The City College of New York

PALM
A Learning Application for children with Down Syndrome

SENIOR DESIGN FINAL REPORT

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PALM

ABSTRACT

Each year, about 6,000 babies born in the United States have Down syndrome [1]. People with Down syndrome attend school, work, participate in decisions that affect them, have meaningful relationships, vote, and contribute to society in many wonderful ways [1.1]. Students with Down syndrome can have a range of abilities. They can learn and develop new skills throughout their lives but reach goals at a different pace [2]. School children with down syndrome face difficulties in coping with academics due to their low cognitive skills. They generally struggle with numeracy and word recognition tasks [3].

As per our research, institutions like DSRF and public schools use colorful flashcards, signed boards, etc. to teach words and numbers to children with Trisomy 21 [4]. We have also found that the usage of Android apps for children with DS has 36.1% improvements in their visuospatial processing [5]. But these apps are mostly for research purposes and not for public use.

Therefore, our goal is to create a gaming/learning application, PALM, which is similar to using flashcards which will make it easier for both the educators, parents and the caregivers to teach them how to read and recognize words and numbers. Our app will use a simple and interactive GUI with different levels of word matching and counting games.

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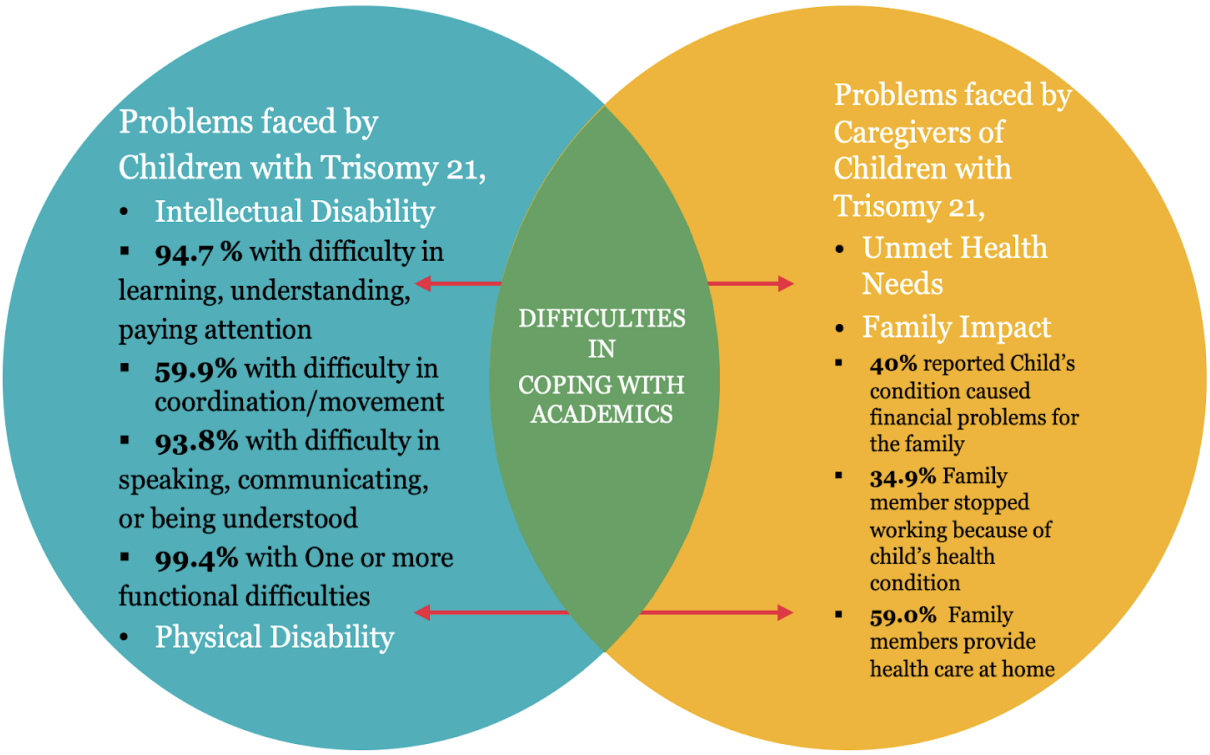
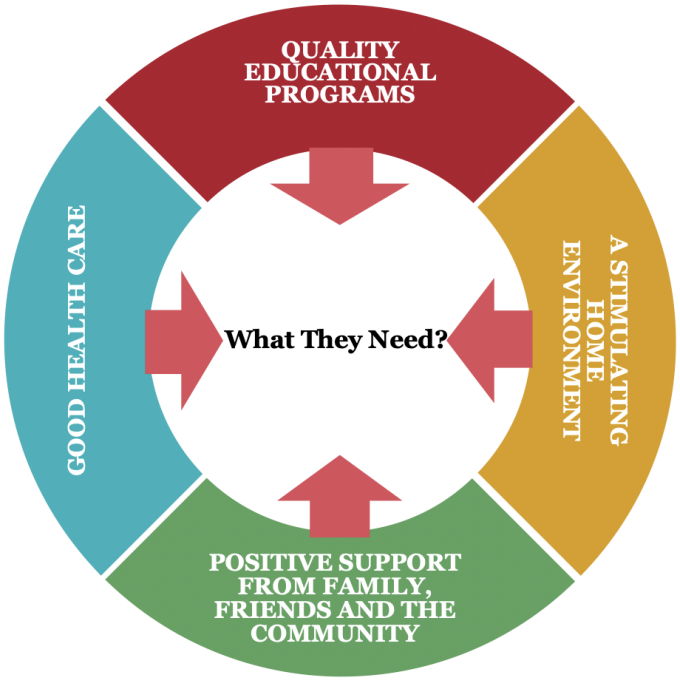
BACKGROUND

Down syndrome is a genetic disorder caused by abnormal cell division resulting in an extra full or partial copy of chromosome 21 [1]. This additional genetic material causes the developmental changes and physical features of Down syndrome. Some common physical characteristics include a flattened face, especially the nose's bridge, almond-shaped eyes that slant up, and short neck [1]. Down syndrome varies in severity among individuals, causing lifelong intellectual disability and developmental delays. It is the most common genetic chromosomal disorder and cause of learning disabilities in children.



Students with Down syndrome can have a range of abilities. They can learn and develop new skills throughout their lives. However, due to the disorder, they would reach goals at a different pace [2]. It is essential to focus on the individual and learn firsthand about their capabilities and special needs. Research shows that they can also learn normal activities if they are provided with a quality education program, a stimulating home environment, positive support from family, friends and community, and a good healthcare system.



Institutions like DSRF and public schools use colorful flashcards, signed boards, etc. to teach words and numbers to children with Trisomy 21 [4]. We have also found that the usage of Android apps for children with DS has 36.1% improvements in their

visuospatial processing. Using technology will reduce the challenges in improving school children's Down syndrome abilities in today's modern world [5].

STATEMENT OF THE PROBLEM

Students with Down syndrome in school face difficulties in learning new material, especially their day-to-day activities, word recognition, and basic mathematical problems. Research shows that most children with Down syndrome make the best progress when educated in mainstream schools alongside their peers. A student with Down syndrome is more likely to experience success in an environment where inclusion is embraced and supported, and their different learning needs are acknowledged and adequately addressed. Children with Down Syndrome are often taught high frequency sight words, and sentence arrangements through colorful flashcards, and signboards that need constant

supervision from the instructors or the parents or their caregivers. Also, it takes a strenuous effort to create flashcards and signs to teach these children.

There are few existing applications, such as, “See and Learn”, on ios platform for Down Syndrome children that are unaffordable for most people as they are expensive and unknown to the majority of people as per their reviews.

We aim to create a gaming/learning application that will motivate the students to learn and boost their home and schoolwork abilities as well as minimize the constant supervision time of their instructors, parents and caregivers. The application will engage users in different levels of word matching problems, encouraging the user to learn numeracy through counting and solve problems in a fun and interactive way. The application will also include a text to speech API that will help the user enhance their cognitive abilities. Our goal is to make it accessible and affordable to the greater mass.

RATIONALE OF SOLUTIONS

The rationale behind creating an app that will motivate children with down syndrome to learn the necessary skills to help shorten the gap between their fellow peers. As mentioned earlier, children with down syndrome suffer from mild to moderate intellectual impairment, which affects their learning process. Moreover, because of that fact, they find themselves lagging behind their fellow peers as they struggle to acquire new skills. As the fellow peers move up the ladder of primary education, a child with

down syndrome feels an immeasurable pressure from their environment to keep up, which only worsens their mental condition. On many occasions, the instructors grow impatient and misbehave with them, which also harms their mental health.

Effective teaching methods for children with down syndrome includes the extensive usage of flashcards, colored signed boards and various objects which will invoke their interest on the subject matter while actively improving their word recognition and language skills.

Renowned research institutions like DSRF (Down Syndrome Research Foundation) and National Down Syndrome Society (NDSS) actively follow these teaching strategies which includes the usage of exclusive physical resources for the children with down syndrome.

Besides the need for physical resources, constant supervision is also necessary to ensure the effectiveness of this teaching approach.

This is where **PALM** comes into play. We understand that it would be highly unfair to offer the same teaching approach while educating normal children and children with down syndrome. We recognize the effective teaching strategies revealed by research foundations for children with down syndrome and our Application, PALM is designed to implement that. Just like the techniques shown by DSRF, our app will feature a matching game packed with high frequency sight words to improve word recognition.

Much like the flash cards, the interface would generate sight words in interactive animated boxes. Instead of hand drawn pictures on signboards, the Application would generate vivid and child friendly images on a simple interface. PALM would also feature the pronunciation of words through the usage of a text to speech API to improve the phonetics of the user. As for numeracy skills, PALM would feature a counting gaming mode where it introduces the concept of number through various objects. Thus, the use of physical resources can be completely avoided through the use of our application while reducing the need for constant supervision.

Our learning app will provide the necessary motivation through a child-friendly interface designed to spark interests in primary education while at the same time helping them develop essential skills. Our app is designed for those children who have the ability to read or recognize words. Our goal is to teach them specific skills through questions and attractive illustrations, and funny animations to get their attention into answering correctly. Thus, we aim to provide the children with down syndrome with an intellectual head start, which helps them keep up with mainstream education.

DESIGN AND DEVELOPMENT OF SYSTEMS

Our goal is to create a virtual platform similar to flash cards that will make it much easier for both the educators and parents to teach them how to read and recognize words and numbers. To create such an app,we have added a Voice prompt to PALM to help children with phonetics. As PALM is solely working to help children with Down Syndrome, we have provided less options to avoid confusion and repetitive customised

options inside the gaming modes to help them memorise the sight words. We have created a Tier system, which is a technique to track progress to unlock new gaming modes.

To achieve our goal in creating an accessible to mass application, we used **Xamarin** Cross-Platform that uses **C#** **&** **XAML.** Xamarin cross-platform was an obvious choice since it allows code reusability for both Android and IOS mobile platforms. We have implemented **Google Cloud Text to Speech API** plugin that is already built in Xamarin. We have used **Firebase** to store user credentials such as username, password and level. We plan to publish this app in **Google Play Store, App Store,** and also we will be creating a **Web App** to make it accessible in any search engine.

XAMARIN

Xamarin extends the .NET platform with tools and libraries specifically for building apps on iOS, Android, macOS, and more.

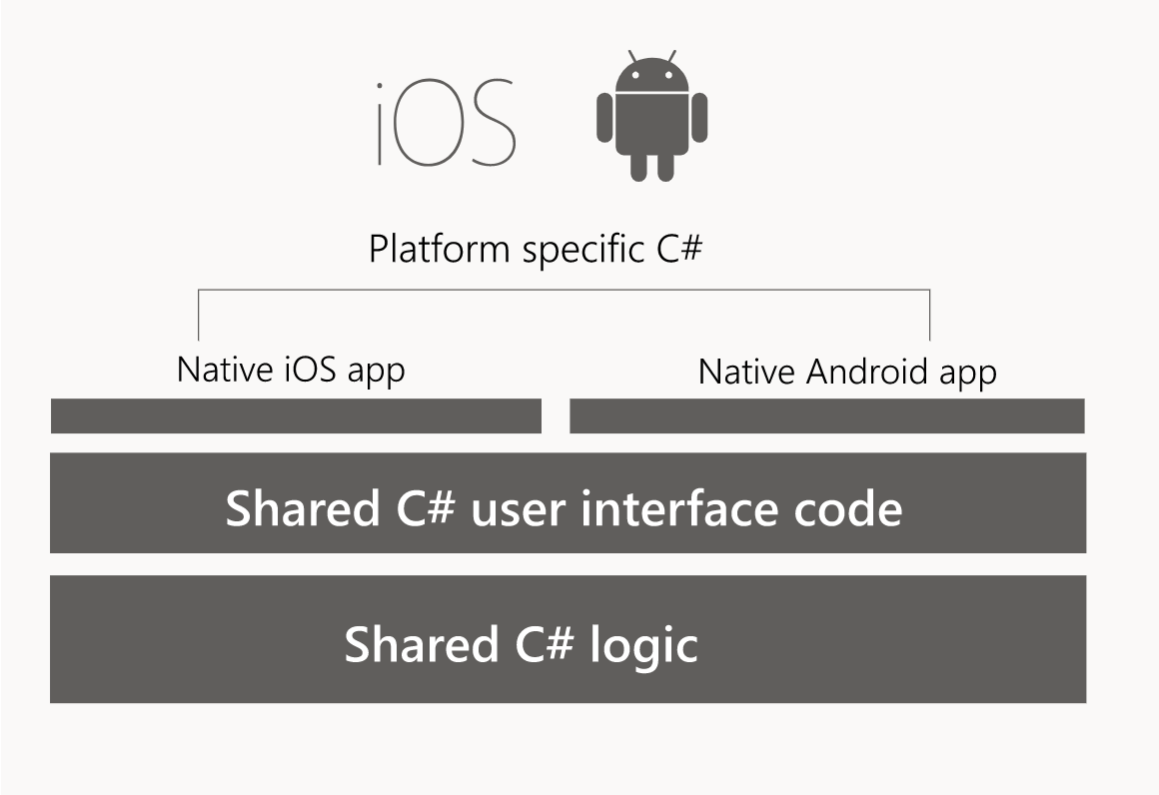
.NET is a developer platform made up of tools, programming languages, and libraries for building many different types of applications. The base platform provides components that apply to all different types of apps. Additional frameworks, such as Xamarin, extend .NET with components for building specific types of apps.

These are some things that Xamarin adds to the .NET platform:

- Base framework for accessing native features
- Extensible Markup Language, known as XAML, for building dynamic mobile apps using C#

- Libraries for common patterns, such as Model View ViewModel(MVVM)
- Platform specific libraries that includes access to APIs from Google, Apple, Facebook, and more to add rich capabilities
- Editor extensions to provide syntax highlighting, code completion, designers, and other functionality specifically for developing mobile pages

Xamarin apps can be developed on macOS and Windows and run on iOS, Android, macOS, tvOS, watchOS, and more. The Visual Studio family of products has tools for building .NET apps on any operating system. There are also command-line tools and extensions for many popular editors.



Apps built using Xamarin have access to the full spectrum of functionality exposed by the underlying platform and device, including platform-specific capabilities like ARKit, CoreML, Fingerprint, Bluetooth, NFC, and more!

Xamarin also integrates with thousands of third-party libraries including Google Play services, Facebook, Google APIs for iOS. You can even bring your favorite native iOS and Android libraries to Xamarin applications with "Binding" projects.

C# & XAML

We have written the back end of our entire app in C# because in XAMARIN, C# is used to write the back end code, such as business logic and data access, to native API access. Xamarin extends .NET, which can use the large ecosystem of packages and libraries available to all .NET developers.

Xamarin allows the use of HotKey technology which is robust and fast. It allows us to see the User Interface as we compile it in real time.

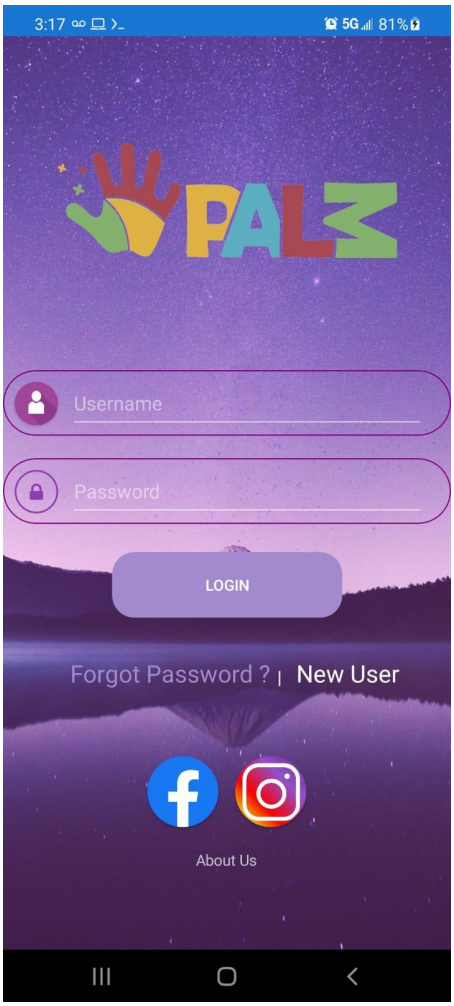
Google Cloud Text to Speech API

Google Text-to-Speech is a screen reader application developed by Google for the Android operating system. It powers applications to read aloud the text on the screen with support for many languages. We have used this API in each of the gaming modes to help children with phonetics and to provide constant repetitiveness if

needed, which will also minimize the need of constant supervision from the parents and instructors.

FIREBASE

Firebase is a platform developed by Google for creating mobile and web applications. It was originally an independent company founded in 2011. In 2014, Google acquired the platform and it is now their flagship offering for app development. We have used Firebase to create a Tier system, which is a technique to track progress to unlock new gaming modes, to store user credentials such as username, password and level.



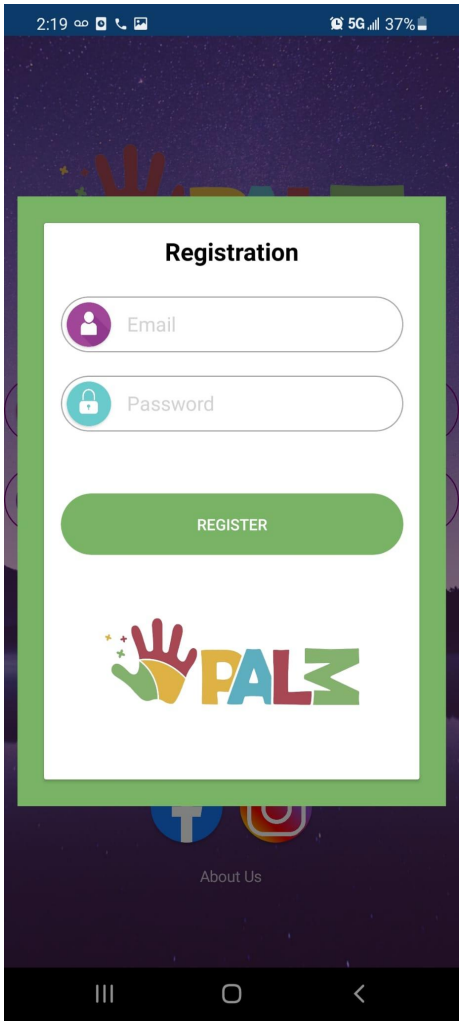
USER INTERFACE DESIGN

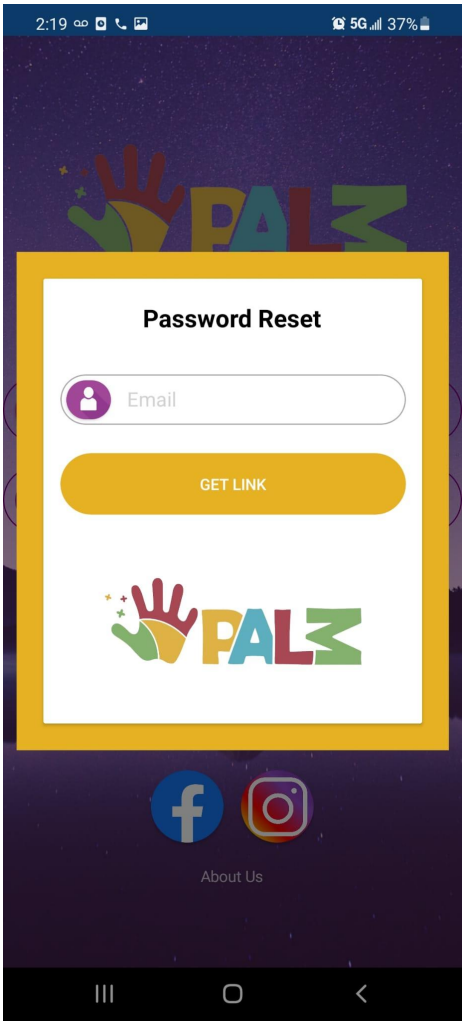
Our educational app's design will feature a colorful interface filled with cartoon illustrations that will provide a child-friendly environment. The app's structure is based on a set of questions about an illustration provided in each round of questions, and the user is asked to choose the answer, which describes the illustration closely.

Our Login Page includes buttons for Username and Password. New Users can register through the “New

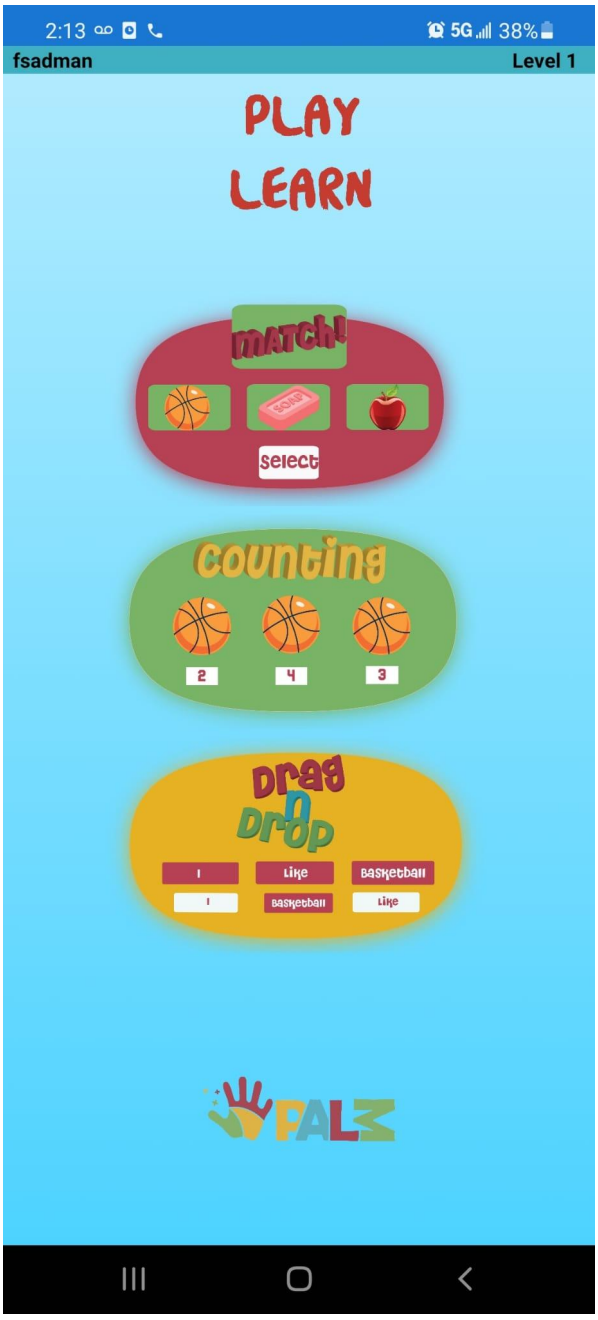
User" button. We also have a button named "Forgot Password" for users in case they need to change their passwords. We have linked our Facebook page and Instagram Account in the login page to provide the users the updated information. They can also learn more about PALM through the "About Us" button.

We have created a seamless way of registration for new users. By just entering an email and a fairly strong password, a new entry of a user is created in PALM's database. We have also provided an option for password reset. The forgot password option is not only easy to use but also secured by Firebase authentication.





Each round would be designed, beginning with attractive animation, and upon receiving the correct response, there would be additional animation while outputting applause sounds. Even if the response is wrong, the app will display words of encouragement and provide a guide to the right answer. Since our app will focus on word recognition as well as numeracy it will feature multiple gaming modes. PALM would feature three gaming modes, namely- Match, Drag n Drop and Count.



"Match" will present the user with an illustration and ask them to choose the corresponding word to the illustration. This mode will only provide three options to maintain the simplicity and avoid confusion among the children with down syndrome. This mode is designed to improve on word recognition skills of the user.

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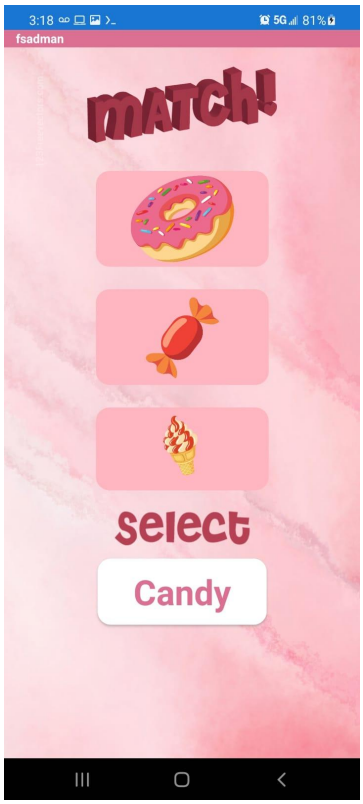
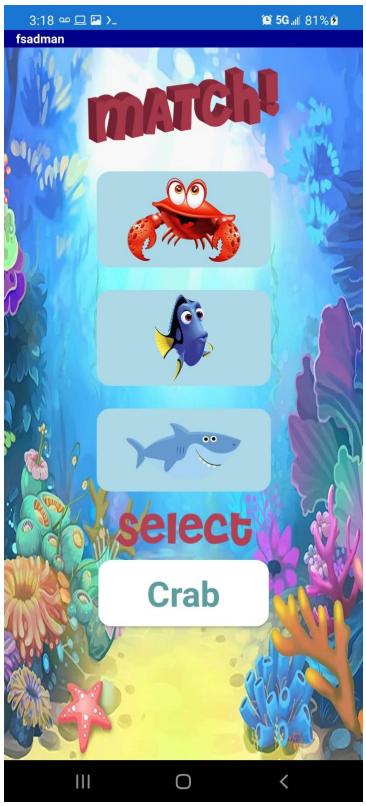
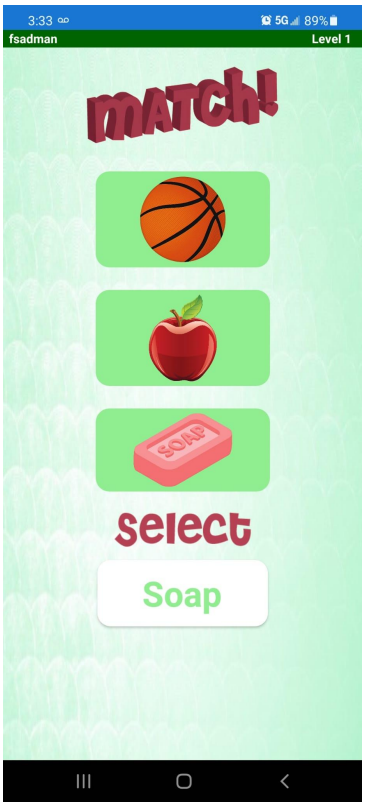
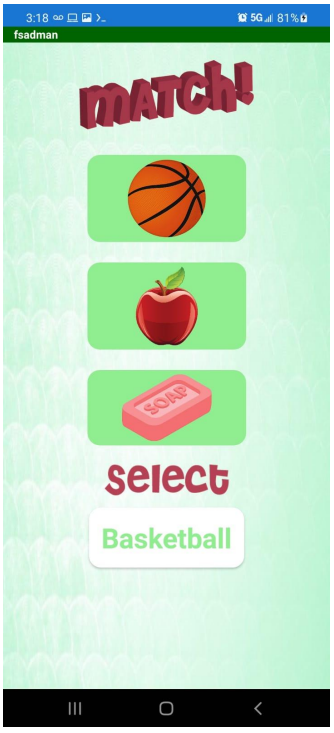
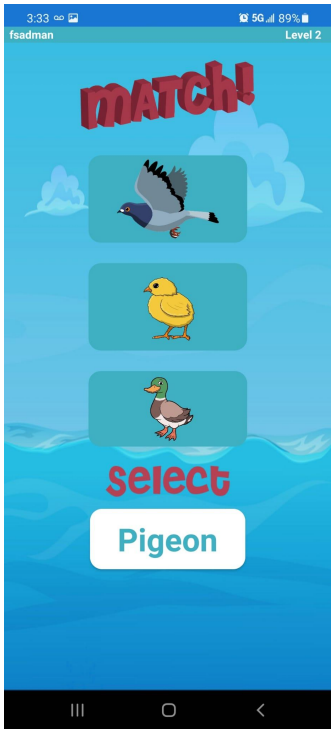
PALZ



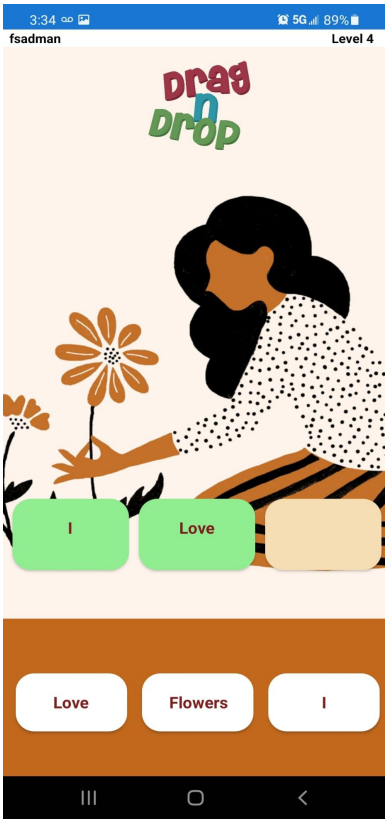


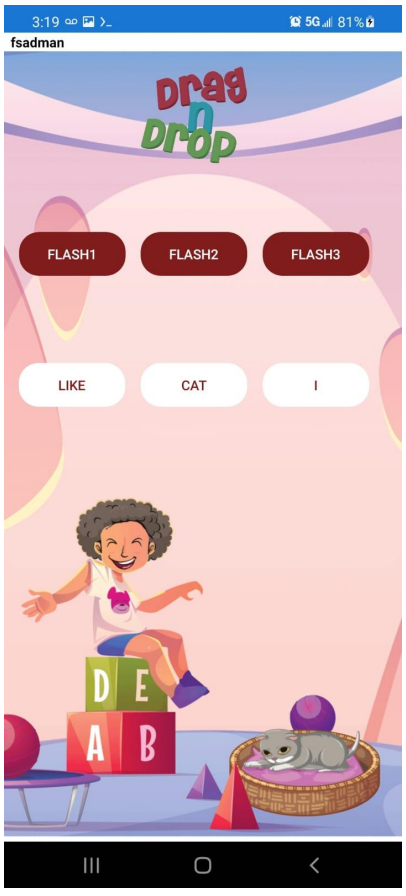


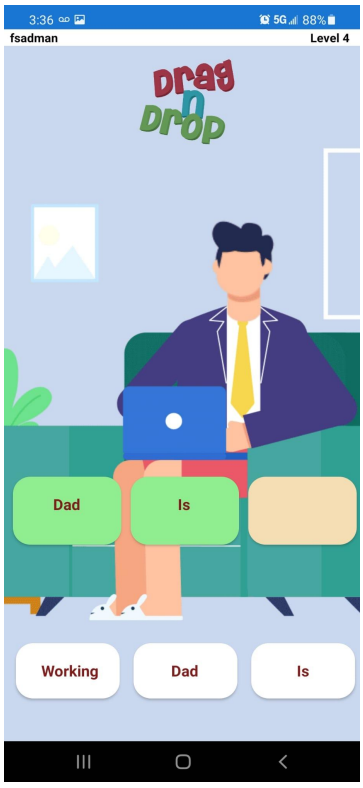


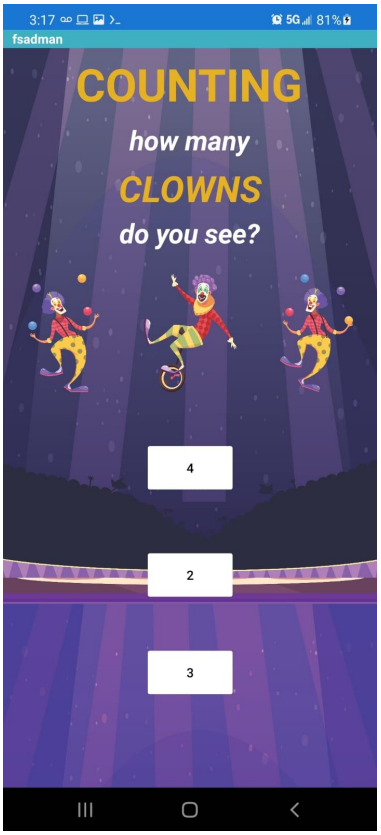


The next mode is called **“Drag n Drop”** as it will feature word cards where the user is asked to rearrange those cards to create simple and coherent sentences. The interface will allow the user to drag the word cards to simulate the workings of a real-world flash card. This mode is designed to improve on word recognition as well as language skills.

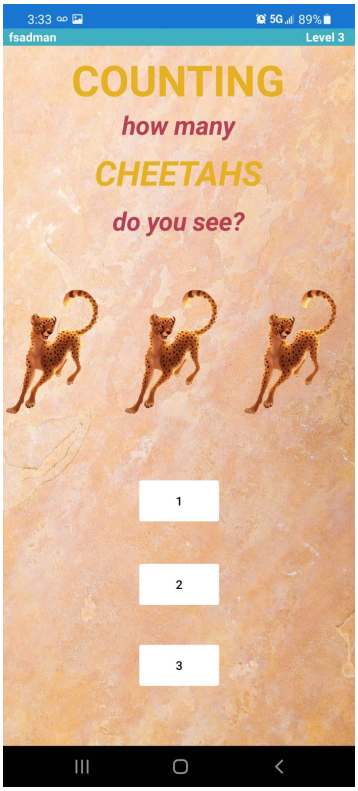


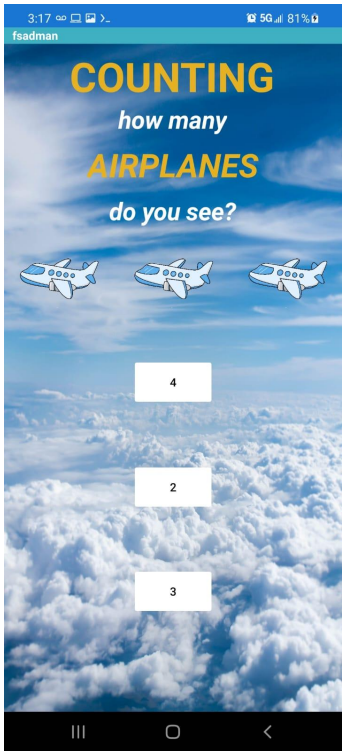


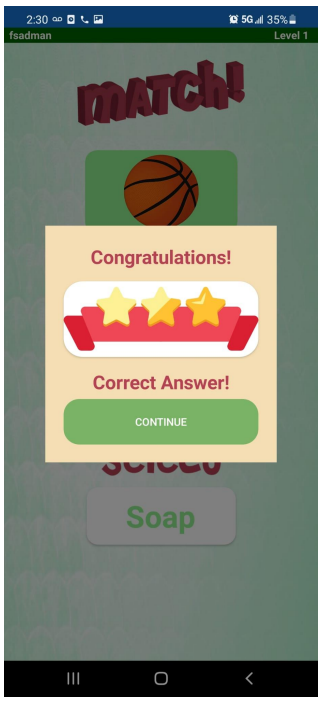


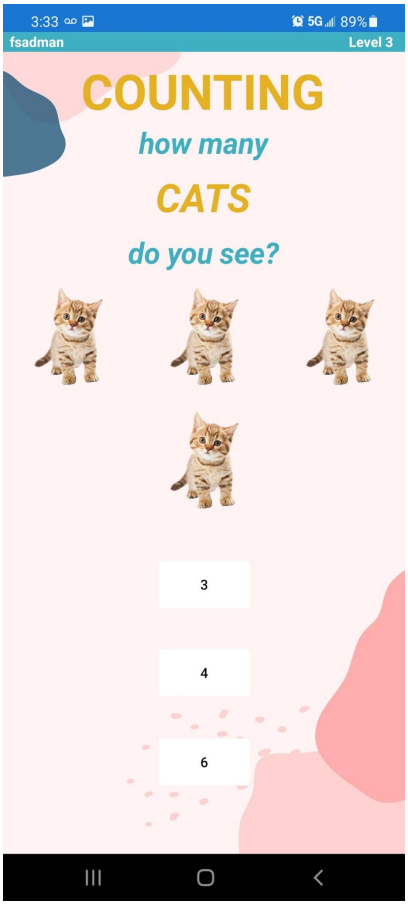


And finally, the app will feature another gaming mode called **“Counting”** where the interface will randomly generate a number of objects and ask the user to select the corresponding option which reflects on the number of objects generated. This mode is designed to improve the numeracy skills of the targeted user.









The app will also feature a tier system that will track the user's progress by measuring the ratio of correct responses to that of the wrong ones. Furthermore, the difficulty is expected to rise as the user advances along with the tier system. Upon reaching certain milestones set in the tier system, users would unlock a new set of questions with more difficulty. However, to fully enjoy the benefit of the tier system and unlock new levels of difficulties, users need to purchase the premium account with a paltry cost of $2.99.

EVALUATIONS WITH USERS AND PARTNERS

Feedback on improvements:

- Using Text to Speech & Animation
- Using colors and sight words
- Keeping a Purchased Premium version for the advanced levels

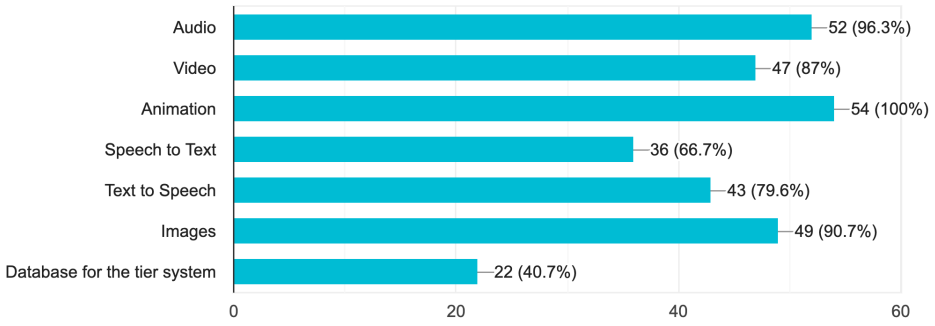
Please provide if you have any suggestions or comments regarding our app. Thank you!

1 response

It would be better if you sequentially design the modes according to the developmental milestones and keep an option as child initially can take parents help, make sure for unlocking the next step, parent are playing (it happens you know). For giving the cue also (for playing)it's also needed to maintain cue hierarchy.
Thank you

Select all the features you think will be useful to add to this app:

54 responses



We were fortunate enough to get an interview with the representatives from the National Down syndrome Society (NDSS), Miss Jessica and Anna, who were informative about how to approach the kids with Down syndrome. They also provided us with resources like different types of sight words and how we can use the sight words and the

images that are being shown to the kids with Down Syndrome by their instructors or parents using flash cards or picture books. We have received valuable information about what we can improve on our app or what positive stuff that we have. These feedback were helpful and those evaluations were taken into consideration while developing the app. Though our app is still in the beta mode, we have tried to incorporate those feedbacks on in each of our gaming modes to make it much more helpful for the children with Down syndrome and to make sure that it is more accessible to them and it is helping not only the children but also helping their parents or caregivers are instructors.

Some feedback from Jessica, "*.....say something differently because lower the pitch just a little bit just so it's not so robotic and I think as long as the other things that are going to keep them engaged. I was going to stay as far as possible are the*

sentences on the last word maybe have the punctuation mark just so visually they're able to see that that's something that would be there and you know again like make sure that font is like pretty basic..... I think as far as our kids having something that is as close to like what they would see and you know like a sight word book or a flash card that says you know basic is possible is helpful without all of the bells and whistles and things like that. And the fact in the more generalization that they can have so if they're seeing it on the app and then like they're seeing it in the you know a sight word book that they're reading this says I like basketball it's not like they can't recognize the word because it's in this fancy pretty font in the app and just in a basic typed out or you know written by their teacher..... as long as you know it's it's very clear that like what the picture is and there's not like several things in the same picture that like could contradict each other but the pictures that you showed me showed us didn't seem that would be a problem at all."

Some feedback from Anna, *"Students be able to master it in the app but then apply it to you know they go outside and they see a basketball and they know that's a basketball and I can write basketball or if basketball and soccer shown to me, I can identify the word basketball and a lot of that definitely comes from that consistency of seeing it in a similar font. I mean obviously schools are going to maybe use something slightly different but you know keeping that as basic as possible. And then like Jesse saying, I thought the pictures and colorful you know and I like to go airplane and it showed little airplanes for the background was clouds because then they start to*

associate. I look up at the sky and I see an airplane! I thought all of that was really great so really you know I don't see much need to change like the visualization of like the pictures and things like that maybe just the same. A simpler font or something more standard that they would see in a book or something like that."

DISCUSSION OF POTENTIAL MARKETS & FUTURE WORK

Our targeted customers would primarily be composed of parents who have children with down syndrome. Our key partners would be institutions like NDSS (National Down Syndrome Society) that work closely with children with down syndrome. We have already managed to get their attention after a successful meeting and they have agreed to provide us with necessary information and local connections. With NDSS on our side, we are also looking to reach out to other local institutions. Our ultimate goal is to design and launch a web app for further accessibility. A web app would allow people without smartphones to use our application seamlessly.

So far, our only cost to develop the application is the registration fee for Play-Store ($25) and App Store ($99). However, we are aware of additional costs that might require in future to acquire a larger database for a larger user number.

Our primary source of revenue would be the service fee of $2.99 for switching to a premium account. A premium account would allow access to a wide variety of questions

with higher difficulty levels. We would also have a donation tab within the application for the funding of future upgrades.

BRANDING

PALM is a cross-platform application that is solely developed to help the children with Down Syndrome to help them learn sight words and numeracy. This app focuses on minimizing the constant supervision time and repetitiveness that is imperative for these children. As we started designing the logo of our app, we kept the children with DS in mind and tried to use the four major colors in the universe. We started with blue and yellow first as they represent the Down Syndrome Awareness colors. Our logo consists of a palm as a medium of communicating with others, specially when one has difficulty in communicating, it plays an important role. The letters PALM where the M is written as 3 symbolizes the fact that we are adding numeracy in our app. There are Stars that look like X which symbolizes the fact that it's an app for the kids where it can represent Hope and Dreams and then again it also symbolizes the extra set of chromosomes of trisomy 21 which is also related to Down syndrome. On the palm that is in our icon you will be able to see that it has the two major Palm lines because most kids with Down Syndrome have two major palm lines in their hand instead of three palm lines. We have created the logo using alternate colors to confirm the usage of it in different platforms as needed and we have used colors that are patent free.

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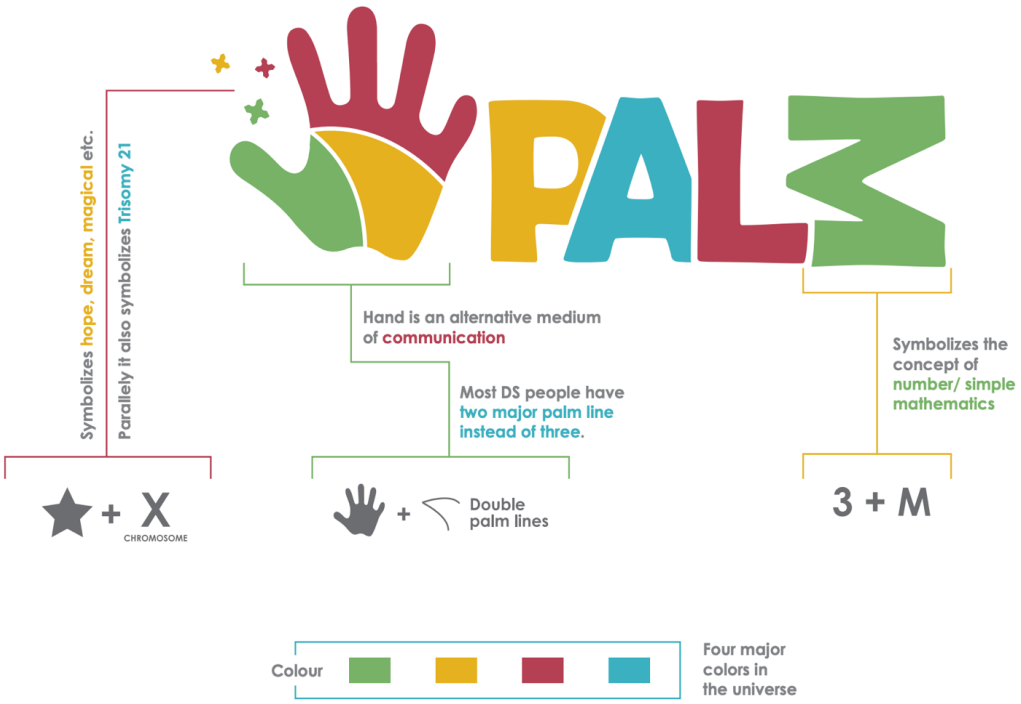
PALM

LOGO DESIGN

INSPIRATIONS



TYPES OF LOGO

PRIMARY

SECONDARY

ICON

The City College of New York

PALS

COLOR PALETTE

ALTERNATE COLORS

The City College of New York

PALM

CONTRIBUTION OF INDIVIDUAL MEMBERS OF TEAM PALM

Kamil R Syed

In the first semester, Kamil researched about Down Syndrome and methods of education of children with Down Syndrome in the schools. Throughout the semester, he also helped the team in updating our wiki page. Afterwards, in the second semester, he constructed questions for the surveys. In the development of the application, he contributed by working on the front-end, researching and finding copyright-free images online and coding in Xaml. He also interviewed Down Syndrome Research Foundation representatives with the team. Kamil has also introduced Xamarin's HotKey feature to the group which enabled a much faster debugging of the program.

Fardin Sadman

Fardin has helped in the research of children with Down Syndrome and the methods of most efficient teaching techniques throughout the first semester. For the second semester, Fardin assumed the role of lead developer as he was responsible to write the complete back end code of PALM, written in C#. Fardin has incorporated Firebase into the application which allows the integration of PALM's database. As a result a secured login and registration system was put in place. He has designed and written the frontend and backend code for the login page with necessary UI elements for the ease of new users. The algorithm for the tier system (reasons for leveling up) and page navigation order was dictated and written by him. The text to speech API was

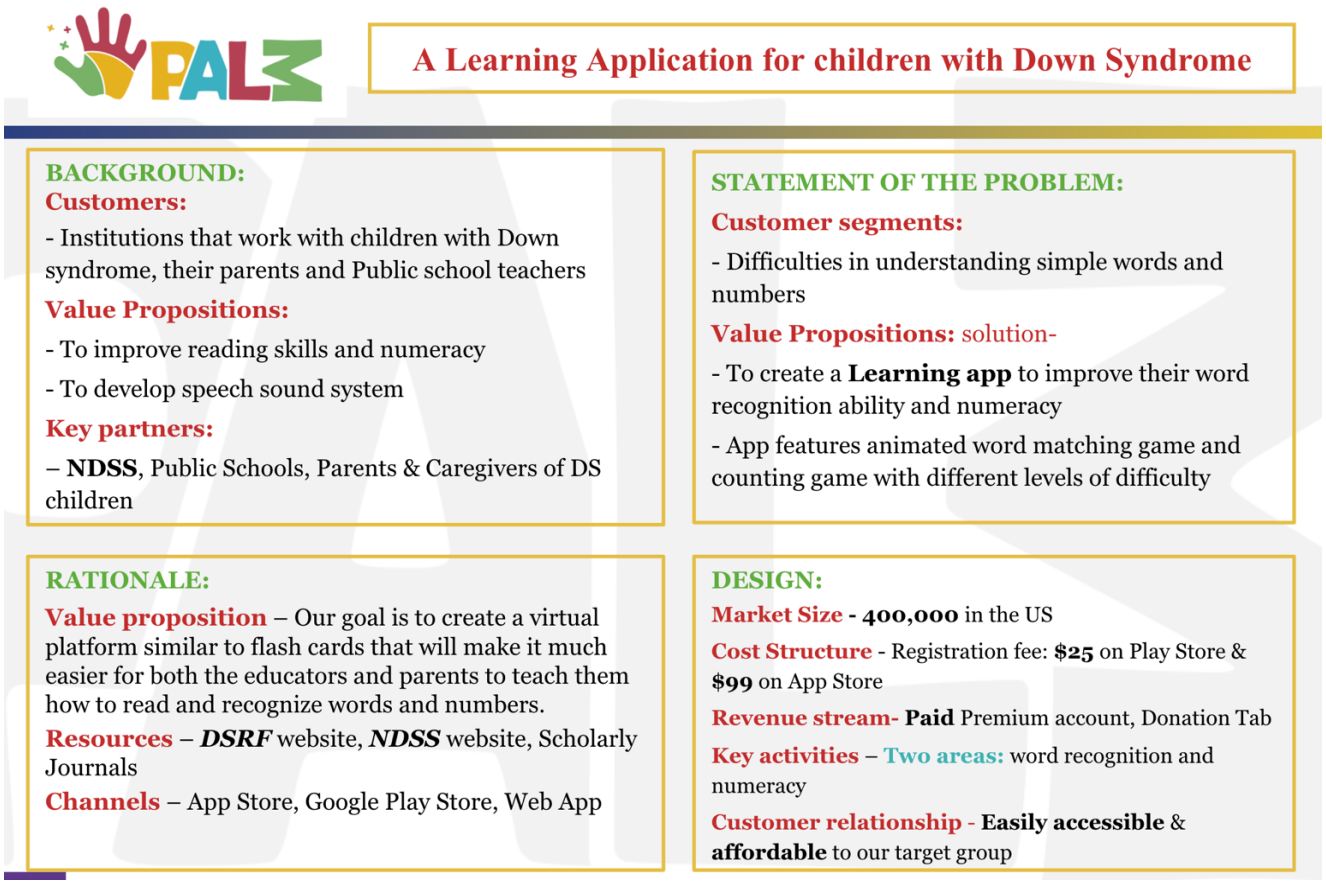
incorporated within the gaming modes by him for the ease of phonetics. Fardin has done extensive research for the construction of Drag and Drop features provided by Xamarin and was successful to implement those in the backend code for the Drag and Drop gaming mode. He has also written an algorithm in C# to ensure a randomized generation of questions in the Match and Counting gaming mode. Fardin has constantly engaged in the general debugging of the program to ensure a seamless user experience free of bugs.

Zakia Mahabub

Throughout the two semesters of developing this project, Zakia has helped with the Branding aspect of the team. She was the one who initially suggested the idea to create an app for the children with Down Syndrome, and persuaded the team to work on it. She has worked on researching the materials to gather more statistical information on Down Syndrome. She consulted with a Graphics Designer to design the logo and the initial interface of the app using photoshop and animation. She worked with the team to update the wiki page in the Fall semester. During the Spring semester, she was responsible for updating the weekly log on the team wiki page. She was also in charge of creating the slides for all the presentations. She worked with the team to create the surveys and branding of them. She has created the PALM facebook page and the PALM instagram account to brand the app among the users. She arranged the interview with Dr. Syeda Tazkia Sultana and Dr. Nazmul Hossain from CRP, Dhaka, Bangladesh to consult with the team on their experiences with the children with Down Syndrome. She

has arranged the meeting with the representatives from the National Down Syndrome Society (NDSS) where the team was able to gather valuable feedback on the improvements needed for the app. She has created the curriculum of the gaming modes to help Fardin and Kamil when they were working on developing the back end and the front end of the app. Zakia was also responsible for the general quality control of the overall team work.

SUMMARY



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