

# Be Heard.

*"I want to talk, and I want to be heard, clearly."*

95% of the Down's syndrome population have articulation defects, which make it hard for them to communicate with others and fit into the society.
However, 'articulation defects' doesn't equal 'impossible to articulate' , and this project is trying to take the equals sign away.

An Application with a device
An Independent Project
09/2020-02/2021

# Background

## How & Why I started

Bei Bei

I first knew Down's syndrome from the book *You're My Baby*. The protagonist Bei Bei is a child with Down's syndrome.

Reports

When working at a local newspaper, I found a series of reports on what difficulties people with Down's syndrome have in communicating with others.

More Information

After some research, I found that the difficulties the Down's syndrome people have to face when communicating were more than I had thought before.

*As a English major, maybe there is something I can do...*

## A Few Facts About DS Population

1000

Each year, Down's syndrome occurs in about 1 in every 1000 babies worldwide.

95%

95% of the Down's syndrome population have articulation defects.

Down's syndrome children made more phonological errors than both normal children and subnormal non Down's syndrome children.

Most errors in speech are made in consnants by children with DS.

## Phonetics Knowledge

### 1.Basic Knowledge

In the production of consonants at least two articulators are involved. The categories of consonant, therefore, are established on the basis of several factors. The most important of these factors are:

(a) the actual relationship between the articulators and thus the way in which the air passes through certain parts of the vocal tract, and
(b) where in the vocal tract there is approximation, narrowing, or the obstruction of air.

The former is known as the Manner of Articulation and the latter as the Place of Articulation (or the Place of Articulatory Gestures).

### 2.How to Determine Whether the Place and the Manner Are Right

(1) The distance between your tongue tip and palate

(2) The strength of the airstream through vocal tract

(3) Your mouth's opening extent

THE INTERNATIONAL PHONETIC ALPHABET (revised to 2005)

CONSONANTS (PULMONIC) © 2005 IPA

| | Bilabial | Labiodental | Dental | Alveolar | Postalveolar | Retroflex | Palatal | Velar | Uvular | Pharyngeal | Glottal |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Plosive | p b | | | t d | | ʈ ɖ | c ɟ | k g | q ɢ | | ʔ |
| Nasal | m | ɱ | | n | | ɳ | ɲ | ŋ | N | | |
| Trill | B | | | r | | | | | R | | |
| Tap or Flap | | ⱱ | | ɾ | | ɽ | | | | | |
| Fricative | ɸ β | f v | θ ð | s z | ʃ ʒ | ʂ ʐ | ç ʝ | x ɣ | χ ʁ | ħ ʕ | h ɦ |
| Lateral fricative | | | | ɬ ɮ | | | | | | | |
| Approximant | | ʋ | | ɹ | | ɻ | j | ɰ | | | |
| Lateral approximant | | | | l | | ɭ | ʎ | ʟ | | | |

Where symbols appear in pairs, the one to the right represents a voiced consonant. Shaded areas denote articulations judged impossible.

Different Places of Articulation

Different Manners of Articulation

→ Different Speech Sounds

# Preliminary Research

## Where Children with DS Make Most Mistakes

Affricate
Lateral
Fricative
Nasal

*(By manner of articulation)*

Alveolar
Dental
Postalveolar
Labiodental

*(By place of articulation)*

## What Types of Errors Children with DS Make Most

*The phonemes that appear to be most error-prone*

1. /z/
2. /θ/
3. /ð/
4. /ʃ/
5. /tʃ/
6. /dʒ/
7. /v/

*(In descending rank order)*

## What Influences the Articulation Accuracy in Children with DS

*The three main reasons are:*

1. Phonological short-term memory
2. Oral motor skills
3. Articulatory muscular system
4. Hearing problems

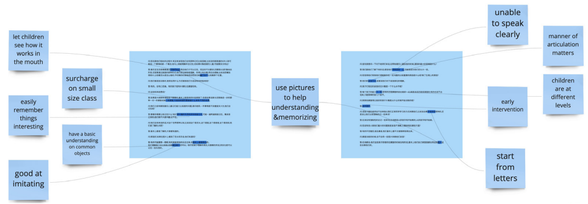
# Primary Research

## Observing

Working in an organization for Down's syndrome children for several days, I had a chance to observe them and communicate with them closely.

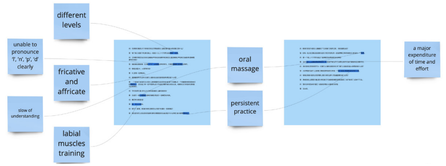
## Expert Interview

Two teachers were interviewed on the importance of articulating, difficulties children with DS faced and speech capacity as well as existing language training methods used by teachers.




Interviewee: Zhang Chao (a special-education teacher)
Way of Interview: voice call
Date: 28th October






- Interviewee: Ms. Yu (a speech coach for children with DS)
- Way of Interview: QQ
- Date: 7th November



## Insights

| Dilemma | Hope |
|---|---|
| Different levels in one class | Early intervention helps |
| | Knowledge of common objects |
| Surcharge on small class | Ability to imitate |
| | Sensitive to pictures |
| Teachers' time insufficient to meet every child's need | Interest in entertaining things |

# Secondary Research

## The Difficulties Children with DS Have in Articulation

- Hearing loss
- Phonological short-term
- Memory deficit




Unable to establish fully phonologically specified lexical representations for words

- Neurological disorders
- Dental abnormalities
- Structural anomalies of the tongue
- Other oral fauces




Aetiological factors of the DS children's articulation disorder

## Why Articulation Is Possible for Children with DS

1.The phonological development of the Down's syndrome is slow but have a normal sequence as normal children.

2. In articulation, Down's syndrome children make fewer mistakes in imitation than in spontaneous production. A model for improves DS children's articulatory ability.

3. Down's Syndrome group's speech capability relies on visual and kinetheic feedback to some degree.

4. Correcting DS children's inconsistency of word production enhance intelligibility.

## Existing Solutions

*Although DS cannot be cured, early speech therapy can help improve pronunciation skills.*

### Tools




**Though these are all helpful tools, they all need teachers or parents to operate.**

### Methods Applied

- Oral perception training
  - Oral desensitization training
  - Oral massage
  - Chewing Exercises
- Functional training of articulation organs
  - For lips
  - For tongue
- Learning letters
  - Using letter cards to help DS children learn the alphabet
- Learning simple words and phrases
  - Give children models for imitation
    - Learn basic category terms
    - Learn adjectives

## Insights

Correction on the frequent phonetic errors is important.

Training on DS children's oral perception and articulatory oragans can be more fun.

Parents should have more time for themselves and be freed from repetitive work.

Targeted one-to-one teaching is hard to achieve in rehabilitation center for children with DS.

# Persona



**Wu Liang**

Wu Liang is a 35-year-old landscape architect, who has two sons. The younger son is a Down's syndrome child.

**Frustrations**

Every weekday, Wu Liang and his wife take turns to teach their younger son pronunciations and life skills, so there isn't enough time for him to draw sketches and attend meetings. Also, he feel sorry for his elder son for little company.

**Wants and Needs**

He hopes to have more personal time.
He needs to communicate more with his older son.



**Jane**

Jane is a speech training teacher in a rehabilitation center for children with Down's syndrome.

**Frustrations**

There are too many students in her class, each of different conditions, so she finds it difficult to take care of each student at the same time.

**Wants and Needs**

She wants an assistant in class.



**Xiao Tong**

Xiao Tong is a 4-year-old child with Down's syndrome, receiving speech training in a rehabilitation agency.

**Frustrations**

She often makes mistakes like substituting /d/ for /t/. Sometimes people cannot understand what she is saying. Also, her speech training teacher is too busy teaching other children to correct her pronunciation occasionally.

**Wants and Needs**

She wants to practice her articulation more.
She needs more attention in class.

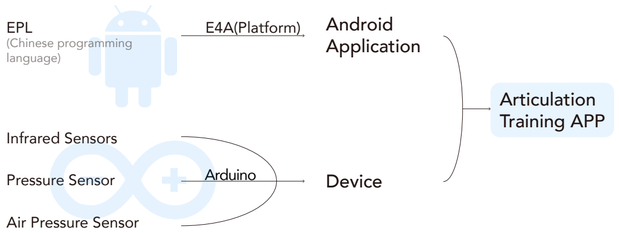
# Ideation

To help the children with Down's syndrome improve articulation and to free their parents and teachers from repetitive work, I came up with the idea of creating a mobile app which acts as an online private tutor. With the app, the children can practice as well as correct their pronunciation and exercise their oral muscles. What's more, parents and teachers can track the children's progress and give timely instructions by associating their accounts with the children's.

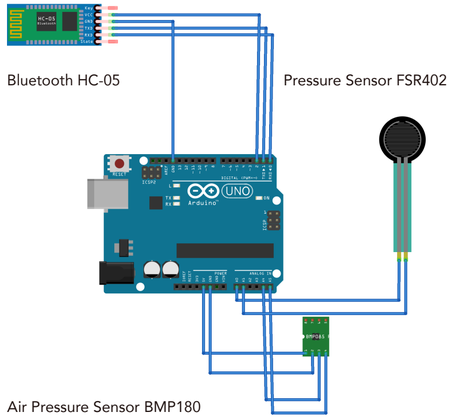
*To assess the pronunciation, I set the criteria based on linguistic knowledge.*



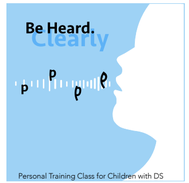

# Technical Support




# Wiring




# Icon

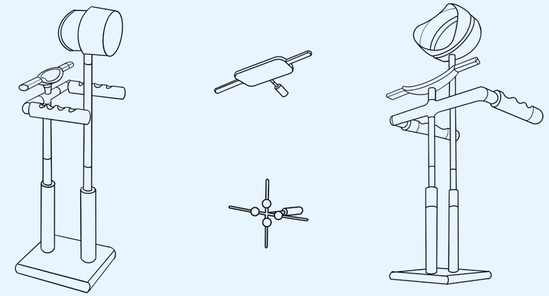



A child is holding up his or her head, full of hope.

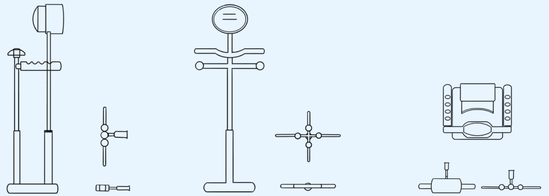
He or she is practicing pronunciation, with the letter 'p' no longer twisted, his or her pronunciation gets clear.

'Be Heard' is like the calls for not only comprehension of words but also understanding in inner thoughts.

# Sketches

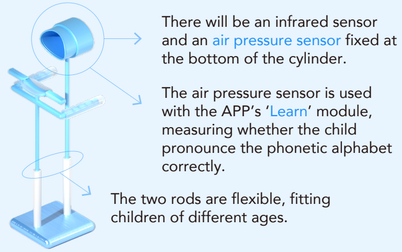


Perspective Drawing



Side View | Front View | Top View

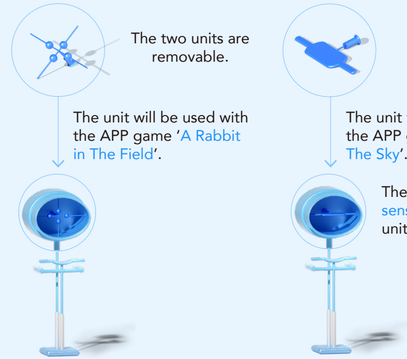
# Modeling



There will be an infrared sensor and an air pressure sensor fixed at the bottom of the cylinder.

The air pressure sensor is used with the APP's 'Learn' module, measuring whether the child pronounce the phonetic alphabet correctly.

The two rods are flexible, fitting children of different ages.



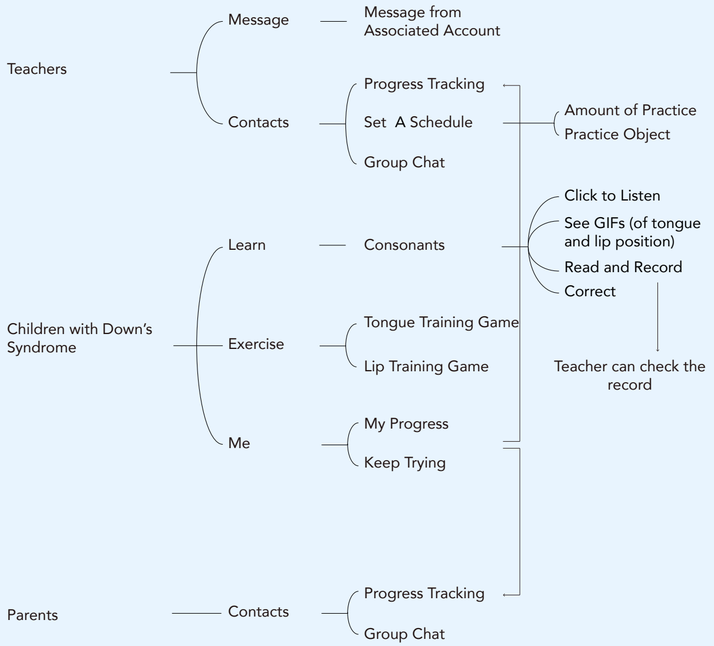
The two units are removable.

The unit will be used with the APP game 'A Rabbit in The Field'.

The unit will be used with the APP game 'A Bird in The Sky'.

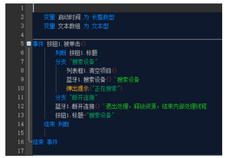
There is a pressure sensor hiding in the unit.

# Function Flow

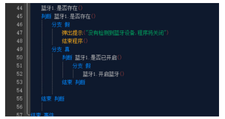



# Coding

## EPL



Start time: long int
Text array: string
Search for Bluetooth devices



If the right Bluetooth device (HC-05) is detected, the application will be connected to Arduino via Bluetooth.



Keycode: int
Var: boolean
Users can press the return key to exit the application.



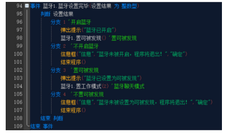
This step is mainly to set the background color and the font used in these pages.



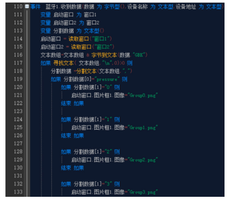
Device address: string
Whether connected: boolean
The application will check Bluetooth connectivity.

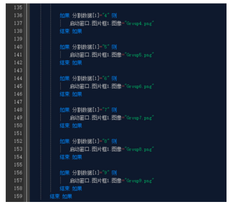


If the Bluetooth connectivity succeeds, go to the page of navigation.
If not, it shows 'Connection Fails'.



You'll be reminded to open your mobile's Bluetooth if it is off.





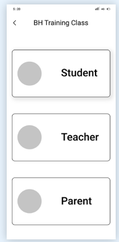
The mobile's Bluetooth receives data.
The air pressure data, as text data, is transferred to digital data, which will be divided into different levels according to their intensities. Different levels are expressed as different numbers of blue stripes.



The bird will be in different positions according to the digital data of stress.

# Wireframe

## Home Page




**Associated Account:**
Students' and teachers' /parents' accounts can be associated as long as both sides add the other side as their associated account.
Associated account allows supervision and guidance from teachers and parents.

**Chat Group:**
A chat group includes a teacher and at least a family of the student.

## Student Flow

Type in your associated number



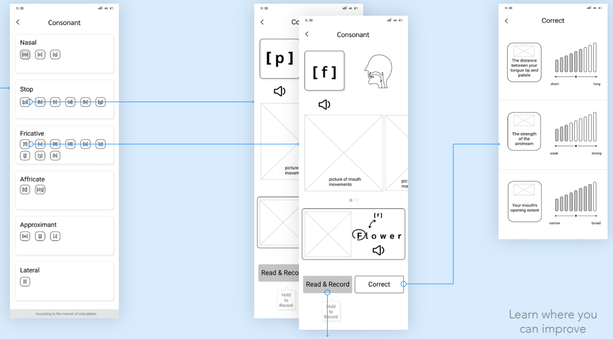

Login/ Signup




Each user will be given a number, making the association process convenient.



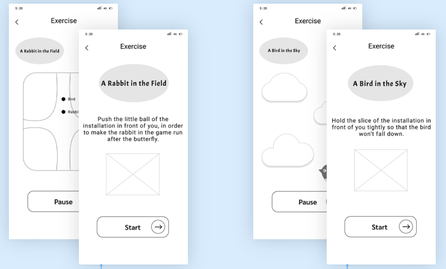

### Learn




Learn where you can improve

The record can be replayed by teachers and parents.

### Game



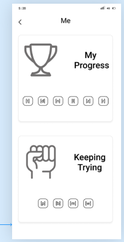

Game1

Instructions

Game2

Instructions

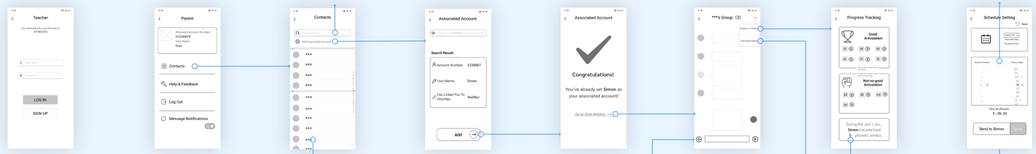
### Me




Feedback on your practice today

## Teacher Flow

Type in the student's name to search for the corresponding chat group




Login/ Signup

Start Page

Chat Box

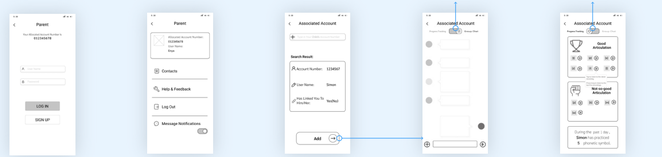
Set a schedule for the student

Updated Daily

## Parent Flow

Parents associate with their child's account the first time using this APP

Switch between two pages




Login/ Signup

Chat Box

Progress Tracking

Once the connection is established, the page will no longer be displayed

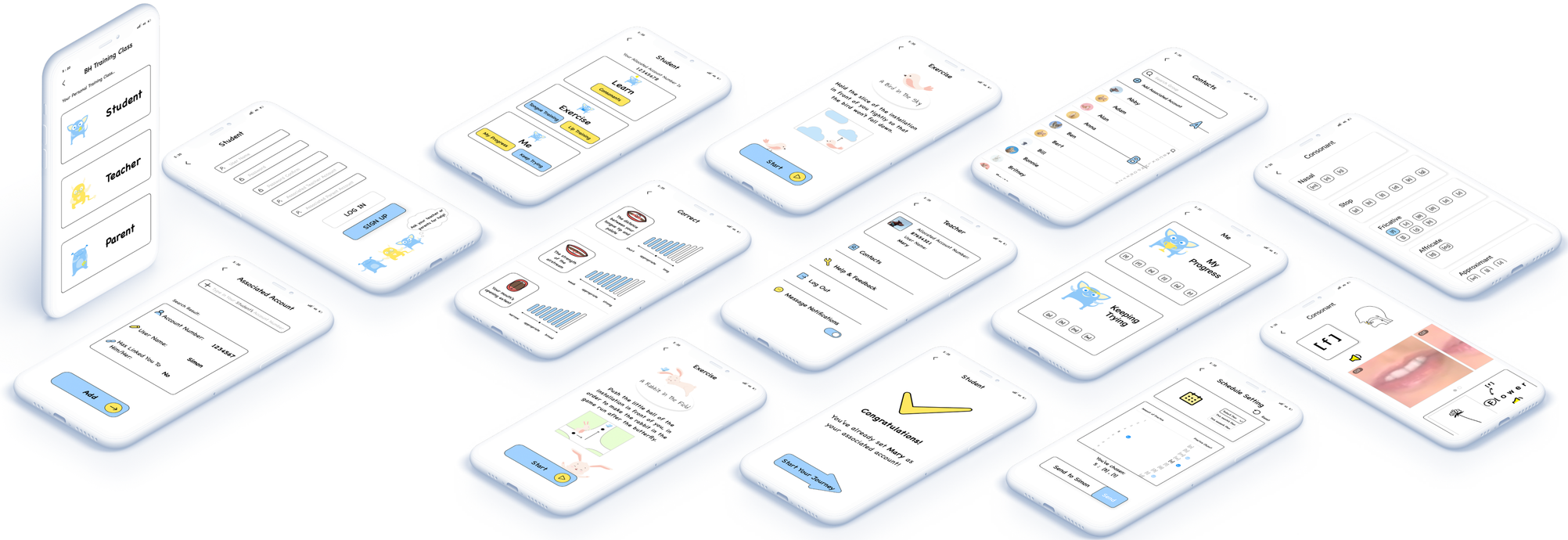
# High Fidelity

**Navigation:**
I used vertically-oriented navigation for most first-class and second-class navigation in the student flow, because its structure is clear and easy to understand. While in the teacher and parent flow, I also used dropdown navigation and segmented navigation, because they are space-saving.

**Button:**
I mostly used round corner buttons, because they are soft and neutral.

**Color:**
I used blue, light blue, yellow and orange to make the screen bright and conspicuous.

I avoided moving between screens in the way of scrolling or sliding, because these two ways are difficult to control for children with Down's syndrome, who have abnormal fingers.



# Final Display

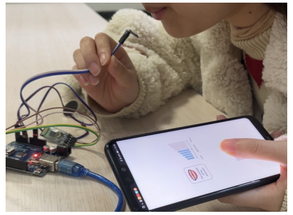
## Without the 3D Printing Model



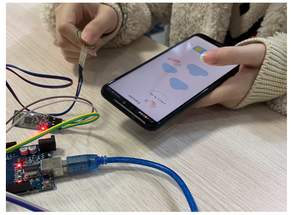
Opening the application



Connecting the Bluetooth

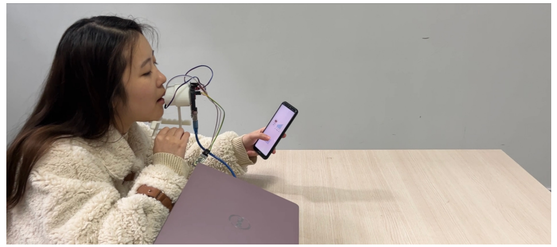


Using the ‘learn’ module



Trying the ‘Game’ module

## With the Model



Correcting her pronunciation errors.



Exercising her oral muscles.

## Reference


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