lot of time itself, and in the event that a patient requires a translator to answer those questions, this elongates that process more. Thus, we have designed a page called “Routine Checklist” to help these doctors solve this problem. The page functions by changing colors with the patient’s answers, which allows the nurse to quickly glance at their screen to see if the patient needs further attention. The questions are all either in the yes/no format, or a scale question. For the yes or no questions, we use a simple button where when the button is clicked, the background color changes to reflect the change. A “yes” is denoted by the button color changing to green, while “no” is reflected by a red color. For the scale questions, the same scale from the “Pain” page is utilized, however, this time it is linked to a change in the background color through a spectrum (from red to green, with orange and yellow in the middle).

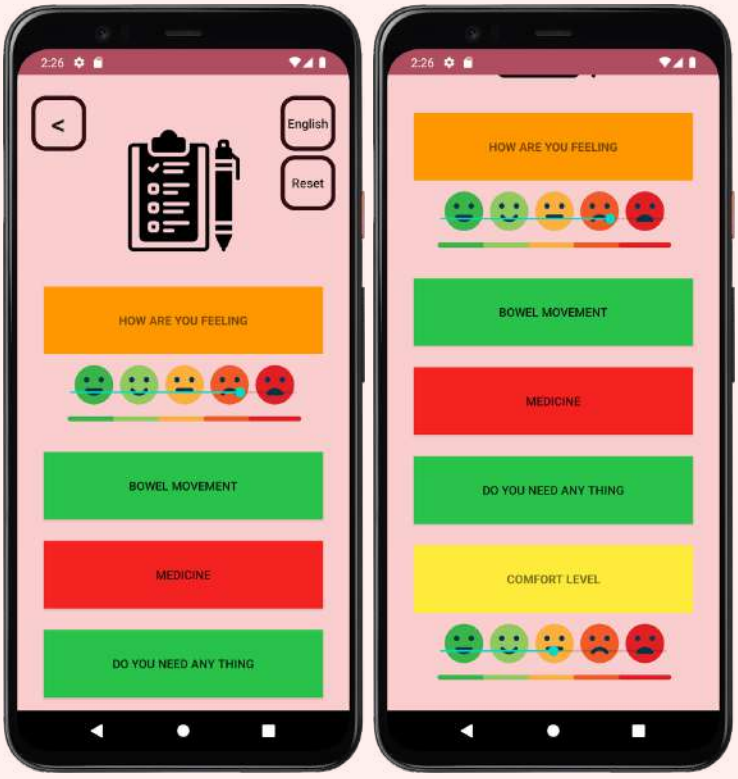

Figure 18: Routine Checklist Page

Another page that was heavily requested by the hospital and our users was a COVID FAQ. This page was created as a response to the ongoing virus that continues to be prevalent in society. This is still a prevalent matter in hospitals as many patients come in concerned about it or with the actual virus with hopes of being treated. For this reason, we implemented this page where patients can ask frequently asked questions about the virus. This page's design is similar to that of the "Common Phrases" page, as it includes a series of common questions associated with a picture. Examples of some of the questions include "Can you show me nearby test sites?", "Can you tell me about the COVID-19 vaccine?", "When will my test results be ready?", "I am feeling sick, can I take a COVID test?", and more. It is our hope that through this page, we can promote a safer way of living and also educate users regarding this deadly virus. This may help us from preventing another COVID surge in the future.

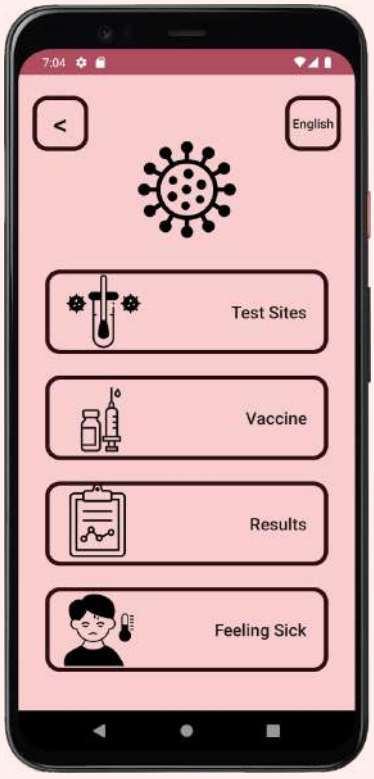

Figure 19: COVID FAQ Page

8. Background Modes

From our user feedback, we realized that many of our users may be low visioned or have some sort of visual impairment, especially since a portion of our users will be older. Thus, to accommodate all users and their preferences, we implemented four different background modes. The different background modes include a default mode, light mode, dark mode, and a colorblind mode. This selection can be made in the settings page, where after selecting a color mode, the entire app will change to that mode.

Figure 20: Different Background Modes

The way we coded this is in Android Studios, we created Themes, which are preset color combinations for the esthetic for the app. We were able to set one color for the background and another for the text. We created several of these themes, accessible through the settings buttons, and saved the data locally on the user's device using the SharedPreferences class.

Evaluation with Users and Partners

To understand whether our app would be accepted by our users, we adopted a few different methods of evaluation. This includes evaluating our app's effectiveness with some doctors from New York Presbyterian Queens Hospital, with our partnering advisors from Long Island Jewish Hospital and Memorial Sloan Kettering, user feedback in the form of surveys and interviews, and beta testing.

1. New York Presbyterian Queens Hospital

After developing our main features, we presented the app to a panel of doctors and medical residents from New York Presbyterian Queens Hospital. This included general surgeon Dr. Chun-Cheng Chen, trauma nurse Francesca Sullivan, and a medical resident. Our app prototype was reviewed by this team in detail and evaluated on whether they believe such a solution would be ideal. After checking every single page, Dr. Chen and his team were very impressed with all the features, especially with the text-to-speech integration that speaks for the patient. They said that this app will help them speed up the way in which hospital procedures are conducted, and that doctors will no longer face so many hurdles in treating patients with language differences. The doctor and his medical resident also provided us feedback to improve our application, such as adding the “Routine Checklist” page to allow teams to speed up their morning rounds. After receiving these positive comments and feedback, we have improved our app and are staying in touch with this team to further the improvement of the app.

2. **Evaluation with LIJ & MSK Partners**

Our medical mentors, Vardah Khan, who is a nurse at Long Island Jewish Hospital and Dristi Talukder, who is a clinical researcher at Memorial Sloan Kettering, also assisted us in evaluating our app's effectiveness. Since our team is composed of students with a technical background, we did not have anyone well versed in medical terminology or procedures. Thus, our medical mentors provided us assistance in this area. We ran each idea we had regarding our app through our advisors, to obtain their professional opinion. After a successful completion of the prototype, we showcased our app to our medical advisors and they both reviewed each and every function to determine whether they would actually help patients. Since our advisors interact with patients for their day to day responsibilities, they were able to tell us which features to include and which to remove. Additionally, since they were also versed in hospital protocols and regulations, they were able to brief us on those policies. After careful evaluation, they determined that our app would not violate HIPPA (Health Insurance Portability and Accountability Act) regulations. This is predominantly because our app does not violate any privacy concerns as we do not store sensitive patient data.

3. **User Feedback (Surveys & Interviews)**

Throughout the design and development process, we made sure to incorporate as much as user feedback as we could, because making our app accessible and easy to use for our users is our main priority. We received feedback in the form of user surveys and interviews, which consisted of one on one feedback. For user surveys, we sent out four different Google Forms surveys throughout different development stages of the app. To obtain the most accurate data, we only sent these surveys to people that could be potential users of the app. In total, we gathered

about 33-35 consistent users to evaluate our app. This includes people that fit our user group of being older, non-tech savvy, and recent hospital patients with low proficiency in English. Additionally, we also make sure to use this same test group of users for all of the surveys, as this allows us to obtain unbiased results. Using the same users also allows for those individuals to see how we've incorporated their feedback into our changes.

From the first stage of development in December, to our final stage in May, we shared our app's progress with our users and they evaluated whether they liked the features or not. We received many positive comments on our use of universal images to represent actions, use of text-to-speech throughout the app, and inclusion of multiple languages. However, each survey we were also provided with ways we can improve. Some of the feedback we received from our users was to separate the text and speech languages for translations, incorporate text-to-speech functionality on the full body diagram, allow patients to indicate duration of pain, and incorporate more background modes [14].

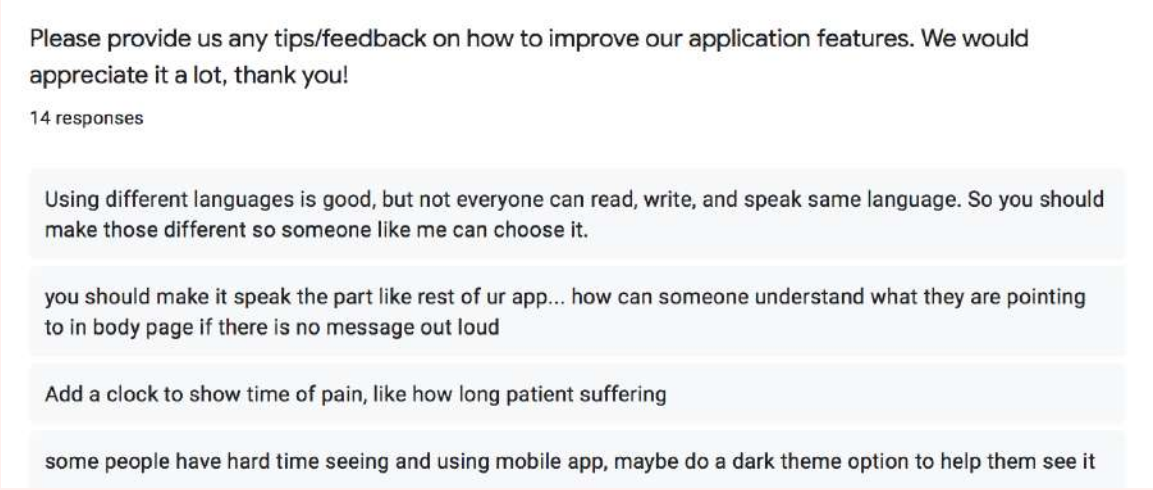

Figure 21: User Feedback on Areas of Improvement

We then made these necessary changes for the next update and received these results on each of the changes. Note that this is the results from the final survey and that is why our results are satisfactory, as we perfected them over the course of the four development phases.

As requested by users, we separated the text and speech language in the settings, and obtained a 87.9% satisfactory result on this update [14].

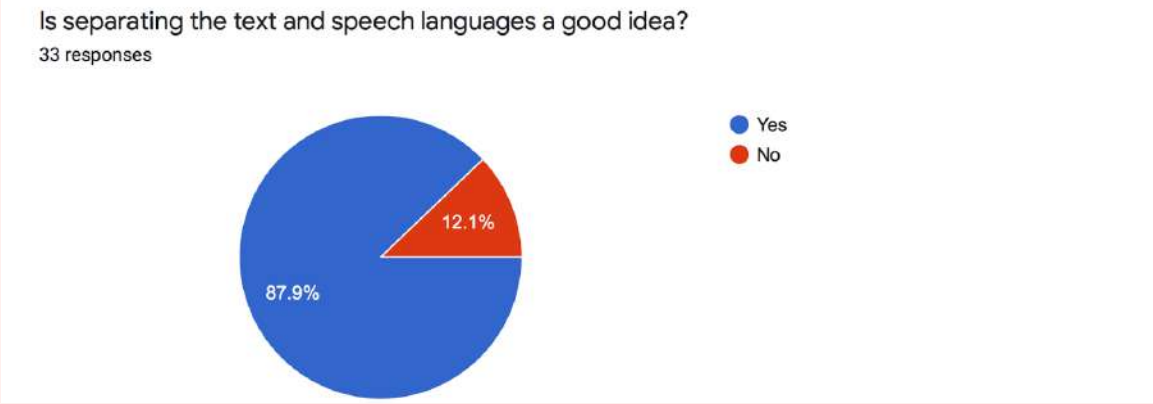

Figure 22: Survey Results on Text and Speech Separation

After we incorporated text-to-speech functionality on the full body diagram like our users wanted, we obtained a 93.9% satisfactory result on this update [14].

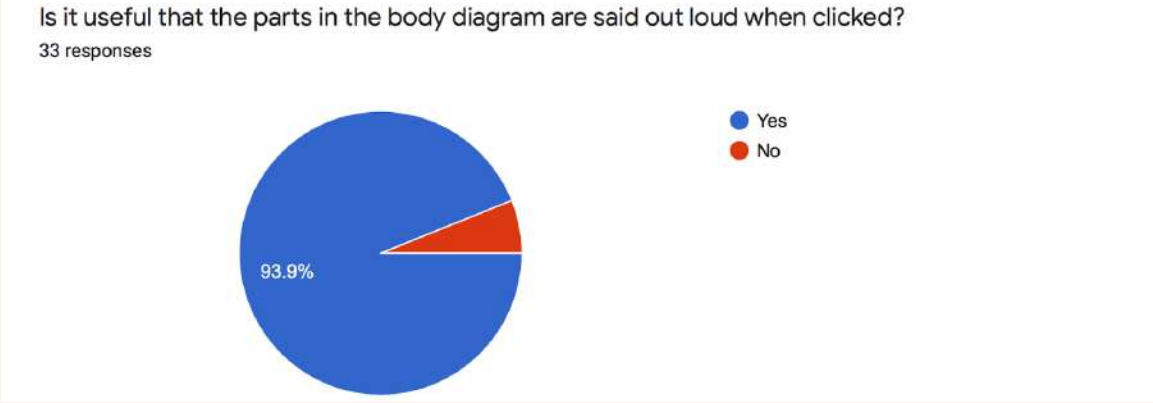

Figure 23: Survey Results on Body Diagram Text-To-Speech Integration

Just as our users had requested, we enhanced our pain page by adding a time indicator to show the duration of pain, and obtained a 87.9% satisfactory result on this update [14].

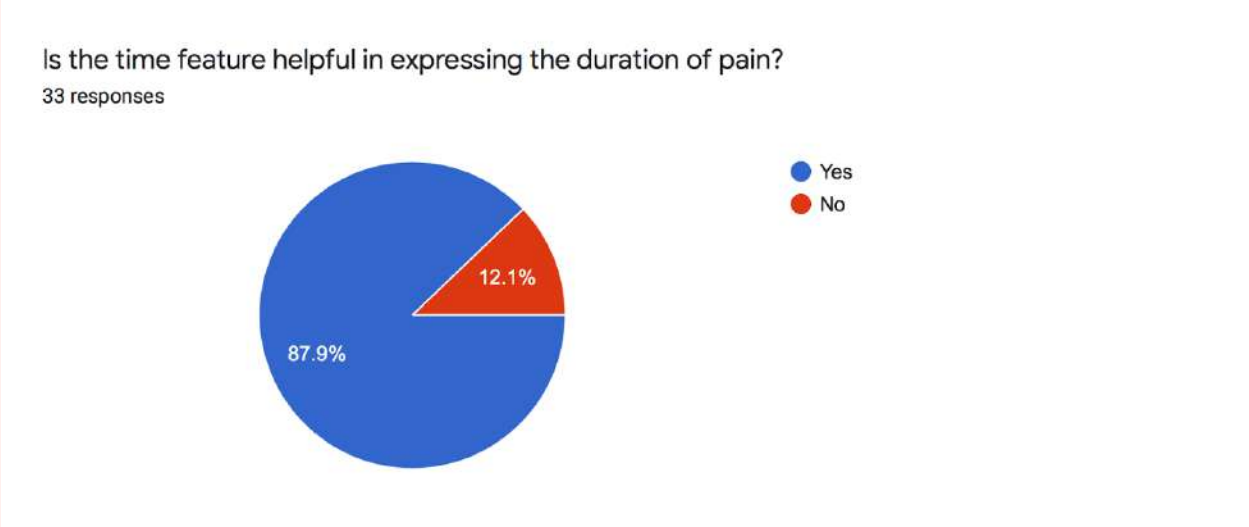

Figure 24: Survey Results on Time Indicator

After we provided options for alternative background modes for low vision individuals, we obtained a 90.9% satisfactory result on this update [14].

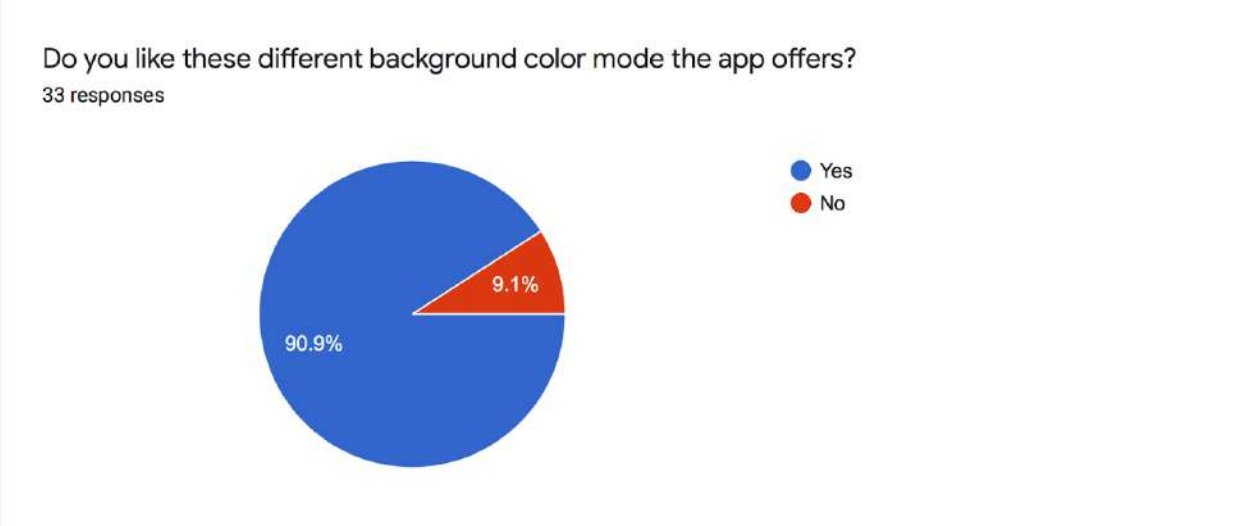

Figure 25: Survey Results on Different Background Modes

Aside from these results, our other surveys also showed that our users accepted our branding techniques in terms of our logo design, name, and app's branding [15]. Additionally, the features survey results showed that users believed all features of the app are useful and will be integral for the functionality of the entire solution [16]. A prominent finding from our user evaluations was that our users believe all pages are user-friendly and easy to use, signifying that this app is ideal for the intended user group we are targeting.

4. Beta Testing

We are currently in our beta testing phase, and are working closely with a group of test users to verify our design before taking further steps in securing partnerships and marketing. Prior to this stage, we had to make sure our application did not have any unexpected crashes as a smooth operation is essential for the beta testing. Our current test group includes those who have recently been in the hospital or are making ongoing visits. The age group of our testers is typically 35-60, which is the target user demographic for us. So far, our beta testers have pointed out a few bugs and issues that we have been working to fix. However, they also report many positives. One of our beta testers, Kalyan, states that the app is "clear and easy to use so far… the pictures really help me understand and I am able to translate to Hindi and get the meanings."

Due to COVID protocols in place at most local hospitals, we are restricted in performing on-site testing. Hospitals rules and regulations currently do not allow us to interact with their patients, and only a maximum of two family members are allowed to visit daily. However, the team we spoke to at New York Presbyterian had told us that after obtaining clearance, they can help us beta test with real patients at their hospital. This will soon provide us with real world scenarios and an analysis on whether this application is ideal in the hospital environment.

Discussion of Potential Markets and Future Work

It is important to understand that while our user group is hospital-based patients, our customers are actually hospitals. This is because hospitals have a lot to gain from a service like our app that will be able to decrease the workload of hospital interpreters. This will save hospitals a countless amount of time, which will increase their productivity. MEDtalk's constant reliability and ability to save time is our ultimate pitch to these hospitals that we want to partner with. And thus, understanding the potential market is critical because it allows us to see how we can push our app into this market to succeed.

1. Market and Revenue

To understand the potential market for this solution, we have to examine the figure below from bottom to top.

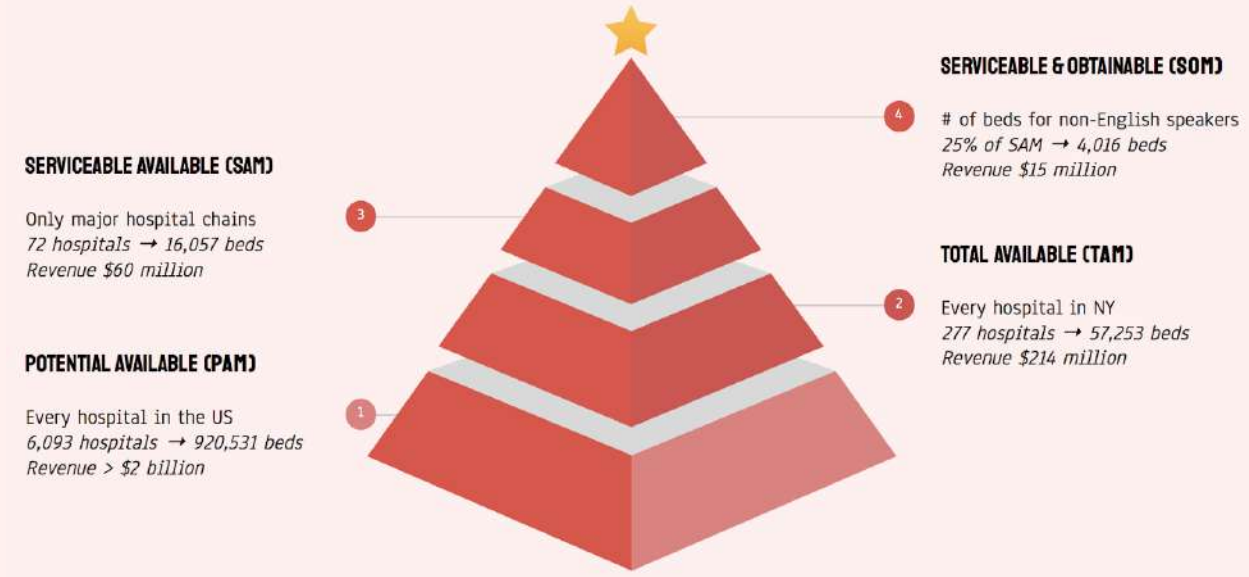

Figure 26: Market Sizing Diagram

This app has the potential to reach every hospital in the United States, however, it needs a lot of time before it can achieve that milestone. This would include a total of 6,093 hospitals, with a revenue potential of about $2 billion. The total available market (TAM) includes only hospitals in New York as there is a lot of diversity here, and this can help us acquire the desired user group. This includes a total of 277 hospitals, with a revenue potential of $214 million. Moving on, the serviceable available market (SAM) is only major hospital chains such as New York Presbyterian, NYU, Mount Saini, Northwell, and NYC Health + Hospitals, totaling 72 hospitals with a revenue potential of $60 million. We believe this is a potential market because we have already spoken to one of these affiliations (New York Presbyterian) and gauged their interests. Finally, the serviceable and obtainable market (SOM) we will pursue is 25% of the previous SAM. This accounts for the number of beds for non-English speakers and we arrived at this number through research which suggests that almost 25% of New York's population is not English proficient [17]. And so, we accounted for 25% of the beds in our SAM and this resulted in a revenue potential of $15 million. Thus, this is the potential market for MEDtalk.

After extensive research, we were able to arrive at a subscription based revenue model for our solution. The way this works is the hospital will purchase a MEDtalk license, where the price of that license depends on the quantity being purchased. By this model, a larger hospital with more patients to cover will pay a higher licensing price, and vice versa. Then the patient will receive access to the app either on their smartphones if they have one, or the hospital bedside devices. To finalize that model, hospitals will continue to renew that subscription yearly to ensure that our company maintains a constant flow of revenue. The price the hospital pays directly revolves around their size and quantity purchased, but one this MEDtalk guarantees for each partnering hospital is that we offer a price that beats the cost of interpreters. After doing

extensive research on how much interpreters are paid across different hospitals across the state, we were able to obtain a competitive pricing package for each of the major hospital chains (New York Presbyterian, NYU, Mount Saini, Northwell, and NYC Health + Hospitals).

Our financial forecast table below shows the competitive prices we offer and our future projected growth throughout the course of five years. To understand how our prices beat that of hospital provided interpreters, let us take a look at the year of 2023, where we hope to partner with New York Presbyterian Hospital, and their 16 locations. They currently spend over $1.8 million in interpreter services, accounting for the fact that the national average median salary for hospital interpreters is $46,000 [18]. According to our pricing, we offer that hospital a total licensing fee of $733,650, which is over 50% cheaper than interpreters.

Our combined yearly analysis shows us that our revenues increase every year, especially as the number of hospitals grow. Our total revenue over the five years is just as we predicted above during the market analysis, $15 million. Most importantly, it is clear that our profit margins increase each year, totaling to $12 million after subtracting expenses.

Year	2023	2024	2025	2026	2027	Total YTD
Hospitals	16	38	55	66	72	72
Total Beds	670	2335	2619	3678	4016	4016
Total Price	$733,650	$2,556,825	$2,867,258	$4,026,863	$4,396,973	$14,581,568
Expenses	$215,200	$439,400	$514,800	$621,200	$622,400	$2,413,000
Profit	**$518,450**	**$2,117,425**	**$2,352,458**	**$3,405,663**	**$3,774,573**	**$12,168,568**

Table 2: Future Financial Forecast

2. Roadmap

In terms of future work, we have created a roadmap that perfectly demonstrates our next steps to be completed. We have already completed a few milestones such as getting into the Zahn Innovation Center's startup program and completing our MVP prototype design. In the month of May, we are continuing our beta testing with our potential user group. This is helping us pinpoint any bugs and monitor system performance. After we obtain the test results, we will make the necessary fixes and be ready to launch the platform in late July. It is our hope that by mid August, we will be able to secure our first hospital partnership. We will do this by speaking with interested hospitals and presenting our product, as well as pricing strategy. Upon securing at least one partnership, we only hope to scale up and grow from here. We will try to target the other hospitals we outlined within our serviceable and obtainable market. We hope that we are able to scale up adequately as presented in our financial forecast chart above. After securing our target market, we hope to grow our product's landscape by reaching the other markets.

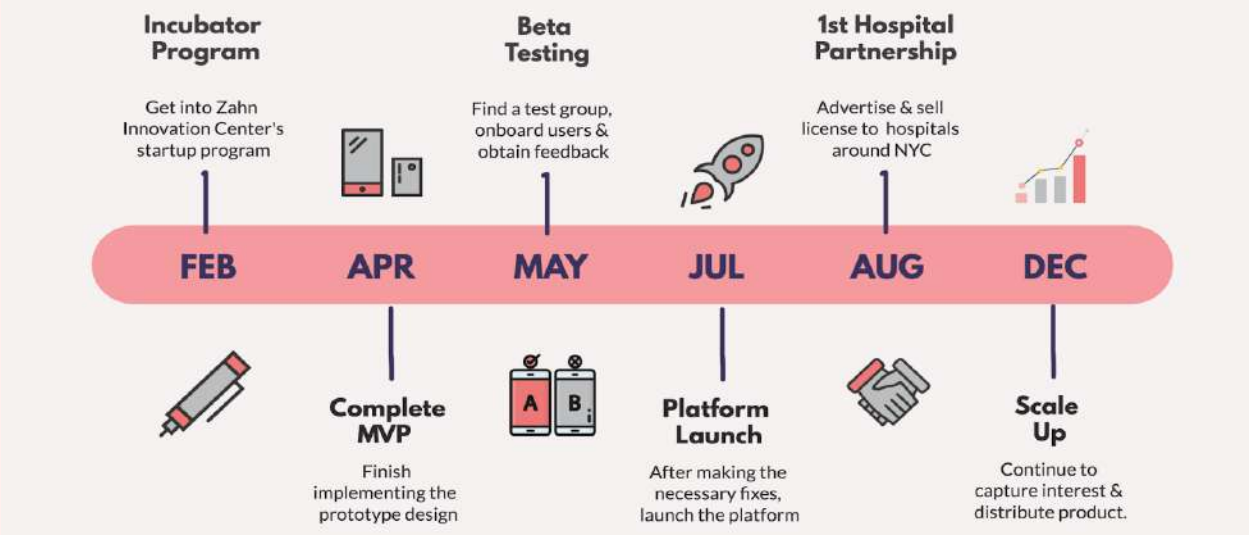

Figure 27: Roadmap of Future Plans

Branding

To build a brand that is truly encompassing of our app's goal, we had to arrive at an encompassing name, slogan, mission, an appropriate logo, and incorporate in-app branding.

1. Name

Our name is a combination of the words "med" and "talk", to signify that our application revolves around facilitating seamless conversations in medical environments, particularly hospitals. Together, the two words create "MEDtalk", where we have chosen to capitalize only the "MED" portion, to draw more attention to this, emphasizing that the app enhances conversations regarding medical related matters.

Figure 28: MEDtalk Name

2. Slogan

The MEDtalk slogan is "*Let Us Do The Talking!*", to encompass the idea that we are here to talk or speak on behalf of those who are affected by language barriers. We want to help them in the most seamless way possible and we have found that that is through the use of this app. We believe that this slogan will easily allow users and customers to distinguish our product from other solutions that may exist in the market. It is easy to remember and fitting for our brand.

Figure 29: MEDtalk Slogan

3. **Mission**

To further build our brand, we have also defined a company mission that we believe truly encompasses what MEDtalk is. The mission statement is as follows:

> *"To be the 'voice' of non-English speaking patients in hospital settings. By facilitating seamless communication between patients and their health care providers, MEDtalk hopes to diminish the gap that language barriers create in obtaining quality healthcare."*

We believe this mission statement is fitting for the direction in which our app is heading because our number one priority is ensuring every patient has a positive experience during their stay at the hospital, where they are provided quality care. No one should have to feel any level of intimidation when going to the hospital, and neither should their language barriers prevent them from taking care of their health.

4. **Logo Design**

To result in the perfect logo, we had to go through an extensive design process where we created many different logo versions. The figure below demonstrates our process, where at first we did a hand-drawn sketch with the letter "M" representing a heartbeat and the "T" representing the universal doctor symbol. However, there was too much going on in this, so we made it simpler by having the word "MED" be inside the "talk", where the letter "T" was replaced with the universal hospital symbol. This version had too much red color, and it was barely legible as one word was inside another. Then we moved the "MED" to be above the "talk", and it looked a bit better but still looked a bit empty, and the white background was way too harsh against the text coloring. Finally, to fix this issue, we created a final version, where audio lines were added to be coming out of the word "talk". A simple pink background was also added, and the word "MED" was shifted a bit to the right. This was the winning logo, and the one we went with.

Figure 30: Process of Arriving at Final Logo Design

The final logo that we decided on is shown below:

Figure 31: Final Logo Chosen

For the design of our final application logo, we incorporated the use of a few shapes into our design to further assert our message. First, we replaced the letter "T" in the word "talk" with the universal hospital plus symbol, denoting that it is a medical app. Then, we made audio lines come out of the word "talk" to symbolize the functionality of MEDtalk: to be the "voice" of non-English speakers. Upon receiving feedback on this logo design, we received a lot of positive comments regarding our color scheme, fonts, and overall concept. Users believe this design

makes it evident that this is an app that deals with communication in the medical field, which is exactly what we were going for.

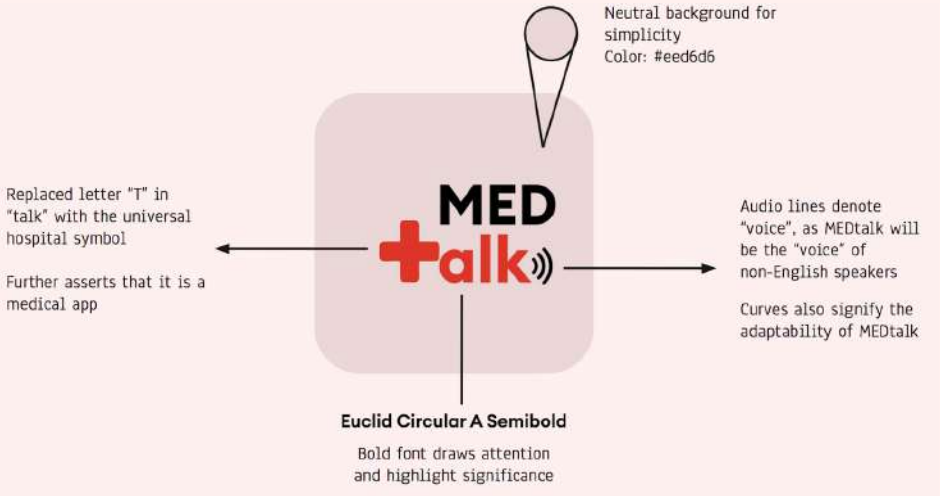

Figure 32: Breaking Down the Design Characteristics

We opted for a soft pink-red background color that is easy on the eyes and symbolizes love, openness, and safety, as these are all the foundations of MEDtalk. We have utilized bold fonts that help us establish a sense of respect which is critical for a startup application. By using the Euclid Circular font, we infused the colors red which signifies warmth, with the standard black for a greater balance. The red color is also the universal medical color, which establishes MEDtalk as a medical related app, while the black denotes a sense of elegance in our brand. This color scheme is used throughout both the logo and actual app for consistency purposes.

Figure 33: Color Scheme of App and Logo

5. In-App Branding

We also incorporated subtle in-app branding techniques to further enhance our brand. The most obvious way we did this is through our splash page. This is the first page the app opens on, and so it was important we create a good first impression to our users. That's why the splash page is animated, where our logo flys in from the left into the center of the screen. This logo then moves into the main menu, and repositions itself to the top. Our slogan is also present on the screen under the logo, and we also animated it to fade into the background. The background color is the same neutral color we chose for our color scheme for consistency. These methods ensured that we were able to promote our brand in a subtle way inside the app itself.

Figure 27: Splash Page for In-App Branding

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We would also like to thank the Zahn Center for providing us the opportunity to participate in the startup venture program. We would like to specifically thank Chris Bobko and Kesia Hudson for all the professional guidance and mentorship along the way.

We would like to extend our thanks to New York Presbyterian Queens, specifically Dr. Chen, nurse Sullivan, and their team for giving us the opportunity to showcase our solution. Thank you for all the feedback and resources you've provided us in hopes of improving our app.

Finally, we would like to thank our medical advisors Vardah Khan from LIJ Hospital and Dristi Talukder from MSK, for always being available when we needed help. Thank you for taking the time outside of your busy schedule to help us perfect the MEDtalk prototype.

Contributions

Throughout the course of the year, our team has constantly communicated with one another and divided the workload amongst each other.

Progga Chowdhury

Report Contribution:

- Evaluation with Users and Partners
- Discussion of Potential Markets and Future Work
- Branding (the evolution of the names, logos and topics of the team project)

Coding Contribution:

- Developed the picture-based UI feature
- Designed the “Main Menu” page
- Designed the “Food” Page
- Designed the “Common Phrases” page
- Designed the 4 alternative background modes

Branding Contributions:

- Created MEDtalk name and slogan

Customer Feedback Contributions:

- Conducted 7 customer interviews
- Prototype feedback survey
- New York Presbyterian Queens evaluation
- Understanding customer needs

Overall Idea Contributions:

- Took on the Technical Product Manager role
- Did minor UI/UX design
- Brainstorming app features and pages
- Conducted market research on hospitals
- Crafted the business model
- PowerPoint Designs
- Team communicator and main Zahn Center lead

Sakil Khan

Report Contribution:

- Rationale of Solutions
- Design and Development of Systems
- References Cited and Acknowledgements

Coding Contribution:

- Developed the text-to-speech feature
- Designed the “Pain” page
- Designed the “Full Body Diagram” with text-to-speech integration
- Designed the “Time Indicator” page
- Designed the “Routine Checklist” page

Branding Contributions:

- Created MEDtalk banner

Customer Feedback Contributions:

- Conducted 6 customer interviews
- Features survey feedback survey
- New York Presbyterian Queens evaluation
- Beta testing onboarding

Overall Idea Contributions:

- Took on the Backend Developer role
- Performed bug fixes and optimized code
- Set up the framework to be used
- Brainstorming app features and pages
- Scoped out the competition
- Crafted the business model
- Helped with Zahn Center assignments

Faez Farhad

Report Contribution:

- Abstract
- Background
- Statement of the Problem

Coding Contribution:

- Developed the alternative language feature (with text and speech separation)
- Designed the “Needs” page

- Designed the “COVID FAQ” page
- Designed the “Settings” page
- Designed the “Splash” page

Branding Contributions:

- Created MEDtalk app logo

Customer Feedback Contributions:

- Conducted 7 customer interviews
- Branding and interface feedback survey
- New York Presbyterian Queens evaluation
- Beta testing onboarding

Overall Idea Contributions:

- Took on the Frontend Developer role
- Performed UI fixes as necessary
- Performed bug fixes and optimized code
- Brainstorming app features and pages
- Performed evaluations with medical mentors
- Helped with Zahn Center assignments
- Recorded demo videos for presentations

Final Video Link: https://youtu.be/896z71lkv2A