Project Title: Lecture Gamification

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Abstract

Gamification is the application of game elements in non-game contexts. This project aims at developing a game application for secondary schools’ classroom, so as to increase the motivation of learning by applying game elements into lectures.

Our final product will be a game which will be played on cross-platform electronic devices and computers. It is not a game for teaching course content, but a game to practice what students have learnt and test their knowledge level. We hope most subjects can apply this game to assist learning. Teachers can input their quizzes or tests easily by multiple choices format on a web interface and students can learn while they are playing the games on mobile devices.

The project planning has been done and the project scope was defined. Currently, we are now working on the detailed design of the system. After the design, we will proceed to the implementation of our work.

Acknowledgement

We would like to thank our supervisor, Dr. T. W. Chim for the advice and assistances on this project. Thank you for giving us guidance and support.
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1 Project Description

In this century, teenagers are spending a lot of the time on playing mobile games. Technologies do not only provide us a platform for entertainment and communication, but also a platform to learn. This project is to provide a learning platform for students. In addition, we hope this platform can help teachers by establishing an efficient teaching process. Gamification is the use of game mechanics in non-game contexts. It makes learning more engaging by the use of features normally found in games to support learning materials. Research had suggested that the use of game elements can help students learn. [1] It is also a huge potential that games can play a role in education. This project aims to apply game mechanics into classrooms of secondary schools, so as to bring a new learning experience and to increase the motivation of learning.

Our final product will be a game application which can be played on cross-platform electronic devices and computers. It is not a game for teaching course content, but a game to practice what students have learnt and test their knowledge level. In secondary school curriculum, there are more than ten subjects. We hope most subjects can apply this game to assist learning. Therefore, general question and answer game will be designed. Teachers can input their quizzes or tests easily in multiple choices format and play with students in the lessons.
2 General background of topic

2.1 Overview

With the development of technology, many institutions are applying different technology to enhance the effectiveness of teaching. E-learning has gained popularity and been developed in the past two decades. With the growth of technology, gamification in education can have more room for development, with more use of electronic devices and software applications.

2.2 Disadvantages of traditional education

Traditionally, unidirectional of teaching is a passive learning method for students. Students follow teachers’ instructions without critical thinking. They may no longer ask more questions to investigate thoroughly. Furthermore, they may lose interest in learn new things. In view of this trend, current schools require a more positive and energetic learning circumstance. How to increase student participation is one of the challenges in a lesson.

Enhancing effectiveness of teaching is also one of the biggest problem for teachers. In nowadays, traditional in-class practices and quizzes spend a lot of time on marking and recording results. Therefore, a teaching tool with effective technological function is required to reduce the time of preparing lectures and teaching materials.

2.3 Gamification

To increase student involvement, lecture gamification will be a good solution. Gamification is the application of game elements in non-game contexts. Research had suggested that the use of game elements can help students learn. [1] An interactive lesson can give better impression and help understanding rather than traditional teaching.

One of the example of game elements is giving rewards. In schools, students will be given rewards if they have good academic performance, which motivating them to study hard. Another example of game elements is ranking. Different students will have different performance. A ranking showing their positions will give competition among students and increase their desires to work hard, so as to not fall below in the ranking.
3 Purpose of project

3.1 Develop games for playing in real-time lecture

The major goal of this project is to develop some games for playing in lectures. Game elements like characters, competitive environment and game mechanics are included to provide a level up system and reward accomplishments such as getting points, badges, lives. Every student can get his/her own character to develop. Teachers can use different games to hold different purposes.

The games can utilize facilities inside a classroom including teacher’s computer, students’ smart phones or laptops and Wi-Fi infrastructure. With the use of this application, this can facilitate teachers in teaching new knowledge to students or helping students to revise what they have learned.

In long term, the development of this project would aim at making the games to be general so that they can be used in different courses.

3.2 Break of tradition by lively and interactive lectures

In this project, changing current teaching style is one of the goals. This application can increase the interactivity and cooperation. When playing with the games, students need collaboration so as to win. Hence, this can promote team spirit. By grouping students into teams, they can collaborate to compete with other teams or earn rewards. In order to earn more points in the games, students are more willing to complete the tasks effectively. Throughout the process of playing games, the happiness of attending class will improve students’ intentions of learning.

3.3 Enhance teaching

In order to motivate student’s learning interest, teachers often have to design some games for playing during lectures. However, this is time-consuming in preparation and they may encounter problems when giving instructions to students to follow the steps. This application can act as a teaching tool, the question-based games can help teachers manage students and reduce their workload.

From the points of view of teachers, with using this application, they can know students’ weaknesses and strength by getting analysis from the game results. After the end of games in lessons, teachers can discuss with students which parts they are not doing well.
4 Previous work in the Field

4.1 Case Study

We have done some case studies on current popular e-learning applications. According to the case studies, one of the game elements is giving rewards. Users will gain some rewards in the application after they completed tasks.

Another example of game elements is ranking. Different users will have different game results. A ranking showing their positions will give competition among users and increase their desires to gain better results, so as to not fall below in the ranking.

4.2 Duolingo

This is an application aims to motivate users to learn languages. [2] Each lesson provides a variety of speaking, listening, translation and multiple choice challenges. By answering questions, user can instantly see which answers get correct and know his or her weaknesses. The application can show how to improve that area. Some gamification concepts are applied. Users can get points when they finish a lesson. However, they may lose hearts when answering incorrectly so that this can motivate them to keep work hard. A spent time record reminds users to stay on track.

Some advantages of this application were analyzed. The interface of Duolingo is clear for users to understand. There are different question types and they will swap frequently so that the users will not become bored for a while. However, one of shortcoming is unclear level. Users may not select a suitable level to start, except he/she is a beginner of that language.

In our application, the design will focus on user-friendly so that it is simple for users to use. The design can be referred to the clear design of Duolingo, especially result analysis and course schedule. Some simple graphics can be applied. Users can check their previous result and correct answers at any time.

![Figure 1 – Duolingo](image-url)
4.3 Classcraft

Classcraft is an online platform created by a high school physics teacher. [3] Students can gain game experience (XP) by completing homework, tests or learning tasks. It uses game mechanics to engage students. Students aware of the rewards for their participation and hence, increase the motivation of learning. Classcraft has integrated with Google Classroom and is available to the classrooms around the world.

It is chosen for one of the case studies because it is popular around the world. However, it is not user-friendly on the design. The main screen is displaying character figure and its detail status. There are many other essential functions or setting hide on the menu with numberless options. Users may not find the function instantly by their intuitive sense. Also, RPG game design is complex. Characters belong to six groups of role. Each role contains different power and still set. Users require some time to pick up their RPG system, especially who are not familiar with RPG game.

Therefore, our application will show all important and common functions in the main game screen. Such as gameplay rules and resume button. The user can always find the functions they need. Also, only 3 roles can be selected for the beginners. Different role will have only one feature so the user can get the difference between easily.

![Classcraft](image)

Figure 2 – Classcraft
4.4 Quiz RPG: The Mystic World of Wiz

This is a quiz-based RPG mobile game for Android and iOS. Players can get fantasy characters to have battles with monsters by answering quizzes. The questions come from knowledge of any aspects and common sense but not only for academic and educational purpose.

There are only 2 type questions to answer. They are multiple choice and ordering question. The user can play without a game tutorial. Time limitation is set for each question. With optimizing use of the sound effect, the user play in a fast pace. However, questions come from knowledge of any aspects. The user may be annoyed by questions they do not interested in.

In our application, to stimulate students to answer questions, time limitation will be applied. Health point of user’s character will be deducted after a certain time. Also, teachers can input and control all questions to be answered by students. It solves the problem of getting confuse in random questions.

![Figure 3 – The Mystic World of Wiz](image-url)
5 Scope of Works

In this project, we target at secondary school teachers and students as the users of the application. Games with different teaching purposes and different scale will be developed. The games are kind of quizzes/tests but in a game format. Teachers can input the contents of the questions and answers in advance. To achieve this, a user interface will be provided to teachers as a control panel.

Two main games will be implemented in order to fulfill different teaching purpose of a lecture. The first game is a small-scale game. This game aims to test student’s strength and weakness in a short time. The second game is a medium-scale competitive answering game which aims at cooperative training. Students will be divided into groups. Each group requires to answer questions as fast as possible in order to win. These two games will be developed in one application with role-playing game style. Each student’s character obtains different ability to help them answer the question.

5.1 System Structure

In this project, a database server will be set up to manage the user data of the system and a game server will be used for handling the process of games. These two servers will be connected to the Internet so that users in anywhere can access the system.

On the other hand, the core of this project, the mobile application games will be developed in cross-platform, so that users with different kinds of smart phones can use this system. A web interface for management will also be developed for teacher to manage and to use the system.
6 Development Tools

6.1 Unity

6.1.1 Game development

To provide different highly-feasible games and optimized graphics, a game engine is required for rendering 2D or 3D graphics. In this project, Unity will be used as the game engine. Unity is a cross-platform game engine with a built-in integrated development environment (IDE). It is used to develop video games for desktop platforms, web plugins and mobile devices like Smartphone, IPad and Android Tablet. The users can play games without broader, whenever they want. Unity provides an integrated development environment to enable simplified, rapid development of games. Elements for creating games such as graphics, sounds, animations can be put together in Unity’s IDE.

For networking part, there are plugins to support Unity’s networking application programming interface (API) management. As the game in this project is a server-client based game, it will require to handle real-time multi-player game requests. Therefore, a dedicated server is needed for guarantee the connectivity and networking performance of clients.

6.2 Node.js

6.2.1 Execution procedure

Among many server-side languages, Node.js was most suitable for developing the game server. Node.js uses an event-based server execution procedure rather than the multi-thread management overhead languages. For these server-side languages like PHP, the multithreaded execution pauses for a while at the point where the slow web server is accessed. While Node.js using JavaScript’s event based programming in the browser. It is an event-based asynchronous function that implement event loop instead of waiting for I/O operations. Therefore, Node.js can still make use of its processing power when the server is waiting for any other operation. This makes Node.js scalable to millions of concurrent connections.

Below are the pictures showing the explanation of event-based execution and multi-threaded execution and the difference between them.

![Figure 5 – Event-based execution](image1)

![Figure 6 – Multi-threaded execution](image2)
6.2.2 Networking host

Before considering to build an independent game server by Node.js, there are other networking host software or Unity plugins as a choice provided for multiplayers’ game development. These companies provide general networking host service. An application can execute online tasks without building any back-end server or support. As these network hosting services are convenient for building an application quickly, many developers employ these service and many supports and tutorials can be found on the Internet.

Some of the common software are chosen for comparison. The detail of comparison is shown in the table below. Although the networking host services are convenient to build a multi-players application, there are still some fatal shortcomings. These services did not support a database to store user’s data. Only signal transformation is available during a game. Therefore, a server is still demanded for supporting database as well as building a login system. Node.js solve this problem by applied Socket.io, a WebSocket library for Node.js that allow for real-time data transfer. [4] It is suitable for multi-player games for sending and receiving objects instantly.

It was also found that the networking services hosted by companies have a limited number of concurrent players from 20 to 30. It is only available to run the application for a small class but not more students. Moreover, their free service may not be stable enough to hold an instant answering base game. In order to get more concurrent players and run the application smoothly, an expensive network service expenditure would be required. Therefore, building an independent back-end server is the only way to eliminate the financial risk.

<table>
<thead>
<tr>
<th>Networking host service</th>
<th>Concurrent players</th>
<th>Tutorial / Support from the Internet</th>
<th>Building a login system</th>
<th>Difficulty of usage</th>
<th>Benefit of usage</th>
</tr>
</thead>
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<tr>
<td>Photon</td>
<td>20 for free</td>
<td>many</td>
<td>no</td>
<td>Only transform signal between user but no handling</td>
<td>No limit for concurrent players</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>expensive</td>
<td></td>
</tr>
<tr>
<td>Unity network</td>
<td>30 for free</td>
<td>many</td>
<td>no</td>
<td>Only transform signal between user but no handling</td>
<td>Easy to implement with Unity</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>expensive</td>
<td></td>
</tr>
<tr>
<td>node.js</td>
<td>250k - 1m depend on memory and CPU</td>
<td>Not many tutorial with Unity but enough for building a server</td>
<td>yes</td>
<td>May not have enough support from the Internet</td>
<td>No limit for concurrent players</td>
</tr>
</tbody>
</table>

Table 1 – Comparison for Networking host service

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6.2.3 Database management system - MongoDB

MongoDB is a non-relational database with query language support. [5] It stores data in documents with variation in structure. Complex structure of data can be stored easily as it uses dynamic schemas. Using MongoDB as the database management system (DBMS) can help building the application faster and manage it more efficiently.

As the system in this project will create large amounts of data transaction, especially during the playing of games, the DBMS used should support high-speed of processes.

With the high transaction rate of MongoDB, it can support rapid read-write operations, which meets the need of the project.

6.3 Software stack used in this project

![Software Stack Diagram]

Figure 7 – Software Stack
7 System Design

7.1 Main Project Flow

To achieve our project objectives, some strategies are identified as each of the following:

Before starting the implementation of the whole application, the project was broken down into some smaller parts as a milestone to build. Our first stage is to construct a minimum viable product. It is a collection of the absolute minimum set of features that will not affect core development. Apart from detailed game design and complicated application flow, game server, database server, login system should be ready to produce the minimum viable product.

In this stage, the database model was designed first. The database is used for storing the data of the whole application, including the questions and answers used in the games, and also the user accounts data. Which kinds of question type used was decided before the implementation of the game. There are multiple choice and reordering question. Then, a backend server was built to handle the user requests and process data from database. Lastly, to test the accuracy of built system core, a login system and a simple game were implemented. Users can register and login and two different interfaces are displayed to teachers and students. The students can enter a game room to play multiple choice quiz game. This game can receive the result and save it in the database.

Once completing the minimum viable product, in next stage, detailed application flow and game interface would be designed. The detail of the games will be designed and hence, the implementation of the game logic. A better user experience would be required in order to achieve our second objective, break of tradition by lively and interactive lectures. In order to get rid of traditional passive lectures, interactive game elements will be applied.

In stage 3, the development is focus on the perspective of teacher to fulfill the third project objective, enhance teaching. What kind of game result analysis they needed and how to display theses results are the main tasks to investigate. Teacher’s computer can display game result of students instantly. The Web interface would be implemented for teachers to import their quizzes and questions.

Before delivery, the whole application will be tested to ensure it can work well. Modification will be made if necessary. Bugs which affect equity of players and lead to unfair game should be eliminated. Through the final developing and testing part, this makes sure our application can be launched smoothly. This will accomplish our first objective, developing games for playing in real-time lecture.

The detail plan of project schedule can be found in Appendix B.

7.2 Game design

In this project, two games in different scales will be developed in order to fulfill different teaching purpose of a lecture. In both game, students require to answer questions which is set by teachers. Students can enjoy the game procedure and get rewards.
Mini games

The mini games aim to test student’s strength and weakness in a short time. Students have to answer the questions by collecting correct items. Each session of game takes around 15 minutes.

In the first mini game, questions will show from time to time, multiple apples will appear with different answer on a tree. The apple will drop randomly, and students have to collect the apples with correct answer in order to earn points. The apple collected will be used as a bonus on the healthpoint in the competitive game.

In the second mini game, it is mining game. Questions will show from time to time, multiple golds or stone will appear with different answer in the underground. Players have to collect the items with correct answer in order to earn points. The golden or stone collected will be used as a bonus on the attack in the competitive game.

Competitive game: Four Kingdoms

The second game is a competitive answering game called Four Kingdoms. This is a medium-scale game which take about 30 to 60 minutes. As the average class size of secondary school is around 28, students will be divided into four groups. With a competitive behavior, each group requires to answer questions as fast as possible in order to attack and win the war.

This game use the apples and golds accumulated in mini games. With a minimum healthpoint in power bar, the apples are the bonus of healthpoint. The more apples collected before, more extra healthpoint will be given. Each kingdoms have their own weapon. The golds collected before also enable players to gain a more powerful weapon or tools with special skills.

The objective of game aims at cooperative training. Students can review what they have learnt in a whole subject or big section. As only four devices are required, it is suitable to play in classroom.
Game Flow

When the game begins, there are 4 kingdoms with their own castle and power bar to show how many healthpoint they have. All players share this game interface in their own devices. To let the cannon get enough power to attack others, players required to answer questions. All players will get the same question at the same time. Player who answer correctly and be the fastest one will get the priority to attack. In the successful interface, player will be asked for selecting which kind of attack, ‘ranged’ means all 3 other castles will be deducted 1HP, ‘individual’ means selected castle will be deducted 3HP.
After selected attack, the game will show which kingdom win this question and wait a few seconds before this attack. If other kingdoms can answer correctly during this short time, a shield will be provided. So that, these kingdoms can catch the chance for defense. However, once the kingdoms answering wrong or time up, they will get damage. So, the game ends when 3 of the kingdoms lose all healthpoint or the kingdom with highest HP when all questions are finished.

7.3 Login System Design

Login system will be used to manage the user accounts. The system would identify whether user is a student or teacher. Each username can only determine one role. The Users who want both teacher and student role are required to register two different accounts – a student account and a teacher account. Different interface would be display for different role. Students are allowed to get their character's data after login and join in an opening game room. Teachers can create a game room in the server so that students can join a certain game room by inputting specific key.
7.4 Database design

For students, character status such as level and items collected in mini game are stored. Students can load these data when they login to the application. They can also get game result and history in application.

For teachers, their prepared questions and quizzes are stored in database. These data would be requested when student join in the room and particular questions would be obtained. Question type is restricted to specific format that is multiple choice and reordering questions. Other question type can be developed later based on this two formats. The number of answer selections is limited to be less than or equal to eight which enable a flexible interface design afterwards.
### 7.5 Big Data Analysis

As the increasing trend of applying big data analytics, this project will utilize big data analytics to improve Education. This analysis step including collecting data from game result, then finding patterns and connections relating to human behavior, finally making new decisions depends on information.

For the first approach, the application will focus on collecting two kinds of data. The first one is the correctness, which indicates the percentage of different choices that student answered. The second one is how long they take to answer certain questions.

The overall goal should be improve student results. We hope teachers can focus on weakness and strength of students so that they can gain a better understanding. Also, the data in real-time can deliver an optimal learning environment. Each individual student have different understanding on different subjects. In a traditional class, a teacher can only use a single way to teach the whole class. If this application could divide different kinds of student and give a more suitable strategy, this situation can be improved.

The web interface for teachers will be developed by D3.js. It helps to visualize the data, so that teachers can easily focus on the results. In this webpage, some pie charts will be used to display the correctness percentage and a timeline to show time used for answering.

![Figure 14](image1.png) – game result – pie chart

![Figure 15](image2.png) – game result – time line
8 Current status

Currently, our first milestone, minimum viable product was completed. Database was set up and ready for use. Login system is functioning properly. A simple application with a simple interface can be launched. Students can play a multiple choice game. After answering all questions, they can review the results.

The second milestone, game design is almost completed. The detailed gameplay and game interface was designed.

![Simple game play](image.png)

Figure 16 – Simple game play

The main flow of finished sample modal can be found in Appendix B.
9 Future Development

In the next stage of development, we are going to continue our implementation of application, including mini game and competitive game. The operations in back-end server and the accuracy of database was ensured, with the attractive graphic design and game design. This will speed up our implementation procedure by developing the game based on our minimum viable product.

We target to finish all game implementations by the end of February. Later, we will develop a fully feature web interface for teachers by three weeks. Testing will be performed afterwards. Improvements including user interface and user experience will be made continually.

![Project Schedule](image)

**Figure 17 – Project Schedule**

10 Limitations encountered

In this project, there are two main risks, security and localhost problem. For security problem, the built login system does not have any authentication yet. It will apply the SSL to tighten security later.

Second, in the development process, we are now using localhost to act as the server to handle and manage the whole system. Using our own notebook computer is not feasible as the dynamic IP is not stable enough to host the application. Also, the resources of notebook computer are not enough to support the running of the whole system. Hence, using the virtual machine provided by service provider such as Google cloud service will be one of the solutions.
Reference:


Appendix A – Project Team Details

Project Team

Two team members including design and implement. Project Manager and Design Architect will be coordinated and work together on this project.

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Duty</th>
</tr>
</thead>
</table>
| Kwok On Ki      | Project Manager | • Project leader and coordinator responsible for overall planning and development of the project  
                    • System Development |
| Sham Cheuk Yee  | Design Architect | • Database management and enhance  
                    • Game design  
                    • Interface design  
                    • Testing     |
Appendix B – Simple model Flowchart

Enter game interface

Get into the room by particular key

Download questions created by that teacher

Get signal from game server to start game

Save result and character lost HP

Correct answer?

No

Yes

Save result and character gain rewards (Exp)

Finish all questions

Send result to game server for analysis

Student can review their result

Teacher get the result and display to students

Communicate results

Figure 18 – Sample Model Flowchart