

The University of Hong Kong

CAES9542 Technical English for Computer Science

Final Report

Topic: An e-learning platform for teaching JavaScript and React Native

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Abstract

This paper introduces an e-learning platform that teaches beginners on writing JavaScript and React Native. The platform is trying to promote programming and encourage people to write codes by providing interesting tutorials of the two programming languages. People can learn the programming scripts and test their knowledge by playing the mini games. The platform also provides functions such as registering as member. It makes use of colorful design and relevant images to attract users. Moreover, this paper compares other e-learning platforms and summarizes the features that worth for referencing. All technical designs are then discussed with the finished implementation of the platform, including the design for user interface, database, tutorial and test cases. There are also multiple tests on the various functions and tutorials of the platform. The paper ends with the discussion on the constraints and future development of the project.

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1 Introduction

This chapter provides a general perspective on the project. It explains the motivation and benefits of the project, and indicates the main features. Scope and deliverables are also clearly stated in this chapter, in order to advance the development of the project.

1.1 Background

In the digital age, computers and smart devices are prevalent. People use them to play games, browse social networking sites or search learning resources. Although they spend lots of time on using the software or websites, the majority may not know how those functions actually work. People are usually scared of programming and have a stereotype that writing codes is complicated and boring. However, it is necessary for modern people to get in touch with programming. By understanding the operations of computers, people can use the machines in a more effective way and develop a sense of computational thinking. Computers are different from humans, it only follows the step-by-step instructions and executes correspondingly. All powerful functions are actually the sequences of commands. When people encounter a complicated problem, computational thinking helps them to divide the problem into small pieces which will be easier to solve. This technique can be applied in any discipline including commerce, archeology and music. For example, people engaged in commerce can investigate the market rules by computational analysis, thereby making a better decision [1]. Therefore, computational thinking is a skill that is beneficial and worthwhile for wide promotion.

Career-wise, people who know programming have the advantages over the others. In United States, 8 of the top 25 jobs are related to technology, including mobile developer and software engineer.

These jobs have high salaries and better career opportunities, while the market is also seeking for IT professionals and engineers [2]. In Hong Kong, there is also a rising demand on software and network engineers. Since the development of Hong Kong highly relies on the financial industry, the transformation of business models will directly affect the job market. When the companies are making everything online and digital, they need to hire more computer scientists for technical support, including data analysts. Therefore, encouraging the students to learn programming is not only beneficial to their future career, but also helping the sustainable development of Hong Kong society.

1.2 Objective

This project aims to enhance people's learning motivation of programming. Since the target user of the platform will be the general public who are beginners as a programmer, it will consider the user experience for both old and young people. Through the use of multimedia and games, the platform will be able to attract users in different age groups. Furthermore, knowledge checkpoints are also included to ensure the user has fully understood the codes.

In the long term, this project also tries to promote the importance of programming in Hong Kong. At this moment, many people still are not aware of how computer science will affect their daily lives and do not interest in computer science. This project offers a more interesting way of studying programming to people and tries to help changing people's attitude towards computer science.

1.3 Scope

E-learning is a popular issue and many educational organizations make an effort to make study easier for everyone. Instead of traditional studying that students need to sit in a classroom and listen to the teachers, e-learning allows students from all ages to study anywhere at anytime. For example, the Chinese University has set up an e-learning center that converts the learning materials of engineering and mathematics courses into e-learning formats and makes them accessible to secondary students [3]. It helps promoting self-learning and encourages students to study on their own.

This project can be regarded as a realization of e-learning that creates an interesting learning experience for beginners on programming. The application provides organized and interactive tutorials that help the user to understand and practice the programming scripts. It also generates a feedback report automatically for checking the learning performance. In addition, the application contains a membership system and allows the user to search for a particular tutorial. It also applies gamification features and academic knowledge into the tutorials in order to keep the balance between studying and entertaining.

1.4 Deliverables

The application consists of two parts: the tutorials and the user interface. Both the well-designed tutorials and the user-friendly interface aim to enhance the user experience for users in any age group and maximize the effectiveness of learning programming. In this stage, this project will only focus on teaching JavaScript and React Native. These two languages are suitable for beginners to

get started with programming because their syntaxes are easy to understand. They also have a similar scripting style and users can choose to learn them together or separately depending on their personal interests. Moreover, the tutorials will contain some mini games. The user need to achieve specific goals to go through the whole tutorial. This design can give a sense of satisfaction to the user and thereby enhancing their motivations to complete the games and study more about the language. After finishing a tutorial, the user will obtain a congratulation message as what they will receive when playing games. In addition, each tutorial is designed to be able to finish within 30 minutes, which cater for the fast pace of living of Hong Kong people.

In order to have a better management of the tutorials, the platform uses different tags to classify the tutorials. The scripts will be divided into different groups by their functions. For instance, 'for loop' and 'while loop' will be grouped together under 'JavaScript looping'. The groups will also be sorted by their difficulties. The easiest tutorial will be shown at the top of the list. This helps improving the user experience by studying from easy level to difficult level. Due to the time constraint, there will be only one tutorial for JavaScript and React Native respectively.

A login system and registration system will also be implemented to manage the accounts. There are two kinds of accounts: student and teacher account. The study performance will be stored for a student, while the teacher account may be allowed to add a tutorial for the platform in the future.

The interface is user-friendly with clear navigations and pleasant design. There are instructions for each function of the platform and each step in the tutorials. Contrasting colors and multimedia are also used to increase the readability.

At the current stage, this project only focuses on developing the computer version of the application. It adopts the display resolution of 1024 X 768, which is an option provided by Unity and can achieve a good user experience. A larger screen size allows more information to be displayed in a single page. Therefore, it is more convenient for user to study the codes with examples and multimedia.

In the remaining parts of this paper, it will provide a literature review of the project, and then discuss the methodology and implementation of the platform. The literature review chapter compares the features of two existing e-learning platforms, Scratch and W3Schools.com in section 2.1 and 2.2 respectively. In the methodology chapter, it introduces the software used in section 3.1, and then presents the designs of tutorials, user interface, database and security system. Next, the results of testing and constraints will be discussed in chapter 4. Finally, the paper will end by providing the future plan of the project and giving a short conclusion.

2 Literature review

In the researching stage, the study on other e-learning platforms was served as an inspiration of the design and development of the project. There are many famous platforms teaching computer science and programming, such as Scratch, W3Schools.com and Code.Org. This chapter lists their main features and introduces the similar elements that were applied into the platform.

2.1 Scratch

The greatest feature of Scratch is the powerful functions that allow the user to show their creativity. Without downloading any software, users can write a program by moving or combining the blocks on this online platform. They can work individually or cooperate with friends. The platform also provides tutorials of some simple games, including catch game and hide and seek. Users can follow the clear instructions to create their own games and make changes to the original design.

Figure 2 is the environment when the user is creating a new project in Scratch. The page is divided into several parts with different functions, including the navigation bar, the stage, the block palette and the script area. The scripts are grouped by their functions, such as 'Sound' and 'Operators'. If the user chooses to follow the step-by-step tutorial, there will be clear instructions with text and animations. These designs will be implemented into the platform to help beginners getting familiar with the platform in a short time. Meanwhile, an output area also contributes to the learning of beginners. Since the platform can compile the codes and show the result immediately, it helps the user to understand how the scripts actually work in a website or an application. The color palette of grey and blue is also worth for referencing as a comfortable design in user interface.

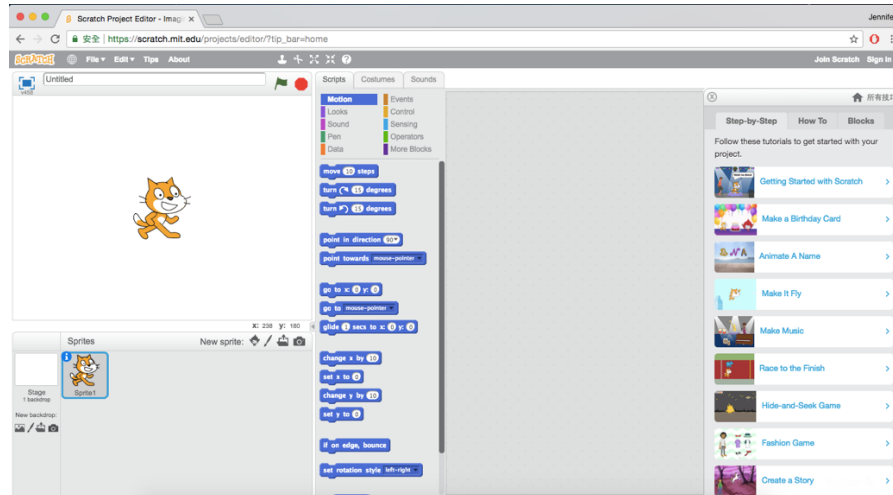


Figure 1. The interface of Scratch Project Editor

2.2 Code.Org

The one-hour tutorial and learning courses in Code.Org are well-organized and attractive to users with different backgrounds. “Hour of Code” is a list of lessons designed to be complete in a limited time. It is more convenient for the user to manage the time for studying the programming language. There is also a short introduction video before each lesson, it helps the user to clearly understand the learning outcome and has an overall view of the lesson. In addition, Code.Org also offers some tutorials with well-known themes such as Minecraft and Frozen. It is an effective way to arouse the curiosity of users and encourage them to explore the behind logic and codes of a game.

It is obvious that the presentation of programming scripts in Code.Org is intelligible and attractive for beginners. Therefore, this project considers a similar approach. Each tutorial will contain adequate interactive components with a specific theme. For example, the user can follow the steps to program an online calculator. Because of the practical program, more users may enjoy the process of programming and obtain a sense of pleasure.

2.3 W3Schools.com

In W3Schools.com, users can find many tutorials related to web design. The tutorials are divided into groups, such as ‘HTML and CSS’, ‘JavaScript’ and ‘Server Side’. Under these groups, the scripts are further subdivided by their functions. For example, the user can see ‘Learn SQL’ and ‘Learn PHP’ under the tag of ‘Server Side’. This design of navigation bar is clear and convenient for the user to search for a particular programming script.

In the tutorials, it explains the reason of learning the language and introduces the scripts with various examples. The user can also try to edit the codes to observe the changes. Figure 3 shows the interface of the Tryit Editor provided by W3Schools.com. For each example, user can modify the code and compile it online. The result will be displayed on the right-hand-side after the user clicks the ‘Run’ button. Similar to Scratch, this feature is effective for learning by helping the user to understand how modification of codes affect the operation of a website or an application.

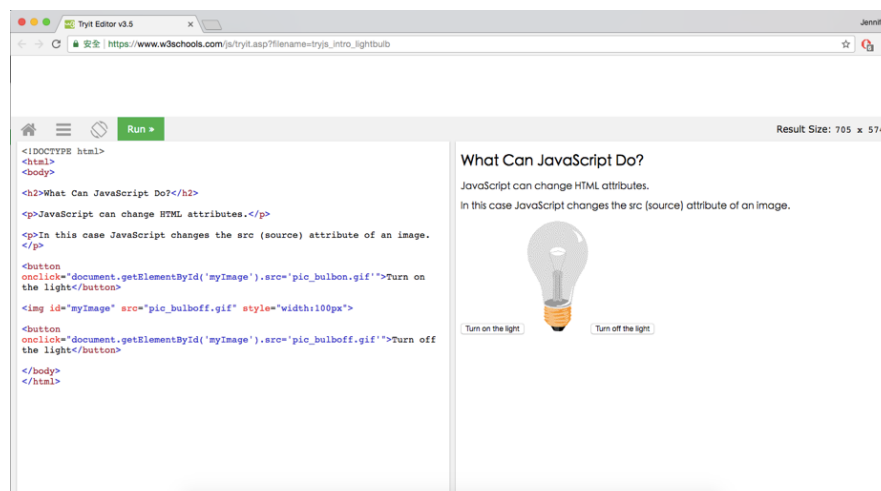


Figure 2. The Tryit Editor in W3Schools.com

This project divides the tutorials into two main groups: JavaScript and React Native. There will be a page for introducing the language respectively and therefore, the user can have a basic concept of the language. The scripts are subdivided by their functions and ordered by difficulties. These features are believed to be user-friendly to beginners on programming.

By studying these existing e-learning platforms, it is believed that a good e-learning platform should be both user-friendly and attractive enough to the user. It can be realized by having features like clear navigation, structured list of tutorials and interactive games. The overall color scheme and use of multimedia elements are also important to consider when designing the platform.

3 Methodology

In this chapter, the realization of the project is discussed with screenshots of the application. It first introduces the main developing software, followed by the design of tutorials, user interface and database. Although the security system is not yet implemented at the current stage, it is important to consider for the future maintenance of the project. Therefore, it is also discussed at the end of this chapter.

3.1 Software

Unity is the main developing tool in this project. Although it is a game engine, it provides powerful functions that meet all requirements for implementing the e-learning platform, such as setting a timer and calculating scores. There are two mini games implemented in the tutorials. User is required to finish the tasks, which is similar to completing the levels in a game. Through this design, user will feel like playing a game and does not get bored when studying the codes. Unity provides a lot of convenience for implementing interactive components, such as the buttons and action listener. After the user finishes the games, a feedback report will be automatically generated. It is possible by writing a behind algorithm in Unity. It helps recording the time used and calculating the final scores. Depending on the score, the platform can also grade the performance of the user and allow he to evaluate the effectiveness of self-learning.

Additionally, Unity can port on different devices, such as Mac, iOS and Android systems. It also allows porting with different screen size. It helps the future maintenance of the project for enlarging the user groups. For example, it is easier to develop a smartphone version of the platform by adjusting the position of components in Unity.

3.2 Tutorial design

According to the features mentioned in chapter 2, the tutorials will be both academic and entertaining. The programming scripts will be divided by their functions, and each tutorial only covers on one topic. For example, the prototype of the platform application includes a tutorial of “Variables and Data Types” for JavaScript, and “Buttons” for React Native. Figure 3 shows the first page of a tutorial. Although there is a brief description on the page of tutorial list, it is essential to introduce the tutorial again and provide more details, such as the related codes and estimated time required. This design helps users to get an overview of what they are going to learn in the next 30 minutes. If they do not want to study this topic, they can simply click the button “< Back to the tutorial list” and return to the previous page. Otherwise, they should click “Start” button to start the tutorial.

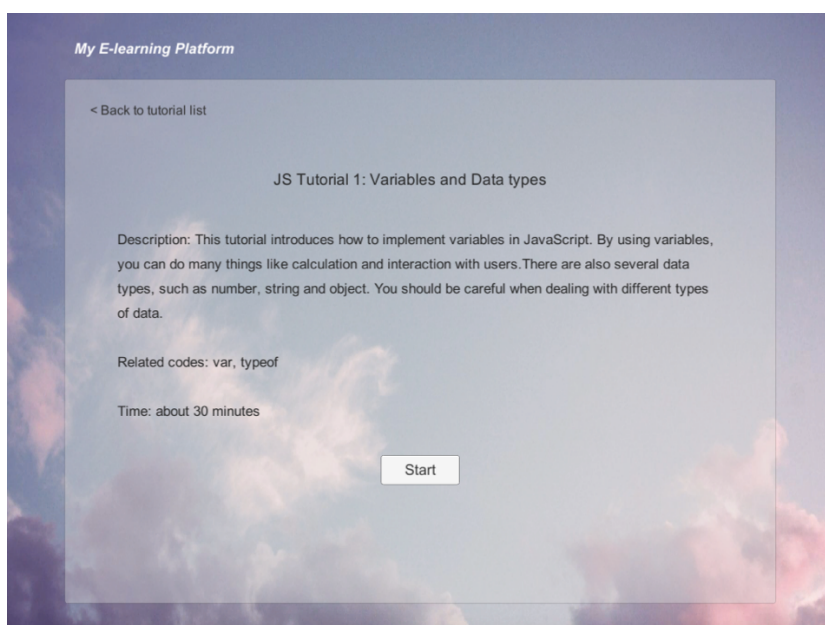


Figure 3. Design of introduction page of tutorial

Before playing the games, user first need to learn the basic knowledge about the scripts. Figure 4 shows how the informative paragraphs are displayed in the platform. In order to have a better display of codes, they will be shown in the form of images. The codes were typed in the software Atom, it has a good color pattern to distinguish the script keywords and the customized variable names.

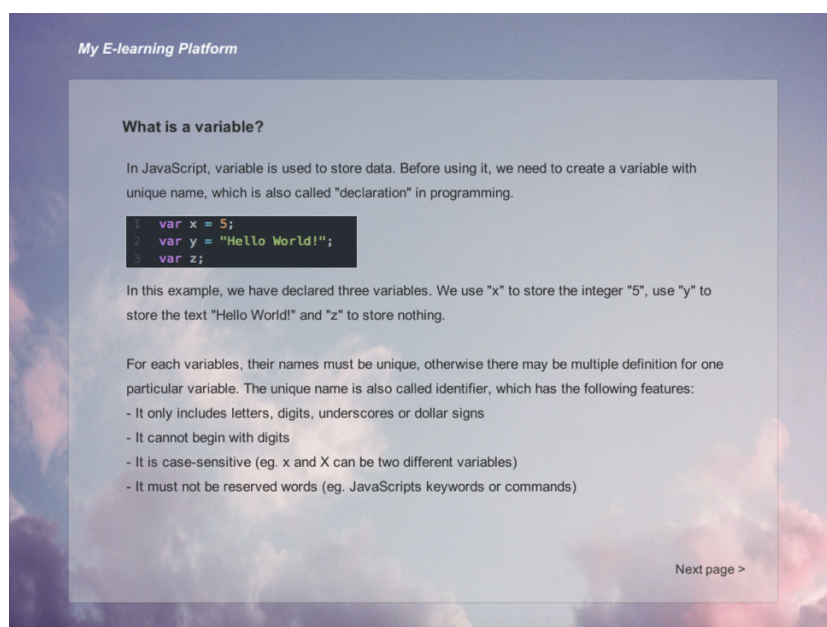


Figure 4. Display of tutorial knowledge

There are two buttons at the bottom of the panel, one is directing to the previous page and one is directing to the next page. The user is not allowed to return to the tutorial list or the introduction page once the tutorial is started. Therefore, there is no "< Previous Page" button on the first page of the tutorial. If the user persists in exiting the tutorial, he can click the "My E-learning Platform" button, which is located at the top-left corner of the page, and he will be directed to the main page of the platform.

After users have studied the syntaxes, they can play a game to test if they have fully understood the knowledge. There are two types of games implemented in the platform: catching game and multiple choices. Figure 5 and Figure 6 show the layouts of the two games respectively. They have a similar design, which contains a task description area and a play area. The top panel describes the rules of the game, such as how to play the game and the specific goal. The status is displayed in the top-left corner of play area, and is updated per frame to inform the user with the progress of game, such as how much time is left or how many questions are answered.

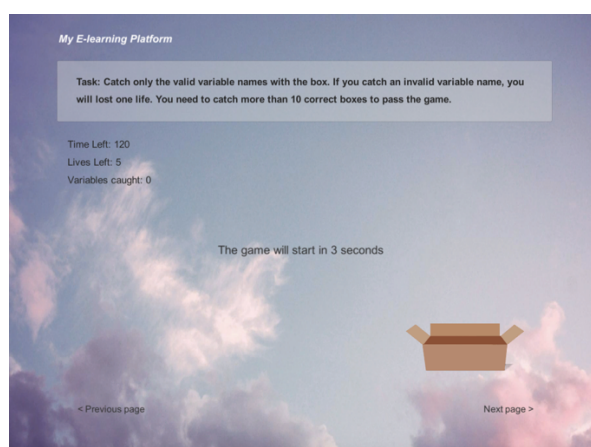


Figure 5. Layout of catching game

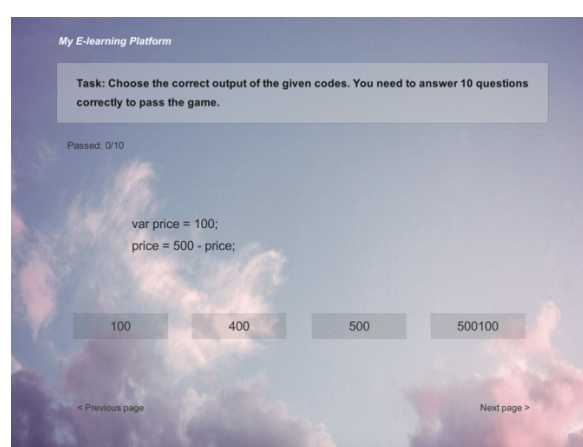


Figure 6. Layout of multiple choices game

Moreover, all questions in the game are randomly selected from the database. There are separated xml file for storing the questions. For the catching game in JavaScript Tutorial 1, different variable names are stored with their types: valid or invalid. The status will be updated once the user has caught a falling variable name. If the variable name is valid, the counter of “variables caught” will add by 1. Otherwise, the user will lose one life. If the user failed to achieve the goal when the time is up or lost all five lives, he will be asked to restart the game. For the multiple choices, both the

question and the four answers are stored and the correct answer is marked. If the user has selected the wrong answer, the corresponding button with wrong answer will be disabled and disappeared. If the user has selected the correct answer, the status will be updated and the next question will be automatically displayed.

When the user access the game page, the button directing to next page will be disabled. This design asks users to complete the game and test their knowledge immediately after the study. The button will remain disabled until the user pass the game. Different message will be shown for different scores. Figure 7 is an example of how the feedback message will be displayed. The message will be automatically displayed when the game is over and the content is depending on the final score. Additional instruction will be displayed under the feedback message.

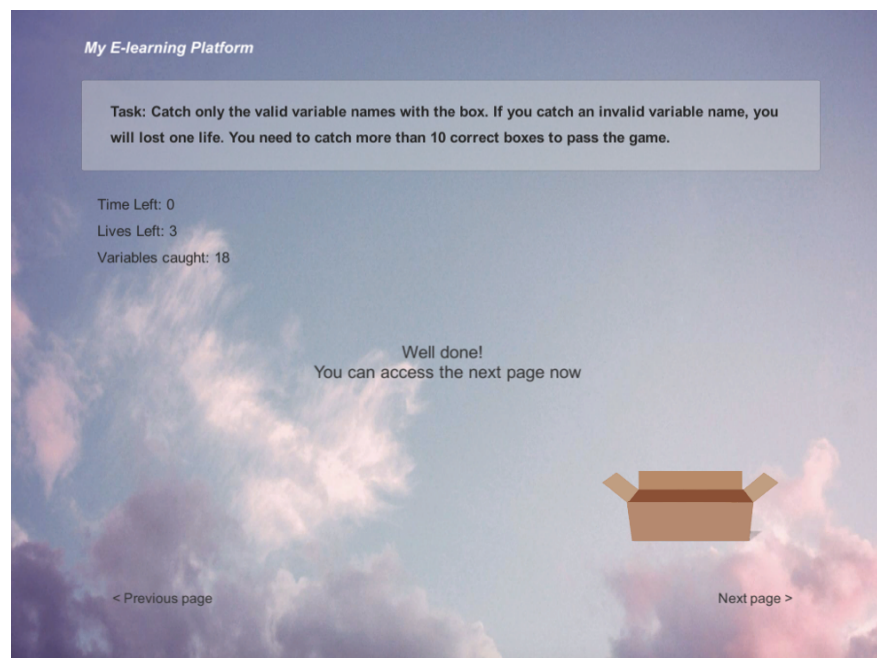


Figure 7. Display of feedback message

Table 1. Feedback messages and instructions in catching game

Status	Message	Instruction
(Time Left: 0) OR (Lives Left: 0) AND (Variables caught < 10)	“You failed!”	Press anywhere to restart!
Variables caught > 20	“Excellent!”	You can access the next page now
10 < Variables caught < 20	“Well Done!”	

The above table shows the message and instruction in different cases. It is possible to change the content easily by modifying the text in the C# scripts. For the multiple choices, it will display only one message: “Well Done! You can access the next page now” after the user finishes the game. The time used and wrong choices of question will not be recorded. When the user has finished the whole tutorial, the platform will show the message as Figure 8, which includes a congratulation message and remind the user with the key points of the tutorial. The user can press the button and return to the page of tutorial list.

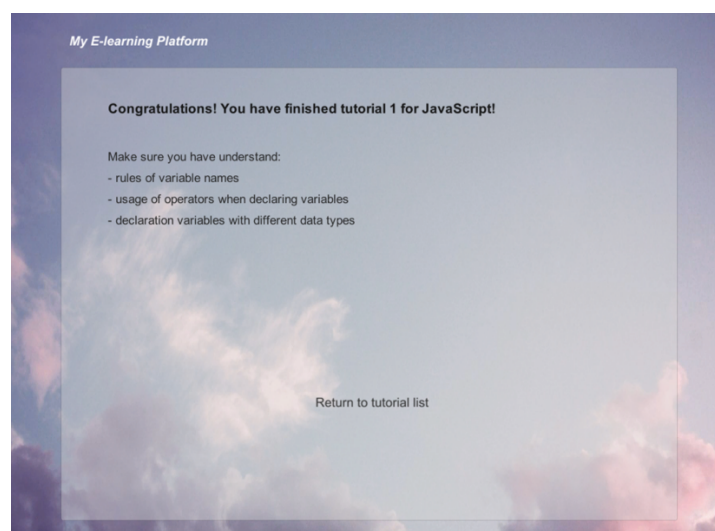


Figure 8. Last scene of a tutorial

3.3 User interface design

Considering of any potential user of the platform, it uses an interface that is user-friendly to any age group. It provides clear instructions for children or the elderly to follow, and a comfortable design for everyone to use. Figure 9 shows the main page of the platform. A title with larger font size is displayed above the navigation bar. The navigation bar clearly displays all components of the platform: login system, registration system and the tutorials of JavaScript and React Native. After the user clicks on the button, he will be directed to the corresponding page.

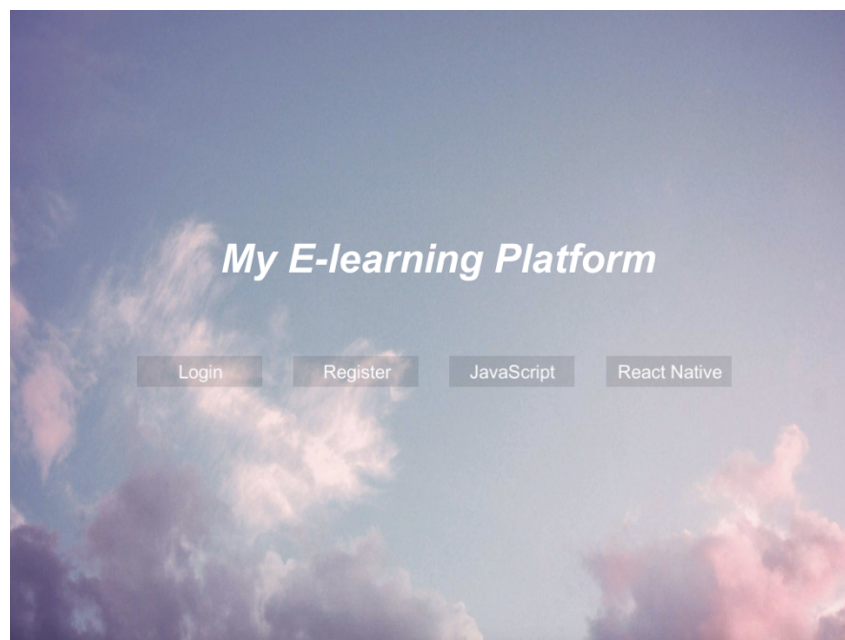


Figure 9. Main page of the e-learning platform

A basic membership system is implemented in the current model of the platform. User can choose to login with existing account, or register for a new student or teacher account. However, it is not essential for the user to login to browse the content of tutorials. It is possible for user to study the whole tutorial as a visitor. The implementation of membership system is only to provide

convenience for future development, such as development of discussion forum or ranking system. Figure 10 is the screenshot of login page and Figure 11 is the one of register page. The designs are relatively simple, but clear instructions are provided. It is believed that the user can login and register without problems.

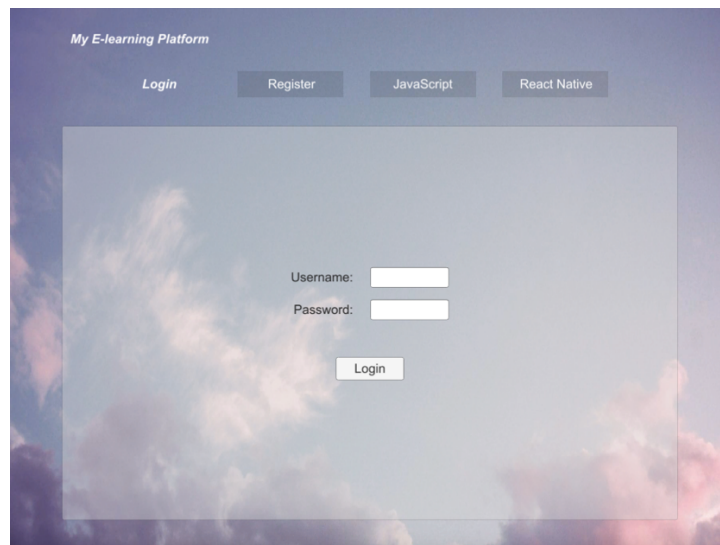


Figure 10. Screenshot of login page

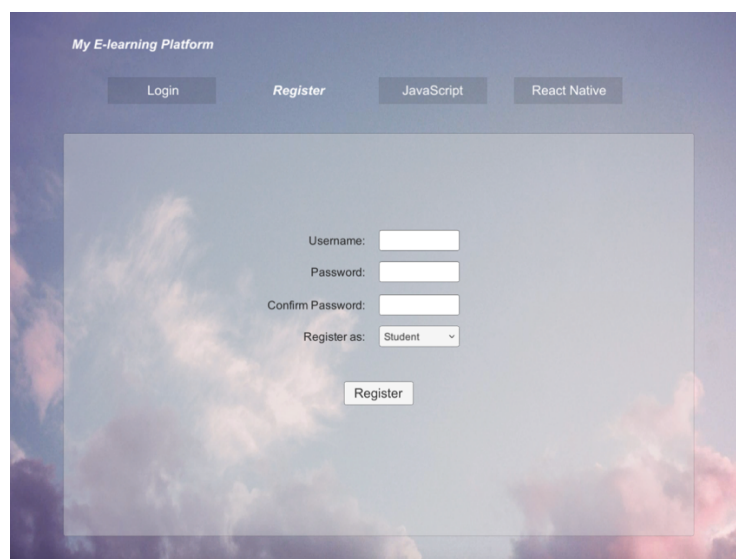


Figure 11. Screenshot of register page

Figure 12 and Figure 13 is the display of the tutorial list of JavaScript and React Native respectively. At the current stage, there is only one tutorial under each group. If more tutorials are added in the future, there will be a vertical scroll bar shown on the right. The list includes a brief description and some related codes of each tutorial, the user can enter the tutorial page by clicking the corresponding button of “Start tutorial”.

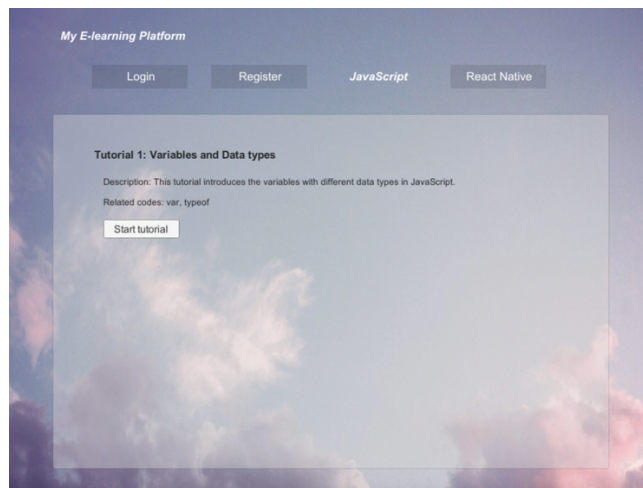


Figure 12. Screenshot of JavaScript tutorial list

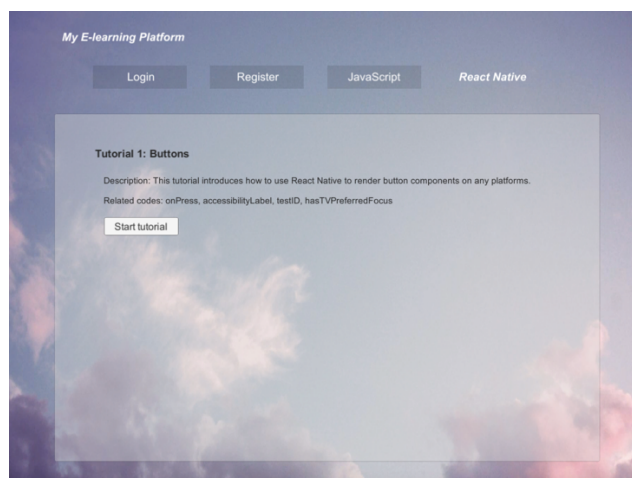


Figure 13. Screenshot of React Native tutorial list

3.4 Database design

This project uses XML files instead of relational databases to store data. There are several reasons of using a XML file. First, it is easier to implement by using XmlSerializer in Unity. Second, it is adequate for storing all necessary information of the membership system, including the username, password and type of account. If there is an update on adding more personal information for the accounts, it is also possible to implement with XML files. In addition, the game data is also stored in XML files. For instance, the second multiple choices game in JavaScript Tutorial 1 stores different variables with their data types. Third, XML files are flexible enough for updating data at the current stage. The files may not be large and can be efficient as relational database [4]. Teachers or administrator can make changes to the question by modifying the xml file and they do not need to compile the whole platform again. In the future development, they may be allowed to add more questions within the platform interface.

The following table provides a general view of what kinds of data is stored for the platform:

Table 2. XML databases of the platform

Database	Stored Data (XML Nodes)
Membership system	<username> <password> <type> // Student or Teacher
Catching game in JavaScript Tutorial 1	<name>

	<type> // valid or invalid
Multiple choices (data output) in JavaScript Tutorial 1	<description> <ansA> <ansB> <ansC> <ansD> <correct>
Multiple choices (data type) in JavaScript Tutorial 1	<description> <type>
Multiple choices in React Native Tutorial 1	<description> <ansA> <ansB> <ansC> <ansD> <correct>

3.5 Security design

A security system is used to avoid unauthorized access to the application. Since the platform may be open to the public in the future, there are potential threats such as DoS attacks, which will disrupt the service temporarily by sending superfluous requests to the server. One of the solutions is blackhole routing. It is a technique that directs the redundant requests to a null interface. However, it is still possible that the service continues to be disrupted if the developer cannot

distinguish the source IP address of the attacker [5]. The implementation of a full defending system may be time-consuming and has a higher requirement on professional knowledge. Due to the time constraint, this project will not implement the security system at this stage. It will be implemented in the future and before launching online.

Apart from cyber-attacks, it is also essential to control the access right of different users. For example, student accounts should be only allowed to browse the tutorial. Teacher accounts are allowed to help modifying the tutorials, such as adding more questions to the database. However, only the administrator should be able to delete any existing tutorials. Therefore, it is clear that the platform needs to provide additional functions for teacher and administrator account. It should also make the source codes of games and internal systems invisible to all user accounts for the security purpose.

A prototype of the e-learning platform has implemented to better present the ideas of this project. The functions and systems mentioned in this chapter are all included in the finalized application at this stage, except for the security system. The application is then tested and the results are shown in the next chapter.

4 Results

After the full development of the e-learning platform, several sets of data are tested for the operation of the application and tutorials. This chapter introduces the design of test cases, and shows the results of testing. In order to improve the performance of the project, some modification is done after testing. It also discusses the constraints of the platform.

4.1 Test case design

In order to ensure all functions in the application work as expected, five sets of test cases are designed. They are test cases for login system, registration system, tutorial games, feedback system and the overall functionality of the platform. This section only covers the general design of test cases and the expected results. Detailed testing will be implemented in the next section.

4.1.1 Login system

To test the login system, there will be different pairs of username and password, including valid and invalid accounts. If the user enters valid pair of username and password, the application should show “Login successfully!” and clear the input fields. The login button will also be disabled. If the user enters an invalid pair, the application should show the corresponding error message, including:

- a) Wrong/Non-existing username: “Invalid username!”
- b) Wrong password: “Invalid password!”
- c) Null input for username or password: “Please fill in all fields!”

4.1.2 Registration system

Test cases for registration system will also consider valid and invalid sets of input. If the user successfully registers an account, the platform will show “Register successfully!” and clear all input fields. Otherwise, the platform shows the error message with the following invalid input:

- a) Duplicate username: “Invalid username!”
- b) Invalid password: “Invalid password!”
- c) Inconsistent passwords: “Passwords do not match!”
- d) Null input for any fields: “Please fill in all fields!”

For the availability of password, the platform requires the password to contain at least one number and letter respectively, and has a minimum length of eight characters. The maximum length of the username and password are set to 20 characters to avoid unnecessary memory for storing the accounts. If the user input more than 20 characters, extra characters will not be stored in the input field. Moreover, if the user chooses to register a teacher account, the platform should display the additional message: “Verification of profession is required”. A teacher account should not be able to login right after registration until the administrator approve the account.

4.1.3 Tutorial games

Apart from the display and flow of a tutorial, this section focus on the gamification features of it. Two types of games are implemented in the platform: catching game and multiple choices. The games should be executable after building the whole program in Unity, and the following features will be tested:

a) Randomly generated questions

For both the catching game and multiple choices, there are separated xml databases for storing the various questions. The questions are expected to be randomly generated, so the games will be assessed for several times to check if it displays different questions in different orders. For example, the first appearing falling boxes in the catching game should be different for every visit.

b) Inserting data to database

Apart from the default database, teachers can insert new questions by modifying the xml files. For the catching game, user can add a new variable and identify whether it is a valid or invalid name. For the multiple choices, user need to input both the question and the four answers, and also state the correct answer. After the xml file is edited, the new questions should be able to show in the game without rebuilding the platform.

c) Movement with mouse

This feature is implemented in the catching game only. User should be able to control the position of the box without clicking the mouse. The box can only move horizontally and with referencing the x-coordinate of the mouse. Due to the limited screen size, there is also a maximum width for moving the box. The box should not be able to move outside the visible area.

d) Countdown timer

This feature is implemented in the catching game only. The time limit of a catching game is set to be 120 seconds. However, the user can change it easily on the Unity interface. The timer should stop at 0 second and the game should also stop. The result of game will then be shown at the center of the page.

e) Lives count

This feature is implemented in the catching game only. User has 5 lives for each play and it will cost 1 life for every wrong catching of box. If the user has lost all 5 lives and has caught one more wrong box, the game will stop. Missing a correct box will not cost any lives.

f) Restart with mouse click

This feature is implemented in the catching game only. If the user cannot finish the task in the limited time or lost all lives, a message “You Failed! Press anywhere to restart!” will be shown at the center of the page. Once the user clicks the mouse, the data should be initialized and this message will disappear. Otherwise, the game will never restart.

g) Displaying the answer

This feature is implemented in the multiple choices game only. If the user chooses the wrong answer, the corresponding button becomes invisible and inactive. If the user chooses the correct answer, next question will be shown immediately and all buttons becomes visible and active.

4.1.4 Feedback system

The feedback report is generated after each game in the tutorials. As mentioned in the previous chapter, the content of feedback is depending on the performance of the user. For example, if the user caught more than 20 boxes in the catching game, the message will be “Excellent!”. If the user caught less than 20 but more than 10 boxes, the message will be “Well Done!”.

4.1.5 Overall functionality

The functionality of the platform includes the display of elements and the links between different scenes. It is important to ensure that each button in navigation bar and tutorial page is linking to the correct page. Moreover, it will be tested for adequateness of clear instructions and user-friendliness of the whole application.

4.2 Testing Results

Depending on the above design, different functions of the platform are tested separately. This section describes the procedure of testing and shows the detailed results. If there are any bugs detected, the solution will also be discussed.

4.2.1 Login system

This system was tested on the login page. The testing data is different sets of valid and invalid pairs of username and password. After inputting the data to provided text fields, the login button is pressed and the output message will be recorded. If the output matches with the expected one, the testing result will be noted as “Passed”, otherwise it will be “Failed”.

Table 3. Testing result of different inputs for login system

Input	Output	Result
Valid username and password	“Login successfully!”	Passed
Valid username, invalid password	“Invalid password!”	Passed
Invalid username, valid password	“Invalid username!”	Passed
Invalid username and password	“Invalid username!”	Passed
Null input for username	“Please fill in all fields!”	Passed
Null input for password	“Please fill in all fields!”	Passed

Table 3 clearly shows that the output of login system work as expected. The messages are able to help the user to correct the mistakes and then login successfully. Furthermore, the login button in the navigation bar should be disabled after user logged in. Otherwise, it is clickable and direct user to the login page. Table 4 lists the testing results of this function, and it was tested with the same sets of data for testing the output of login system. It is concluded that login system works perfectly at this stage and no modification is needed.

Table 4. Testing result of login button for login system

Input	“Login” button	Result
Valid username and password	Disabled	Passed
Valid username, invalid password	Enabled	Passed
Invalid username, valid password	Enabled	Passed
Invalid username and password	Enabled	Passed

Null input for username	Enabled	Passed
Null input for password	Enabled	Passed

4.2.2 Registration system

This system was tested on the register page. The testing data is different sets of valid and invalid pairs of username and password. After inputting the data to provided text fields, the register button is pressed and the output will be recorded. If the output matches with the expected one, the testing result will be noted as “Passed”, otherwise it will be “Failed”. The following table shows the detailed testing results of register system:

Table 5. Testing result of registration system

Input	Output	Result
Valid username and passwords	“Register successfully!”	Passed
Duplicate username and valid passwords	“Duplicate username!”	Passed
Duplicate username and invalid password	“Duplicate username!”	Passed
Duplicate username and inconsistent passwords	“Duplicate username!”	Passed
Valid username and invalid passwords	“Invalid password!”	Passed
Valid username and inconsistent	“Passwords do not match!”	Passed

passwords		
Null input for username	“Please fill in all fields!”	Passed
Null input for password	“Please fill in all fields!”	Passed
Null input for confirm password	“Please fill in all fields!”	Passed

The table shows that the registration system is working as expected. However, the system only shows “Invalid password!” without the details of a valid password. It is better to modify the output message with detailed description. As mentioned before, the checking scheme is used to check if the password has a minimum length of 8, and contain at least 1 letter and 1 digit. After the modification, there was an additional testing with different invalid passwords. Table 6 shows the detailed results of the additional testing and it is believed that the user experience can be enhanced through this improvement.

Table 6. Testing result of modified registration system

Input	Output	Result
Valid username and passwords	“Register successfully!”	Passed
Valid username and invalid password (less than 8 characters)	“Your password should have a minimum length of 8!”	Passed
Valid username and invalid password (contain numbers only)	“Your password should contain at least one letter!”	Passed
Valid username and invalid password (contain letters only)	“Your password should contain at least one digit!”	Passed

4.2.3 Tutorial games

This system was tested on the tutorial page. The mentioned features in previous session are tested separately. If the effect matches with the description, the result will be mark as “Passed”. Otherwise, it will be “Failed”. Table 7 and Table 8 are the detailed testing result of catching game and multiple choices game respectively.

Table 7. Testing result of catching game

Features	Effect	Result
Randomly generated questions	The first appearing variable was different for each play, the variables also appeared with different orders	Passed
Inserting data to database	After adding a new variable in xml file, it was able to shown in the game without rebuilding the platform in Unity	Passed
Movement with mouse	Able to horizontally control the box without clicking the mouse, there was also a reasonable boundary of the movement	Passed
Countdown timer	After 10 second of preparation, the timer was started automatically	Passed

	and stopped at 0	
Lives count	The lives count was minus by one when catching a invalid variable name	Passed
Restart with mouse click	When the game was terminated, the message “Press anywhere to restart!” was shown. The game is restarted only when the mouse was clicked once. Moving the mouse is not able to restart the game	Passed

Table 8. Testing result of multiple choices game

Features	Output/Effect	Result
Randomly generated questions	The first appearing question was different for each play, the questions also appeared with different orders	Passed
Inserting data to database	After adding a new question in xml file, it was able to shown in the game without rebuilding the platform in Unity	Passed
Displaying the answer	The clicked button was disappeared and inactive if it was	Passed

	<p>the wrong answer for the question;</p> <p>all buttons became active and</p> <p>visible when a new question was</p> <p>displayed</p>	
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The results show that the tutorial games are operated well and the features were correctly implemented. There is no delay on displaying the message or showing the effects. Therefore, it is also believed that the platform works effectively.

4.2.4 Feedback system

This system was tested on the tutorial page. As the feedback message of multiple choices game is the same, the testing focuses on the output of catching game. If the output is following the rules mentioned before (see Table 1 in Chapter 3), the result is marked as “Passed”, otherwise it will be “Failed”. The following table shows the detailed results:

Table 9. Testing Result of feedback system

Game Status	Output Message	Result
<p>Time Left: 0</p> <p>Lives Left: 2</p> <p>Variables caught: 5</p>	<p>“You failed! Press anywhere to restart!”</p>	Passed
<p>Time Left: 56</p> <p>Lives Left: 0</p> <p>Variables caught: 8</p>	<p>“You failed! Press anywhere to restart!”</p>	Passed

Time Left: 0 Lives Left: 2 Variables caught: 10	“You failed! Press anywhere to restart!”	Passed
Time Left: 0 Lives Left: 5 Variables caught: 14	“Well Done! You can access the next page now”	Passed
Time Left: 76 Lives Left: 0 Variables caught: 17	“Well Done! You can access the next page now”	Failed/Passed
Time Left: 0 Lives Left: 2 Variables caught: 20	“Well Done! You can access the next page now”	Passed
Time Left: 0 Lives Left: 2 Variables caught: 30	“Excellent! You can access the next page now”	Passed
Time Left: 15 Lives Left: 0 Variables caught: 25	“Excellent! You can access the next page now”	Failed/Passed

There are two confusing cases found in the testing. In the description, it said “You need to catch more than 10 correct boxes to pass the game”. However, there is two cases to end the game: 1) Time is up; 2) Lost all lives. If the user has caught adequate boxes, but lost all lives before the time is up, the current system will define this case as a successful case. This problem is caused

by the order of if statements in the scripts. However, it should not be a mistake of the platform as the case actually satisfied the requirement described on the page. Therefore, the scripts will not be changed at the current stage. In the future, it is possible to implement some improvements with the changes on the rules of game.

4.2.5 Overall functionality

The functionality was tested through the whole application. It first checked if all buttons are directing to the correct page. This was tested on the main page, login page, register page, JavaScript page, React Native page. Then, the buttons in the two tutorials were tested. The buttons should be able to direct the user to correct previous or next page. During the testing, there were no bugs detected and the platform was operated correctly and effectively. In addition, the text, images and buttons are also shown clearly and help maintaining a good readability.

4.3 Constraints

Due to the limited developing time, this project may not be able to support some functions or provide various tutorials of the two programming languages. The executable application at this stage can be regarded as a prototype of the e-learning platform. It only includes the basic functions and two template tutorials which are the references of how the programming knowledge will be presented through text and games. This section concludes several limitations of the current application which are found during developing or testing.

4.3.1 Inadequate tutorials

The finalized application only provides two tutorials in total for the two programming languages. That is, there is only one tutorial for each language. It is caused by time constraint and the delayed schedule of the project. The time spent on studying React Native and designing the application is more than expected. In addition, the project was struggled for developing a real-time compiler of programming scripts, which is the original idea for interaction component included in the tutorials. The design was then changed to the current format, the catching game the multiple choices. Implementation of mini games is believed to be able to attract users and help them understand the syntax. However, it may fail to allow users to actually write codes and test their knowledge with practical exercise. It is also better to increase the categories of games, so the user will not get bored by only two types of games. At the current stage, there is a lack of tutorials and games to be displayed in the application.

4.3.2 Simplified functions for membership system

A membership system has implemented in the application, but it is only used for login and register. Comparing to other existing e-learning platforms, these functions are too simplified and may not be convenient enough for users. For example, users cannot trace back the tutorials they have learnt before. When the user-friendliness of the application is testing, there are also feedbacks which requires for a ranking among all users. It can then provide a stronger sense of playing games to them. It may also stimulate users to repeat the game in order to obtain a higher score. Therefore, the current functions provided by membership system may be too simplified.

4.3.3 Impossible to search for a tutorial

As there are only two tutorials provided in the application, it is relatively convenient for the user to search and finish a tutorial. However, there will be a problem if more tutorials are added to the list. Although the tutorials are already divided into two groups: JavaScript and React Native, the user may still find it difficult to search for a particular tutorial. There are a lot of scripts to be learnt for these two languages, the user may only be interested in one of them. In this case, as the application does not provide any search function, the user can only search in the whole list. It will be extremely inconvenient for users to find a tutorial when the tutorial database is extended in the future.

4.3.4 Not supporting multi-platform

Through the consideration of user experience and potential device, this project only focuses on developing an application worked on the computers. According to a survey by GO-Globe, the percentage of usage of non-mobile web device is 90.9% while the one of mobile web device is 77.4%. Among all devices, desktop computer is the most common device used for internet service [6]. Comparing the screen size of smartphones, computers screen is more preferable for learning purpose. It improves user experience since user can obtain more information within a scene. Furthermore, a computer application can also be used by schools to teach programming during lessons. However, the rise of smartphones cannot be ignored. In the 21st century, people may spend more time on using smartphones instead of desktop computers. For example, it is common that people are playing with smartphones during taking bus or MTR. An application

that can only work on desktop computers may be less convenient for those who prefer using smartphones, especially for the teenagers. More users may choose to learn programming through this e-learning platform if it is able to provide an application that can work on multiple platforms, at least including desktop computers and smartphones.

4.3.5 Not supporting multi-language

Nowadays, people living in different countries share the same online resources. Therefore, the potential user of this e-learning platform can be people who speak other languages rather than English. In Hong Kong, some people may find it difficult to understand the programming syntax by English. They may prefer an explanation in Chinese. However, it would cost much more time on preparing the tutorials. Consequently, this project only provides an English version, which is the international language and can increase the number of users as much as possible. Meanwhile, some scripts or syntaxes are not able to translate into Chinese or other languages. They may be more confusing to understand after translation. But in the future, it is still possible to develop a Chinese version. It will be beneficial to people who are not good at English.

4.3.6 Failed to implement a full security system

As mentioned in the security design section, it is hard and time-consuming to implement a full security system which can avoid cyber-attacks. If the application is planning to go online, it is essential to consider the security problem. For example, it should control the unauthorized

access of unknown IP addresses and reject any redundant requests to protect the server. The source code of the applications and tutorials are also should be invisible to all users for safety purpose. If the membership system is further improved and contains some private information of users, such as phone numbers or emails, it is also necessary to protect the privacy of all member accounts.

5 Future works

Based on the constraints discussed in the previous chapter, this chapter provides a future view of how this project can be further improved, such as increasing the number of tutorials and implementing more functions. The improvements will be focus on enhancing the effectiveness of learning programming scripts and increasing the user-friendliness of the platform.

5.1 Adding more tutorials

The current application only contains two tutorials, which are inadequate for having a full understanding on JavaScript and React Native. For instance, user should know how to display data using JavaScript or how to implement a function using React Native. In addition, programming codes may keep updating or changing with time. It is essential to add more tutorials and update them regularly. The tutorials will have a similar format, containing instructional text and entertaining games. They also allow users to learn the programming languages from basic to advanced. That is, the tutorials will be ordered by their difficulties, the easiest one will be shown at the top of the tutorial list. In the future, the following tutorials can be added:

Table 10. Tutorials to be added for JavaScript and React Native

JavaScript	React Native
<ul style="list-style-type: none">• Events (onchange, onclick, onload, onmouseover...)• Math (Math.PI, Math.round(), Math.sqrt(), Math.ceil()...)	<ul style="list-style-type: none">• Input handling (onChangeText, onSubmitEditing, placeholder...)• Navigation (UINavigationController, NavigatorIOS, passProps...)

<ul style="list-style-type: none"> • Comparisons (==, ===, !=, >, <...) • Forms (disabled, max, min, pattern, required, type...) • Functions (function myFunc(){ }, return...) • HTML DOM (innerHTML, attribute, document.getElementById...) • AJAX (XMLHttpRequest(), onreadystatechange, responseText...) • JSON (JSON Array, JSON.parse(), JSON.stringify...) 	<ul style="list-style-type: none"> • Button (onPress, title, color, disabled, accessibilityLabel, testID...) • ScrollView (alwaysBounceVertical, onScroll, pagingEnabled...) • Animated (Animated.Value(), Animated.decay(), Animated.timing...) • Setting (get, watchKeys, clearWatch...) • Transforms (decomposedMatrix, rotation, transform, transformMatrix...) • Vibration (vibrate(duration/pattern), cancel...)
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The tutorials introduced in the above table has referenced some existing online resources of JavaScript and React Native. The list is also not covering all knowledge about the two programming languages. Therefore, there may be some unmentioned scripts or functions to be included in the tutorials during future development.

After adding more tutorials, the display on navigation bar may also be changed. In the current application, the navigation bar only contains a button of “JavaScript” and a button of “React Native”. These two buttons will direct user to the corresponding page of tutorial list. This design will be relatively inconvenient and time-consuming if the user wants to find a particular tutorial. Therefore, it may be better to implement a dropdown menu on the navigation bar and display the major groups of tutorials.

5.2 Adding more games

The tutorials can be more attractive and entertaining by containing different types of games. Apart from catching game and multiple choices, there are also other choices of e-learning games, such as matching games and crossword puzzle game. These games can be implemented in the tutorials to help the user understanding the syntaxes. For instance, it is possible to implement a card game in tutorials to check if the user can obtain the output of different codes. The output is set as the enemy and the user needs to defeat the enemy using their own cards, which actually represent different sets of codes. If the user chooses the card with corresponding codes, the enemy will be defeated. Otherwise, the use will lose a life. This card game gives the user a sense of playing games rather than learning something. Therefore, users can enjoy the process of learning programming and their knowledge is also tested during the tutorial. It achieves the goal of e-learning.

Another possible game to be implemented is typing game. The flow will be the same with a normal typing game, but the words showing become lines of codes. User is required to input the same code within a limited time. It is essential for user to actually type some codes instead of only observing them. Otherwise, user may easily forget some simple syntax of coding, such as putting “;” at the end of a statement. Therefore, the updated tutorials can also include a typing game in the future development of the project.

5.3 Allowing open discussion

When the user is studying the codes, he or she may encounter a problem and does not know where to ask. An open forum which allows users to discuss online may be able to help. Due to the

implemented simple membership system, it is possible to create a discussion forum without an additional collection of the information of users. Take Stack Overflow as a reference, user can open a new post to ask a question, or leave a comment in other posts to answer others' question. However, allowing open discussion may bring problems like someone leaving a misleading message or an advertisement. In this case, the membership system should be updated for security purpose. The username of each comment should be recorded, and the account can be deleted or blocked for misusing the forum.

5.4 Implementing search function

As mentioned in the constraint session, it is inconvenient for the user to search for a particular tutorial in the current model. In order to enhance the user experience, a search function should be implemented. The input field for searching can be put in the navigation bar, therefore the user can search in any pages. Moreover, there should be a database storing the keywords or related codes of each tutorial to support this new function. When the user clicks the "search" button, the platform should call a function to compare the similarity of user input and keywords of each input. The page when then be updated and show the results ordering by their similarities.

5.5 Customization

Considering the user experience of any potential user, providing customization can enhance the user-friendliness of the platform. For example, it can allow user to adjust the font size and change the color pattern of the whole application. In the future, the platform may also provide tutorials in both English and Chinese. Although the codes are displayed in English, a Chinese explanation may help the user to understand the syntax.

6 Conclusion

This paper provides the details of the e-learning platform, which includes background, literature review, methodology, testing result and possible future developments of the project. A prototype of the platform is also developed for displaying the operation of the platform and the presentation of programming knowledge. The various functions are introduced in the methodology chapter, such as providing a clear navigation and including some mini games in the tutorial to attract the users. In addition, users can choose a tutorial with their interests by looking at the description and related codes. This design can provide users a clear overview for what they are going to learn in the next 30 minutes. They can also obtain a feedback report to check if they have fully understood the programming scripts. After the full implementation of application, all functions were tested and hence found out the constraints and improvement needed. For example, only two tutorials were included due to the time constraint. In the future, the application can be further improved with adding more functions and tutorials. It is also possible that user is allowed to customize the interface, including changing the color pattern and font size.

In the long term, this project is hoping to encourage more people to write codes and learn about programming. Although it is hard to change people's attitude towards programming in a short time, this project tries to introduce programming from a more entertaining perspective. By learning JavaScript and React Native, people are able to write their own websites or phone applications, or at least make them realize that programming is not that boring or complicated. They can enjoy programming by finishing the continuous tasks and tutorials, and try to practice their knowledge. It also stimulates innovation in the technology field as users may have different backgrounds and interests. Furthermore, this project tries to help promoting the importance of programming and

maintaining the sustainable development of computer science in Hong Kong. From the perspective of the general public, they may have a negative stereotype on programming and misunderstand the difficulties for being a computer scientist. It is essential to educate people about programming and computer science.

Personally speaking, this project teaches me how to deliver my ideas and implement the design in the program. During this year, I have done a lot of researches on existing e-learning platforms and studied the new programming language React Native. I also designed the user-friendly interface and implemented games to enhance the attractiveness of the platform. I think the most difficult part of the project is to implement the features and make the ideas become real. For instance, I originally planned to implement a real-time compiler for programming scripts and allowed user to write their own codes. However, it is hard to implement in Unity within a limited time. Finally, I chose to implement some mini games instead of it. Therefore, it is also important to consider personal ability when doing a project. Furthermore, I learnt to design a flexible time schedule for the project. Comparing to have a strict deadline for every stages of the project, it is better to set a period, such as from January to March, as there are always unexpected factors like additional works. Being aware of time management is what I also learnt in this project.

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