CSIS0801 Final Year Project 2013 – 2014

FYP13002 Educational Software with Interactive Robot Platform

Intermediate Project Report

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Executive Summary

Technologies on gadgets are becoming more and more useful in nowadays life. It does not only provide us a platform of entertainment and communication, but also a platform to learn. Nowadays, the most commonly used high-tech gadgets include smartphone and tablet. In this project, we will integrate tablets with robot to assist children in learning.

Our project aims to provide children, especially children with special needs, an interactive robot platform for educational purposes. New technologies are implemented in our project as well, including but not limited to augmented reality, voice recognition and hand-writing recognition. With the aid of robot, we hope that children's interests in learning can be aroused. Besides, the project is expected to provide a communication and monitoring platform for parents. We expect this system can help children to learn efficiently.

Section 1: Project Overview

1.1 Background

In this century, children can gain knowledge from school as well as self-learning at home with the assistance of their parents or some tools. Traditional tools include story books, word cards, puzzles, and so on. Yet, children are now learning with traditional tools together with modern high-tech tools such as tablet to improve the effectiveness of learning.

Nowadays, many parents focus on their work in an attempt to earn more money so that their children can enjoy a better living environment. They are too busy and tired of reading story books with children after a whole day of work. Besides, they usually hire a maid to take care of their children and send them to various classes like play group and abacus class. Most parents would like to teach their children to read and write outside classes. Some children may even have chance to learn such things since they were toddlers.

Therefore, a platform will be provided in this project for children to learn and for parents to monitor and communicate with their children. To arouse children's interests in learning, robot is a good option. Children can be attracted by the robot, followed by interacting with the robot during their learning. Recently, there are a variety of choices in the market; however, we aim at providing parents a platform that allows parents to monitor their children's learning progress in order to have a better understanding of their learning progress.

Everything ranging from watching television to talking to friends, which are intuitive tasks for normal people, can be quite difficult for the hearing impaired. Thus, we consider building a system which can be used by them as well.

With the aid of robot and tablet, we hope that children can improve their reading and writing skills as well as gaining knowledge in mathematics. We also hope parents can have a closer connection with their children through our monitoring and communication features.

Currently, there are existing smartphone applications which help children to learn and help the Deaf and Blind to use a smartphone or tablet. For applications with learning purposes, they are usually games like crossword puzzle and music games. For applications designed for the Deaf and Blind, they are usually a speech-to-text converter and media player specifically designed for them. Therefore, we would like to develop our software with new ideas that do not exist in today's market.

1.2 Special Educational Needs

We aim to provide a platform which can be used by the hearing impaired. Hearing impaired implies partial inability to hear, which can be divided into several levels – mild, moderate, moderately severe, severe and profound. Hearing impaired is found to be more sensitive to high pitch as well.

For hearing impaired children, their progress in learning is generally slower than normal hearing children. In classrooms, teachers will usually pair up hearing impaired students with normal hearing students which allow them to ask normal hearing students questions about the concept they do not understand. Teacher will also maintain visual focus on them in classroom.

Furthermore, hearing impaired children are found to be weaker in reading and mathematics. They may encounter difficulties in learning these aspects. Thus, they need to pay more efforts to learn in order to have improvements.

Apart from the hearing impaired, we also aim at providing a better visual image for the color blind. Red-green color blindness, which is known as the most common type of blindness, actually divides into different subtypes. And one of its sub-types, called deutan color vision deficiencies (Deuteranopia), is the most well-known form of color blindness.

In specific, patients with this color blindness are considered as “green weak”. They are weak in discriminating small differences in hues from red, orange, yellow, green region in the light spectrum. Below are the pictures showing the color chart of normal people and deuteranopia people.

Normal

Color Blindness (Deuteranopia)

1.3 Related Work

There are some education applications designed for children available in the current market, such as Kids Math, Kids Opedia, Kids Write ABC and Story Rhymes. We have tried out some of the applications, followed by analyzing the application with its pros and cons. The conclusion after analysis is discussed below.

We found that multiple choice options provided in some available applications are good for children to use. However, in order to provide a better user experience, we think that our application should allow children to modify their answers before submitting the whole task.

Besides, we realize that some applications provide a report viewing page and we found that it might be too detailed for children to read and understand. Therefore, we suggest creating two different reports for parents and children in our application – a simplified version for children while a detailed version will be available for their parents.

In our application, we aim to teach children the correct stroke order of an alphabet character instead of the shape alone. The available applications in the market do not provide such features to teach children with the appropriate stroke order. Therefore, we aim at providing animations to show children the right stroke order.

From our observation, it is not easy to find a popular application with multiple learning areas in the market. Instead, most popular applications focus specifically on solely learning areas. We also noticed that there are very limited applications for disabilities such as color blind people and hearing impaired. The applications designed for them mainly involve tests for color blindness and speech to text translator. It is very hard to find an application for them to use for learning. Although there is only a minority of children suffering from these disabilities, we still hope to cater for them with our disabilities friendly features.

1.4 Role of Robot

Robot plays an important role in this project. Not only can it arouse children's interests, it can also keep their attention, especially for younger children.

Besides, results of games or exercise can be indicated by robot. It can present the result in a fun and interactive way. Robot can also assist in different functions such as indicating direction.

With the sound and visual effects, together with robot, learning can be more interesting and comprehensive.
Robotic car will be used in this project. We believe that our system can be extended to other robot with more features in the future, such as robot with movable hands to enhance the learning experiences.

Section 2: Objective

2.1 Develop educational software

To develop multi-platform educational software, which support iOS and Android devices, with interactive robot platform to aid children aged from 3 to 8 in learning.

2.2 Design for the hearing impaired and color blind people

To provide hearing impaired children an interactive platform to learn at home and to provide a better visual image for color blind children.

2.3 Enhance children-parents bond

To enhance the connection between children and parents, especially working parents, with the aid of communication and monitoring features.

Section 3: Strategy

To achieve our objectives, we have identified some strategies to achieve each of the following:

In order to achieve Objective 1 – Develop education software, our educational software will integrate software application and robotic car to provide an interactive way of learning for children. The application involves learning areas such as reading, speaking, writing and mathematics. With the use of new technologies, we hope to arouse children's interests, as well as keeping their attention, especially younger children.

To fulfill Objective 2 – Design for the hearing impaired and color blind people, two disability friendly features will be provided for the hearing impaired and color blind. We hope these additional assistive features will be helpful and useful for them.

Lastly, to accomplish objective 3 – Enhance children-parent bond, communication platform will be provided for communication between children and parents. Besides, a monitoring feature will be specifically available for parents to view the progress of their children.

Section 4: Development tools

1. Unity

It is a cross-platform engine with a built-in IDE, supporting development for iOS, Android, Windows, Blackberry 10, OS X, Linux, etc.

It supports C# programming languages and the use of Vuforia. Unity is easy to use and suitable for our application implementation as it is designed for 3D development.

2. NGUI

Next-Gen UI kit (NGUI) is a powerful user interface system and event notification framework for Unity. It facilitates the design and development of our user interface. For example, we can drag and drop pre-set buttons and panels easily. It also provides font maker, atlas maker, etc, which can be used to create and modify atlases directly.

3. HOTween

It is an object-oriented tween engine for Unity. In our project, we make use of this engine to enhance the visual and audio experience. It is easy to use and provide high flexibility.

4. Vuforia

It is a software platform that enables augmented realities (AR) app experience. Augmented reality is a live view of a physical, real-world environment whose elements are augmented by computer-generated sensory input.

Vuforia is the most popular and award winning SDK in the market. It also supports features such as virtual button and video playback, which can be used in our application.

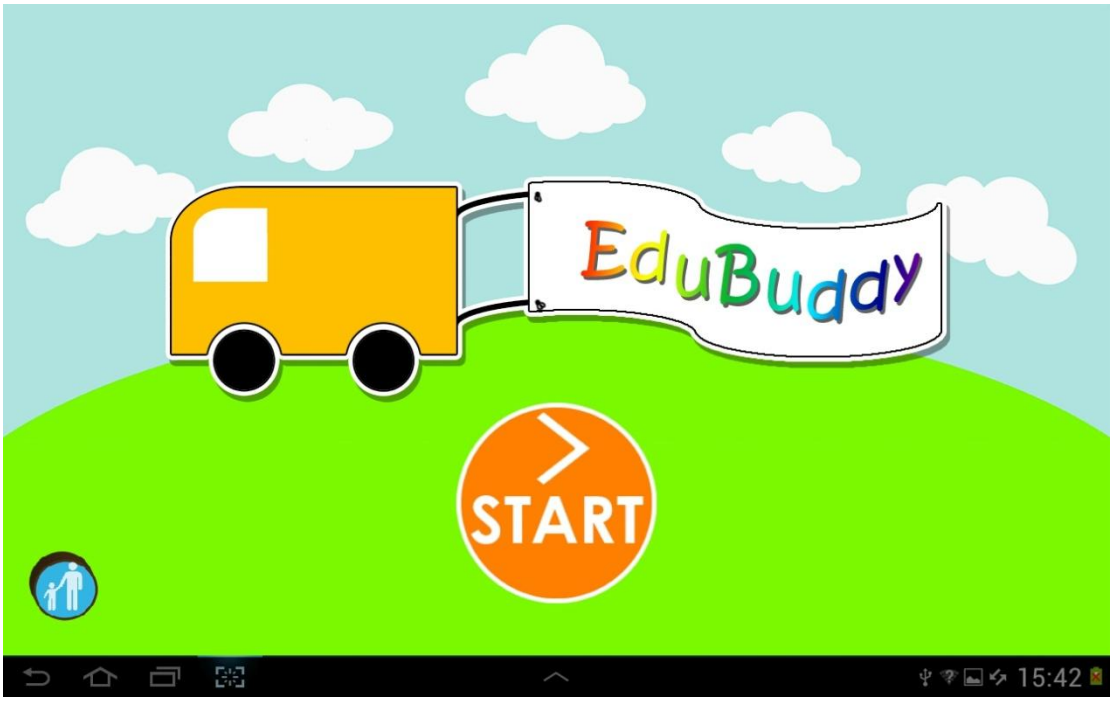
Section 5: System Design

5.1 Main Application Flow

5.1.1 Overview

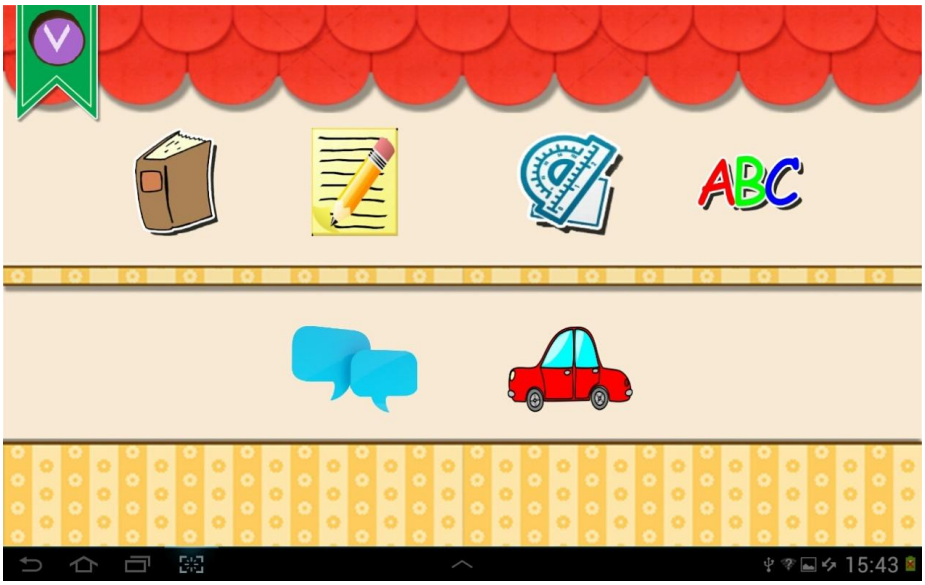
Our software application consists of four main learning areas and some other features. As our target audience is children aged from three to eight, the design of our user interface tends to be more eye-catching by using bright colors. Besides, in order to help the children understand the content in an easier way, the use of long paragraph or difficult words are avoided. Instead, mainly pictures and simple words are involved. Furthermore, unnecessary information and buttons are also forbidden, so as to make the application more user-friendly and simple for children.

Below is the design of the start page of our application:



The start page consists of two buttons – a large animated “START” button for children and a small parent’s account icon in the bottom left corner.

And below is the main lobby of the children side:

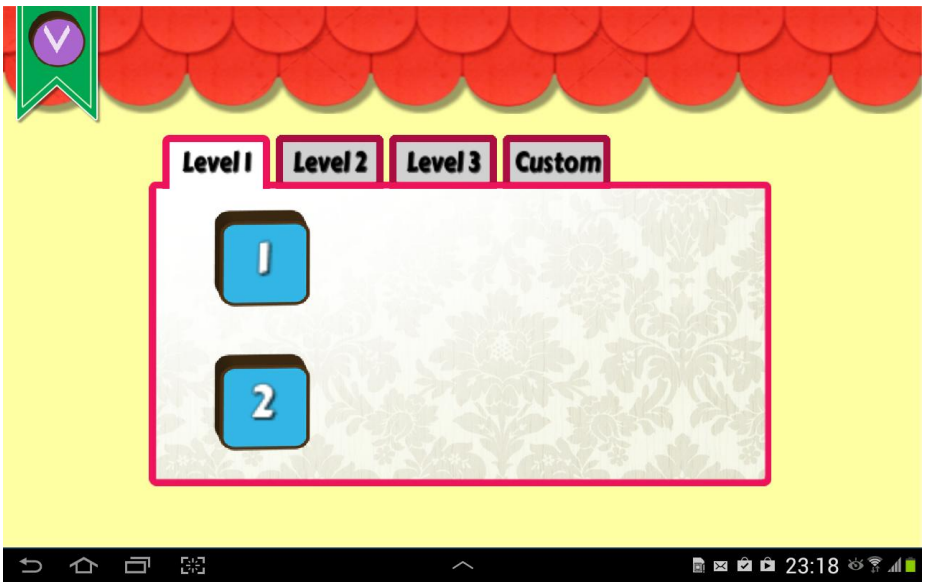


There are six icons in the main lobby including the four main learning areas, chatroom and car control. On the top left corner, there is a small pull down menu which allows user to control the volume and back to the last menu throughout the whole application.

The main flow of the application can be found in Appendix I.

5.1.2 Four main learning areas

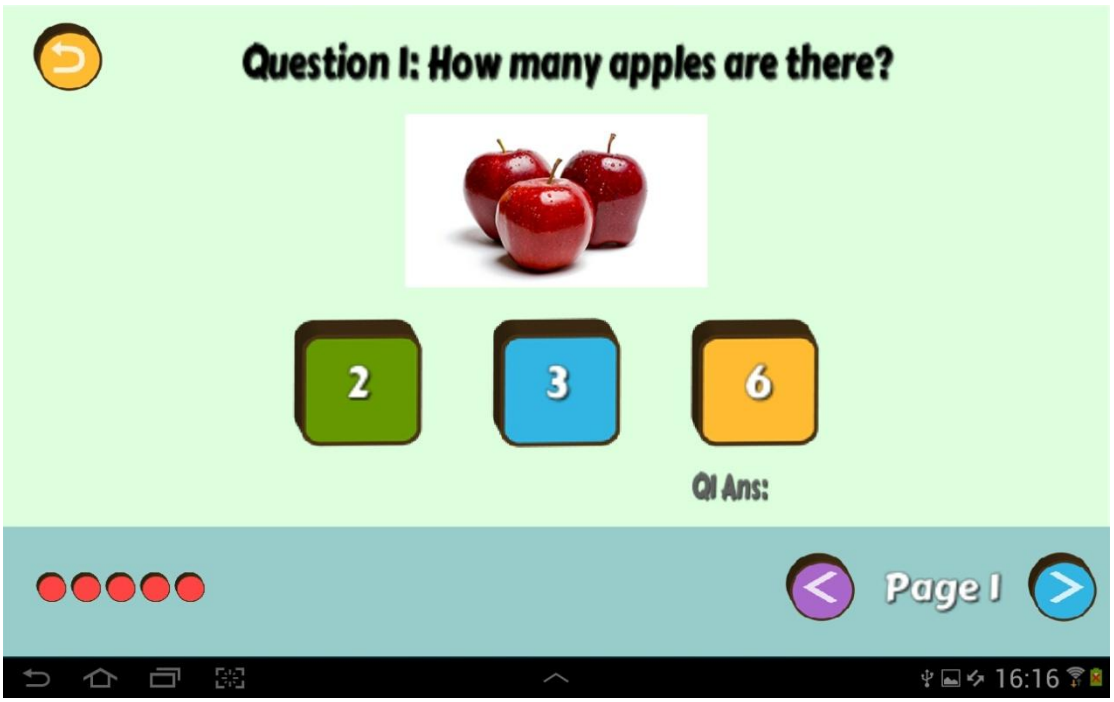
There are four main learning areas for children, including “Math & Logic”, “Read & Speak”, “Vocabulary” and “Writing”. Detailed flowcharts of each learning area can be found in Appendix II, III, IV and V. In each of the learning areas, a level lobby, which contains three levels and a custom tab, is shown as follow:



Children are allowed to choose the difficulties according to their own needs.

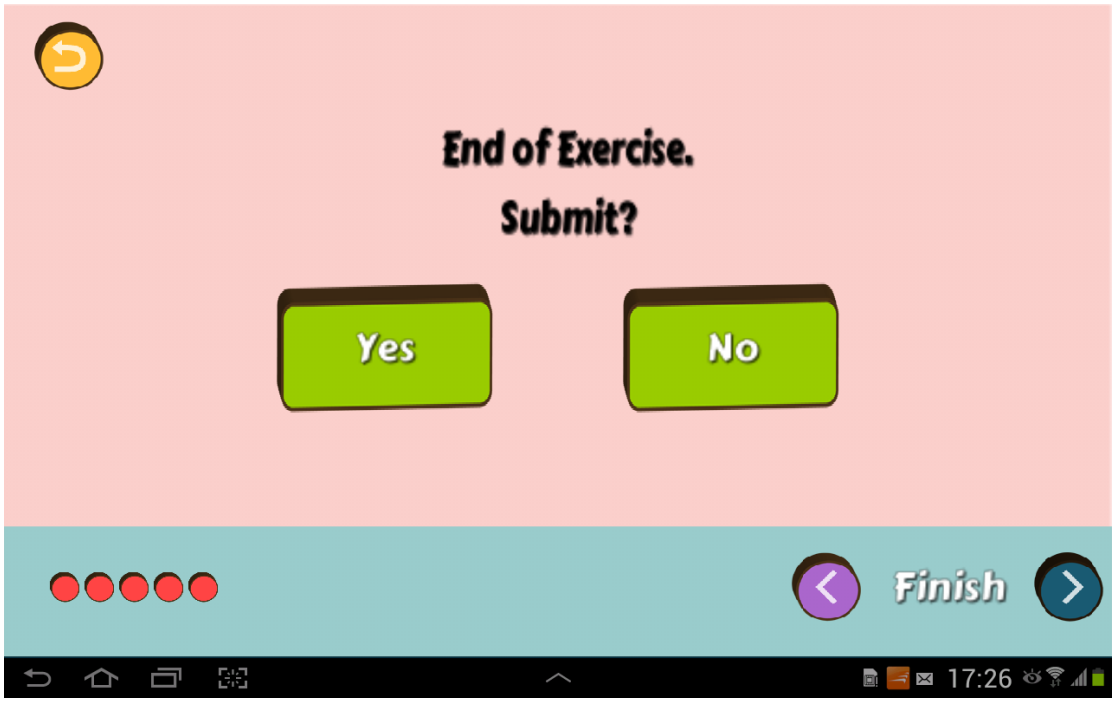
“Math & Logic” learning area

In “Math & Logic” learning area, children are required to answer multiple choices questions regarding mathematical and logic. Question types include comparison, simple calculation, etc. AR will be used in this learning area to visualize abstract concepts and logics, such as sense of space and shape. AR feature will be implemented in later stage of development. Below is the user interface of a sample question set:

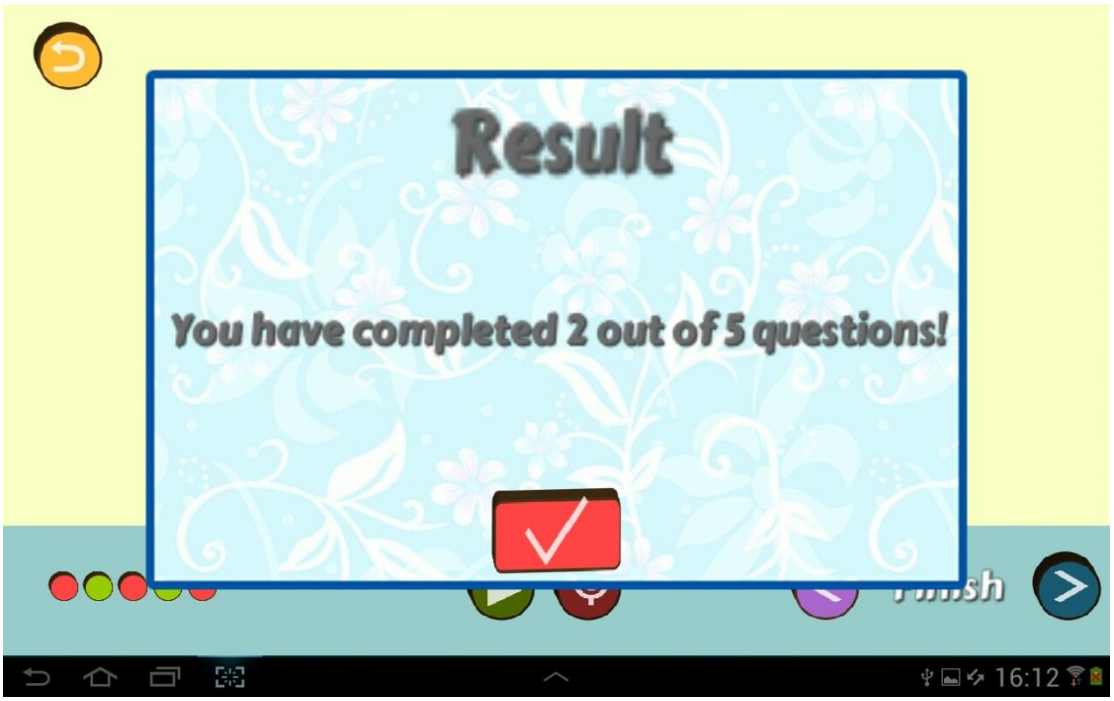


There is a bottom bar on the bottom of all question sets, which formed by a progress bar and a page control panel. The progress bar on the bottom left corner is used to indicate the progress of that particular question set with red and green light indication. Red represents the children have not finished the question and green represents the children have finished the question. Moreover, there is a page control panel in the bottom right corner for children to go to next page or previous page.

The last page of each question set is shown as follows:



Children are required to submit their answers at the end of each question set. They may choose to go back to modify their answers as well. After the submission, system will check the correctness of the submitted answer and display the result as shown below:



The design of the bottom bar, submission page and result page remain the same across all the learning areas, which is easier for children to follow. Meanwhile, consistency of the application can be maintained.

“Read & Speak” learning area

In “Read & Speak” learning area, each question set contains a story. Children are required to listen to the story and learn how to pronounce each word. Below is one of the pages in a question set:

In this learning area, two buttons are added in the middle of the bottom bar for children to play and record soundtracks.

The dot corresponding to each question will turn green after the children completed the voice recording of a page. The proposed solution for voice recognition includes using Google API and the speech library in Unity. However, we are investigating (i) which method is more suitable to be included in our project, (ii) the accuracy of each method.

“Vocabulary” learning area

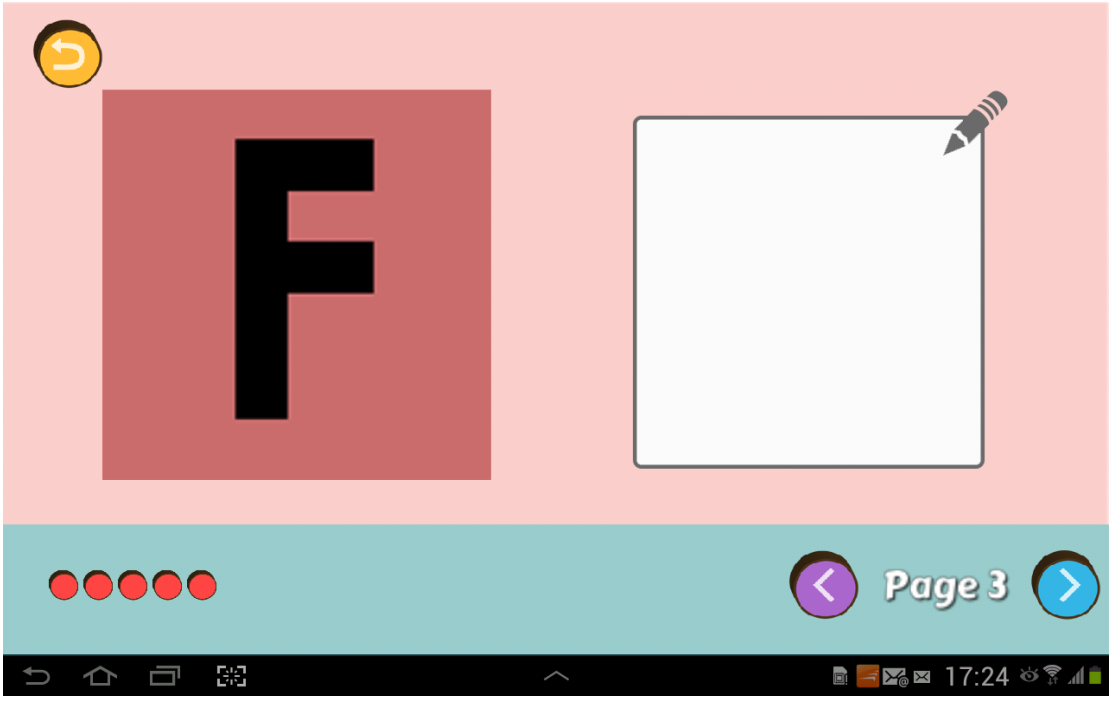
Children can learn different vocabularies in the “Vocabulary” learning area in an interactive way. We make use of AR to visualize the object and below is a sample AR image seen via our application:

Although this is not the complete version of this learning area, we still can see the successful implementation of AR using Vuforia. Besides, we are trying to add the bottom bar and text display in this page as well.

With the use of AR, we try to educate and visualize something that cannot be commonly seen in daily life such as extinct species and galaxy. We hope that children can have a clearer understanding of the object by showing a 360 degree view of the object.

“Writing” learning area

In “Writing” learning area, children are required to write alphabet letters in the correct stroke order. There is an animation panel and a writing panel as shown below:



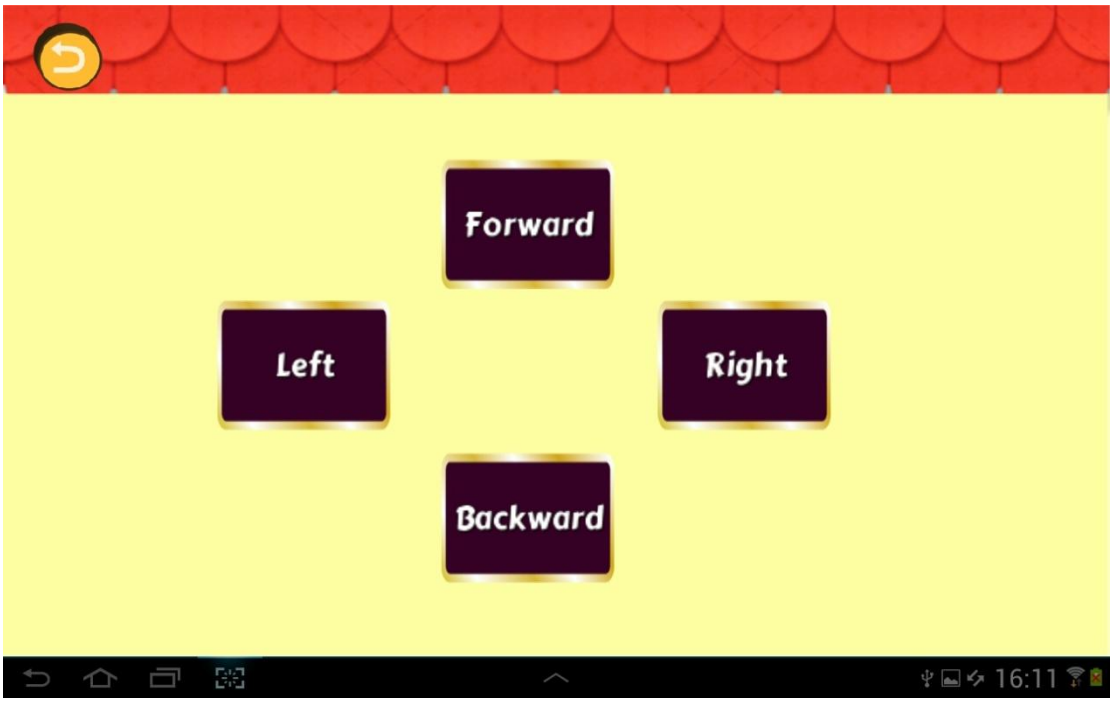
Possible methods for the implementation of writing panel include using JavaScript and HTML5 canvas. However, we still need to investigate on how to recognize the stroke order of the writing and the suitable implementation method. Therefore, handwriting recognition will be a challenge for us.

5.1.3 Other features

There are some other features included in our application, including robotic car control, chatroom and parent's account.

Robotic car control

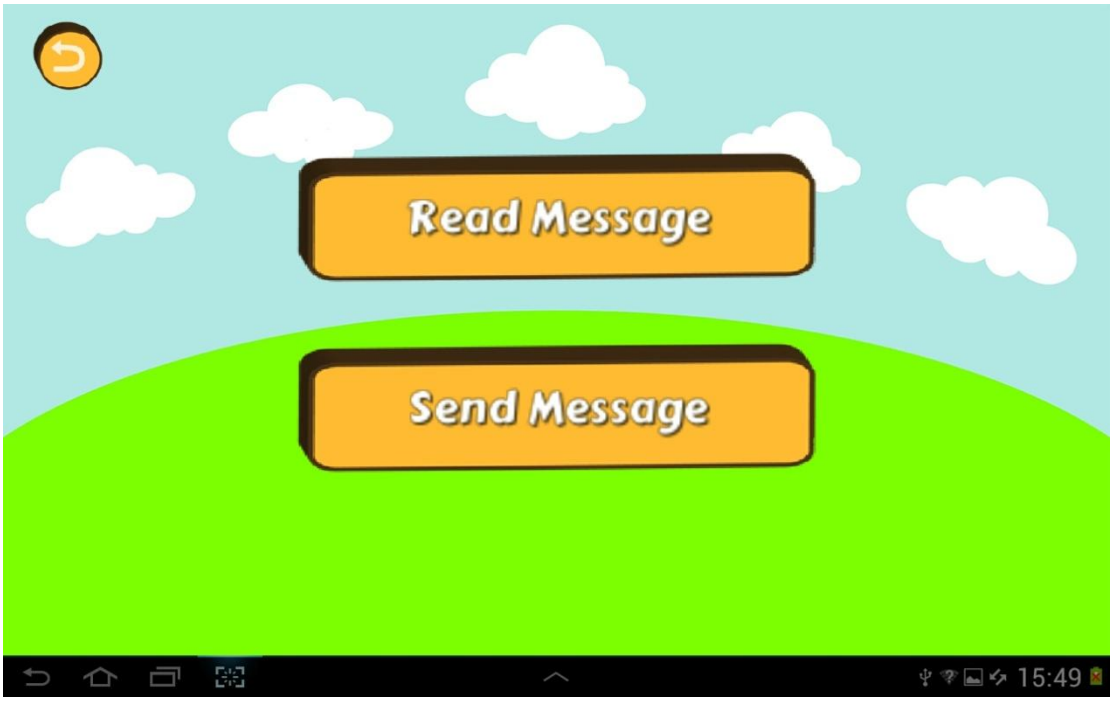
Robotic car is not only used to provide feedback, but also provide other features. Below is the design of the robotic car control:



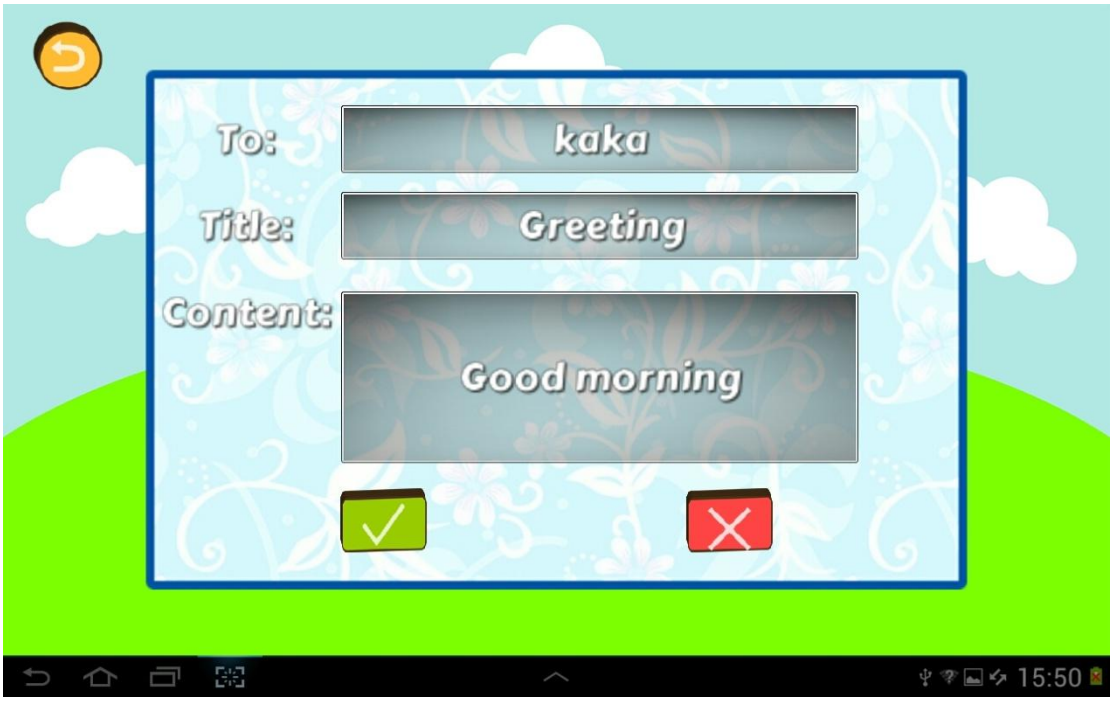
This panel can be accessed directly from the main lobby for convenience. We aim at providing robotic car control feature to entertain children and allow them to learn the sense of direction. The robotic car we are using now can communicate with the tablet via infra-red technology. However, we cannot bind to the car control service that is provided by the technical team of the car company. This feature is still under investigation and development. The flow chart of "Car Control" can be found in Appendix VI for more information.

Chatroom

In order to enhance the bonding between parents and children, a communication platform, chatroom, is provided. The detailed flow of "Chatroom" can be found in Appendix VII. User is allowed to send and read message inside chatroom as shown below:

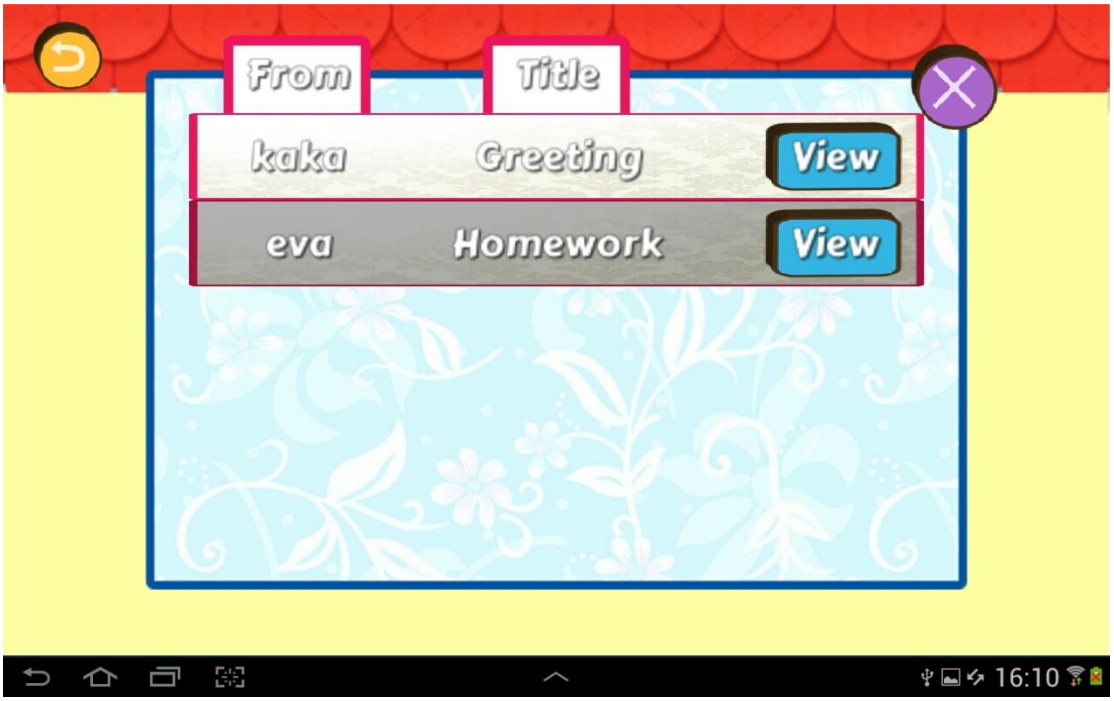


As there are two accounts in the same device – parent's account and children's account, communication is allowed within the same device. Below is the design of the "Send Message" session inside chatroom:



Users are required to input the receiver, title and content. Besides, internet connection is needed to use this feature. If there is no internet connection, there will be a “no internet connection” message to alert user.

Once the user sent out the message, it will be sent and stored in the database. Messages are retrieved from the database upon the system request (when user enters the “Read Message” session), and below shows the “Read Message” session:



In the database, there is a field in each message storing the status of the message – read or unread. Read and unread messages are displayed in different colors in this session as shown above. Furthermore, we are going to improve the user experience by making few changes – (i) display the date and time of the message received and (ii) add notification icon in the main lobby to alert the user of the unread message.

Parent’s account

Aiming at providing communication and monitoring features, we have set up a parent’s account which requires password to login. Therefore, the use of the account by children can be avoided. Features provided in parent’s account include parent’s chatroom, setting, view report and customize question. Detailed flow chart of the features inside parent’s account can be found in Appendix VII, VIII, VIIII and X.

Below is the lobby of the parent's account after successful login:

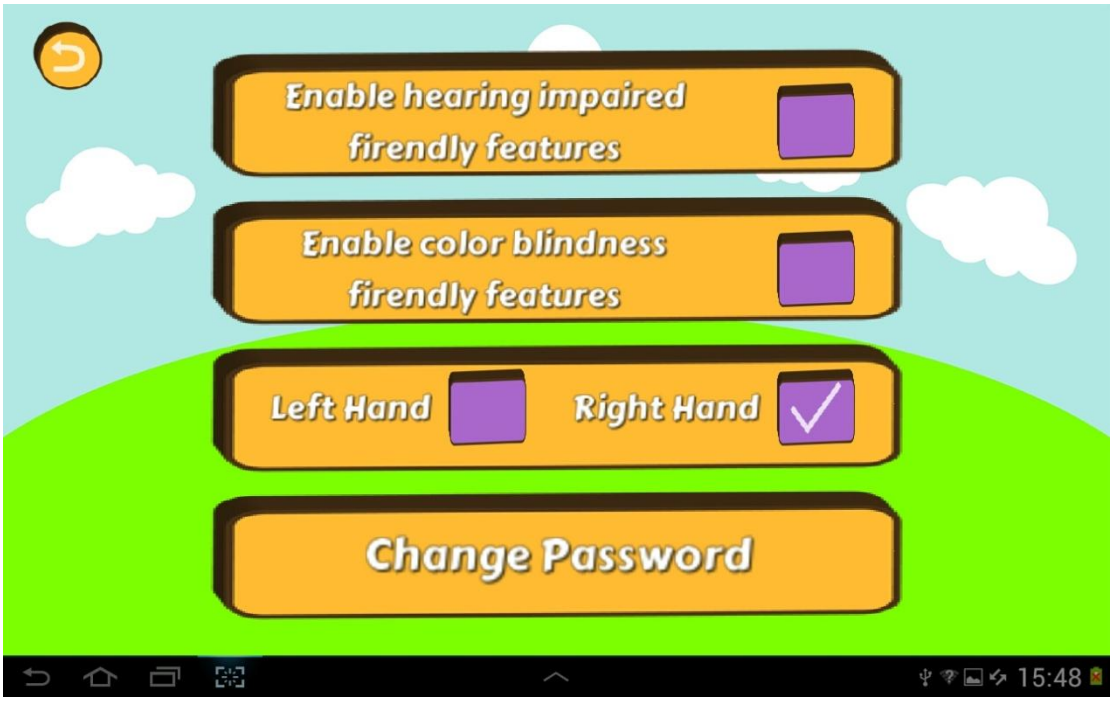
The chatroom feature is the same as the one in children's account. Besides, "Customize Question" session will be implemented later to allow parents customize questions for their children according to their children's needs.

Apart from the communication platform, we also aim at providing parents a monitoring platform. In this way, parents can easily know their children's progress without using the application with them. Therefore, a "View Report" session is included in the parent's account.

In this session, parents are allowed to view detailed progress report of their children as shown below:

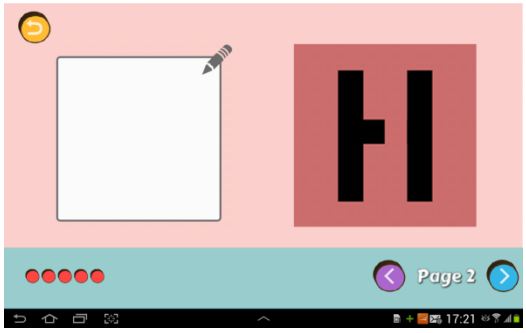
The result of each question set will be stored in the database and retrieved in this session. We would also like to provide the children's submitted answer for parents to review, especially for "Writing" and "Read & Speak" learning area. Every person has different voice and speaking speed; therefore, it is hard to ensure 100% accuracy of the voice recognition and parents can act as an additional checker to review the answer once again.

Another feature for parents is the "Setting" session. Disabilities friendly features are available here by parents. Below is the design of the "Setting" session:

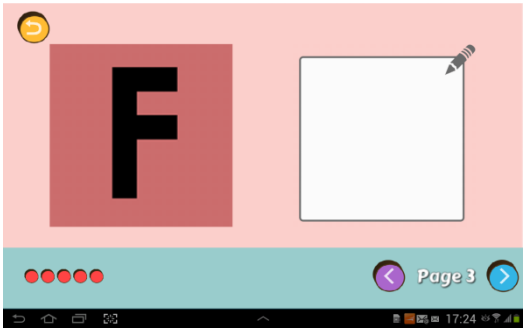


Besides, parents can set the left/right hand for their children. We aim to provide a better user experience, especially for the "Writing" learning area, with this information. We can see below that the position of animation panel and the writing panel will be changed according to the setting.

With left hand setting



With right hand setting



Furthermore, parents can occasionally change their password here for security issue.

5.2 System Architecture

5.2.1 System Structure

Our application is development in Unity using Model View ViewModel structure. The Model View ViewModel (MVVM) is an architectural pattern used in software engineering.

There are three layers in a MVVM structure. View is on the top of the hierarchy, followed by View Model and Model. Each level can only access the level below but not above.

View refers to all elements displayed by the graphic user interface such as buttons, labels, and other controls. It controls the UI changes, like assign words that shown on the screen or remove a sprite from screen. View Model is an abstraction of the view that also serves in mediating between the view and the model. It is responsible for calculation and backend logic for the program. Model refers to a domain model which represents the real state content and the data access layer that represents the corresponding content. In our project, Model is used for linkage to data access object, accessing database and storing data.

MVVM enables true separation between “View” and “Model”, which gives a proper layering of the coding. Data is not stored in the view, and the view is just for presentation of the data. This allows us to make changes to “Model” without the need to change the “View” and vice versa. It can also minimize the interaction between the “coding” and the user interface.

5.2.2 Database design

When launching the application, UDID of each device is being registered to database for first time user. The application will first check the database to see if it is already registered. If the device is already registered, the UDID will be set as identifier. Two accounts will be generated for each device – a children account and a parent account.

The ER-diagram in Appendix XI has shown the entity-relation diagram of the database structure of the chatroom. This is used to store the message sent and allow users to read their respective messages in the application. It enables sending messages between parents and children in a single device and between different devices.

Apart from chatroom, we have designed several tables to store the data of the application including the question sets, submitted results, user information and relevant information.

Section 6: Future Development

In the next stage of development, we are going to continue our implementation. There are several difficulties that we may encounter in the near future including the implementation of writing panel, robotic car control, and AR.

First, the implementation of writing panel would be a big challenge. We need to implement a writing panel which can display and recognize the hand writing. We are going to pay more efforts to investigate the method and also improve the accuracy of the hand writing recognition.

Second, there are some technical issues when we are trying to bind the car control service of the robotic car. Therefore, we have not fully implemented the “Robotic car control” session and integrated robotic car into our application yet. We will consult the technical support from the manufacturer or developer of the robotic car to get more details.

Third, although the AR camera is functioning properly now, we would like to include the bottom bar in the AR camera for user convenience. We tried to change the AR camera to a smaller size in Unity; however, it does not work with a proper size. Therefore, we will try to do research and investigate for other possible methods in the coming few months.

All in all, we target to finish the development of our application by the end of February. We will continue to make improvements, including user interface and user experience, and perform testing of the application afterwards.

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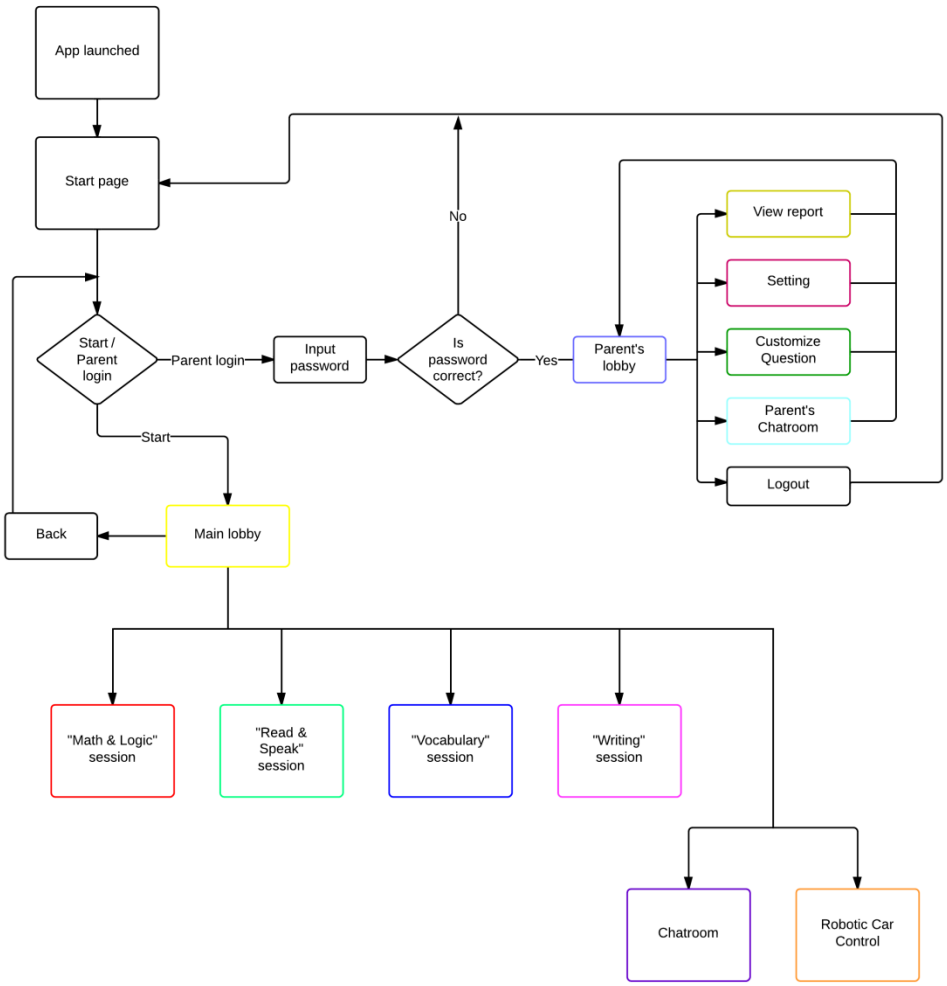
[Untitled photograph], Retrieved September 27, 2013 from http://hearinglosslane.org/support-us/

Appendices

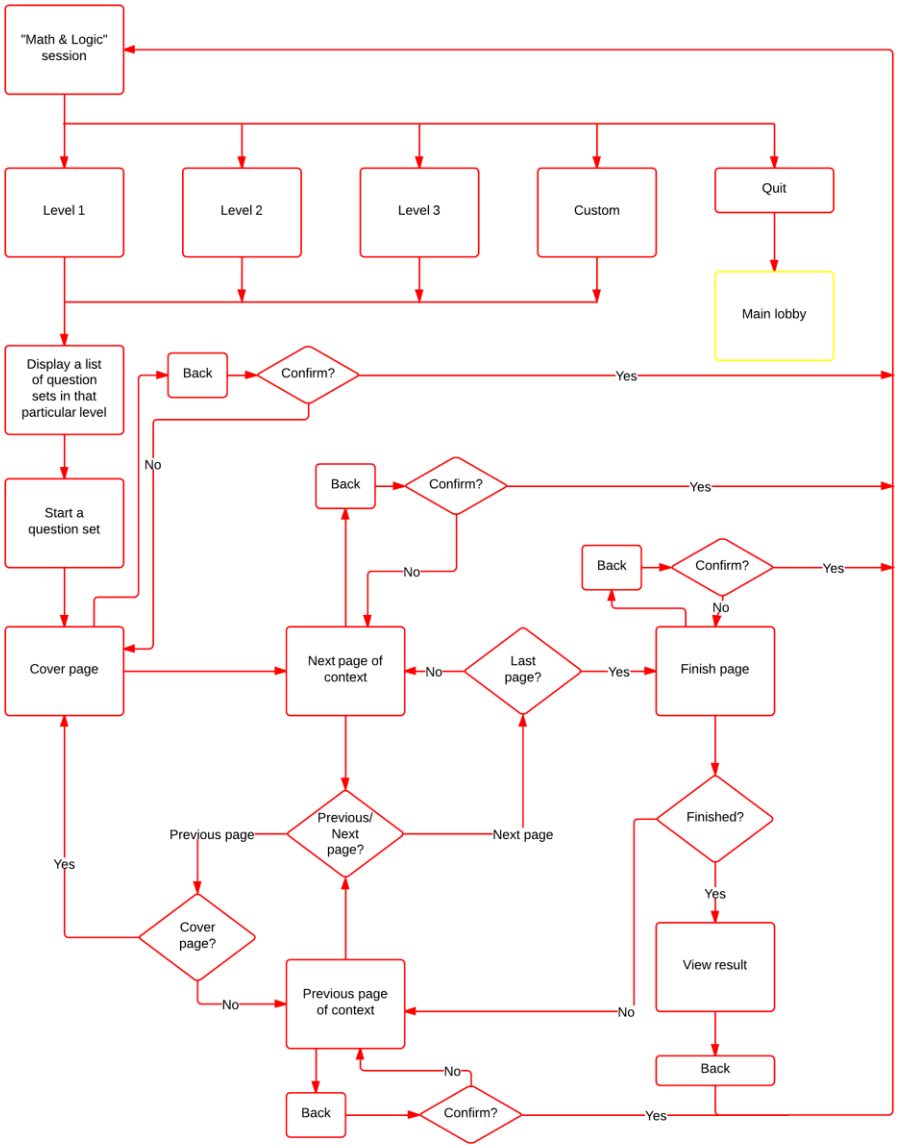
Appendix I: Main flow of the application

Main flow chart:



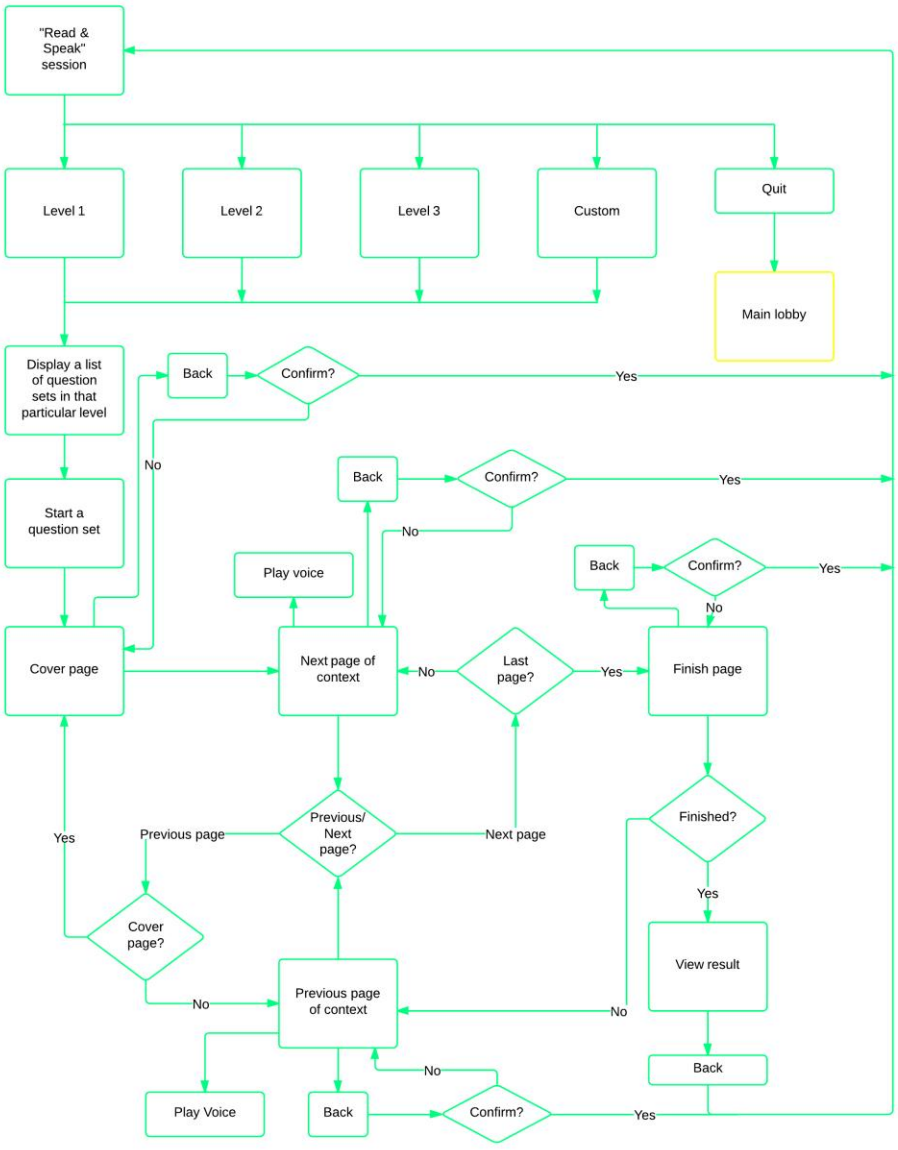
Appendix II: Flow chart of “Math & Logic”

Flow chart of “Math & Logic” session:



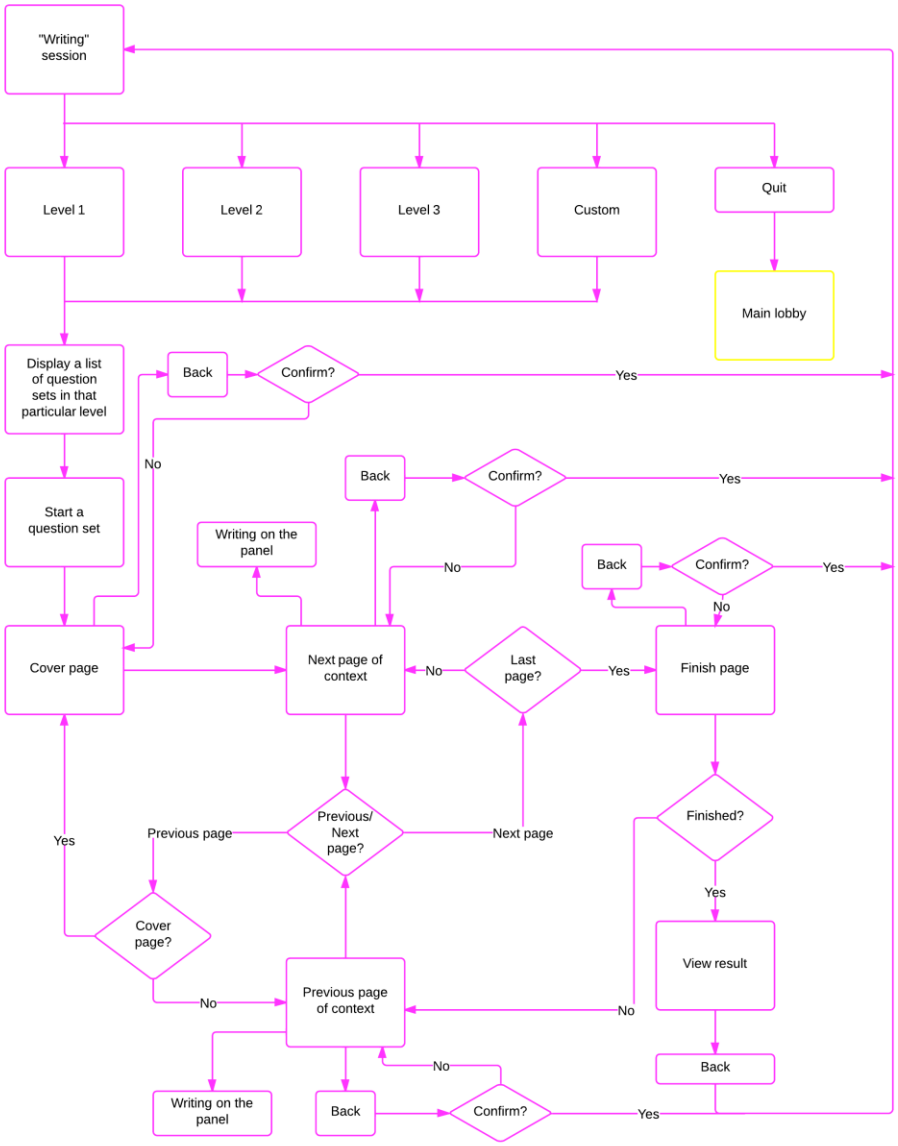
Appendix III: Flow chart of “Read & Speak”

Flow chart of “Read & Speak” Session:



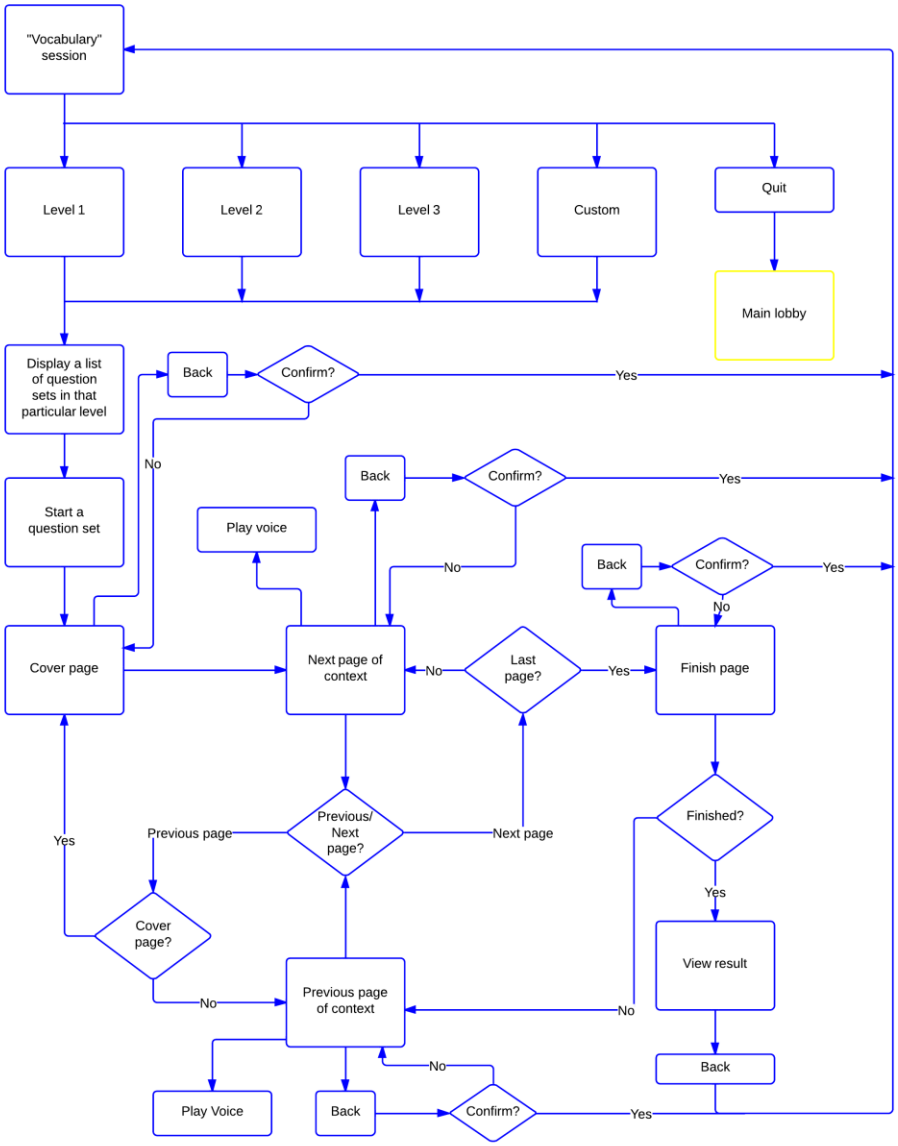
Appendix IV: Flow chart of “Writing”

Flow chart of “Writing” Session:



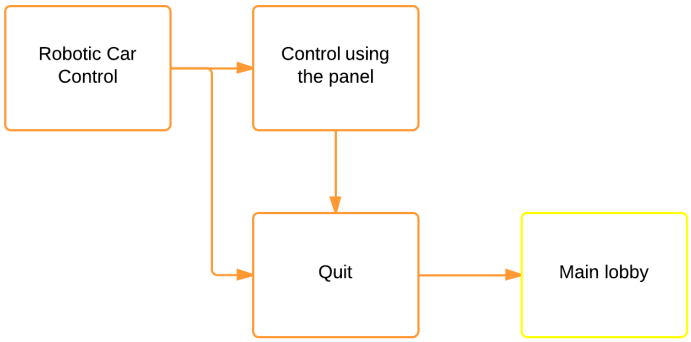
Appendix V: Flow chart of “Vocabulary”

Flow chart of “Vocabulary” Session:



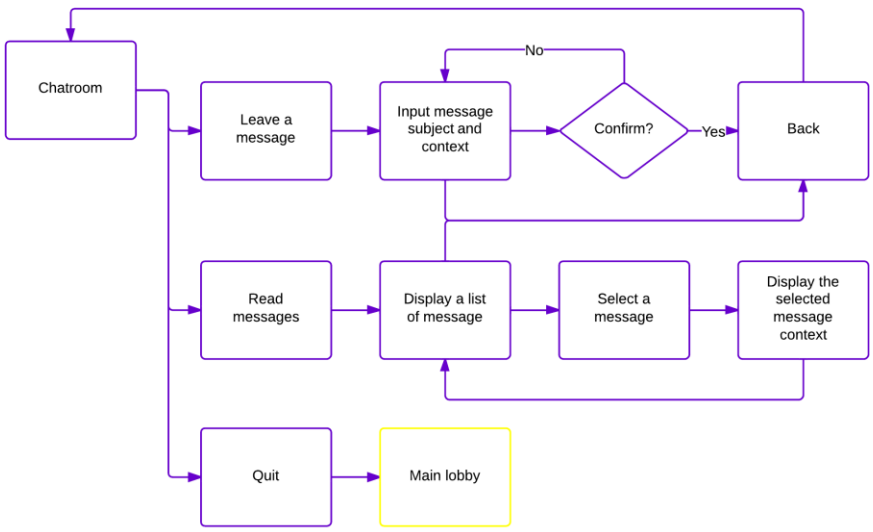
Appendix VI: Flow chart of “Car Control”

Flow chart of “Car Control” Session:



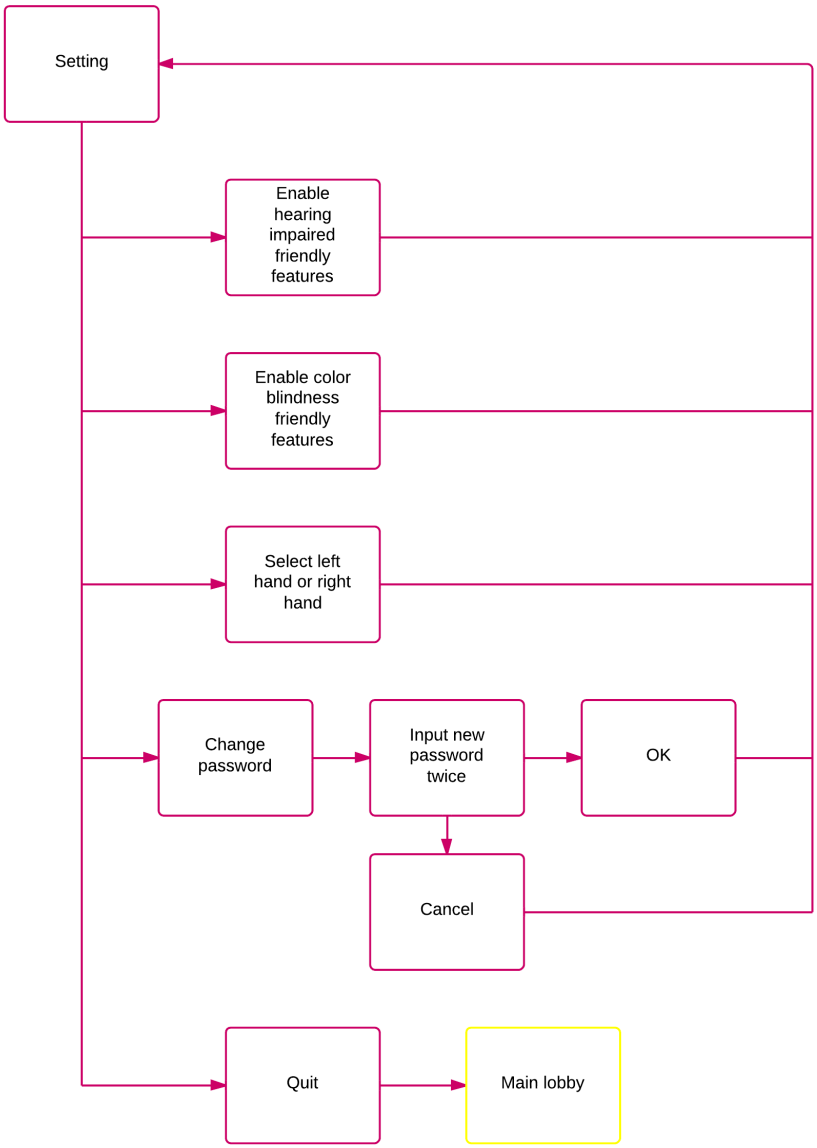
Appendix VII: Flow chart of “Chatroom”

Flow chart of “Chatroom” session (Flow chart of Chatroom under parent’s account is the same as “Chatroom”):



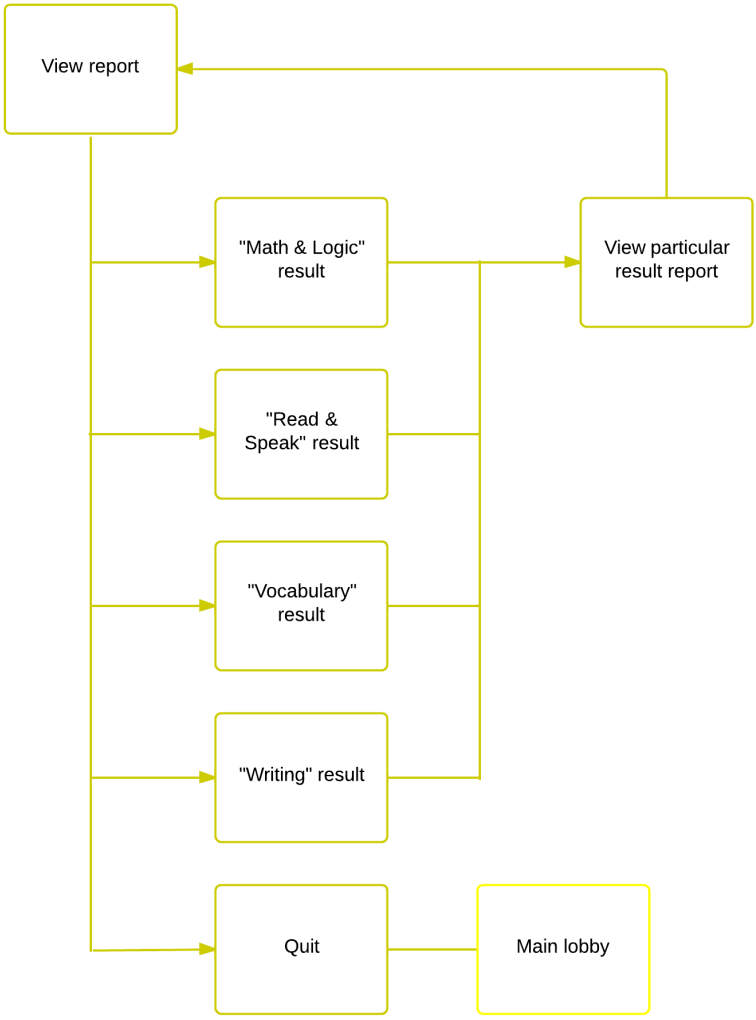
Appendix VIII: Flow chart of “Setting”

Flow chart of “Setting” session under parent’s account:



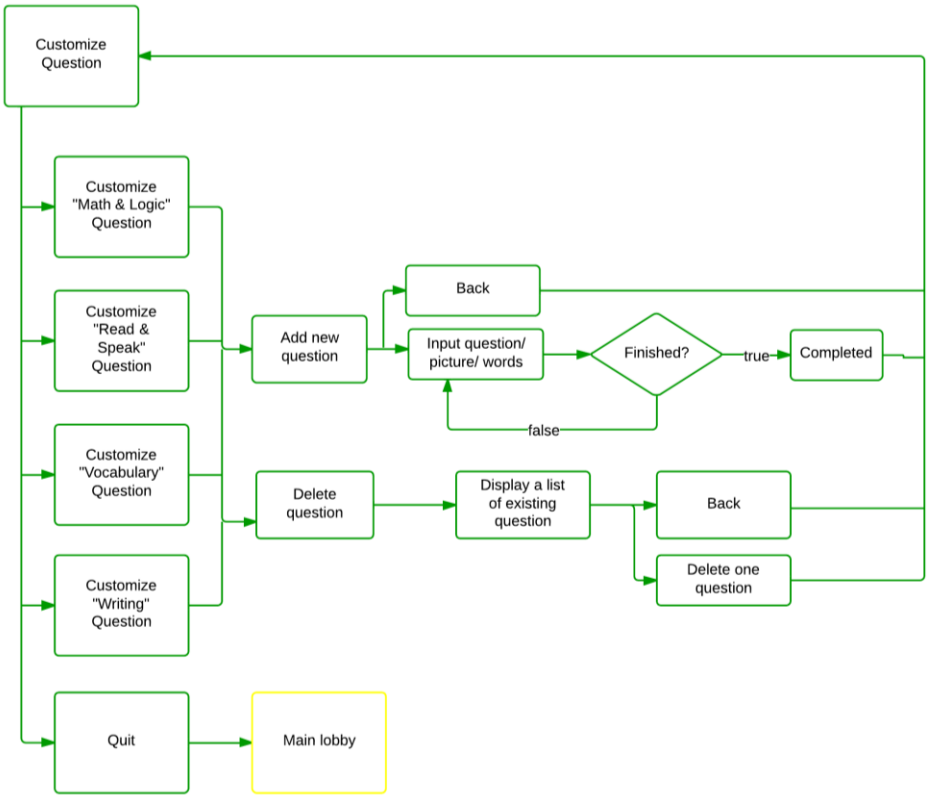
Appendix IX: Flow chart of “View Report”

Flow chart of “View report” under parent’s account:



Appendix X: Flow chart of “Customize Question”

Flow chart of “Customize Question” session under parent’s account:



Appendix XI: ER-diagram of Chatroom

ER-diagram of Chatroom for parent and children: