

**The University of Hong Kong**  
**Department of Computer Science**



**Final Year Project**  
**STEM Portal**  
**Project Plan**

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## **1. Introduction**

STEM, abbreviated from Science, Technology, Engineering and Mathematics, has been a hot topic in education since the 1990s. Educationists have devoted countless efforts in advocating STEM education in many regions. Aimed to enhance STEM education in Hong Kong, STEM portal is a web platform in which teachers and parents can discuss to form a resourceful environment for students to learn outside classrooms.

### **1.1 Background**

Many modern reform initiatives require professionals in the field of STEM, an example includes Hong Kong's Smart City initiative. In light of this, the Hong Kong Government introduced STEM education in its Policy Address in 2015 (HKSAR, 2015). Nonetheless, countries around the world have already been promoting STEM education for decades. In particular, the US started advocating such topic back in the 1990s (White House, 2018). This indicates Hong Kong is a step behind the pace of curriculum development in STEM education. To tackle this situation, STEM portal is developed for further enhancing Hong Kong students' learning experience in STEM education. With the involvement of parents, they can discuss through the online forum in the portal, while students may try on hands-on experiments with instructions in the portal with parents. As a result, STEM knowledge can be delivered more effectively to students.

### **1.2 Research and Comparison of Existing Solutions**

This section searches for existing solutions or similar applications both in Hong Kong and overseas. Then it analyses the pros and cons of the solutions.

#### **1.2.1 STEM@HKUST**

STEM@HKUST is an online platform for the public to know more about STEM(HKUST). In terms of site structure, since the site aims at the public, there are no login features. In terms of functionality, there is news notice board, video showcases that introduce different STEM-related topics. Users can also receive information about events that will be held shortly. Nevertheless, the information at STEM@HKUST is mainly collected from the Hong Kong University of Science and Technology. Users may not receive STEM information comprehensively.

### **1.2.2 HKedCity**

HKedCity is an interactive online platform for teachers, parents and students (Hong Kong Education City, 2019). In terms of site structure, there are separate sections for each of the users, where users can log in and quickly browse for what they want. In terms of functionality, there are discussion forums, learning materials, as well as minigames for primary school students to learn from playing. Yet, the user interface and user experience could be better improved to attract more users in the long term as many of the discussion topics are out of date.

### **1.2.3 STEM Learning**

STEM Learning provides thousands of free-to-access resources to support the teaching of STEM subjects for both primary and secondary schools in the UK (STEM Learning Ltd). In terms of site structure, users can log in and search for stem-related teaching materials. This portal has a better user interface and user experience. In terms of functionality, there are comments & ratings given to learning materials, learning materials, recruiting stem ambassadors, registering Continuing Professional Development (CPD) activities, as well as a recommendation list.

## **1.3. Project Objectives**

STEM portal ultimately aims to enhance Hong Kong students' learning experience in STEM education. There are several objectives to achieve the goal, and they are as follows:

- To act as a platform for teachers and parents for exchanging materials
- To encourage students to try on hands-on projects
- To provide initiative for students to learn by themselves
- To strengthen communication between teachers and parents

It is believed that through the use of the portal, teachers will know more about the learning situation of students. Moreover, students can also enjoy watching interesting videos and playing fun games while learning STEM topics.

## **2. Project Scope**

This section defines the scope of the project by defining groups of target users and listing out system features.

### **2.1. Target Users and User Goals**

#### **2.1.1 Primary School Students**

Primary school students want to learn things in interesting ways, such as playing minigames and watching interesting videos. They also want to try to carry out experiments by themselves or with parents at home.

#### **2.1.2 Primary School Teachers**

Primary school teachers want to receive feedback from parents and students on their learning materials. They also want to track students' learning progress. Moreover, they want to exchange teaching materials with other teachers. They also want to communicate with parents privately.

#### **2.1.3 Parents**

Parents want to exchange information with other parents and teachers. They want to know how to teach their children at home. Moreover, they want to know what STEM activities will be held shortly. They also want to talk to teachers about their children.

### **2.2. System features (with feature priority list)**

This section defines system features that appear in the portal. The project will be divided into two phases. They are as follows:

#### **2.2.1 Phase 1: Core Features**

This phase focuses on core features that provide general usage for users, so as to satisfy users' needs.

##### **2.2.1.1 Discussion Forum**

Users use this feature to discuss with each other. User can create post and ask questions in the forum, while others can answer questions by replying to the post. In particular, parents can exchange information with other parents on

how to teach their children outside classrooms. Moreover, teachers can also answer questions that are raised by parents. Furthermore, users can upvote or downvote posts and favor posts that they want to save.

#### **2.2.1.2 Sharing Teaching Materials**

Teachers can use this feature to share their own teaching materials with other teachers. Teachers can only download shared materials if they have uploaded their own teaching materials and allow access to other teachers.

#### **2.2.1.3 Authentication and Cookies**

Users are required to log in before they could use any features. They must register as either a student, a teacher or a parent. This increases the interactivity of the portal as users can interact with other users through the portal.

#### **2.2.1.4 STEM Meter**

Users can gain experience according to their actions and activities, such as playing games, making comment or completing online courses. After earning enough experience, the meter is then fully filled and the user is leveled up. Users can earn different titles according to their levels and display their titles on the dashboard.

#### **2.2.1.5 Recommendation Engine**

Users' actions on the website are tracked, it predicts news and learning materials that users are interested in, and generate a recommended list for them. This makes users have a better user experience.

### **2.2.2 Phase 2: Advanced Features**

This phase focuses on advanced features that provide extra materials to improve users' experience.

#### **2.2.2.1 User Dashboard**

When users log in to the portal, they will see their own dashboard. Users can receive notifications from groups, such as schools or friends, about



upcoming events from the dashboard. Moreover, users can decorate their own dashboards according to their status.

#### **2.2.2.2 News Board**

Users can receive the latest news about STEM. Users are not required to log in to get the information.

#### **2.2.2.3 Games**

Users can have entertainment in the portal, the portal provides three games in total. The first game is Magic Cube. It is a problem-solving game. Players need to alter the orientation and position of pieces with different shapes to form a 3x3 cube. The second game is CodeSomething! It is a coding game. Players need to choose the correct logical operator to make the code have the desired output. The third game is SolveThEM. It is a game related to Mathematics. Players are required to select the correct answers within a limited time in order to make the equation makes sense. It is hoped that the games could provide fun and happiness to students while learning STEM topics.

#### **2.2.2.4 Unlocking achievements**

Users can unlock achievements once they complete all the requirements of specific achievement to earn pins and STEM Meter experience. Pins can be displayed on users' dashboards.

#### **2.2.2.5 Online Curriculum**

Students can attend courses in the portal. There will be designated courses for different students according to their backgrounds. The courses consist of different sections, with video recordings. Checkpoints will be included at the end of each section, in which students have to answer and get certain points to continue studying.

### **3. Methodology**

This section defines the ‘how’ aspects of STEM portal, including technologies, techniques and tools used in the course of project development.

#### **3.1 Techniques and Algorithms**

##### **3.1.1 Frontend (User Interface)**

Vue.js, a JavaScript library for building

##### **3.1.2 Authentication**

JSON Web Tokens (JWT) is used for transferring authentication tokens between clients and the server.

##### **3.1.3 Database**

MongoDB Atlas is used as the NOSQL database for online storage. It has advantages over SQL solution counterparts such as higher performance and flexibility in data structure.

##### **3.1.4 Games**

Phaser, a JavaScript game engine for building browser-based games is chosen for development of the three games. It makes use of WebGL and canvas technology for high performance rendering, along with a comprehensive list of game systems and cross-device support. On the other hand, Pixi.js is not a game engine and does not provide features such as physics simulation, collision detection and animations. Also, when compared with melonJS, Phaser has a more consistent API documentation and a broader community support.

##### **3.1.5 Recommendation Engine**

The engine generates recommendation lists based on users’ search history and rating of forum posts. There will be a tag for each of the posts, news and learning materials. Based on the users’ interest in certain areas, the engine will get a query from the database ranked by rating. Rating of posts will be calculated from the number of upvotes and total number of users visit on the post. Moreover, some

thresholds will also be set when getting the query from the database, such as rating and whether the post has been accessed in recent times.

### 3.2 Development Tools

During the course of developing this project, Visual Studio Code is used as the IDE, Git is used as the version control software, and Github is used as the repository hosting service. Finally, Vue Devtools is used to assist during debugging process.

### 3.3 Project schedule

Date	Detailed Work(s)	Remarks
October 2019 - November 2019	User Interface Design	
	Implementation of Database (MongoDB)	
	Implementation of Authentication System	
November 2019 - January 2020	Implementation of Games (Part 1)	Complete Game 1 and 2
	Implementation of Discussion Forum	
	Implementation of Sharing and Archive Platform	
	Implementation of STEM Meter	
	Implementation of Recommendation Engine	
January 2020 - March 2020	Implementation of User Dashboard	
	Implementation of News Board	
	Implementation of Achievement System	
	Online Curriculum Design	

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	Implementation of Games (Part 2)	Complete Game 3
January 2020 - April 2020	Graphic Design on the Portal	

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