COMP4801 Final Year Project
Progress Report 2

Interactive Web Content for STEM

Department of Computer Science
University of Hong Kong

Ho Ka Chun
3035276579

Supervised by
Dr Vincent Lau

January 11, 2018
Abstract

STEM Education is promoted worldwide to equip students with the capability to get ready for the challenge in the world with rapid economic, scientific and technological developments. STEM Education in Hong Kong is mainly promoted in the curriculum context. However, the success of STEM Education cannot be achieved in schools alone and STEM development in Hong Kong is falling behind.

A web tool is developed as the Final Year Project for enhancing teenager’s knowledge and motivation of STEM with interactive content related to science and mathematics. The web application is deployed on the Amazon Web Services (AWS) and user data will be stored in the AWS relational database.

This application can allow users to study STEM contents on the internet. STEM education no longer limited in schools. It is hoped that the application can help students to study STEM knowledge in an efficient way, as well as promoting STEM education in Hong Kong.
Acknowledgement

I would like to express my greatest appreciation and gratitude to Dr Vincent Lau for the constant supervision and guidance of my FYP project. He has been simulating suggestion and providing information regarding the project.
# Table of Contents

Abstract ........................................................................................................................................... 2  
Acknowledgement ......................................................................................................................... 3  
List of Figure ................................................................................................................................. 6  
Abbreviations ............................................................................................................................... 6  

1 Introduction ...................................................................................................................................... 7  
   1.1 Background .................................................................................................................................. 7  
   1.2 Motivation ...................................................................................................................................... 8  
   1.3 Objective ...................................................................................................................................... 8  

2 Methodology .................................................................................................................................... 9  
   2.1 System Architecture ..................................................................................................................... 9  
      2.1.1 Presentation Layer ............................................................................................................... 9  
      2.1.2 Data Access Layer .............................................................................................................. 10  
      2.1.3 Cloud Computing ............................................................................................................. 10  
   2.2 Single Page Application .............................................................................................................. 10  
   2.3 Features Design .......................................................................................................................... 11  
      2.3.1 Simulation of Topic ........................................................................................................... 11  
      2.3.2 Video Recommendation .................................................................................................... 12  
      2.3.3 Game ....................................................................................................................................... 13  
      2.3.4 Animation ........................................................................................................................... 13  

3 Current Progress ............................................................................................................................. 14  
   3.1 Overview ..................................................................................................................................... 14  
   3.2 Finished Work ............................................................................................................................. 14  
      3.2.1 Web Interface ....................................................................................................................... 14  
      3.2.2 Set up of API and database ................................................................................................. 15
3.3  Future Work

3.3.1  STEM Contents

3.3.2  Game

3.3.3  Comment Section

4  Difficulties and Limitation

4.1  Difficulties

4.2  Limitation

5  Conclusions

6  References
List of Figure

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1</td>
<td>System Architecture</td>
<td>9</td>
</tr>
<tr>
<td>Figure 2</td>
<td>Simulation of Fourier Transform</td>
<td>11</td>
</tr>
<tr>
<td>Figure 3</td>
<td>Video of Fourier Transform</td>
<td>12</td>
</tr>
<tr>
<td>Figure 4</td>
<td><em>Mini Game of Cryptography</em></td>
<td>13</td>
</tr>
<tr>
<td>Figure 4</td>
<td>Animation of Cryptography</td>
<td>13</td>
</tr>
<tr>
<td>Figure 4</td>
<td>Image of Web Interface</td>
<td>14</td>
</tr>
</tbody>
</table>

Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>API</td>
<td>Application programming interface</td>
</tr>
<tr>
<td>MVC</td>
<td>Model-view-controller</td>
</tr>
<tr>
<td>AWS</td>
<td>Amazon Web Service</td>
</tr>
<tr>
<td>STEM</td>
<td>Science, Technology, Engineering, Mathematics</td>
</tr>
</tbody>
</table>
1. Introduction

1.1 Background

STEM is a short-term for Science, Technology, Engineering and Mathematics. In the age of information, most fields of study and application such as engineering, accounting, medicine play an important role in modern economies, they are indispensable to technology-driven society and they rely on a strong STEM background. For instance, STEM-related jobs are continuously growing worldwide. According to the report of U.S. Economics and Statistics Administration. STEM-related jobs grew 24.4 per cent over the last decade, and STEM-related jobs are predicted to grow by 8.9 per cent from 2014 to 2024 [2]. The current STEM workers are not adequate for the growing demand in the society. Therefore, a solid STEM education is essential to sustainable economic growth and competitive advantages [1].

Apart from society development, being proficient in STEM is beneficial to personal life. As STEM disciplines encourage creativity, critical thinking and problem-solving, it helps teenagers to develop a logical mindset. Students with a logical mindset are able to solve complex questions and develop solutions for real-world problems in different disciplines. Besides, most of the STET-related jobs are well-paid and secured. According to the report of U.S. Economics and Statistics Administration, the salaries of STEM job is 29% higher than the non-STEM job and the unemployment rate is lower than non-STEM job [2]. Therefore, being proficient in STEM increase personal capability and competence in different industries, and it is beneficial for pursuing a better job in the future.
1.2 Motivation

First, the promotion of STEM education in Hong Kong is mainly archived in schools alone, STEM education is rarely promoted outside of schools. Second, there are many STEM resources on the internet, but most of them are designed as teaching tools for teacher only. As a result, there are few STEM contents for students to learn on the internet. Last but not least, most of the STEM resources are lack of interactive contents. The ways that students study the STEM resources are simply reading and watching, the lack of interactive contents of STEM resources has lower efficiency of learning STEM and makes STEM contents look boring.

1.3 Objective

This project aims to create an online learning platform with interesting and interactive content related to STEM to assist high school students in learning STEM and promote STEM education in Hong Kong. The contents are designed to enhance high school student’s knowledge and motivation of STEM. To achieve this, the website will provide a user-friendly interface and give a real-time response to users to improve the efficiency of learning STEM.

The goal of this project is to create a website which has the following features:

1. Serving as an online learning platform for STEM Education.
2. Providing Interactive Contents for users to study STEM knowledge efficiently.
2. Methodology

In this section, it introduces the system architecture and web interface structure of the web application. Next, the design of interactive contents will be included at the end of this chapter.

2.1 System Architecture

Figure 1. System Architecture.

The web application consists of two layers – presentation layer and data access layer. The web interface is the client application. Clients communicate with the application programming interface by the HTTP protocol. The API is responsible for processing client requests. Also, The API is connected to the database to handle the storage and retrieval of user data.

2.1.1 Presentation Layer

A user interface written in Angular 6 has been used in the Presentation Layer. It is responsible for the delivery of information to the user. Angular is a JavaScript Framework which used to build a single page application. There are many popular JS Framework and Library in the market such as Angular, Vue.JS, React.JS. Angular is used in this application because it is written in typescript which is easier to maintain and has higher scalability.
2.1.2 Data Access Layer

An application programming interface is written in C# and a MSSQL server relational database is used in the Data Access Layer. There is two popular type of web application in the market, application programming interface and Model View Controller Template. The web application used API because it allows other application to access the data in the database which help further development of the related application. Besides, the application used MSSQL server because it is well supported by C# which can simplify database problem compare to others.

2.1.3 Cloud Computing

The web application is developed with cloud computing platform Amazon Web Services. There are two reasons for using cloud computing. First, there is no hardware configuration and maintenance as they are provided by the third party. Second, cloud computing is device and location independent. It enables users to access the web application using a web browser regardless of their location. The reason for choosing AWS among all the cloud computing platform in the market is the fact that AWS provides clear documentation and various supports for a web application.

2.2 Single Page Application

The web interface is developed as a single page application. Single Page Application has better interactivity and responsiveness than Traditional Page Application. In Single Page Application, most user interactions can be handled without reaching the server which means users can instantly receive the response from the application without waiting for the server. It also provides end users with a more comfortable experience such as no page reloading.
2.3 Features Design

This section will describe the features provided by this application and the interaction between users and the application. The Application consist of three type of interactive contents, they are Simulation, Video and Game.

2.3.1 Simulation of Topic

The application provides simple simulations of each topic to help users to study STEM knowledge. Users can try different input in the simulation section, the web application will automatically calculate the output and give a real-time response to the user. Users can play with the simulations and study STEM topics without acquired any related knowledge.

Figure 2. Simulation of Fourier Transform
2.3.2 Video Recommendation

Video are recommended at the end of each topic for users to study the related topic of STEM knowledge. Users can watch the video in the web application and interact with the simulation contents with the video contents.

*Figure 3. Video of Fourier Transform*
2.3.3 Game

The application provides games for users to test their understanding of STEM topics. After the user read all the materials in some topics, a game challenge is offered to the user. For example, there will be a game related to cryptography that requires the users to decrypt some encrypted message with different encryption technique. Moreover, the game result will be stored in the database for analytical use.

![Image of a Caesar Cipher Mini Game](image)

*Figure 4. Mini Game of Cryptography*

2.4.4 Animation

Animation are designed to give visual information of STEM topics. It can help users to understand topics like cryptography which can be illustrated with animation.

![Image of an Animation of Cryptography](image)

*Figure 5. Animation of Cryptography*
3. Current Progress

3.1 Overview

In the first semester, most of the time has been spent on studying STEM contents and designing interactive contents. Half of the works are finished so far. The rest of the works are expected to be finished in the second semester. This section will discuss the finished works and the future works in details.

3.2 Finished Work

3.2.1 Web Interface

This is the major part of this project as the application heavily depends on the design of the interactive contents in the web interface. The web interface has been set up on AWS S3 Services and it can be accessed by the public. The interactive contents of Fourier Series and Fourier Transform have been implemented. Simulation and Video are displayed at the website. Users can read the materials and interact with the contents to study STEM knowledge.

![Image of Web Interface]

*Figure 6. Image of Web Interface*
3.2.2 Set up of API and database

An API and a database have been set up on Amazon Web Service to support the web application. Users can register as a member of the web application by a sending request to the API. The API is connected to the database and able to handle storage and retrieval of user data. Also, the API also handle the intensive calculation of the simulation such as some interactive contents of Fourier Transform to provide a better experience to users.

3.3 Future work

3.3.1 STEM Contents

The application is expected to deliver at least 3 main STEM topics to users. Currently, only Fourier Transform and Cryptography have been delivered in the application. More STEM topics such as Basic Coding will be delivered to integrate the application into an online learning application.

3.3.2 Data Collection

The web application will record the time that user have spent on some section and the result of mini game. API and database tables will be designed in the future to process the data and store them in the database. The data will be used for analytical use to study the difficulty of STEM topics.

3.3.3 Comment Section

The application will allow users to leave comments and questions in the web interface. The comments are stored in the database and can be retrieved by other users. This allows other users to answer the questions. The comment section can provide a peer learning experience to users to improve the efficiency of learning.
4. Difficulty and Limitation

4.1 Difficulty encountered

The biggest challenge in the project is designing interactive content. As there are countless STEM-related topics, it is infeasible to design all of them. Moreover, the content must be inspiring and interactive in order to increase the interest and motivation of STEM. The proposed method for designing content is to select the most popular and common STEM topics as the content. Also, the application will collect feedback from users for designing better interactive content.

4.2 Limitation of the project

In the current stage, the web application only supports English. As the current Education curriculum context in Hong Kong are teaching in English or Chinese, students who are not good at English may not understand the STEM content of the application. It is best to use English because it is the most common language in the world and it is more effective in searching. Multiple languages will be focused in the future scope if it is necessary.

Another limitation is from Amazon Web Service, the current services used in this application only allow 20000 Get Requests per month which means only 20000 views per month. The application will be out of service if the website is frequently accessed.
5. Conclusion

The online learning platform for STEM education is illustrated in this project. It aims to enhance teenager’s knowledge and motivation of STEM. Interactivity is the key component of the online learning platform, it is anticipated that interactive web content helps students acquire and pursue STEM knowledge more efficiently.

Cloud Computing is used in the online learning platform for the purpose that learning STEM is not limited in schools. Users can access the platform in everywhere to learn STEM, also cloud computing simplifier the development and maintenance of the application as hardware configuration and maintenance are provided by the third party. Therefore, using cloud computing helps both users and developers, it can provide a convenient environment to promote STEM education in Hong Kong.

The development of the application is under progress. Web interface with interactive contents and API with a database are implemented. Future works include more STEM contents, game and comment section.

Based on the current progress and difficulties encountered in this project, enhancing user experience and designing interactive STEM contents will be focused in the later scope. It is expected that the quality will be further improved in the second semester.
6. References

Available: https://blog.anton-paar.com/why-stem-education-is-so-important/
[Accessed: 2018, Sep 26]

[Accessed: 2018, Sep 26]