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Dissertation Title
Efficient Object-structure-based E-learning IOS App

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ABSTRACT

This project aims to build an E-learning app based on the requirement by a president of a college in Hong Kong. Target users of the app are primary school students and teachers. The destination of the app is to help them to enhance math-learning and teaching efficiency both in and after class. Besides, interaction pattern are considered during the design phase of the app. The tasks of building the app are separated into 3 parts: 1) Math-learning; 2) SVG controller; 3) Mind-map by our teaching assistant. I am responsible for the first part of the tasks. Therefore, I was involved in the design ideas, implementation, UI design and icons collection, testing, user research and feedbacks. Finally, our first version product called Skyapp 1.0 has been on the Apple store. And we are doing pilot test in two primary schools in Hong Kong.

Keywords: E-learning app, Interaction, Whiteboard, Primary school teachers and students

Table of Content

1 • Introduction.....	1
2 • Analysis of Problem.....	2
2.1 Generability.....	2
2.2 Math.....	3
2.3 Certain apps downloaded.....	4
3 • Theoretical Principles.....	5
3.1 Design.....	5
3.1 Implementation.....	7
3.3 Testing.....	8
4 • Method of Investigation.....	9
5 • Design and construction of software system.....	10
5.1 Use case.....	10
5.2 Senarios for each use case.....	10
6 • Theoretical/Algorithmic/Experimental results	21
7 • Discussion.....	30
8 • Conclusions.....	31
9 • Appendices.....	31
10 • Acknowledgements.....	31
11 • References.....	32

1. Introduction

Nowadays, as the Internet and electronic devices spread widely and fast all over the world, people in various fields begin to use them as tools to enhance their work and learning ability. Particularly in some developed countries and regions. In Hong Kong, there are some primary schools that will use iPads as learning devices for teachers and students in and after class. And this is where the product idea comes from or we would say that this is where the custom requirements come from.

Indeed, there are already some excellent products about e-learning in the market. They are summarized and recommended by American primary schools about ipad apps in sorted ways. After doing some research about these, I finally come to the idea of the “Whiteboard” element in our app. Thus, our app is based on the whiteboard to enhance learning and teaching efficiency. And our focus is on:

1. “Whiteboard” as a tool or interaction pattern for teachers and students; and users could use their hand to write on the board.
2. The application could recognize handwriting symbols automatically and transform them to electronic version;
3. The application could recognize some answers automatically and give hints to students;
4. The application could record the steps or footprints automatically of students using the iPad;
5. The application could visualize the data or steps and organize the data automatically to show students’ learning process, which is called “Mind-Map” in pedagogics domain.

2. Analysis of Problem

To design a good application, we need to do some research on the emerging products and do some comparison between them. So here we adopt a method called comparative analysis which also includes the summarization of the products.

2.1 Generality:

- 1) Keynote-Easy to do presentations, animated charts and transitions;
- 2) iMovie - create high-quality videos anywhere, anytime , in iPhone, iPod touch, iPad 2 can be used
- 3) Pages-production, editing, viewing file
- 4) Numbers-like Excel Spreadsheet Application
- 5) BrainPoP Featured Movie-Tim and Mobi humorous dialogue and animations mathematics, English, social, scientific and other knowledge, there are more than 750 movies, each movie has ended quiz(Quizzes), all have a complete dialogue English subtitles, but also there ESL (English as Second Language) content .
- 6) Non-free Whiteboard Lite--On-line real-time interactive whiteboard, iPhone, iPod touch, iPad can be used.
- 7) iBooks-eBook bookstore eClicker Client-interactive classroom software, teachers can in class for students to answer the question, the statistical results immediately, master degree students to understand
- 8) Comic Life- produced cartoons (Comic) Tools
- 9) TypeDrawing-Creation TYPOGRAPHY ART and add the photo WATERMARK artistic creation.
- 10) Animoto Videos- will the iPhone photo you add music into a professional a type of film, just a few minutes, you can share with your friends
- 11) Discovery Education-Educational videos
- 12) Mobile Mouse-Your iPad into a wireless mouse computer

- 13) Professor Garfield Cyberbullying-Garfield teach children how to safely use the Internet to determine the credibility of information, to avoid cyberbullying
- 14) Sundry Notes- a full-featured notebook software. Face the audience when the iPad VGA cable connected projector or television screen on the iPad up on the projector, you punctuate briefing on filling iPad, synchronous display, and let you do the briefing- Blackboard Presenter
- 15) Little artist HD-with finger drawing tool
- 16) Templates for Elementary Students- 15 file format to enable students to make a report or homework, finishing news.
- 17) Notability- will turn into a spoken text or take notes
- 18) TeachMe: for the kindergarten level, teach spelling, addition and subtraction within 10, so that children learn side collecting stickers, wall stickers can show and share.

2.2 Math

For math, especially for math-learning, is temporarily the most part of observation and research. The result is, the interests and the results of learning math will definitely enhanced using iPad applications. So we have summarized the emerging product below:

- 1) MathBoard – Learning Math (Add, Subtraction, Multiply, Division)
- 2) MATHsKOOL 1- 12 games to learn math skills, high grades suitable for primary school
- 3) Free Graphing Symbolic Calculator – Math Plots calculator Ruler-instant measurement plot size.
- 4) Math Quizzer- Interactive fun way to reinforce arithmetic skills
- 5) Ace Kids Math Games-animation to each children to count, add and subtract, there are incentives to enhance learning motivation
- 6) Math Bingo-bingo game will be fun to join mathematical exercise
- 7) iFactor quadratics- learn decomposition binary simple equation
- 8) eSolver HD- teach you the solution of binary linear equations

- 9) Math Flash Cards-the same as the conventional memory and lets you repeat enhance learning
- 10) Numerate: Count, Add and Subtract-interactive games teach you to learn to recognize numbers as well as simple addition and subtraction
- 11) MakeChange- practice counting and addition
- 12) Equation – quick and easy tool for the solution of binary linear quations
- 13) Park math- teaching preschool children to mathematical
- 14) Motion Math-you can guess from the name, it is in motion control iPad App, familiar concepts and estimation scores
- 15) Math Ninja Lite- learn and apply addition, subtraction and mixed computing tasks to achieve Ninja
- 16) Math Ninja HD- Another similar games, applications, addition, subtraction and mixing operations to reach ninja mission, to protect the tree house.
- 17) Motion Math Zoom-learning to count line (Number Line) and set up a numerical concepts.
- 18) Pizza Fractions-Pizza as an example to practice the concept of fractions.

2.3 Certain apps downloaded

The forestall summarization give us a very clear view of how our application should be designed. For better solution, I downloaded the following apps to my iPad:



These certain applications conform to some described characteristics in our apps. For example myscript calculator could recognize handwriting lines automatically and transform them to the electronic format. Besides, some of them include the recording function inside the apps.

In this report, I will elaborate every stage during the project: design, implementation, testing and user research for every part.

3. Theoretical Principles

3.1 Design

During the design process, it includes the user-interface design, icons collection, and the human-computer interaction design.

Before designing the application, we need to repeat the target functions of our apps. And in our case, we would like to help (1) teaching in the classroom and (2) self-directed learning at home. But no matter what we design, we follow the following design principles in our app.

1. More pupil-friendly interface: colorful and animation but learning than playing.
2. Control functions of the application makes the app much more usable for teachers to lock the students' actions.



3. Simple and clear
4. Modularity: for example, we may have calendar, play, course review, worksheets, testing

for students, communications with teachers and some other useful modules for the user interface.

5. Diagnostic test: The teacher gives the students tests to see their strong as well as week section of the math subject.
6. Navigation patterns: colorful right or left side navigation to browse subject in easy mode. (Equation, inequation, formula, variables, constants, numbers, functions, logarithms, integration, square,)
7. Main Content
8. Test
9. Report

For example, we have the application called XClass which has the control function. The main issue our application needs to solve is the interaction between teachers and students. So the whiteboard is to show some calculations to students in the projector and we would like to make the content in a modular manner and different modules have different shape and color to draw students' attention. We can classify the modules by "Time, "Content", etc. Besides, we could include IT resource library in our application.

What's more, we need to support learning at home for students for them to finish homework, reviewing lessons, doing tests and for teachers assign assignments, producing report and assessment about students.

So, finally the basic function is settled down to design a whiteboard for teachers to teach in class and save the notes for students to review after class.

And for user interaction design in our application, we follow the design tips for a great flexible user experience:

1. Progress message and indicator shows while the application loads;
2. A feedback message is displayed when an action is performed;

3. Match between system and the real world. The system should speak the users' language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order.
4. Organized as a library that contains your media library: music, movies, shows, audiobooks. Beneath the library is the store where you can buy more media to put in your library.
5. The branches and hierarchy of a mind map can be easily reorganized visually in a non-linear manner. An outline would never work, but this matches the paradigm exactly.
6. User control and freedom (NAVIGATION)
7. Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Supports undo and redo and a clear way to navigate.
8. Search is easy to open, enter info, execute or cancel.
9. Clearly marks where the person is and where they can go by showing the section in each menu.
10. Cell editing shows row and column ids, and the cells used in the equation. The equations could be saved and canceled.
11. Undo and redo buttons are available in the toolbar, and can also be accessed with the standard keyboard shortcuts.
12. Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.

3.2 Implementation

According to the ideas from design phase, we also have some implementation principles to illustrate.

For implementing better interaction results, we need a server to connect teachers and students and the application together. Special database needs to be designed during the implementation process.

In a word, all implementation steps need to conform to the design phases.

3.3 Testing

As testing is a imperative part of the agile development process, I've also been involved in the testing phase. We have a programmer who mainly writes codes for the application so that it will has high efficiency to separate the programming and testing apart, which means that testing and programming are done by two people.

In testing phase, I adopt a way called Unified Modeling Language concept. Though the Unified Modeling Language is a general-purpose modeling language in the field of software engineering, which is designed to prove a standard way to visualize the design of a system. The document included in it could be a better way to represent clear use cases, scenarios, steps in the testing document.

4. Method of Investigation

In agile software development, user research is also a critical part during the process. User research basics focus on understanding user behaviors, needs, and motivations through observation techniques, task analysis, and other feedback methodologies. Mike Kuniavsky further notes that it is “the process of understanding the impact of design on an audience.”

The types of user research you can or should perform will depend on the type of site system or app you are developing, your timeline and your environment.

Guided by the user-centered design process, we have following user research methods: card sorting, contextual interviews, first click testing, focus groups, Heuristic evaluation/expert review, individual interviews, parallel design, personas, prototyping, surveys, system usability scale, task analysis, usability testing, use cases.

In our whole process, we adopt use cases, usability testing, task analysis, personas, parallel design and focus groups.

Use cases: provide a description of how users use a particular feature of our application. They provide a detailed look at how users interact with the app, including the steps users take to accomplish each task, which we mainly use in our testing phase.

Usability testing: identifies user frustrations and problems with our applications through one-on-one sessions where a “real-life” user performs tasks on our app.

Task analysis-Involves learning about user goals, including what users want to do on our application, and helps us understand the tasks that users will perform on our app. We mainly do this in the design phase.

Personas: The creation of a representative user based on available data and user interviews. Though the personal details of the persona may be fiction, the information used to create the user type is not.

Parallel design- A design methodology that involves several designers pursuing the same effort simultaneously, but independently, with the intention to combine the best aspects of each for the ultimate solution.

Individual interviews: One-on-one discussions with users show you how a particular user works. They enable you to get detailed information about a user’s attitudes, desires, and experiences.

Focus groups-Moderated discussion with a group of users, allow you to learn about user attitudes, ideas, and desires.

5. Design and construction of hardware/software system

Below is the use case designed for the application:

5.1 Use case

Use case	Actor(s)	Description	Interaction Pattern
A math teacher	Teacher	Teacher could use the app to	Teacher

is preparing class work for Class 4A using SkyApp		prepare the content before the class	
A math teacher is teaching in class	Teacher	Teacher could use white board to teach in class and save the notes of the class.	Teacher->Class
The math teacher is delivering the classwork during/after class	Teacher Students	Teacher uses the whiteboard to give questions and distribute them to students	Teacher->Class/ Student
Answer Questions	Students	Student use whiteboards to answer questions and submit it to the teacher	Student->Teacher
Praise Students	Teacher/Students	Teacher could give icons to students by their performance on tests.	Teacher->Students
Facilitating sharing in the classroom	Teacher Student	Teacher uses the control panel to change the project to show students' work	Teacher->Class Student->Class
Presentation of the students' data objects	Teacher Students	Students use mindmap to find the reviewing classes	Students
Game	Teacher Student	Teacher assigns students to play a game	Complex and multiple

5.2 Scenarios for each use case

5.2.1 Prepare Class Work

Use Case Name	A math teacher is preparing class work for Class 4A using SkyApp
Actor(s):	Teacher
Description:	Teacher could use white board to prepare notes for the class
Reference:	SkyApp

Typical Course of Events (Scenarios):	Actor Action	System response:
	<p>Step 1: Initiate this use case when the teacher logs in. Teacher inputs account and password that have been stored in the database, chooses language mode and clicks login button.</p>	
	<p>Step 3: Teacher clicks the “add” button to add a new whiteboard.</p>	<p>Step 2: The app goes to the “Main View” page.</p>
	<p>Step 5: Teacher clicks the whiteboard.</p>	<p>Step 4: The app shows a whiteboard on the left top corner.</p>
	<p>Step 7: Teacher clicks the “draw” button and draw on the whiteboard and clicks “finish”.</p>	<p>Step 6: The app goes to the “Note View”.</p>
	<p>Step 9: Teacher clicks the “add picture” button to add a picture from the gallery.</p>	<p>Step 8: The app shows the drawing on the whiteboard.</p>
	<p>Step 11: Teacher clicks “add text” button and inputs the text and clicks “Done” to add a text.</p>	<p>Step 10: The app shows the picture on the left top corner on the whiteboard.</p>
	<p>Step 13: Teacher clicks “internet” button to use the internet.</p>	<p>Step 12: The app shows the text on the left top corner</p>
	<p>Step 14: Teacher clicks the “camera” button to take a picture of the document.</p>	
	<p>Step 16: Teacher clicks “save” to save the notes to database.</p>	<p>Step 15: The app shows the picture of the document on the left top corner.</p>
	<p>Step 18: Teacher clicks “back” button to go back to the “Main View”</p>	<p>Step 17: The app shows the success message.</p>

Alternative courses	None
Pre-conditions:	The teacher logs in successfully.
Post-condition:	Teacher has successfully created new note.
Assumptions:	None
Remarks:	For every object the teacher adds on the whiteboard, he/she could single click or “long press” it to edit.

2. Teach In Class

Use Case Name	A math teacher is teaching in class	
Actor(s):	Teacher	
Description:	Teacher could use white board and the projector to show the notes and teach in class as a real-life blackboard.	
Reference:	SkyApp	
Typical Course of Events (Scenarios):	<p>Actor Action</p> <p>1. Teacher connects the ipad with the projector.</p> <p>2. The following steps are the same with the use case “prepare class work”</p>	<p>System response:</p> <p>The steps are the same with the use case “prepare class work”</p>
Alternative courses	In step 16, teacher could choose not to save the note for class, and clicks “back button. The app will show a message, teacher clicks “yes” and goes back to the “Main View” page.	
Pre-conditions:	The teacher finished the use case “prepare for the class”	
Post-condition:	Teacher has successfully taught the class using the whiteboard the projector.	
Assumptions:	None	
Remarks:	For every object the teacher adds on the whiteboard, he/she could single click or “long press” it to edit.	

5.2.2 Delivering Class Work In/After Class

Use Case Name	A math teacher is teaching in class
Actor(s):	Teacher & Students
Description:	Teacher assigns exercise and tests in class.
Reference:	SkyApp

Typical Course of Events (Scenarios):	<p>Actor Action</p> <p>Step 1: Teacher finished the steps in the use case “Prepare for the class”.</p> <p>Step 2: Teacher clicks the “draw” button to give questions to students.</p> <p>Step 3: Teacher clicks “teacher mode” button to choose “Open answer” and then clicks “OK”.</p> <p>Step 5: Teacher clicks the “answer box” button in red and put it to cover the text.</p> <p>Step 6: Teacher clicks the answer box to give answer</p> <p>Step 7: Teacher clicks “hide all answers”</p> <p>Step 9: Teacher clicks “distribute” and choose a group, then clicks “distribute” at the bottom.</p>	<p>System response:</p> <p>Step 4: The app shows a successful message. The “teacher mode” button changes into “distribute” button and is in gray. At the bottom, the tool bar shows “answers” button in gray.</p> <p>Step 8: The answer box shows the “lock”</p> <p>Step 10: The app shows a successful message.</p>
Alternative courses	<p>In Step 2, teacher could also 1) Clicks “text” button to type something on the whiteboard; 2) Clicks “gallery” button to choose a picture from the iPad; 3) Clicks “camera” button to take a picture.</p> <p>In Step 6, if the teacher forgets to give the answer in the answer box, clicks the “hide all answers” button and clicks “distribute”, the app will show a alert message. And the locked answer box will become editable.</p> <p>In Step 9, if the teacher forgets to choose a group, and clicks “distribute”, the app will show an alert message “Please choose a group.”</p>	
Pre-conditions:	<p>The teacher goes through the steps he/she needs in the use case “prepare for the class”.</p>	

Post-condition:	Teacher has successfully distribute the exercise/test to the target students.
Assumptions:	Followed by the use case “ Students answer questions. ”
Remarks:	For every object the teacher adds on the whiteboard, he/she could single click, double click or “long press” it to edit.

5.2.3 Student Answer Questions

Use Case Name	The students do the exercise/tests given by their teacher.	
Actor(s):	Students	
Description:	In students mode, students could do the exercise and tests given by teachers.	
Reference:	SkyApp	
Typical Course of Events (Scenarios):	<p>Actor Action</p> <p>Step 1: Student-Tansy logs in and enters to the “Main View” page.</p> <p>Step 3: Tansy clicks on a whiteboard to open the exercise.</p> <p>Step 4: Tansy double clicks the answer box and type in the answer.</p> <p>Step 5: Tansy clicks “save” button to save the answer.</p> <p>Step 6: Tansy clicks “back” button to go to the “Main View” page.</p>	<p>System response:</p> <p>Step 2: The app shows the exercise with a tag on the left top corner of the whiteboards.</p> <p>Step 7: The app changes the “question” tab to “answered already”.</p>
Alternative courses	<p>In the use case “prepare for the class”, Step 3, if teacher chooses the answer to be “fill in the blanks”, in this use case, step 2, the app will show the “question” and “testing” tab on the whiteboard.</p> <p>Still, in Step 5, if students clicks “submit”, and typed in the right answer, the app will show a message “You’re right.” But if the answer is wrong, the message will show you are wrong and let you try it again.</p>	
Pre-conditions:	The teacher distributes the questions to students successfully.	
Post-condition:	Students finish the questions given by teachers.	
Assumptions:	Followed by the use case “ Praise Students ”.	
Remarks:	For every object the teacher adds on the whiteboard, he/she could single click or “long press” it to edit.	

5.2.4 Give Praise to Students

Use Case Name	A math teacher gives praise to students	
Actor(s):	Teacher Students	
Description:	Teacher could give students praise by looking at their performance on tests.	
Reference:	SkyApp	
Typical Course of Events (Scenarios):	<p>Actor Action</p> <p>Step 1: Teacher goes to the “Note View” page.</p> <p>Step 2: Teacher clicks “Performance” icon.</p> <p>Step 4: Teacher clicks “view” button to see the students’ answers.</p> <p>Step 5: Teacher clicks the “back” button to go to the “Note View” page.</p> <p>Step 6: Teacher clicks “distribute” and choose a group and a gift, then clicks “OK”.</p>	<p>System response:</p> <p>Step 3: The app could calculate the marks, trials, and time automatically and show the results on the window.</p> <p>Step 7: The app shows a success message.</p>
Alternative courses	None	
Pre-conditions:	Students have already submitted the answers to teachers.	
Post-condition:	Students receive the icons teachers send to them.	
Assumptions:	None	
Remarks:	For every object the teacher adds on the whiteboard, he/she could single click or “long press” it to edit. I think this kind of user experience is a little bit uncomfortable.	

5.3 Application work flow

Then the following images show the pages of the application: the login page for both teachers and students. Teachers’ and students’ accounts have been stored in the database. There are 2 language modes: Complex Chinese and English for users to choose.

天空 SkyApp

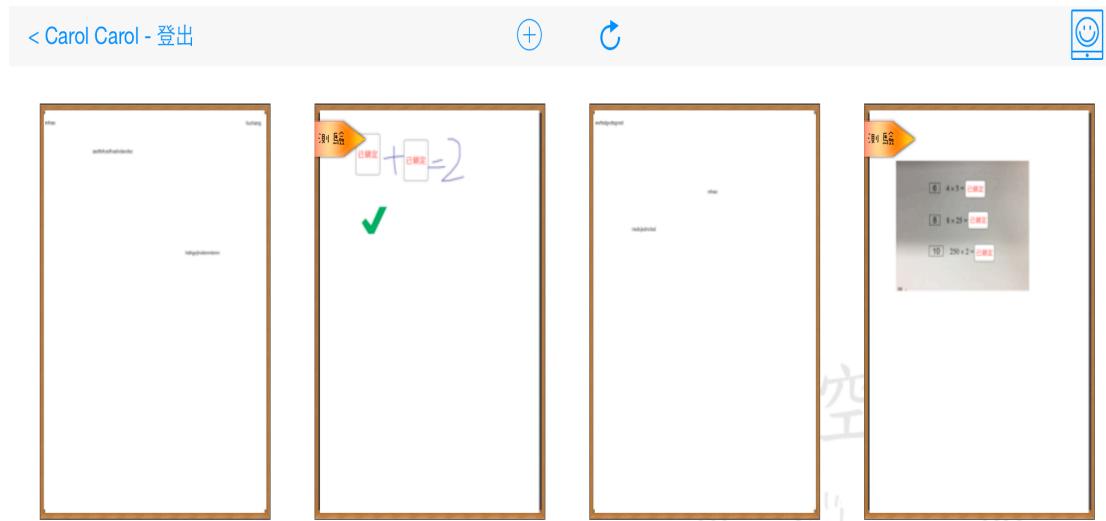
帳戶 (Account):

密碼 (Password):

語言 (Language): 中文 English

登入 (Login)

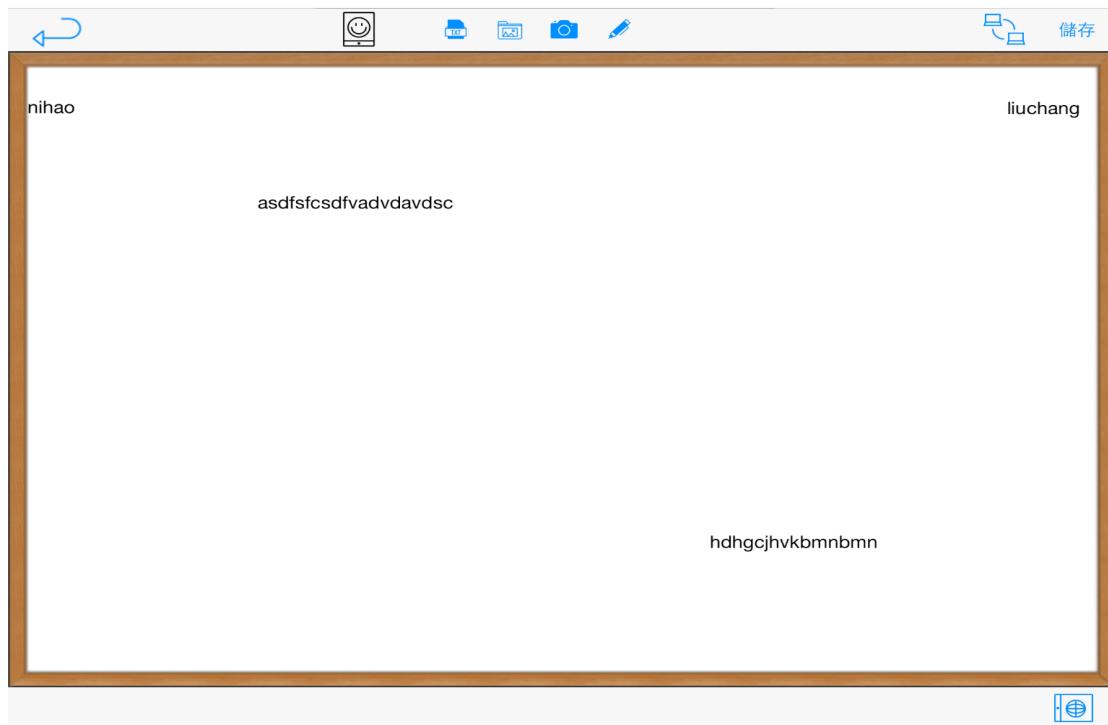
The following image shows the main page of the application. It includes the “logout” button, the user’s name, the “add board” button, the “refresh” button, and the “achievement” button.



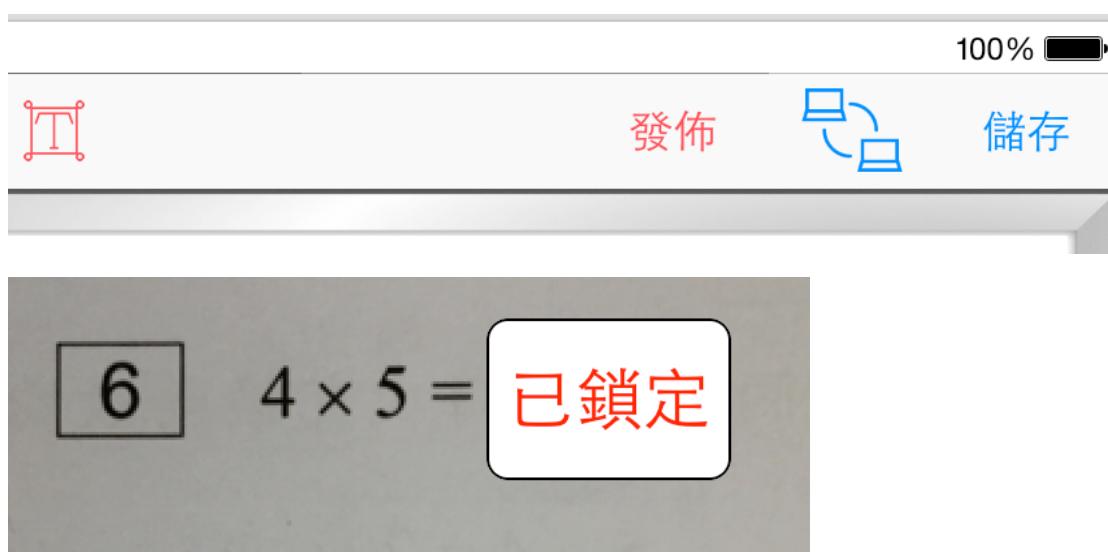
From above picture, we could see that there are tags on the left top corner of the “whiteboard” button, which are decided by teachers when teachers assign tests or exercises to students.

Then, after clicking on the “whiteboard” button, the following page will show up which is called “whiteboard” page. On this page, you could do any operations you want on it by choosing “draw”, “add text”, “take a picture” or choose pictures from gallery” buttons. Besides, on the right bottom corner, there is an inside-app browser for users to search for useful information. This page shows only the teacher-mode whiteboard, because on the right top

corner of this page, there is only “point-to-point” transformation and “save” function which means teacher could choose to save the note or not and assign the note to individual student.



And after saving the notes to the database, and then come back, teachers could modify the questions on the whiteboard like shown below. There is a small answer box to hide the answer and lock the answer for students to think about. Then there is a “distribute” button for teachers to assign the work to target learning groups.





The above pictures show the functions of certain buttons. For example, the “point-to-point” transformation button, different button functions for teacher and students mode.

Besides, after students finishing answering the questions, teachers could see the result of their answers and recording of their answering: time consuming, student, marks, feelings about the tasks, trials, and the groups they belong to for teachers to understand more about the students and conduct much more efficient teaching plan in the future.

Group	Student	Marks	Feeling	Trials	Time Taken	
HKU Develop Team	Tansy Tansy	0		0	0	View
HKU Develop Team	Carol Carol	0		0	0	View
HKU Develop Team	Ying Ying	3		2	34	View
Group	Student	Marks	Feeling	Trials	Time Taken	
HKU Develop Team	Tansy Tansy	0		0	0	View
HKU Develop Team	Carol Carol	3		1	19	View
HKU Develop Team	Ying Ying	0		0	0	View

[顯示所有答案](#)
 [隱藏所有答案](#)


Then it comes to the most part in our application-reward and “gamification”.

The following page shows the gifts list chosen by teachers. If the students’ answers are correct, then they could get an icon chosen by teachers in advance.- Which is shown in the next picture.

選擇一份禮物給答對的學生(不選也可)



Gift Number: 1

Gift Number: 2

Gift Number: 3

Gift Number: 4

發佈

NO. 1



NO. 2



NO. 3



NO. 4



NO. 5



NO. 6



NO. 7



NO. 8



6. Theoretical/Algorithmic/Experimental results

6.1. Testing server

6.1.1 Xcode

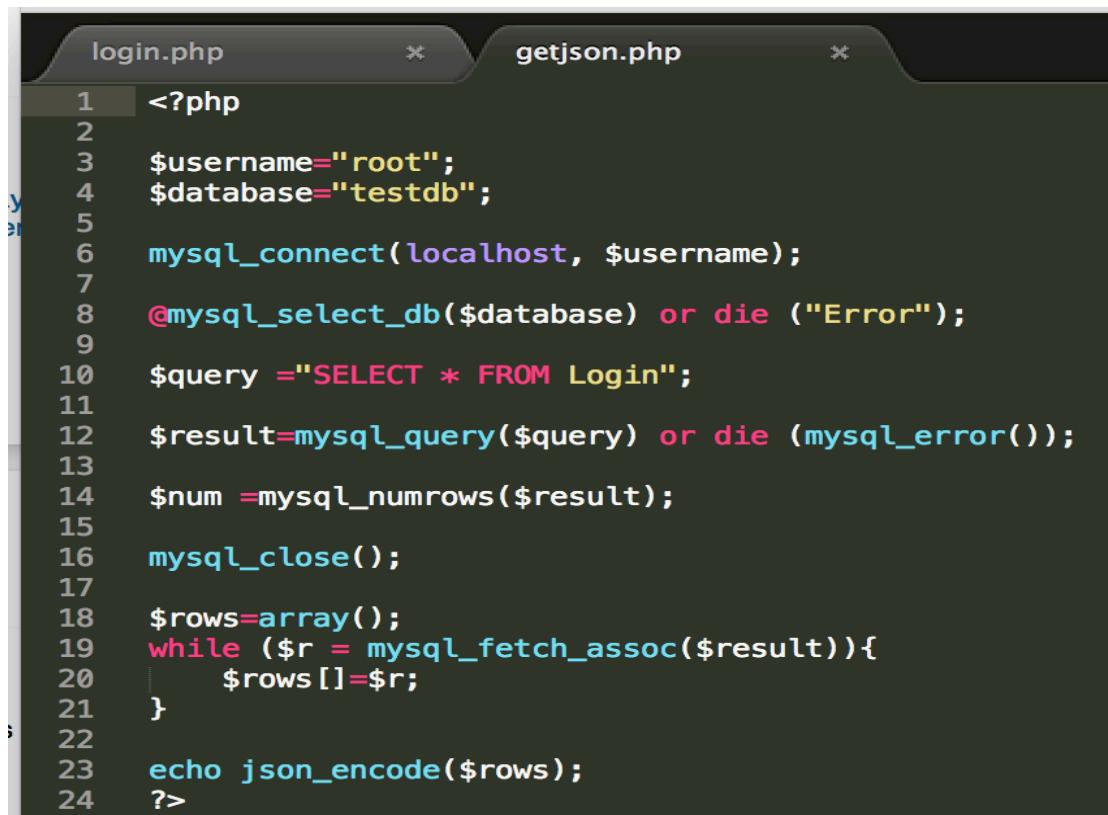
```

1 #define kPostURL @"http://localhost/testingServer/Login.php"
2 #define kName @"name"
3 #define kPass @"password"
4
5 -(void) postMessage:(NSString*) password withName:(NSString *) name{
6     if(name !=nil&& password !=nil){
7         NSMutableString *postString =[NSMutableString stringWithString:kPostURL];
8         [postString appendString:[NSString stringWithFormat:@"?%@=%@", kName,name]];
9         NSLog(@"%@",kName);
10        [postString appendString:[NSString stringWithFormat:@"&%@=%@", kPass,password]];
11        NSLog(@"%@",kPass);
12        [postString setString:[postString stringByAddingPercentEscapesUsingEncoding:NSUTF8StringEncoding]];
13        NSMutableURLRequest *request=[[NSMutableURLRequest alloc] initWithURL:[NSURL URLWithString:postString]];
14        [request setHTTPMethod:@"POST"];
15        postConnection=[[NSURLConnection alloc] initWithRequest:request delegate:self startImmediately:YES];
16    }
17}

```

6.1.2 PHP

Besides, we need to connect the codes in xcode with php server and implement basic functions in the php file:



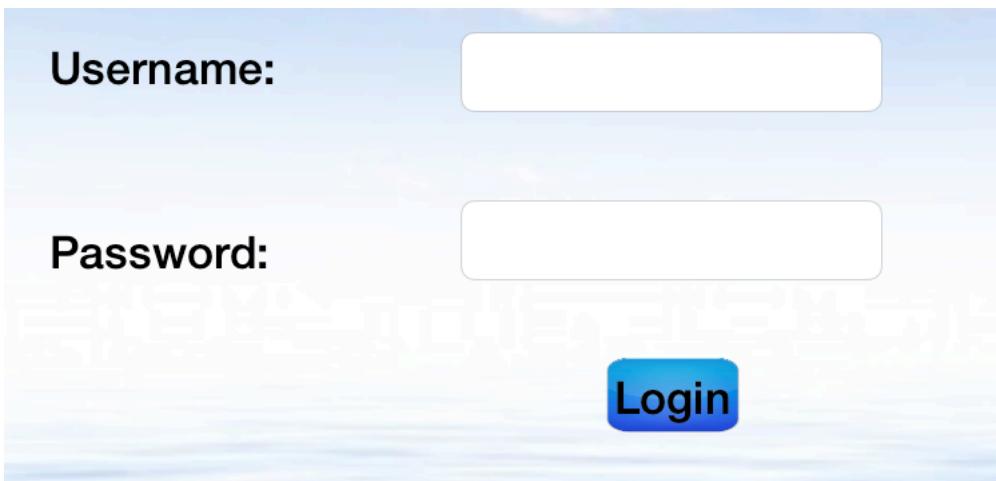
The screenshot shows two tabs in Xcode: "login.php" and "getjson.php". The "login.php" tab is active, displaying the following PHP code:

```

1 <?php
2
3 $username="root";
4 $database="testdb";
5
6 mysql_connect(localhost, $username);
7
8 @mysql_select_db($database) or die ("Error");
9
10 $query ="SELECT * FROM Login";
11
12 $result=mysql_query($query) or die (mysql_error());
13
14 $num =mysql_numrows($result);
15
16 mysql_close();
17
18 $rows=array();
19 while ($r = mysql_fetch_assoc($result)){
20     $rows []=$r;
21 }
22
23 echo json_encode($rows);
24 ?>

```

The result is like this: after inputting the username and password into the login page, the database will record the username and password in pairs.



+ Options

			id	name	password
<input type="checkbox"/>			1	Tansy	123
<input type="checkbox"/>			2	Leo	123
<input type="checkbox"/>			3	Carol	123
<input type="checkbox"/>			4	Lucas	123
<input type="checkbox"/>			5	chim	123

Check All / Uncheck All With selected:

6.2 “Add Button” function

```
- (IBAction)addButtonClicked:(UIBarButtonItem *)sender {
    NSLog(@"addButtonClicked");
    [self processAddButton];
}
```

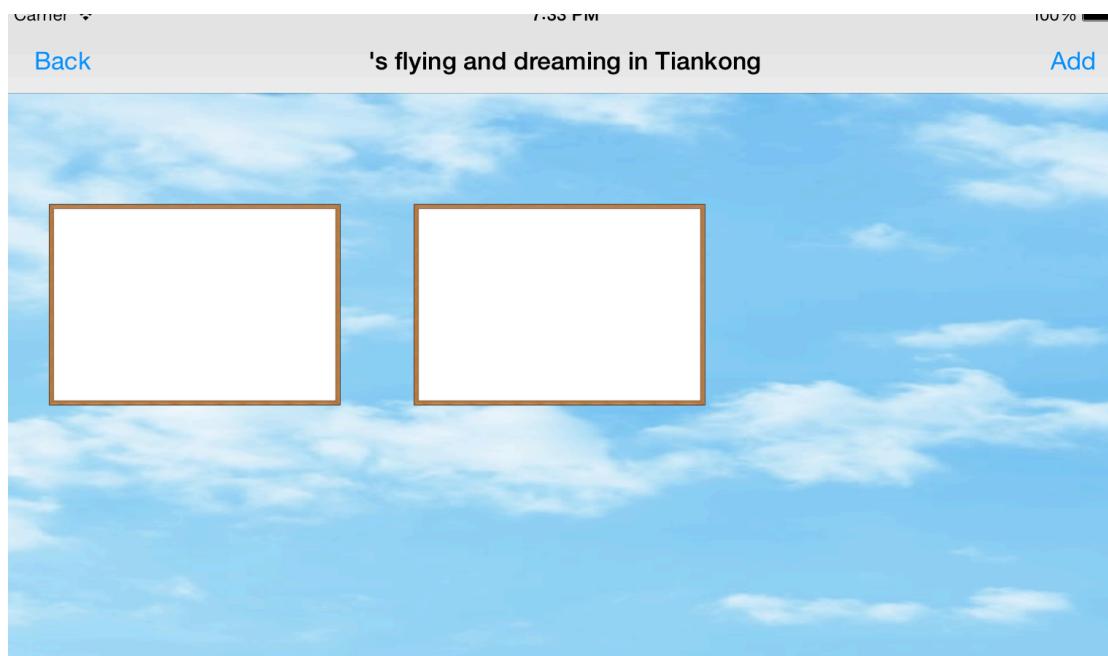
```

-(void) processAddButton{
    boardsNumber=boardsNumber+1;
    int i;
    for (i=0; i<boardsNumber; i++) {
        NSLog(@"processAddButton");
        // create button object
        UIButton * button =[UIButton buttonWithType:UIButtonTypeSystem];
        //set button size
        [button sizeToFit];
        CGRect buttonFrame =button.frame;
        buttonFrame.size=CGSizeMake(200, 138);
        button.frame=buttonFrame;
        //set background image
        [button setBackgroundImage:[UIImage imageNamed:@"whiteboard.png"]forState:UIControlStateNormal];
        // set button center
        button.center=CGPointMake(130+250*(i%4),145+205*(i/4));
        [self.view addSubview:button]; //显示button在view上
        [button addTarget:self action:@selector(whiteBoardButton:) forControlEvents:
            UIControlEventTouchUpInside];
        NSLog(@"action successful");
        UILongPressGestureRecognizer * longPress=[[UILongPressGestureRecognizer alloc] initWithTarget:self
            action:@selector(handleLongPress:)];
        longPress.minimumPressDuration=1;
        [button addGestureRecognizer:longPress];

        if (boardsNumber>=13) {
            NSLog(@"SORRY!");
            UIAlertView *alert = [[UIAlertView alloc] initWithTitle:@"Adding Whiteboards Warning"
                message:@"You can only add 12 whiteboards at
                most now ! "
                delegate:nil
                cancelButtonTitle:@"OK"
                otherButtonTitles:nil];
            [alert show];
            break;
        }
    }
}

```

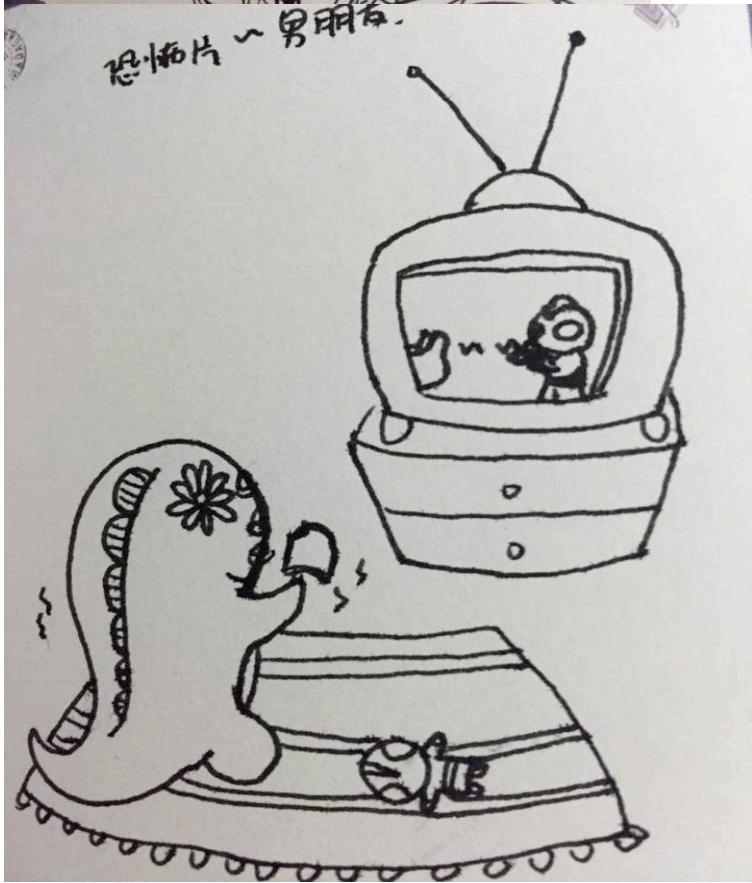
The result is as follows:



In this case, only 12 whiteboards could be added on this main page.

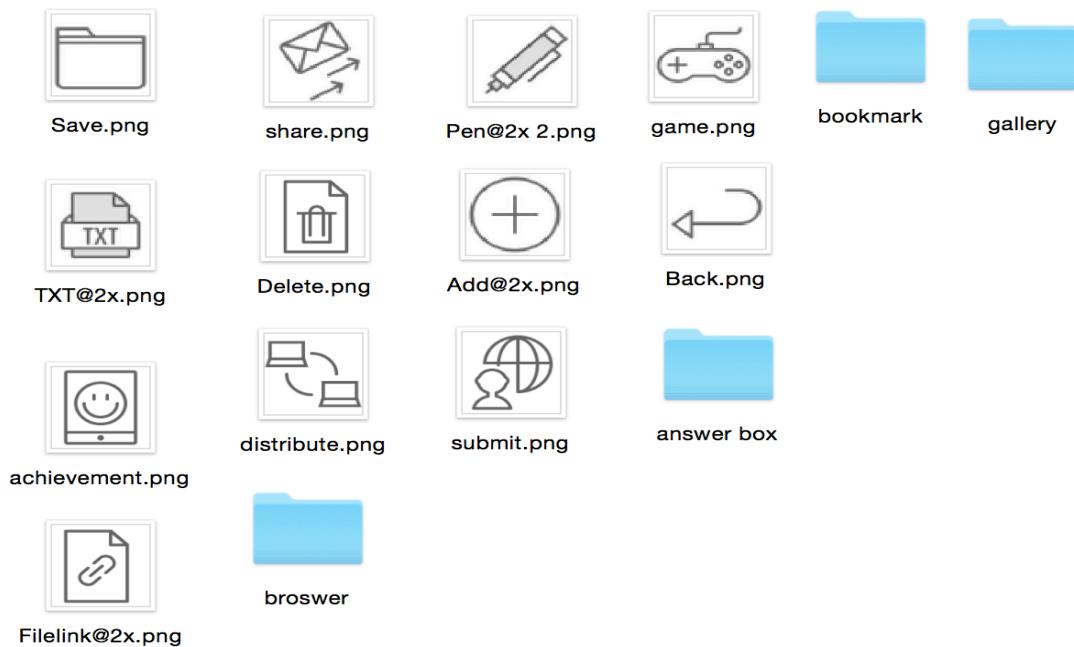
6.2 Icons drawn and collection:

For better interest for primary school students, I drew some animation characteristics:







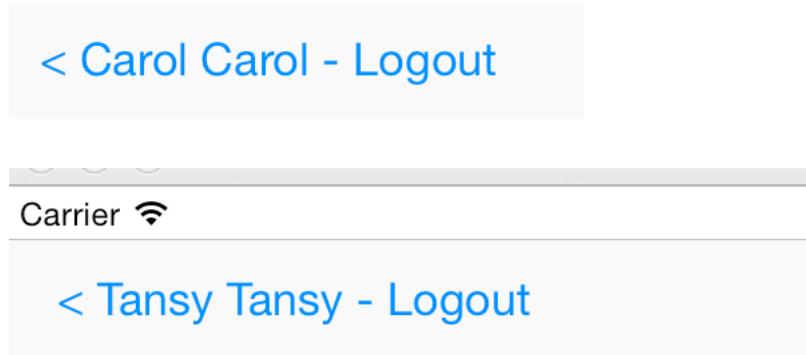


The previous icons are standard icons of various format I bought on the internet.

6.3 Testing

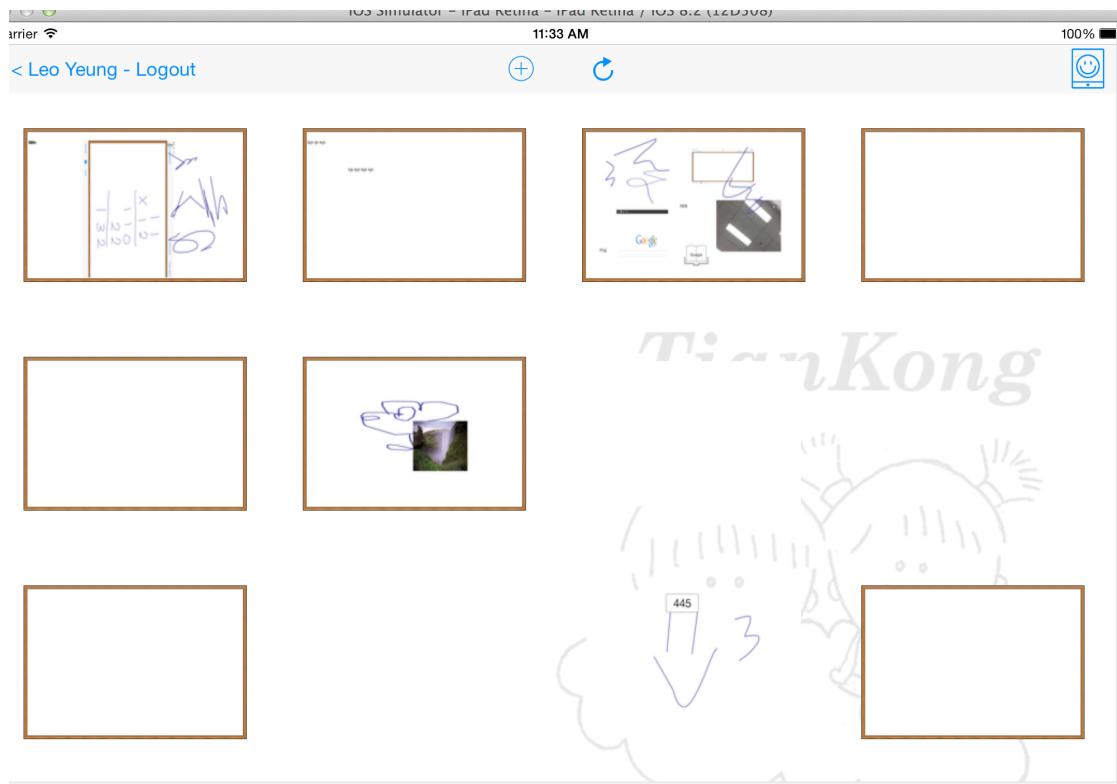
After iterative testing, we have several bugs below:

1. Account's name: iterative names

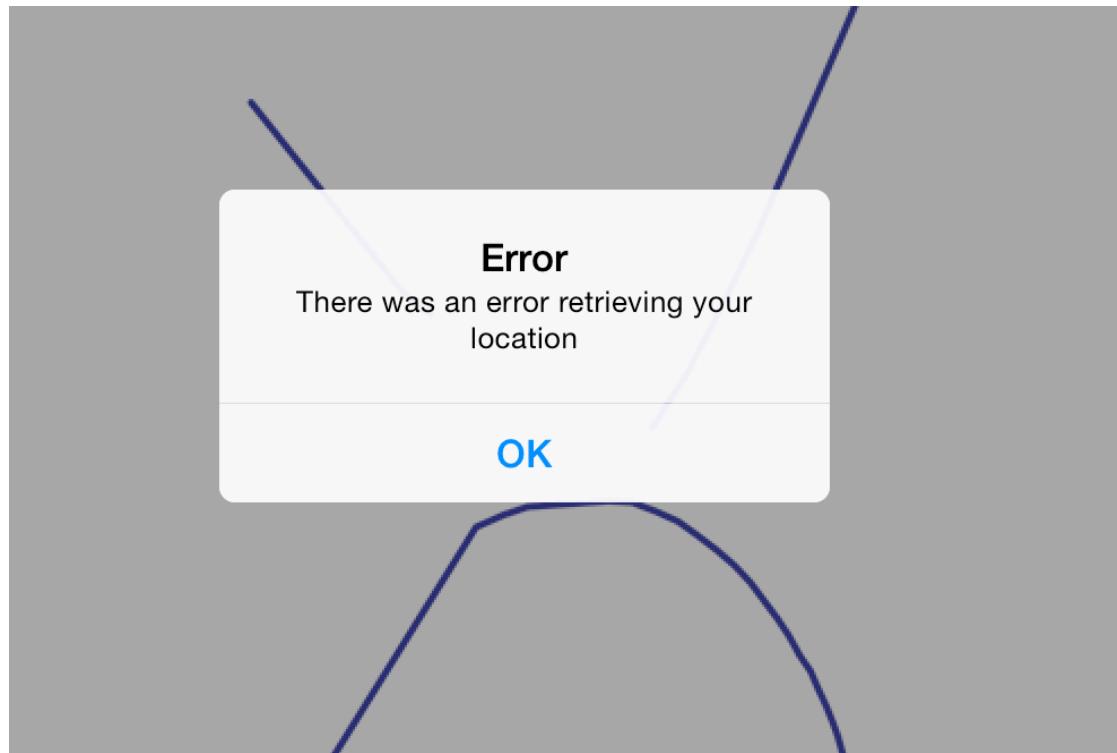


2. When I log in as Leo:

After clicking the “add” button:



3. Whenever I enter into a new page, this alert window comes out:



7. Discussion

From previous analysis, we could say that for inputting methods:

- 1) You can draw and express whatever you want with enough space and pages, teachers and students could imitate, invent any symbols or use any ways to express their questions, answers, ideas and etc. They can use their imagination like flying freely in the sky.
- 2) Gulf evaluation and execution time are shorter: There is only one action to do: drawing. So obviously, it is much simpler and more convenient for primary school students to use.
- 3) Besides, we also would like to design some ready-made shapes like circle, cube, coordinate axis, and some elementary symbols for teachers and students to use and also for better user interface.

For interaction patterns:

As the interaction is the main issue we need to solve for teachers and students, certain design patterns are need to be designed.

Our design is based on the whiteboard due to the drawing function in the first part about input method. The interaction pattern consists of teacher to class, teacher to single student, student to student, students to class. Basically, we need a server to store data, to change information, and to do the communication actions. The concept is like that: teachers distribute questions or tasks on whiteboard using drawing method, in the meanwhile, enrolled students will receive the questions and answer them on whiteboards, submit it to server. After that, teacher will receive the answer and could see the process, he/she then gives grades, comments and feedbacks to students. As we can see, both actions could be done in and after class.

For “Gamification”:

It is quite a new concept I learned in the “User Interface Design” class, but I do believe that it is an excellent element and solution to our problem and app. There are some reasons for it: 1.

Children love game; 2. It makes class more interesting; 3. It better enhances efficiency in learning; 4. It makes teachers much more relax when teaching a class. 5. It is practical, better combines the theory with real life.

However, game may also distract students from class and learning language. When teachers are using it, he/she must pay more attention to students and way of doing it. And that makes the design of game in the app a very crucial part.

Some good gamification examples and ideas are: 1. We can use poker cards to represent numbers; 2. We use prize system and interesting icons for students to collect. And more fascinating ideas are to be designed.

8. Conclusions

To enhance math learning, we use “drawing” method, whiteboard interaction pattern, and “Gamification in our app. All design ideas we do is for better user interface, user interaction, and achieve better efficiency in learning. In a word, we help teachers to teach, we help students to learn. And most importantly, after having interviews with teachers from primary school in Hong Kong, we got positive user feedbacks and will revise our applications in future.

9. Appendices

Software we use: xcode, xampp, filezilla, phpadmin

10. Acknowledgements

The completion of this undertaking could not have been possible without the participation and assistance of my supervisor Dr.Lucas. C.K. Hui, my teaching assistant Leo Yeung Cheuk Yu and the outside supervisor Dr.Shum. Their contributions are sincerely appreciated and gratefully acknowledged. To all my fellow students, doctors and TAs, who in on way or another shared their support, either morally, financially or physically, thank you.

11. References

1. There are some good apps to refer to: such as “BaiBoard”, “Educreations”, “Jot! Whiteboard Free”, “Math Animations”, “MyScript Calculation”, “ShowMe Interaction Whiteboard”, “Nearpod (From Dr.Shum)”
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8. E-learning methodologies A guide for designing and developing e-learning courses
9. DESIGN AND DEVELOPMENT OF MOBILE LEARNING APPLICATION Maryam Farahmand Khanghah¹, Siti Hajar Binti Halili²