

TARUMT Game-based Learning System

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TARUMT Game-based Learning System

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Declaration

The project submitted herewith is a result of my own efforts in totality and in every aspect of the project works. All information that has been obtained from other sources had been fully acknowledged. I understand that any plagiarism, cheating or collusion or any sorts constitutes a breach of TAR University rules and regulations and would be subjected to disciplinary actions.



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Abstract

Due to the pandemic of covid-19, Tunku Abdul Rahman University of Management and Technology (TARUMT) shifted most of its courses from face-to-face learning mode to hybrid or online learning mode, which led to many problems such as students' inability to concentrate in class and students' difficulty in interacting with others. In order to solve these problems, the author and the author's partner propose a TARUMT Game-based Education System that can help to increase student engagement and motivation in the learning process.

The TARUMT Game-based Education System is developed by the author and the author's partners and it contains two subsystems, the TARUMT Game-based Learning System as a front-end system and the TARUMT Game-based Teaching System as a back-end system. This project will focus on the front-end system with several proposed modules, including student login and maintenance module, participating in classroom module, participating in game module, score and ranking module and claiming power exchange module.

The system is using a prototyping model as the approach for system development, and using Apache NetBeans IDE to write and execute the HTML, CSS, PHP and Javascript programming codes as well as XAMPP used to manage the MySQL local database. Moreover, unit testing and black box testing methods are used to perform system testing, as well as the test results will be documented using test plans and test cases to ensure that all modules functionality perform well.

However, some future improvements to the system could be made, such as adding more question types to the game, the score earned for a question could be designed to be calculated based on accuracy and speed, the ability to check if the game has completed the setup, adding more power types and limiting the number of times a student can play that game based on the game type.

Acknowledgement

First of all, I would like to thank my partner, Muk Yin Man, who worked with me on this TARUMT Game-Based Education System project. Throughout the project, we have put a lot of effort and came through a lot of discussion to keep improving the system. Not only that, she also provided me with a lot of suggestions when I was stuck in the front-end user interface development.

Next, I would also like to express my gratitude to my supervisor, Ms. Lee Seah Fang, who gave me and my partner a lot of guidance and advice throughout the project to make this project better.

Last but not least, I am also thankful to my family members that helped me to test my system a few times and found out some minor bugs that exist in my system. Without them, I may not find out the minor bugs.

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Chapter 1

Introduction

1 Introduction

TARUMT Game-based Education System is a proposed system for TARUMT instructors and students to conduct their teaching and learning in a game-based mode through any internet-connected devices. The major problem faced by existing systems is the poor user interface which makes it difficult for users to use the systems. Most of the existing systems are focused on fulfilling all the needs that may be required by the public, therefore the existing systems usually consist of too many useless functions and result in a cluttered user interface. For example, the Kahoot! Kids feature in the Kahoot! platform is designed for kids and it is useless for college students.

From the perspective of TARUMT, the existing systems lack uniqueness and time consuming for students to find the function they want to use from the cluttered user interfaces. TARUMT wanted to have a system that could meet all their requirements and have some unique features compared to existing systems but there are no superfluous or useless functions in the system. Therefore, this proposed system is specifically designed for TARUMT in order to come up with a system that they are satisfied with.

In this proposed system, instructors and students can login to the system by using their TARUMT email and password. After logging in, instructors are allowed to maintain their accounts profile, maintain the classrooms and games, manage classrooms with students and manage power exchange stores. Students are allowed to maintain their account profile, participating in classrooms and games, exchange powers for games and view score and ranking.

In order to provide more fun to the students, this proposed system will provide a unique feature which is a power exchange store. This feature can help to improve the entertainment of the game for students, so that the game is no longer monotonous and simple. Students can exchange various powers in their best interests to achieve higher scores and higher rankings among players.

1.1 Objective

To enhance the user experience by offering all games for free

Most of the existing game-based learning systems are charging players a fee to unlock certain games, which results in limited games that free players can play and the majority of those using the systems are students who do not have an income. This may degrade the user experience for players when they find a game they are interested in but cannot play. To promote their learning experience, all games are free for them to play.

To allow students to play the games anywhere anytime

TARUMT Game-based Learning System is a web-based system that can be accessed through an internet-connected pc or laptop. Students can access the website and play games anytime and anywhere as long as they have a device and internet.

To provide students with more control over the game

Most of the game-based learning systems on the market provide players with less control, for example Quizizz provides the power-ups features, but players gain the power randomly. Therefore, a power exchange store is provided in the TARUMT Game-based Learning System; this store allows players to exchange the powers they want by using the accumulated points in the game. This feature may reduce players' dissatisfaction with the system's random allocation of powers.

To provide students with a more competitive atmosphere

TARUMT Game-based Learning System provides a score and ranking function that can create a competitive atmosphere for students. With this function, students' scores are made public and ranked according to their scores to motivate students to put more effort on study for better scores and rankings. Creating a competitive atmosphere can make the learning environment more positive and fun.

1.2 Background

There are several existing similar products or systems that were developed and launched on the market, one of them is Kahoot!. Kahoot! is a game-based education platform that is targeting the public as their market and it provides a lot of functions and features to meet the public's needs. Kahoot! does provide a free version which is the Basic version for their users but it limits some functions of the system. Three advanced versions are also available in Kahoot! which is Pro, Premium and Premium+, the more advanced the version, the more features users can use. It also offers both free games and paid games to its players; some games are charged some fees to unlock it. There are various main functions that Kahoot! offering such as registration and login, create and play games, create and join classrooms and so on.

There are a few limitations of current business processes and the environment of the existing systems. Firstly, the user interface of existing systems or platforms are commonly complex and poor which make it harder for users to find the function they want. Since the existing systems or platforms are designed to meet the needs of the public, it usually consists of too many functions and this leads to a messy user interface. Second, existing systems generally have a simple and similar game process, resulting in the fun level of the game cannot be improved. These systems are usually regular quizzes and no special or interesting features are added to the game such as power-ups features.

The TARUMT Game-based Education System is specifically designed for Tunku Abdul Rahman University of Management and Technology (TARUMT). TARUMT needs a platform that can provide their students with an interactive learning environment, but the existing game-based learning systems in the market do not meet all their requirements and they prefer to have a unique system. Therefore, the target market of the proposed system is the instructors and students of TARUMT.

1.3 Advantages and Contributions

Free of Charge for All Functions

The main competitive advantage is all the functions and features that are provided by the TARUMT Game-based Learning System are totally free of charge, students can access all the games without paying any fees. For other game-based learning systems on the market such as Kahoot!, they charge some fees to unlock certain games because the target market for these systems is not just students.

Additional Feature - Power-ups Store

The TARUMT Game-based Learning System offers an additional feature that is not found in other systems on the market, which is Power-ups Store. Students can exchange the power they need from the store to help them gain a better score in the game. Other systems on the market such as Quizizz do not allow players to exchange powers, it just randomly assigns powers to their players. Some systems like Kahoot! do not even provide power-ups feature to their players.

Information Updated Instantly - Score and Ranking

The score and ranking function of the TARUMT Game-based Learning System is instantly updated as new players play the game and leave new records. Instructors and students can always get the most accurate score and ranking information for each game. Providing accurate information at all times is a characteristic of a good system and it means the system is reliable.

User-friendly User Interface

The user interface design of the TARUMT Game-based Learning System is simple and clean since the system only consists of the major functions that TARUMT needs and there are no other unimportant functions because our target market is only TARUMT. Most of the systems on the market contain too many functions because they need to meet the needs of the public and the user interface becomes complicated, making it difficult for users to find the functions they want.

1.4 Project Plan

1.4.1 Project Scope

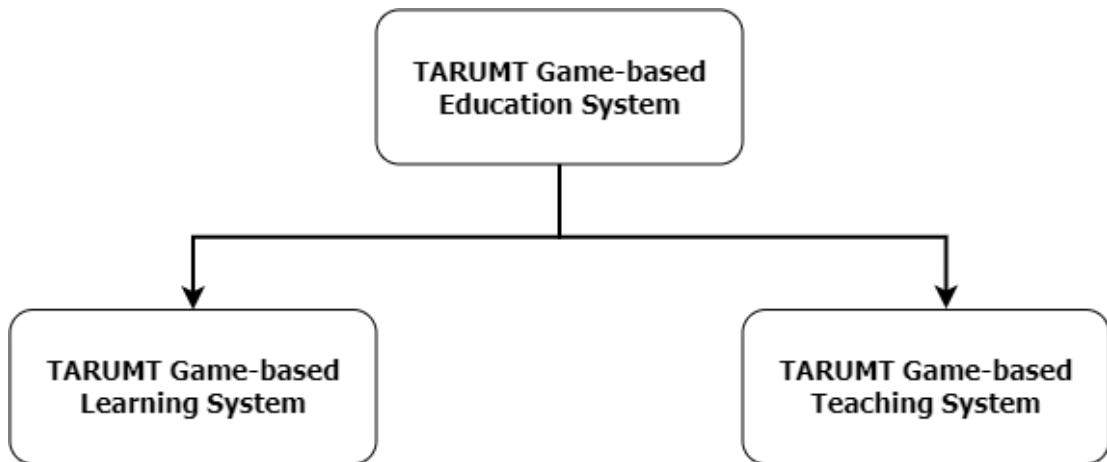


Figure 1.1 : Hierarchical Chart of the TARUMT Game-based Education System

Figure 1.1 shows that the TARUMT Game-based Education System consists of 2 subsystems which are TARUMT Game-based Learning System as the frontend system and Game-based Teaching System as the backend system. This system will be developed by 2 people, the author (Yap Yoon En) and the author's partner (Muk Yin Man). The author is responsible for the TARUMT Game-based Learning System and TARUMT Game-based Teaching System will be handled by the author's partner.

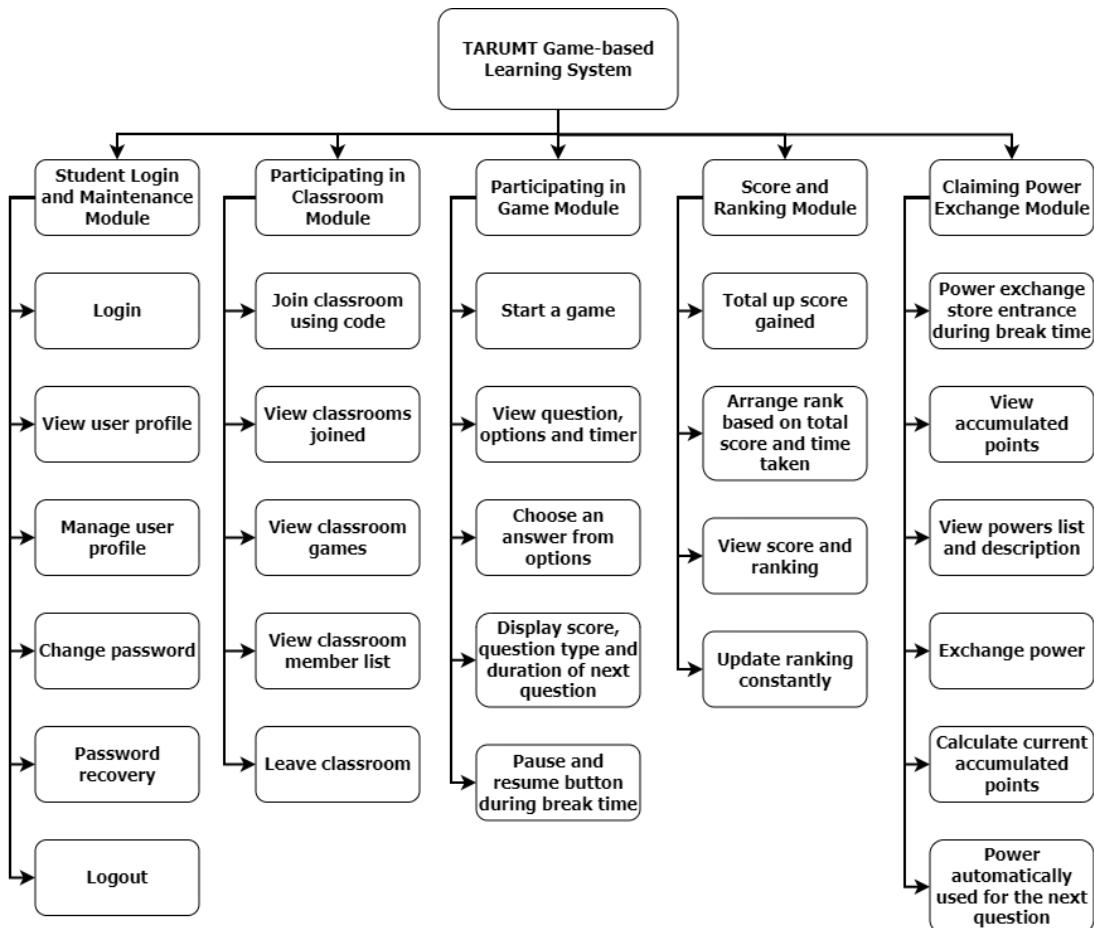


Figure 1.2 : Hierarchical Chart of the TARUMT Game-based Learning System

Figure 1.2 shows that the TARUMT Game-based Learning System consists of 5 modules which are student login and maintenance module, participating in classroom module, participating in game module, score and ranking module and claiming power exchange module.

Student login and maintenance module allows students to log in to the system by using their TARUMT student email and password. TARUMT will register an account for each student and use the student's Identity Card number as the default password for the account. After logging into the system, students are allowed to view their account profile and modify their account password and account profile such as profile picture and username. Students are also able to log out their account. Not only that, the system allows students to recover their password when students forgot their password.

Participating in classroom module allows students to join classrooms by using codes that are shared by instructors. After joining classrooms, all the classrooms joined will be displayed on the page and students are able to enter into the classroom to launch the games that are created

by instructors. After entering the classroom, students can view a list of members of that classroom. Students are also allowed to leave the classroom by clicking the leave button.

Participating in game module allows students to select and start the game they want to play. After students start the game, questions, answer options (if any) and timer will be displayed and students should choose an answer from answer options or provide an answer in text before the time ends. The question will be automatically skipped if the student is not answering before the time ends. Students will not get a score for the question if they are not answering or answered incorrectly. The score, question type and duration of the next question will be shown during the break time before the next question starts so that students can decide whether they need to exchange power or which power they want to exchange. The pause and resume button will be shown during the break time so that students are able to pause and resume the game only during the break time.

Score and ranking module allows students to view their scores and ranking when the game ends. The score gained for every question will be totalled up and ranked based on each student's total score and total time taken to answer questions. The ranking will be constantly updated as new players play the game and leave a new record.

Claiming power exchange module allows students to exchange powers during the break time of the games. Before every question starts, the entrance of the power exchange store will be shown and students are allowed to enter the store to exchange a power by using the accumulated points in the game and the power will be automatically used for the next question. Students can view their accumulated points after entering the store so that students can know how many points they have earned. Powers list and description are included in the store so that students can understand what powers are and how powers work. The default powers provided are double scores power(used for ranking), double points power(used for power exchange), and eliminating a wrong option power(remove one incorrect option in a multiple-choice question).

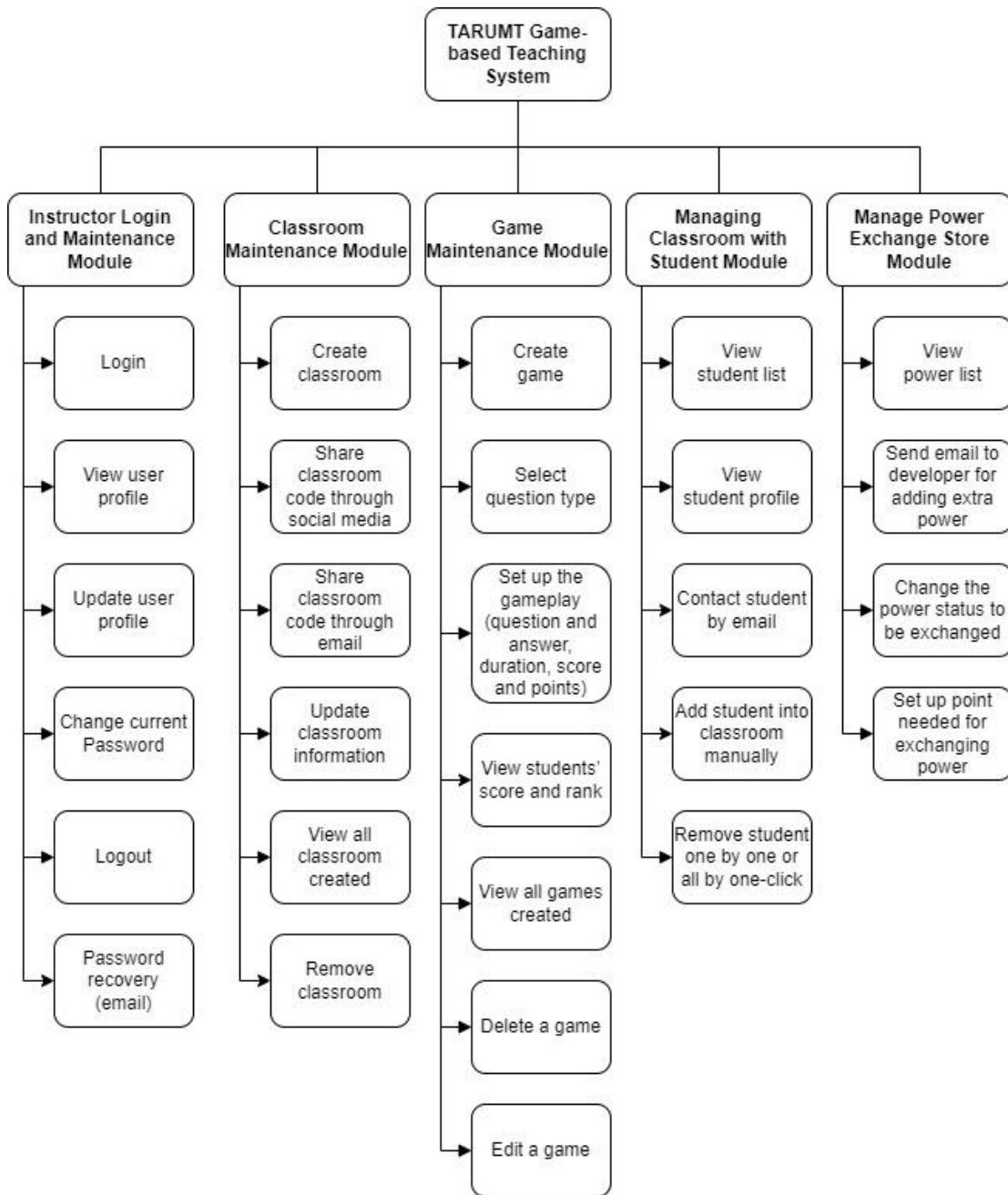


Figure 1.3 : Hierarchical Chart of the TARUMT Game-based Teaching System

Figure 1.3 shows that the TARUMT Game-based Teaching System consists of 5 modules which are instructor login and maintenance module, classroom maintenance module, game maintenance module, managing classroom with student module and manage power exchange store module.

Instructor login and maintenance module allows instructors to log in to the system by using their TARUMT staff email and they can modify their account setting after logging in. Classroom maintenance module allows instructors to view, create, update or delete classrooms for different subjects or courses and share the classroom codes to their students.

Game maintenance module allows instructors to create, update, view or delete games for particular classrooms and they can set question type, points, score, time, questions and answers for the game. Managing classroom with student module allows instructors to add, view and remove students from their classroom. Manage power exchange store module allows instructors to set the points needed in the store for students exchanging the powers and change the power status.

1.4.2 Project Schedule

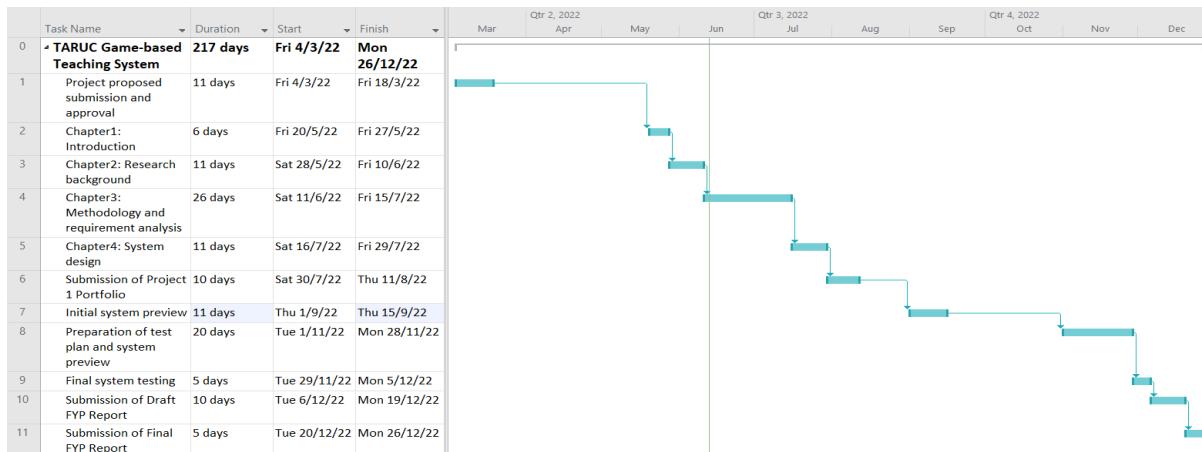


Figure 1.4 : Project Schedule Gantt Chart

Table 1.1 : Project Schedule

Schedule	Schedule Goal	Deadline
Project proposed submission and approval	To get approval for proposed idea	18/03/2022
Chapter1: Introduction of the project	To provide clear project objectives and background	27/05/2022
Chapter2: Background and related work of the project	To better understand the proposed system	10/06/2022
Chapter3: Methodology and requirement analysis	To gather and analyze the requirement information	15/07/2022
Chapter4: System design	To make a draft for system design	29/07/2022
Submission of Project 1 Portfolio	To submit the Project 1 Portfolio from chapter 1 to 4	12/08/2022
Initial system preview	The system has all of the necessary functionality and can run normally	15/09/2022
Preparation of test plan and system preview	To create test plan for system testing	28/11/2022
Final system testing	To conduct a final testing for the system	05/12/2022
Submission of Draft FYP Report	To submit the draft of FYP report and ensure everything is well-organized	19/12/2022
Submission of Final FYP Report	To submit the final version of FYP report and associated deliverables	26/12/2022

1.5 Project Team and Organization

Table 1.2 : Project Team and Organization for TARUMT Game-based Education System

Sub-Module	Yap Yoon En	Muk Yin Man
Module 1 : Student Login and Maintenance	x	
Module 2 : Participating in Classroom	x	
Module 3 : Participating in Game	x	
Module 4 : Score and Ranking	x	
Module 5 : Claiming Power Exchange	x	
Module 6 : Instructor Login and Maintenance		x
Module 7 : Classroom Maintenance		x
Module 8 : Game Maintenance		x
Module 9 : Managing Classroom with Student		x
Module 10 : Manage Power Exchange Store		x

1.6 Chapter Summary and Evaluation

This chapter has introduced the TARUMT Game-based Education System and discussed the project plan and modules handled by author and author's partner in detail. The author is convinced that this system is able to be developed as planned and it will be able to compete with other existing systems through its benefits such as free of charge, additional features, information updated instantly and user-friendly user interface.

The difficulty that the author faced is identifying the unique features of the system compared to other existing systems on the market. Since too many similar systems have been developed and launched on the market, systems without unique features will lack competitiveness and will not be able to stand out from the crowd. But the problem is that unique features are not easy to think of because most of the systems on the market are very complete and it is difficult to identify areas that need to be strengthened.

In order to solve this difficulty, the author brainstormed with the author's partner and did a lot of research to find out where the existing systems need to be improved and come up with ways to improve.

Chapter 2

Literature Review

2 Background and Related Work

The project background including the nature of the proposed system, target users, business environment and existing real life business processes will be covered in this chapter. A literature review discussing similar research work that has been done by others in relation to game-based learning systems will also be included. Other than that, a feasibility study will be done in this chapter to explain and show how this proposed system is feasible from various aspects.

2.1 Project Background

The proposed system is a system for educational purposes that can help in improving the overall teaching and studying experience of TARUMT. This system mainly focuses on enhancing the user experience by improving the gameplay and user interface. The system includes all the main functions that allow users to create, manage, view and participate in classrooms and games. In order to achieve user experience enhancement, power-ups and power-ups store features are provided to improve gameplay and only main functions are developed for better and cleaner user interface.

The proposed system is specifically designed for TARUMT and this system will only be used in TARUMT for teaching and learning purposes, so the targeted users will be TARUMT instructors and students.

Since the targeted users will be TARUMT instructors and students, the business environment of the proposed system will be TARUMT campuses. The system will be used by the targeted users in TARUMT campuses for education purposes.

There are many similar game-based education systems that have been developed and released to the market such as Kahoot!, Quizizz and Archy Learning. Kahoot! charges students to unlock certain games and charges instructors from \$0 to \$9 per month. It does not provide the power-ups and power-ups store features in their gameplay. Quizizz does not charge any fees to play the games but it charges instructors from \$0 to \$149 per month. It does provide the power-ups feature in their gameplay but it does not offer a store for players to exchange the power on their own. Archy Learning does not charge any fees for students but it charges instructors from \$15 to \$100 per month. It also does not provide the power-ups and power-ups store features in their gameplay. Even though Kahoot! and Quizizz does provide a free plan for instructors, it has a huge restriction on using the systems.

2.2 Literature Review

Efficiency of Game-based Learning System

People are constantly looking for more interesting, fun and motivating learning methods. Nowadays, technology is increasingly integrated into educational environments (Licorish, S. A., Owen, H., Daniel, B. K., & George, J. L., 2018) and online game-based learning systems have become a trend. In a game-based learning system, the content of the lessons are mapped into the games, offering a scenario environment of learning and continuous interaction and feedback to enhance the interest and motivation of learning. Game-based learning is usually designed to increase learners' desire for competition and goal achievement, while games can also be a good way to facilitate teacher-student interaction.

From the research done by Teerawat, K., Ier-on, H., Pattaraporn, K. & Noppon, W. (2017), it compared the learning performance between two experimental groups, Group A and Group B, in order to investigate the effectiveness of the game-based learning system. Group A consists of 17 students learnt using the game-based system while Group B consists of 14 students learnt using the traditional learning approach. The results showed that the Group A students' performance was higher than Group B students.

Other than that, the research done by Ching-Hsue, C. & Chung-Ho, S. (2012) also indicated that compared to traditional face-to-face learning methods, game-based learning has a higher student achievement. In the pre-test, the average score of Group A who used the game-based learning method was 71.36 while the average score of Group B who used the traditional method was 72.37. In the post-test, the average score of Group A improved to 80.24, while the average score of Group B dropped to 72.14. A comparison of the pre-test average score and post-test average score showed that students who used the game-based learning method have improved significantly in their average score while students who used the traditional method did not change much in their average score.

To conclude, using a game-based learning system in the learning process is efficient in improving student performance compared to the traditional face-to-face method.

Competition in Learning Process

According to Tom Malone's theory of intrinsically motivating instructions, three categories that can make learning become fun are Challenge (goals with uncertain outcomes that make learning more challenging), Fantasy (captivate through intrinsic or extrinsic fantasy) and Curiosity (making learners curious about things through human curiosity about graphics and audio) (Sabandar, G., Supit, N. & Suryana, E., 2018).

Research done by Worm, B. S. & Buch, S. V. (2014) has conducted an experiment between competing groups and non-competing groups and this experiment has verified that competition in the learning process helps in motivating the students since students' scores are shown on the completed test and it can be compared with other students. Compared to the non-competing groups, competing groups all wanted to be better in their results and they showed a positive attitude towards the competition.

The results of Corell, A., Regueras, L. M., Verdú, E., Verdú, M. J. & de Castro, J. P. (2018) also showed that students who used competitive learning tools performed better in their academic outcomes. The students enjoyed learning by participating in competitions and they were motivated to find learning information in different ways to improve their position in the rankings.

As a conclusion, the quiz module with competition widgets can help to encourage students to spend more time in the learning process in order to gain better results. The use of competitive learning techniques can also increase the challenge of learning as well as motivate students, may build a sense of competition among students and construct a more fun learning environment.

Student Perceptions of Game-based Learning

According to the research conducted by Zi-Yu, L., Zaffar, A. S. & Farida, G. (2020), 88.55% of study group students expressed a high interest in continuing to study using game-based learning. Moreover, none of the participants in the study group indicated that the learning process was uninteresting. Thus, participants showed a very high degree of involvement, interest and motivation. Therefore, the research hypothesis 1 which is “the use of game-based learning increases student attraction, motivation, the desire to continue learning and make it more intense” has been confirmed.

The results of Felszeghy, S., Pasonen-Seppänen, S., Koskela, A. & et al. (2019) also show that students are satisfied with how the game-based learning system enhances their practical abilities and creates a new interactive, relaxed place for communication between students and instructors. From their results, 77.5% respondents indicated that the system increased their motivation to learn, 86.88% respondents indicated that the system enables students to overcome individual difficulties, 66.88% respondents felt the gamification system helps to build collaboration and 68.13% respondents felt the system can help them to promote interest in learning.

From these research results, it can be known that the students have an active and positive attitude towards game-based learning and most students are willing to continue this kind of learning style.

2.3 Feasibility Study

Technical Feasibility

Technical feasibility is the process of figuring out how to produce the proposed system to determine whether it is possible. The proposed system is an online web-based system so that laptops are required for coding and testing. Software tools and IDE that are needed for coding are Apache NetBeans, XAMPP and MySQL. The programming languages that will be used to develop the proposed system are PHP and CSS, both the author and the author's partners have relevant knowledge and familiarity with these programming languages. Therefore, the technical area of this project is feasible.

Economic Feasibility

The software tools and IDE required for development purposes (Apache NetBeans, XAMPP and MySQL) can be downloaded and accessed for free. As a result, there are no extra costs charged for the tools that will be used to develop the proposed system. Other than that, both the author and the author's partner have their own hardware devices that can be used for coding and testing, therefore there is no need to purchase any hardware devices.

Schedule Feasibility

Schedule Feasibility is to estimate how much time the system will take to complete and determine if your project schedule is achievable so that the project can be completed on time. The author and the author's partner estimate that this proposed system will take approximately 10 months to complete. The documentation parts which are Chapter 1 to 4 are given approximately 5 months to complete and another 5 months are given to complete the system development and testing. 5 months for 4 Chapter documentation are reasonable so that the risk of the system cannot be completed in time is very low. Apart from that, 5 months for system development and testing is achievable since the proposed system focuses only on the main functions. Therefore, the schedule of this proposed system is reasonable and achievable.

2.4 Chapter Summary and Evaluation

Since the proposed system is specifically designed for TARUMT, the business environment will be the TARUMT campuses and the targeted users will be TARUMT instructors and students. The project is considered as feasible to develop after conducting the feasibility study from various perspectives because the required hardware and software tools are available, the cost required are affordable, the schedule is achievable and the proposed system can solve the problems of existing systems.

The problem that the author faced when producing Chapter 2 was lack of understanding of the feasibility study. Since the author has no experience in doing feasibility studies, it is not easy for the author to prepare the feasibility study. In order to solve the problem, the author did a lot of research on Google and referred to the feasibility studies that have been done by others to better understand the feasibility study.

Chapter 3

Methodology and Requirements Analysis

3 Methodology and Requirements Analysis

In this chapter, methodology applied during the development phase and the techniques used by the author to gather requirements will be explained. Other than that, the functional and non-functional requirements of the system will be discussed and the development environment will be specified. Finally, the author will give an overview use case diagram to illustrate the modules of the whole system and a detailed use case diagram of each module that the author deals with.

3.1 Methodology

First and foremost, the author will use a use case diagram to specify the events in the system and show the relationship between the users and their related use cases. The overview use case diagram will be used to show the modules of the whole system and detailed use case diagram used to illustrate the modules that are handled by the author. Use case description will also be used by the author to describe step-by-step what actions that actors should take in order to achieve a specific goal. By using use case diagrams and use case description, the author can learn and have a better understanding of the different kinds of users and use cases of the proposed system.

Next, an activity diagram for each module that is handled by the author will be prepared during the chapter of system design. An activity diagram visually presents a sequence of actions or control flow in a system, similar to a flowchart or data flow diagram. Not only that, the entity relationship diagram (ERD) will also be prepared to illustrate the relationship between sets of entities stored in the database, which helps to better understand the logical structure of the database.

Other than that, the prototyping model was jointly decided by the author and the author's partner as the approach for system development. A prototype model is a system development model in which a working system prototype is designed, built, tested, and reworked until an acceptable prototype is obtained, which also provides the basis for producing the actual system. Since a working prototype of the proposed system will be created before the actual system is developed, it can help to detect bugs and find missing functionality earlier. Not only that, the prototype model also helps to reduce the effort required to develop the actual system and the possibility of errors in the actual system since the development of the actual system does not begin until all specifications are clear.

Last but not least, the author and the author's partner will perform unit testing and black box testing for the proposed system to verify that all the requirements and functions of the system are fully developed. The unit testing will be done by the author and the author's partner to test

individual units and ensure that every unit of the system works as expected. The black box testing will be done by the testers who do not understand the internal code structure, implementation details and internal paths of the system and the testing will mainly concentrate on input and output of the system.

3.2 Requirements Gathering Techniques

Brainstorming

In order to gather the requirements of the proposed system, the author and the author's partner have conducted multiple brainstorming sessions. Brainstorming is a collective creativity technique that strives to come to a conclusion for a particular problem by gathering a list of ideas contributed spontaneously by members. During the brainstorming sessions, the author and the author's partner came up with the ideas and summarized the functions, roles and modules that the proposed system should have and how the system differs from existing systems. Other than that, the author and the author's partner have discussed the user interface design of the proposed system in order to produce a system with a clean and user-friendly interface.

Document Inspection

The author and the author's partner searched for documentation of similar existing systems as a reference and identified what functionality and requirements that the proposed system might need to have. By referring to the documentation found on the web, the author and the author's partner have improved and more completely collected the requirements and functionality of the proposed system.

3.3 Functional and Non-Functional Requirement

3.3.1 Functional Requirements

The proposed system is separated into a frontend system which is handled by the author (Yap Yoon En) and the backend system which is handled by the author's partner (Muk Yin Man). There are 5 modules in the frontend system include student login and maintenance module, participating in classroom module, participating in game module, score and ranking module and claiming power exchange module. While the 5 modules in the backend system include instructor login and maintenance module, classroom maintenance module, game maintenance module, managing classroom with student module and manage power exchange store module. For the overall system, readers could refer to Chapter 1 Section 1.4.1.

Student Login and Maintenance Module

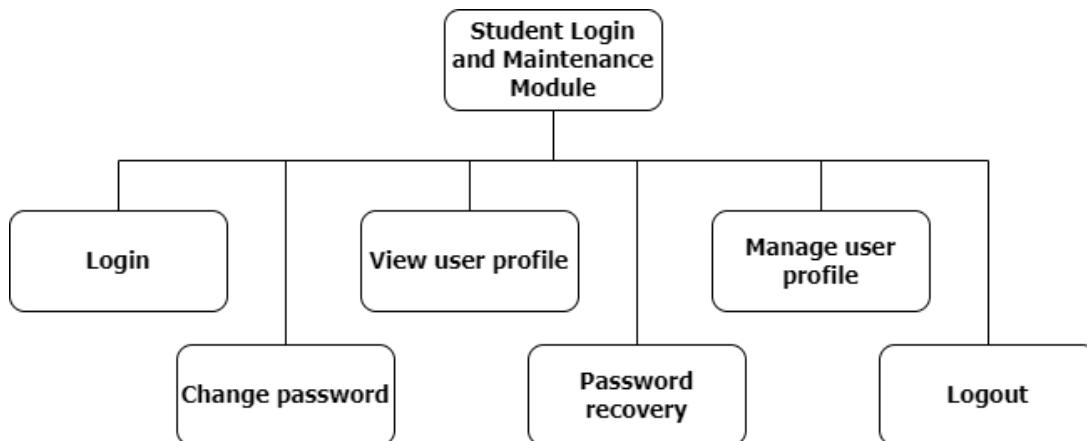


Figure 3.1 : Student Login and Maintenance Module Hierarchical Chart

Student login and maintenance module allows users to log in to the system by using their TARUMT student email and password. TARUMT will register an account for each student and use the student's Identity Card number as the default password for the account. If the email or password field is empty or not found in the database, the system will request users to re-enter again and prompt an error message to provide some guidance for users. If the email and password are correct, the user will be redirected to the home page.

After logging in, users can modify their account passwords, view and manage their user profiles, such as profile picture and usernames. On the homepage, there will be a user profile picture button and a logout button in the top-right corner, if users click on the profile picture button, the system redirects users to their user profile page, where users can decide whether to change their password or update their profile. The system will verify the information entered

by users before updating the data to the database. If the information is invalid, users will be required to re-enter the information again. If users click on the logout button, the sessions will be terminated and users will be redirected back to the login page.

Not only that, users are able to recover their password on the login page if they forgot their password. After users click on the “Forget Password?” button, the system will require the users to enter their email address for validation purposes and the system will send a verification code to the email address. Once users have entered the correct verification code, the system will allow them to reset the password.

Participating in Classroom Module

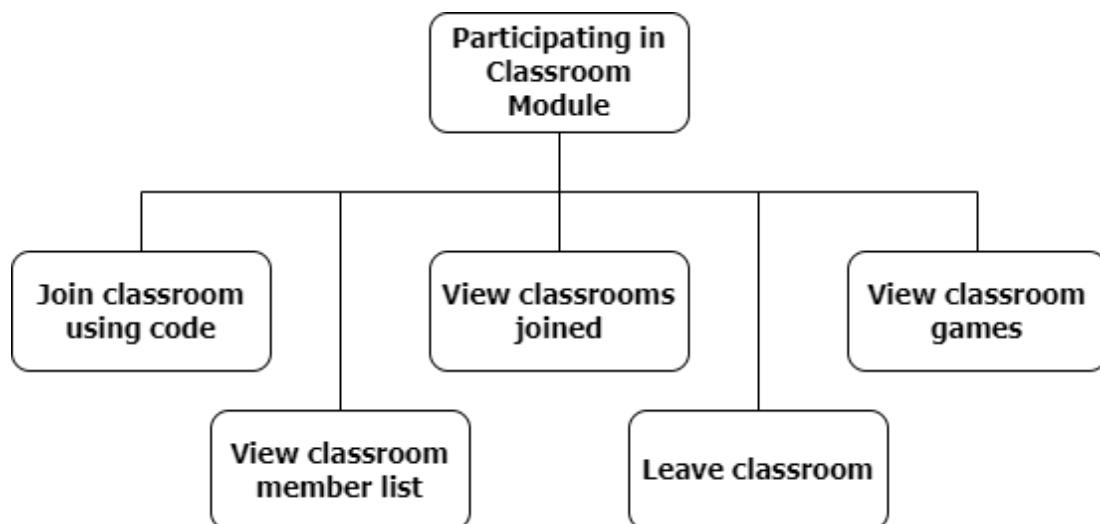


Figure 3.2 : Participating in Classroom Module Hierarchical Chart

Participating in classroom module allows users to join classrooms by using codes that are shared by instructors when they are on the home page. Users can redirect to the classroom joining page by clicking the “Join Classroom” button on the home page. After users fill in the classroom code and click the Join button, the system will verify whether the classroom code exists. If the classroom code is not found in the database, users will be required to re-enter the classroom code again. If the classroom code is found, the system will update the users' joined classroom to the database.

After joining classrooms, the system redirects users to the home page. All the joined classrooms will be displayed on the home page and users are able to enter into one of the classrooms by clicking the classroom. After entering the classroom, users are able to view all the contents of the classroom including the games that are created by the instructor and the members list of that classroom. Users are also allowed to leave the classroom by clicking the

leave button. When users decide to leave the classroom, the system will prompt a confirmation box for users to confirm their action. After users confirm to leave, the system will update the database.

Participating in Game Module

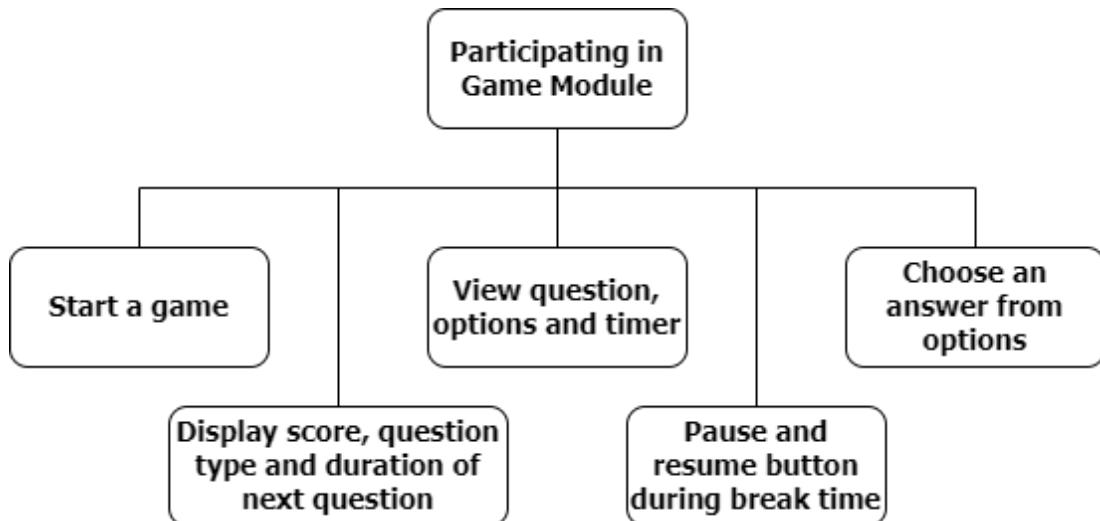


Figure 3.3 : Participating in Game Module Hierarchical Chart

Participating in game module allows users to select and start the game they want to play. After users start a game, the first question, answer options (if any) and timer will be displayed on the screen and users should choose their answers from answer options (multiple-choice question, true-false question) or provide answers in text (fill-in-the-blank question) before the time ends.

For multiple-choice and true-false questions, if the selected option is correct, the system will change the background colour of the selected option into green colour, otherwise the background colour will be changed into red colour. For fill-in-the-blank questions, if the answer is correct, the system will display a green tick, otherwise the system will display a red cross. The question will be automatically skipped if the user is not answering before the time ends. Users will not get a score for the question if they are not answering or answered incorrectly.

A 10 seconds timer and the score, question type and duration for the next question will be shown during the break time before the next question so that users can decide whether they need to exchange power or which power they want to exchange. The pause button, resume button, skip button and entrance of the power exchange store will be shown during the break time so that users are able to pause or resume the game, skip the break time or enter into the

store during the break time only. If users click on the pause button, the system will pause the timer and users can click on the resume button to resume the game. If the users click on the skip button or when the 10 seconds timer expires, the system will start the next question immediately.

Score and Ranking Module

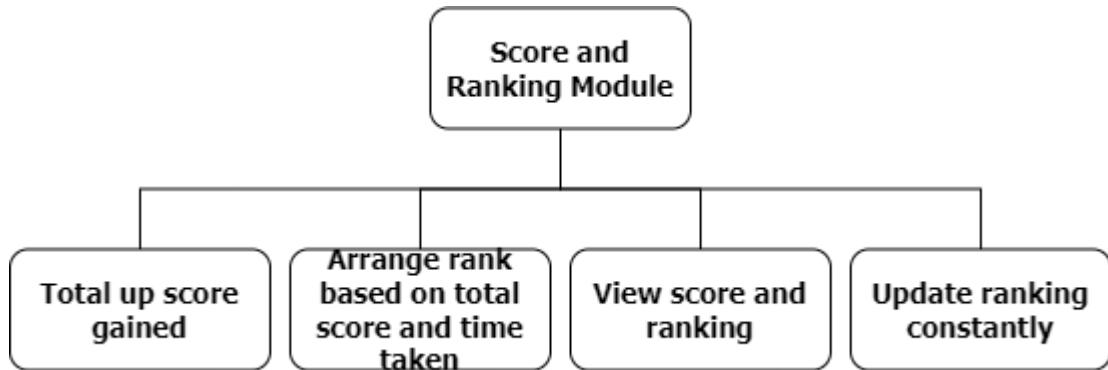


Figure 3.4 : Score and Ranking Module Hierarchical Chart

Score and ranking module allows users to view their scores and ranking when the game ends. When the game comes to the end, the system will display an end game page, telling the user that the game is over and the user can click anywhere on the screen to view the score and ranking for that game.

The system will total up the score the user gained on every question and arrange the rank based on the total score and time taken of each user who has played that game. The ranking will be sorted from the highest total score to the lowest total score and the ranking will be constantly updated as new players play the game and leave new records. When there are users with the same score, their ranking will be sorted from the shortest time taken to the longest time taken.

Claiming Power Exchange Module

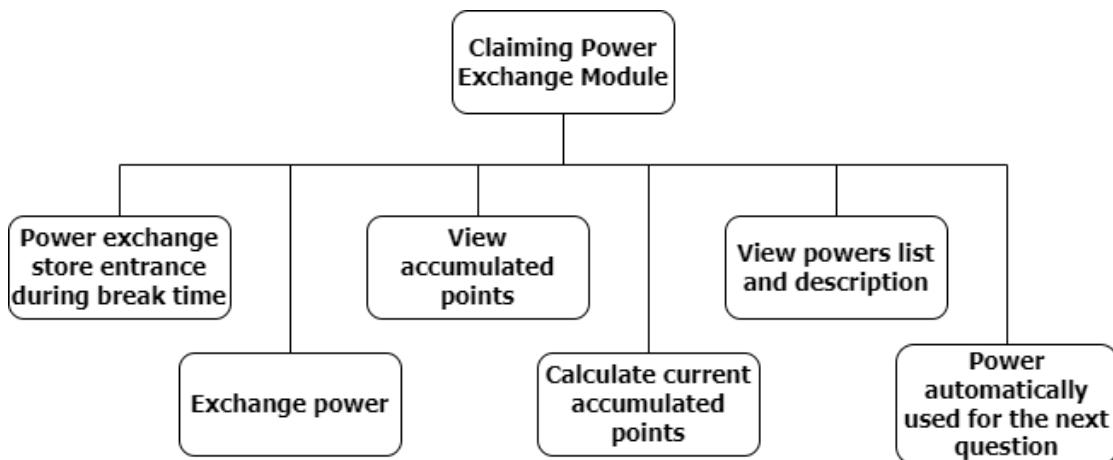


Figure 3.5 : Claiming Power Exchange Module Hierarchical Chart

Claiming power exchange module allows users to exchange powers during the break time of the games. Before every question starts, the entrance of the power exchange store will be shown and users are allowed to enter the store to exchange a power by using the accumulated points in the game.

Users can view their accumulated points after entering the store so that users can know how many points they have earned in the game and powers list and description are also included in the store so that users can understand what powers are and how powers work. The default powers provided are double scores power(used for ranking), double points power(used for power exchange), and eliminating a wrong option power(remove one incorrect option in a multiple-choice question).

When a user decides to exchange the desired power, the system will prompt a confirmation box to prevent accidental clicks. Then, the system will check whether the user's point is enough to exchange the power. If the point is enough, the system will calculate the user's current point and update it into the database, else the system will prompt an error message to tell the user that the exchange process is unsuccessful. After the user exchanges a power successfully, the system will start the next question immediately and use the exchanged power automatically.

3.3.2 Non-functional Requirements

Usability

Usability measures how friendly and easy for users to use the TARUMT Game-based Education System. The user interface of the system is simple and clean since the system only consists of the major functions that TARUMT needs, therefore users are able to find the features they want easily. Next, the system also provides error messages and guidance for users to handle the errors. For example, if the user enters an invalid email or password, the system will check it and display the error message “Invalid email or password, Please try again.” to let users know what they have to do to fix the error.

Performance

Performance is the ability of a system in the form of responsiveness to various actions within a certain period of time. The TARUMT Game-based Education System has a fast response for various actions of users. For example, when the user chooses an answer, the system immediately responds to the user whether the selected answer is correct.

Availability

Availability means the degree to which a software system can be accessed by the users when it is required. TARUMT Game-based Education System is a web-based system that can be accessed through an internet-connected pc or laptop and it is available 7 days per week and 24 hours per day. Therefore, users can access the website anytime and anywhere as long as they have a device and internet.

Security

Security refers to the degree to which a software system safeguards the information or data so that users or other systems have the degree of access to these data based on the authorization level. The TARUMT Game-based Education System has no self-registration function and is only available for TARUMT emails. Therefore, the risk of information leakage is reduced since external emails are not able to access the system.

3.4 Development Environment

3.4.1 Hardware Specification

Table 3.1 : Hardware specification for system development

Hardware	Specification
Operating System	Windows 10 Home, 64-bit OS
Processor	Intel I5 Processor, 7th Generation with 330 Megahertz(MHz) or above
RAM	192 Megabytes(MB) or above
Hard Disk Space	75 Megabytes(MB) of HDD Storage Space or above
Screen Resolution	800(width) x 600(height)

For the frontend of TARUMT Game-based Education System, the minimum hardware requirement for the development device is Windows 10 Home with 64-bit operating system. The processor requirement is Intel I5 Processor, 7th Generation with 330 Megahertz(MHz) or above at least 192 Megabytes(MB) of RAM. Next, a development device also requires at least 75 Megabytes(MB) of HDD storage space and a screen resolution of 800(width) x 600(height).

3.4.2 Software Specification

Table 3.2 : Software specification for system development

Software	Software Specifications
Operating System	Windows 10 Home, 64-bit OS
IDE	Apache NetBeans IDE 12.0
Programming Language	PHP 7.4.27, HTML, Javascript, CSS
Database	MySQL
Web Server	XAMPP 7.4.27 and above
Browser	Google Chrome on Windows with version 103.0.5060.134(64-bit)

For the frontend of TARUMT Game-based Education System, the minimum software requirement for the development device is Windows 10 Home with 64-bit operating system. The programming languages are PHP 7.4.27, HTML, Javascript and CSS, which are used to develop web-based applications with Apache NetBeans IDE 12.0. MySQL is used as the database for the proposed system and it can be managed through phpMyAdmin. XAMPP 7.4.27 and above used by the author to create a web server on the development device and browses the proposed system using Google Chrome on Windows with version 103.0.5060.134(64-bit).

3.5 Requirements Analysis

3.5.1 Overview Use Case Diagram

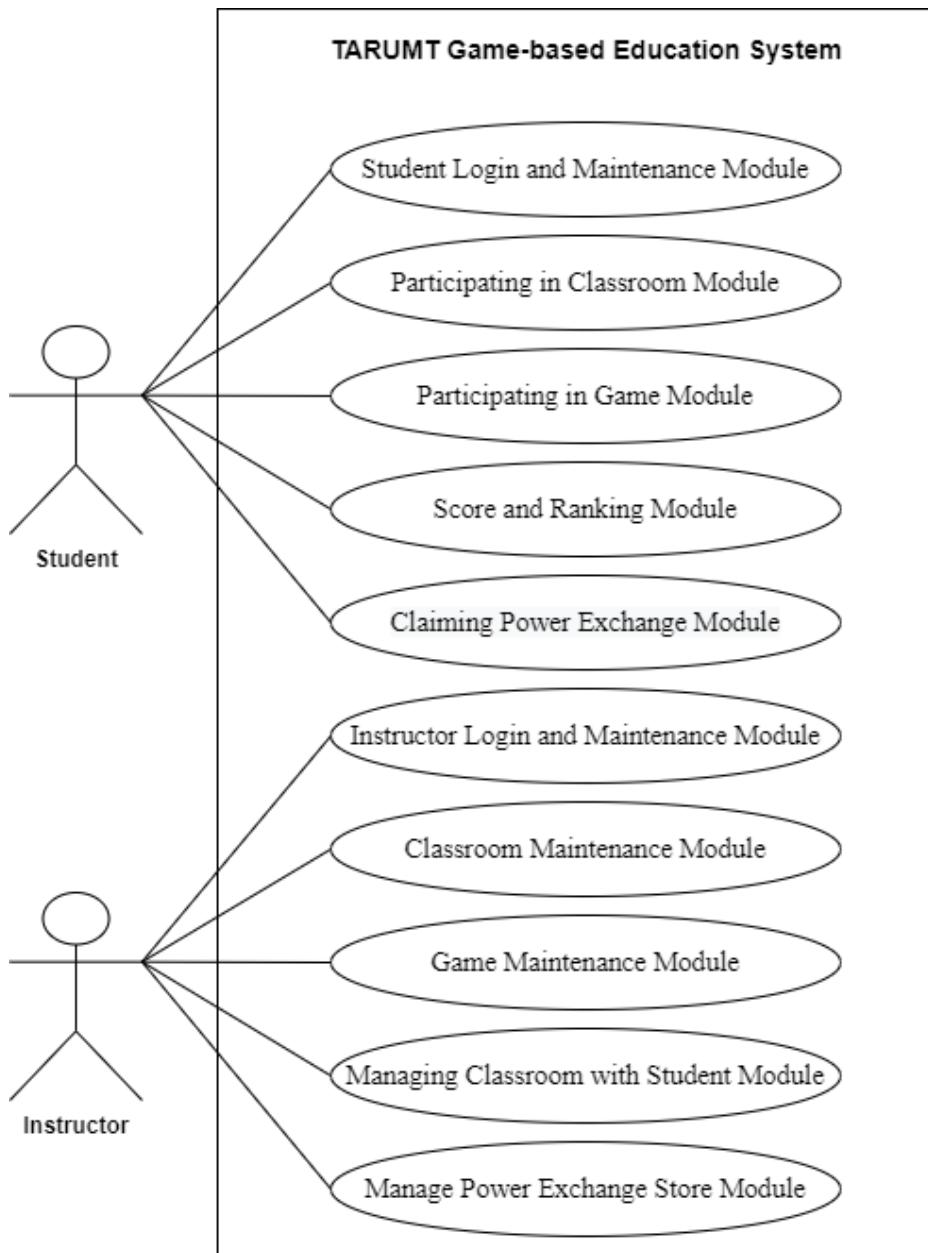


Figure 3.6 : TARUMT Game-based Education System Overview Use Case Diagram

Figure 3.6 represents the overview of the TARUMT Game-based Education System. There are two actors that will concern in this system which is student and instructor. The author is in-charge of the modules that can be performed by students which are student login and maintenance module, participating in classroom module, participating in game module, score and ranking module and claiming power exchange module. Besides, the rest of the modules that are mainly related to instructors will be handled by the author's partner.

3.5.2 Detailed Use Case Diagram

Student Login and Maintenance Module Detailed Use Case Diagram

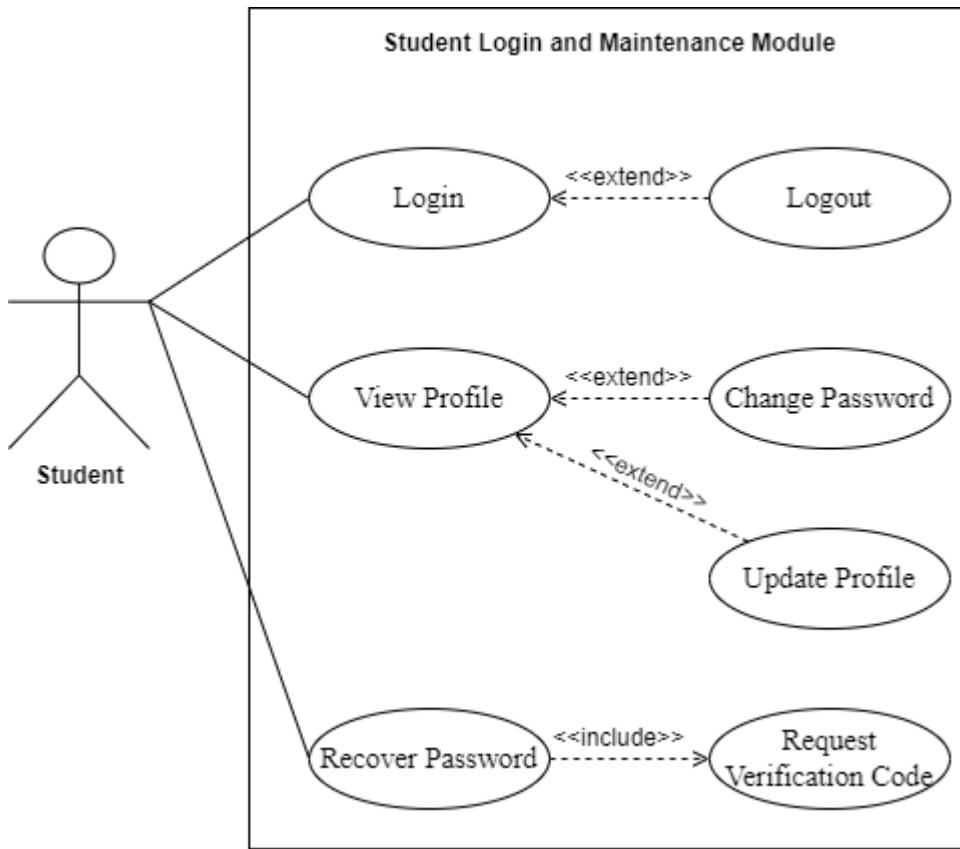


Figure 3.7 : Student Login and Maintenance Module Detailed Use Case Diagram

Student Login and Maintenance Module Detailed Use Case Description

Use Case Name: Student Login and Maintenance Module								
Actor: Student								
Brief Description: System allows users to reset password, login, view and update their account.								
Pre-condition: The user must have an account. The system is displaying the frontend login page.								
Main Flow:								
<table border="1"> <thead> <tr> <th>Actor Action</th> <th>System Respond</th> </tr> </thead> <tbody> <tr> <td>1. User clicks on the “Forget Password?” Button.</td> <td>2. System redirects the user to the verify email page.</td> </tr> <tr> <td>3. User fills in the email address.</td> <td></td> </tr> <tr> <td>4. User clicks on the “Verify” Button.</td> <td>5. System verifies the email address.</td> </tr> </tbody> </table>	Actor Action	System Respond	1. User clicks on the “Forget Password?” Button.	2. System redirects the user to the verify email page.	3. User fills in the email address.		4. User clicks on the “Verify” Button.	5. System verifies the email address.
Actor Action	System Respond							
1. User clicks on the “Forget Password?” Button.	2. System redirects the user to the verify email page.							
3. User fills in the email address.								
4. User clicks on the “Verify” Button.	5. System verifies the email address.							

7. User fills in the verification code.	6. If the email exists in the database, the system redirects the user to the verify code page and sends a verification code to the email.
8. User clicks on the button.	9. If the user clicks on the “Verify” Button, the system verifies the verification code.
11. User fills in the password and confirmed password.	10. If the verification code matches the code that the system sent to the email, the system redirects the user to the reset password page.
12. User clicks on the “Reset” Button.	13. If the password format is valid and confirmed password matches with password, the system updates the database and redirects to the login page.
14. User fills in the email and password.	
15. User clicks on the “Login” Button.	16. System verifies the email and password entered.
18. User clicks on the “Profile Picture” Button.	17. If inputs exist in the database, the system redirects the user to the home page.
20. User decides to either change password or update profile. If the user decides to change password S1: Change Password is performed. If the user decides to update profile S2: Update Profile is performed.	19. System shows the user profile with two buttons: Change Password and Update Profile.

Sub Flow:**S1: Change Password**

1. User clicks on the “Change Password” button.
2. System shows the password editing page with two options: Change and Cancel.
3. User enters the current password and clicks on the “Change” button.
4. System verifies the current password.
5. If the current password is correct, the system requires the user to input a new password and confirmed password.
6. User enters all the input fields and clicks on the “Change” button.
7. System verifies the input.
8. If input formats are valid and the confirmed password matches with the password, the system updates the password into the database and prompts a success message.

9. System redirects the user to the login page.

S2: Update Profile

1. User clicks on the “Update Profile” button.
2. System shows the profile editing page with two options: Update and Cancel.
3. User edits the profile data in the text field and clicks on the “Update” button.
4. System verifies the input.
5. If input formats are valid, the system updates the user profile into the database and prompts a success message.

Alternative Flow:

A1. Step 6:

If the email does not exist in the database, the system prompts an error message and requests the user to re-enter again.

A2. Step 9:

If the user clicks on “Resend” Button, the system will resend the verification code to the email.

A3. Step 10:

If there is an empty field or verification code is not matched, the system prompts an error message and requests the user to re-enter again.

A4. Step 13:

If there is an empty field or password format is invalid or a confirmed password does not match with the password, the system prompts an error message and requests the user to re-enter again.

A5. Step 17:

If there are empty field(s) or incorrect email or password, the system prompts an error message and requests the user to re-enter again.

A6. S1, Step 3:

If the user clicks on the “Cancel” button, the system redirects back to the user profile.

A7. S1, Step 5:

If the current password is incorrect, the system prompts an error message and requests the user to re-enter again.

A8. S1, Step 6:

If the user clicks on the “Cancel” button, the system redirects back to the user profile.

A9. S1, Step 8:

If the input formats are invalid or the confirmed password does not match with the password, the system prompts an error message and requests the user to re-enter again.

A10. S2, Step 3:

If the user clicks on the “Cancel” button, the system redirects back to the user profile.

A11. S2, Step 5:

If the input formats are invalid, the system prompts an error message and requests the user to re-enter again.

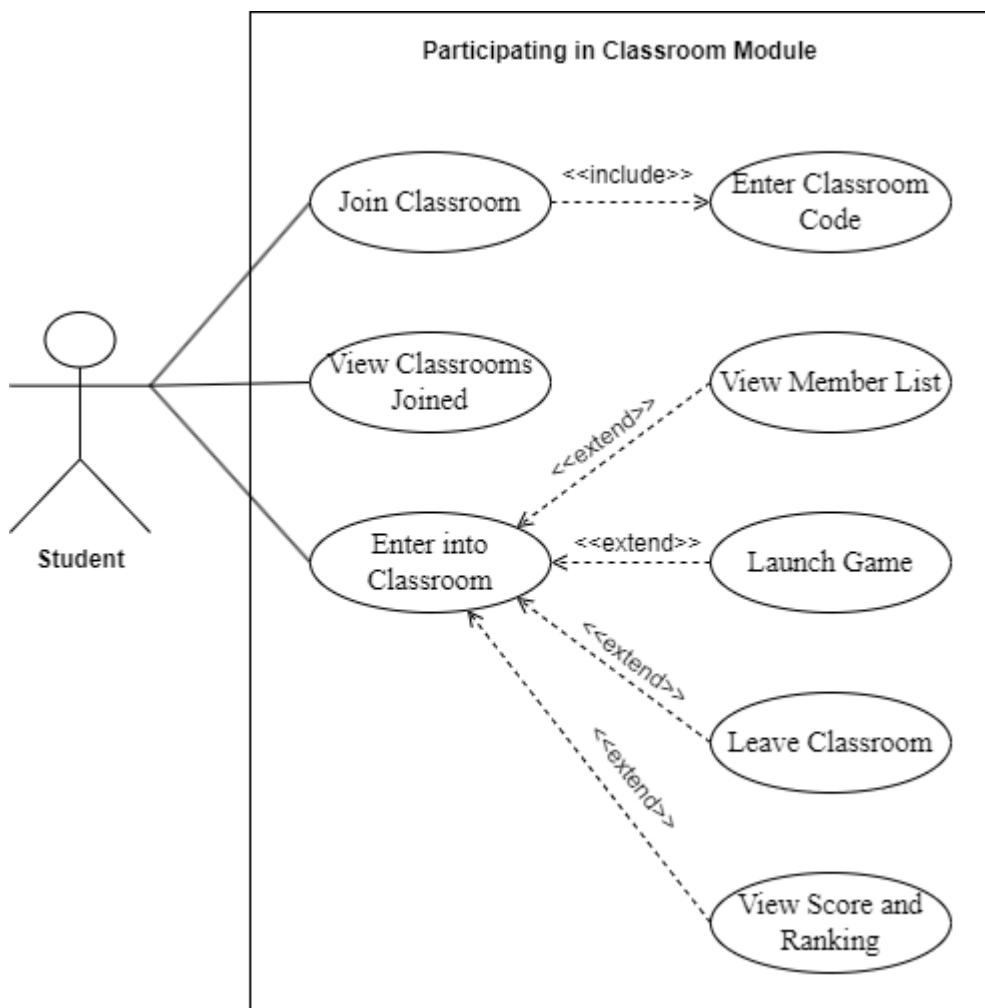
Participating in Classroom Module Detailed Use Case Diagram

Figure 3.8 : Participating in Classroom Module Detailed Use Case Diagram

Participating in Classroom Module Detailed Use Case Description

Use Case Name: Participating in Classroom Module
Actor: Student
Brief Description: System allows users to join, view, enter and leave classrooms.

Pre-condition: The user must be logged in. The system is displaying the frontend home page (classroom listed).	
Main Flow:	
Actor Action 1. User decides whether to join a new classroom. If the user decides to join a new classroom S1: Join Classroom is performed.	System Respond
2. User clicks on the classroom that wants to enter.	3. System redirects the user to the selected classroom main page.
4. User decides to either view the member list, launch the game, leave the classroom or view score and ranking. If the user decides to view the member list S2: View Member List is performed. If the user decides to launch the game S3: Launch Game is performed. If the user decides to leave the classroom S4: Leave Classroom is performed. If the user decides to view score and ranking S5: View Score and Ranking is performed.	
Sub Flow:	
S1: Join Classroom 1. User clicks on the “Join Classroom” button. 2. System shows the classroom joining page with two options: Join and Cancel. 3. User enters the classroom code and clicks on the “Join” button. 4. System verifies the classroom code. 5. If classroom code is found in the database and the user has not joined the classroom before, the system updates the joined classroom lists into the database and prompts a success message. 6. System redirects the user to the home page.	
S2: View Member List 1. User clicks on the “Member List” button. 2. System redirects the user to the selected classroom member list.	

S3: Launch Game

1. User clicks on the “Launch Game” button.
2. System redirects the user to the selected game page.

S4: Leave Classroom

1. User clicks on the “Leave Classroom” button.
2. System prompts the confirmation box with two options: OK and Cancel.
3. User clicks on the “OK” button.
4. System updates the joined classroom lists into the database and prompts a success message.
5. System redirects the user to the home page.

S5: View Score and Ranking

3. User clicks on the “View Score and Ranking” button.
4. System redirects the user to the selected score and ranking page.

Alternative Flow:**A1. S1, Step 3:**

If the user clicks on the “Cancel” button, the system redirects back to the home page.

A2. S1, Step 5:

If the classroom code is not found in the database or the user has joined the classroom before, the system prompts an error message and requests the user to re-enter again.

A3. S4, Step 3:

If the user clicks on the “Cancel” button, the system redirects back to the selected classroom main page.

Participating in Game Module Detailed Use Case Diagram

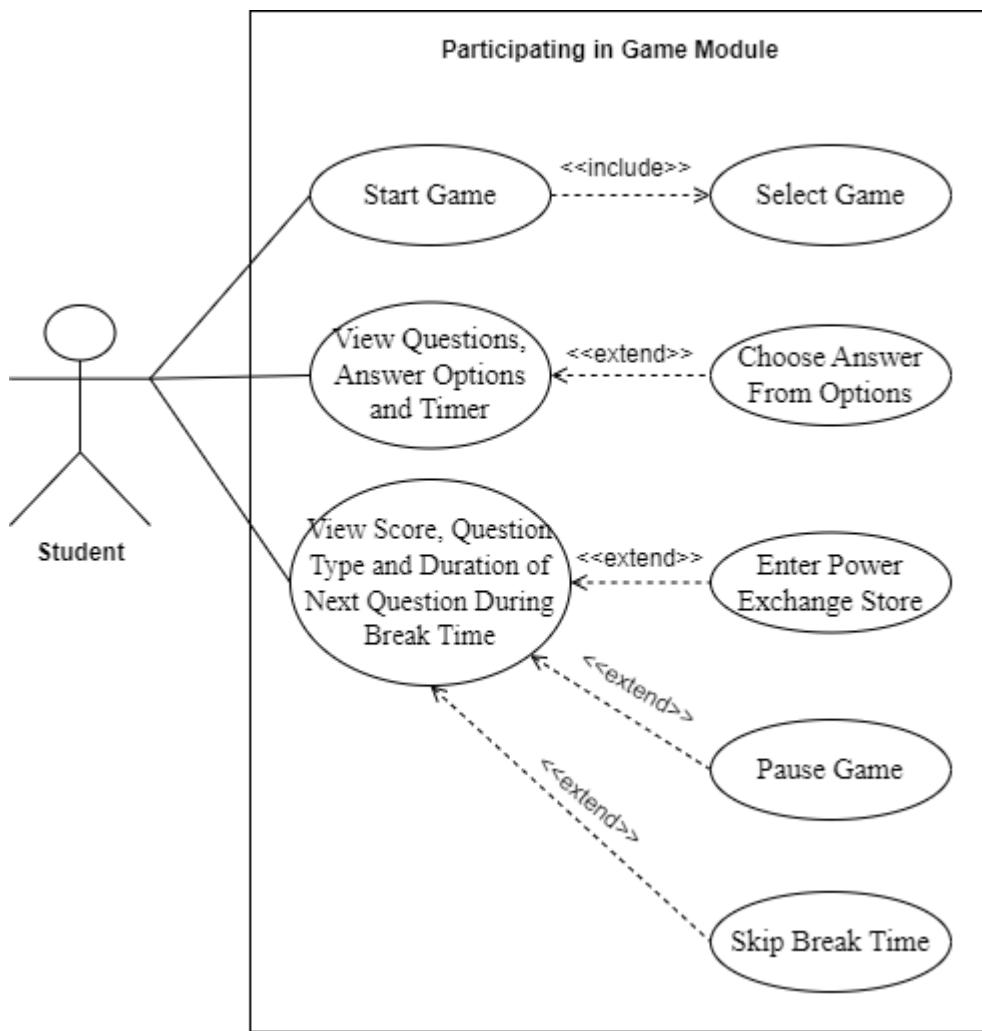


Figure 3.9 : Participating in Game Module Detailed Use Case Diagram

Participating in Game Module Detailed Use Case Description

Use Case Name: Participating in Game Module						
Actor: Student						
Brief Description: System allows users to start and play games.						
Pre-condition: The user must be in a classroom that contains games.						
Main Flow:						
<table border="1"> <thead> <tr> <th>Actor Action</th> <th>System Respond</th> </tr> </thead> <tbody> <tr> <td>1. User starts a game.</td> <td>2. System redirects the user to the game starting page.</td> </tr> <tr> <td>4. User selects the answer from options or</td> <td>3. System displays the question, answer</td> </tr> </tbody> </table>	Actor Action	System Respond	1. User starts a game.	2. System redirects the user to the game starting page.	4. User selects the answer from options or	3. System displays the question, answer
Actor Action	System Respond					
1. User starts a game.	2. System redirects the user to the game starting page.					
4. User selects the answer from options or	3. System displays the question, answer					

provides an answer in text before time ends.	options (if any) and timer.
	5. System responds to the user whether the answer is correct.
	6. System checks whether the next question exists.
8. User decides whether to enter the power exchange store, pause the game or skip the break time. If the user decides to enter the power exchange store S1: Power Exchange Store is performed. If the user decides to pause the game S2: Pause Game is performed. If the user decides to skip the break time S3: Skip Break Time is performed.	7. If the next question exists, the system displays a game breaks page that shows a 10 seconds timer and the score, question type and duration for the next question.
	9. After the 10 seconds timer expires, the system loops back to Step 3.
Sub Flow:	
S1: Power Exchange Store 1. User enters the power exchange store. 2. System redirects the user to the power exchange store page.	
S2: Pause Game 1. User clicks on the “Pause” button. 2. System pauses the timer.	
S3: Skip Break Time 1. User clicks on the “Skip” button. 2. System displays the next question, answer options (if any) and timer.	
Alternative Flow:	
A1. Step 7: If the next question does not exist, the system redirects the user to the end game page.	
A2. S2, Step 2: If the user clicks on the “Resume” button, the system continues the timer.	

Claiming Power Exchange Module Detailed Use Case Diagram

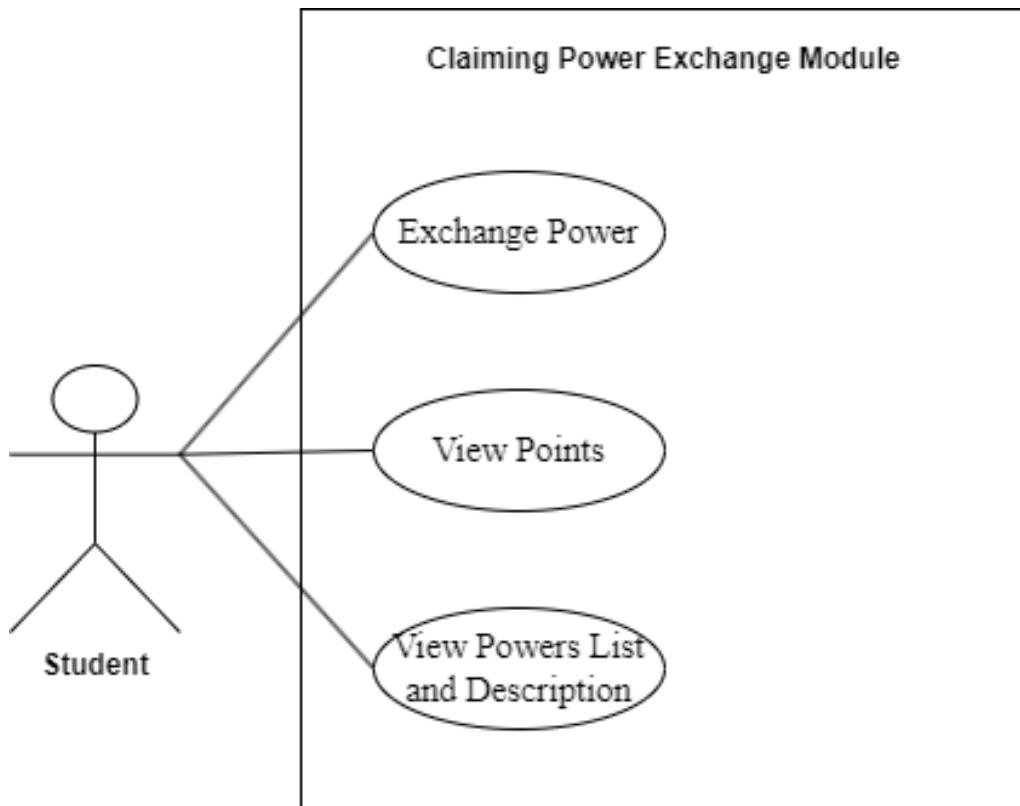


Figure 3.10 : Claiming Power Exchange Module Detailed Use Case Diagram

Claiming Power Exchange Module Detailed Use Case Description

Use Case Name: Claiming Power Exchange Module	
Actor: Student	
Brief Description: System allows users to exchange powers during game breaks.	
Pre-condition: The user must be in game break.	
Main Flow:	
Actor Action	System Respond
1. User clicks on the entrance to enter into the power exchange store.	2. System redirects the user to the power exchange store page.
3. User decides whether to view the powers list and description. If the user decides to view the powers list and description S1: Power List is performed.	
4. User clicks on the “Exchange” button	5. System displays a confirmation box with

for the desired power.	two options: OK and Cancel.
6. User clicks on the “OK” button.	7. System determines the number of points that will be claimed based on the power that the user selected.
	8. System checks whether the user's point is enough to exchange the power.
	9. If the user's point is enough, the system deducts the points to be claimed from the user's points.
	10. System displays the next question, answer options (if any) and timer.
	11. System uses the power automatically.

Sub Flow:
S1: Power List
<ol style="list-style-type: none"> 1. User clicks on the “Power List” button. 2. System redirects the user to the powers list and description page.

Alternative Flow:
<u>A1. Step 6:</u>
If the user clicks on the “Cancel” button, the exchange power process cancels and the point remains unchanged.

<u>A2. Step 9:</u>
If the user's point is not enough, the system prompts the error message and the user's point remains unchanged.

3.6 Chapter Summary and Evaluation

In this chapter, the author has discussed methodology applied, the techniques used to gather requirements, the functional and non-functional requirements, the development environment, overview use case diagram, a detailed use case diagram and description for each module that the author deals with.

The problem that the author faced was lack of understanding when producing detailed use case diagrams and detailed use case description since the author has not reviewed this knowledge for a long time. In order to solve the problem, the author did a lot of research on Google and referred back to the previous diagrams done when the author learned the OOAD subject.

Chapter 4

System Design

4 System Design

In this chapter, the author will discuss the system design which includes activity diagram, database design and user interface design. For the activity diagram, only the modules that are handled by the author will only be prepared. For the database design, the author will use an entity relationship diagram (ERD) to illustrate the overall database structure and the relationship between sets of entities stored in the database. The author will also prepare a data dictionary to describe the details of entity structure for each database table. Lastly, the user interface design of the proposed system will be presented.

4.1 Activity Diagram

In this part, the activity diagram will be prepared to help the author to visually present a sequence of actions or control flow in a system. An activity diagram illustrates the steps in an activity and the order in which they are presented. Student login and maintenance module, participating in classroom module, participating in game module, score and ranking module and claiming power exchange module will be presented with activity diagrams.

Student Login and Maintenance Module Activity Diagram

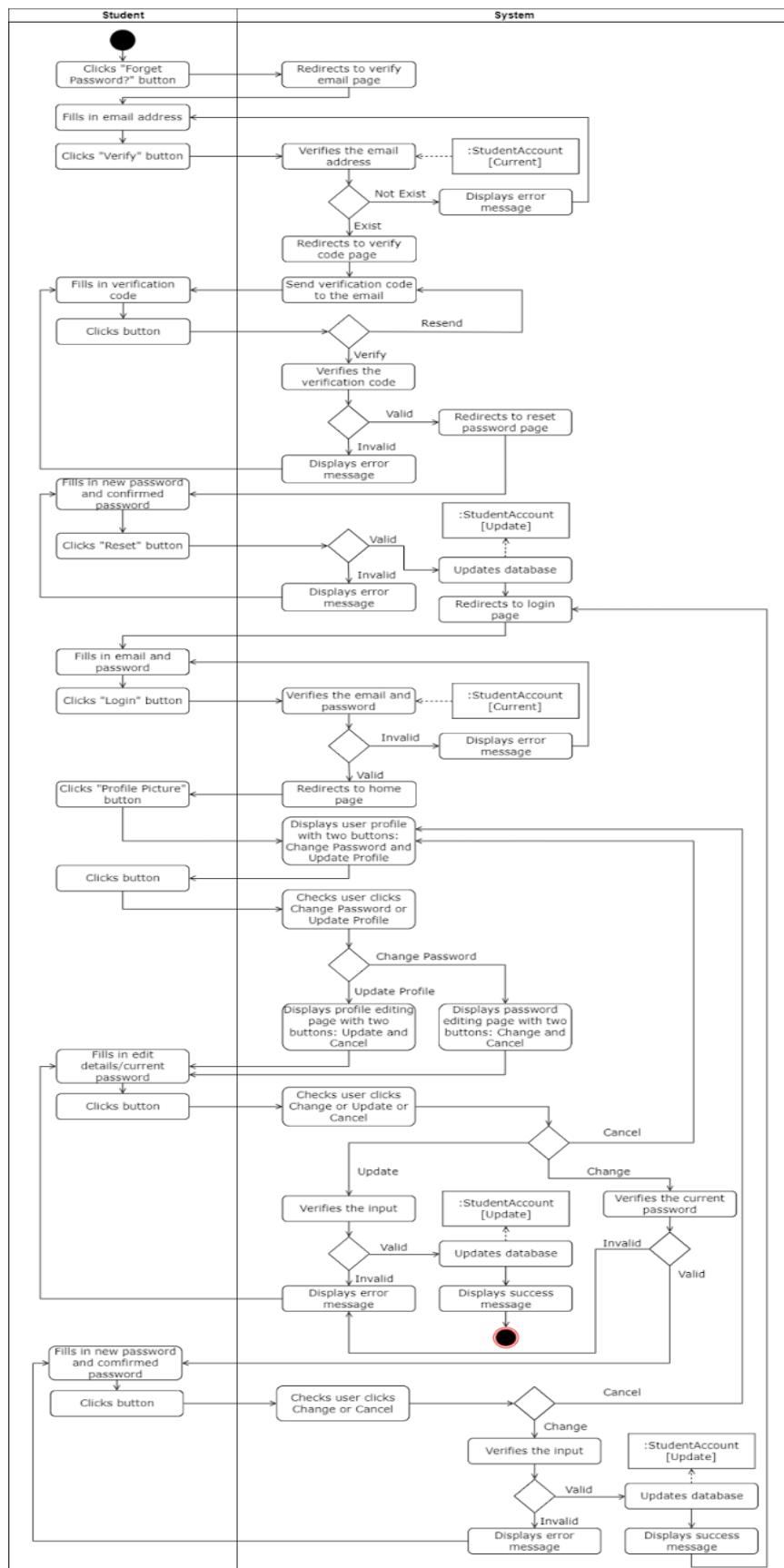


Figure 4.1 : Student Login and Maintenance Module Activity Diagram

The figure above shows the logic flows of the Student Login and Maintenance Module. First, when the user forgot the account password, the user can click on the “Forget Password?” button to reset the password and the system will redirect to the verify email page. The user is required to fill in the email address and click on the Verify button. After that, the system will redirect to the verify code page and send the verification code to the email if the email exists in the database. If the email is not found in the database, the system prompts an error message and requires the users to re-enter again.

On the verify code page, the user can request the system to resend the verification code by clicking the Resend button. After the user fills in the verification code and clicks the Verify button, the system will verify the verification code. If the code is invalid, the system prompts an error message and requires the users to re-enter again, else the user will be redirected to the reset password page. The user is required to fill in the new password and confirmed password and then click the Reset button. If the input format is valid, the system will update the database and redirect to the login page, else the user will be required to re-enter again.

On the login page, the user needs to fill in the email and password and click on the Login button. Then, the system checks whether the email and password is valid. If invalid, the system prompts an error message and requires the user to re-enter again, else the user will be redirected to the home page.

Next, the user clicks on the profile picture and the system will display the user profile with two buttons: Change Password and Update Profile. If the user clicks on Change Password, the system displays the password editing page, else the system displays the profile editing page. If the user wants to change their password, the user is required to fill in the current password and click on the Change button. If the current password is incorrect, the system will require the user to re-enter the current password, else the user will be required to enter a new password and confirmed password. If inputs are valid, the system updates the database, displays the success message and redirects users to the login page. If the user wants to edit their profile, the user is required to fill in the edit details and click on the Update button. If the input is invalid, the system prompts an error message and the user is required to re-enter again, else the system updates the database and displays the success message. The user can cancel these operations by clicking the Cancel button and then the system will redirect back to the user profile.

Participating in Classroom Module Activity Diagram

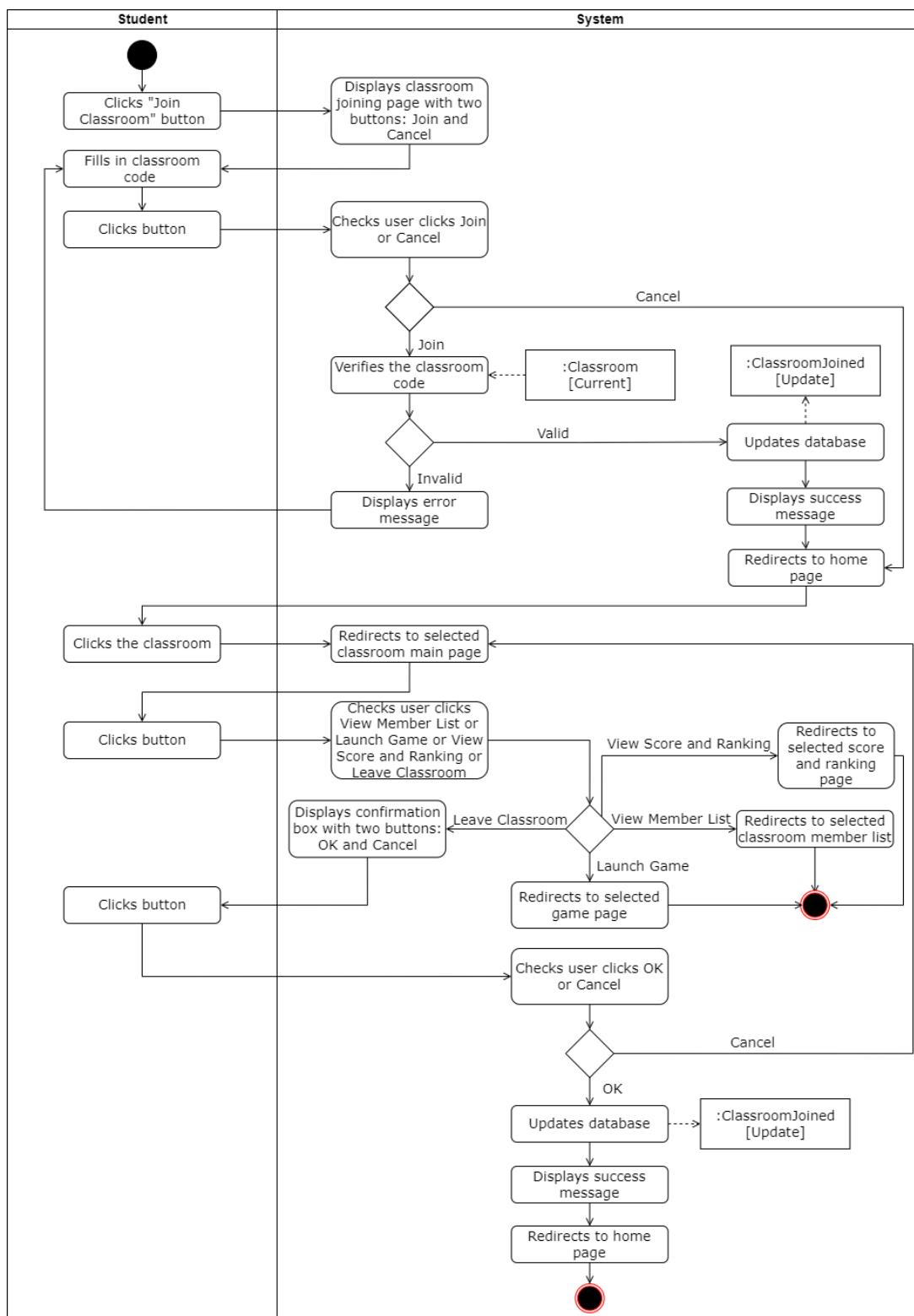


Figure 4.2 : Participating in Classroom Module Activity Diagram

The figure above shows the logic flows of the Participating in Classroom Module. First, the user clicks on the Join Classroom button and then the system displays the classroom joining page with two buttons: Join and Cancel. Then, the user is required to fill in the classroom

code and clicks on the Join button. The user can cancel this operation by clicking the Cancel button. After the user clicks on the Join button, the system checks whether the classroom code exists. If classroom code is not found, the system prompts an error message and requires the user to re-enter again, else the system updates the database, prompts a success message and redirects the user to the home page.

Next, the user clicks on the classroom and the system will redirect to the selected classroom main page. If the user clicks on View Member List, the system redirects to the selected classroom member list page, else if the user clicks on Launch Game, the system redirects to the selected game page, else if the user clicks on View Score and Ranking, the system redirects to the selected score and ranking page, else if the user clicks on Leave Classroom, the system displays the confirmation box with two buttons: OK and Cancel. The user can cancel the leave classroom operation by clicking the Cancel button and then the system will redirect back to the selected classroom main page. After the user clicks on the OK button, the system updates the database, displays a success message and then redirects the user to the home page.

Participating in Game Module Activity Diagram

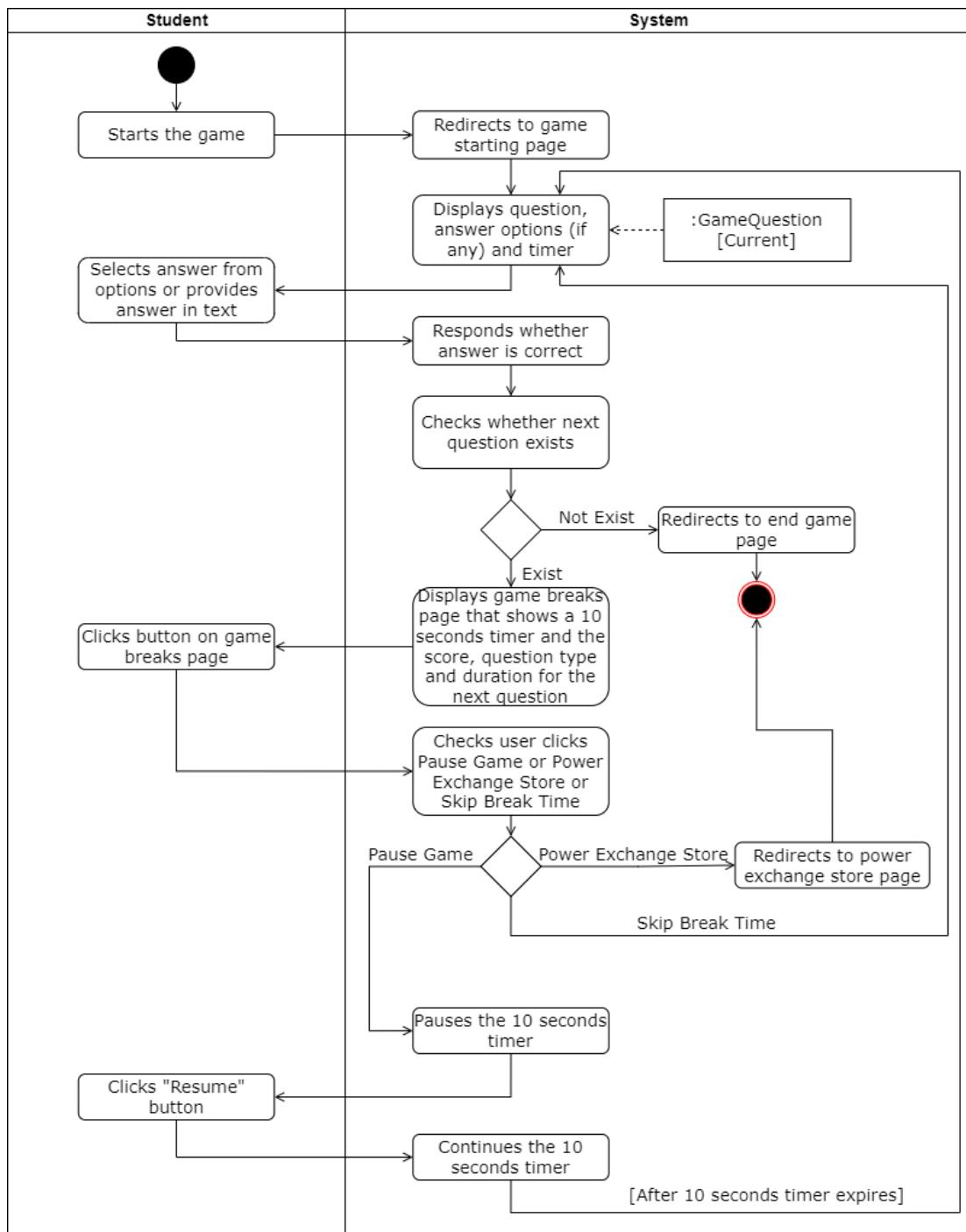


Figure 4.3 : Participating in Game Module Activity Diagram

The figure above shows the logic flows of the Participating in Game Module. First, the user starts a game and then the system redirects to the game starting page and displays the question, answer options (if any) and timer. The user chooses answer(s) from the options or provides the answer in text and the system responds to the user whether the answer(s) is correct. After that, the system checks whether the next question exists in the database, the system will redirect to the end game page if the next question does not exist.

If the next question exists, the system displays the game breaks page that shows a 10 seconds timer and the score, question type and duration for the next question. When the user is on the game breaks page, the user is allowed to pause the game, skip the break time and enter into the power exchange store. If the user decides to enter into the power exchange store, the system redirects to the power exchange store page. If the user decides to skip the break time, the system starts the next question immediately. If the user decides to pause the game, the system pauses the 10 seconds timer and the timer will be continued if the user clicks on the Resume button. After the 10 seconds timer expires, the system displays the next question, answer options and timer.

Claiming Power Exchange Module Activity Diagram

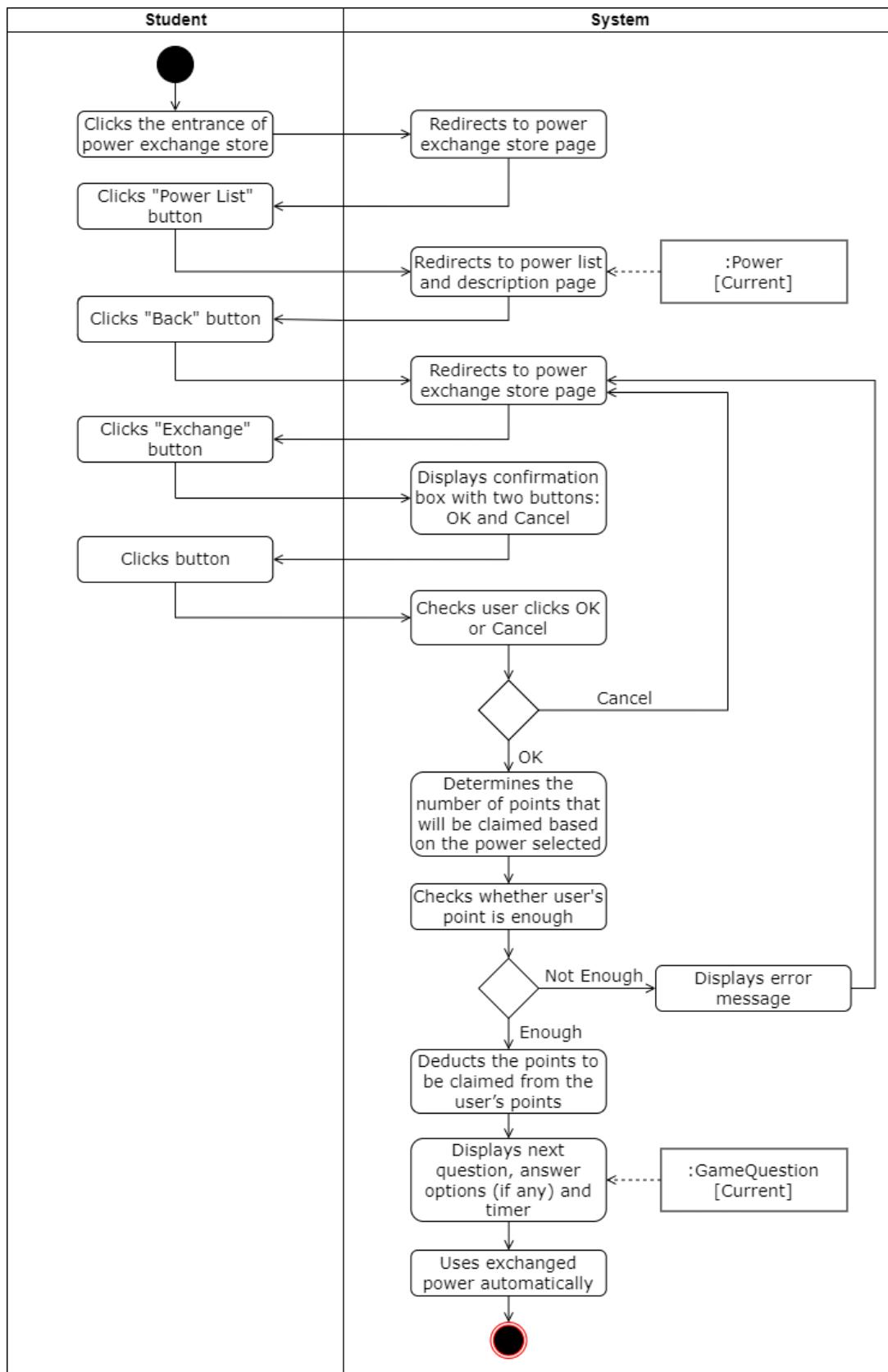


Figure 4.4 : Claiming Power Exchange Module Activity Diagram

The figure above shows the logic flows of the Claiming Power Exchange Module. First, the user clicks on the entrance of the power exchange store and then the system redirects to the power exchange store page. Then, the user clicks on the Power List button and the system redirects to the powers list and description page. If the user clicks on the Back button, the system redirects back to the power exchange store page.

After that, the user clicks on the Exchange button of the desired power and then the system prompts a confirmation box with two buttons: OK and Cancel. The user can cancel this operation by clicking the Cancel button. After the user clicks on the OK button, the system determines the number of points that will be claimed based on the power the user selected and then the system checks whether the user's point is enough. If the point is not enough, the system prompts an error message and redirects back to the power exchange store page. If the point is enough, the system deducts the points to be claimed from the user's point. After that, the system displays the next question, answer options (if any) and timer and then the system uses the exchanged power for that question automatically.

4.2 Database Design

4.2.1 Overall System Entity Relationship Diagram (ERD)

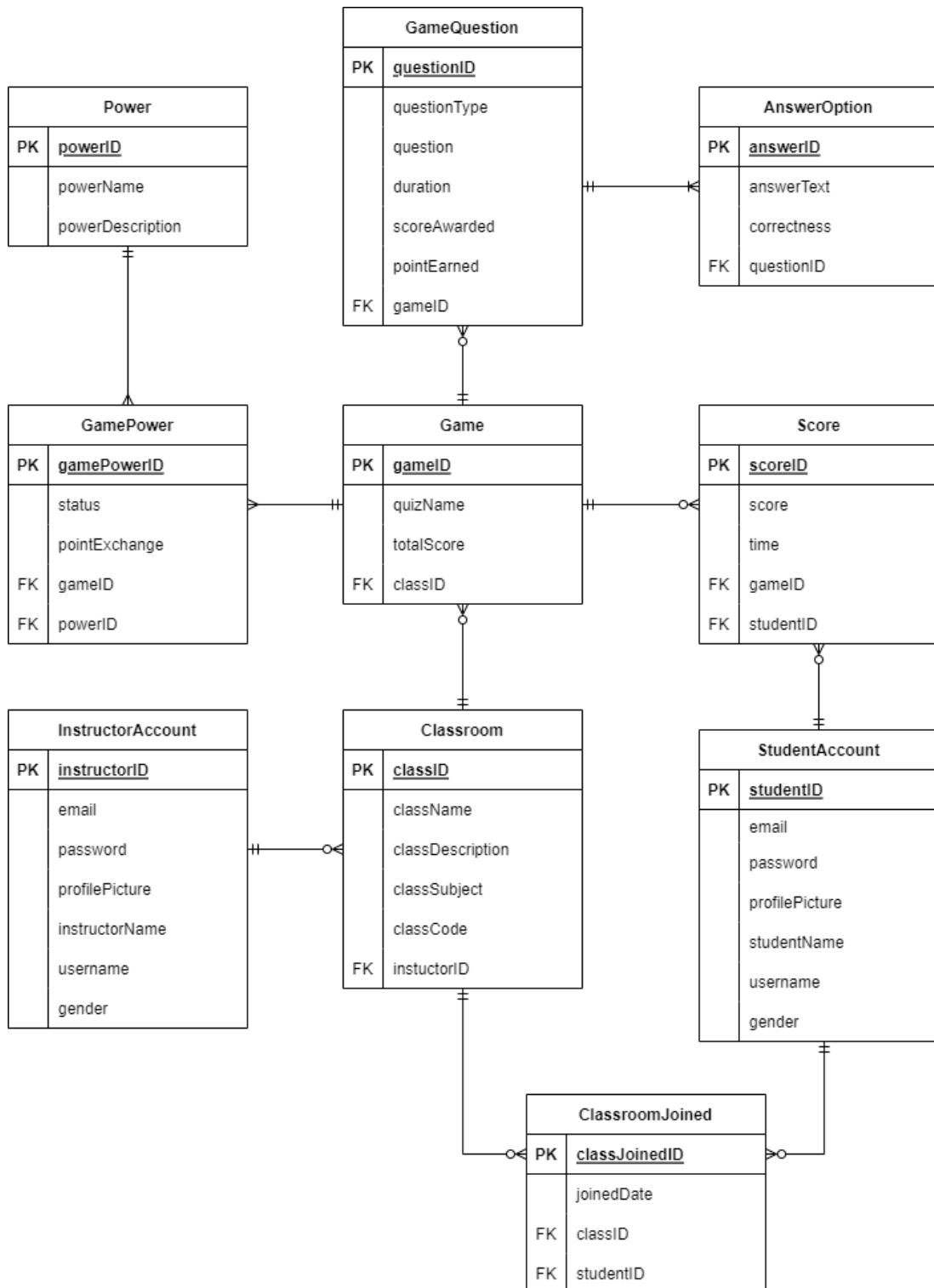


Figure 4.5 : Entity Relationship Diagram of Overall TARUMT Game-based Education System

4.2.2 Data Dictionary

Table Name: StudentAccount

Description: This table stores the students' information that are registered by TARUMT.

Attribute Name	Data Type	Description	Allow Null	Key (PK/FK)	Reference
studentID	VARCHAR (8)	The id of the student table. E.g.: "ST000001" "ST" refers to a student, followed by 6 digit numbers.	No	PK	-
email	VARCHAR (50)	TARUMT student email. E.g.: "xxxxx-xx19@student.tarc.edu.my"	No	-	-
password	VARCHAR (100)	The password of the student account. Minimum length is 8 and maximum length is 100, the password must include at least 1 number and 1 alphabet. Default: Student's IC number	No	-	-
profilePicture	VARCHAR (20)	The profile picture of the student account. Default: Blue Profile Picture	No	-	-
studentName	VARCHAR (40)	The student's full name as per IC.	No	-	-
username	VARCHAR (50)	The username of the student account. Default: Student's IC name	No	-	-
gender	CHAR(1)	The gender of the student. E.g.: 'M' represents Male and 'F' represents Female	No	-	-

Table Name: InstructorAccount

Description: This table stores the instructors' information that are registered by TARUMT.

Attribute Name	Data Type	Description	Allow Null	Key (PK/FK)	Reference
instructorID	VARCHAR (8)	The id of the instructor table. E.g.: "IN000001"	No	PK	-

		“IN” refers to an instructor, followed by 6 digit numbers.			
email	VARCHAR (50)	TARUMT instructor email. E.g.: “xxxxx@tarc.edu.my”	No	-	-
password	VARCHAR (100)	The password of the instructor account. Minimum length is 8 and maximum length is 100, the password must include at least 1 number and 1 alphabet. Default: Instructor's IC number	No	-	-
profilePicture	VARCHAR (20)	The profile picture of the instructor account. Default: Red Profile Picture	No	-	-
instructorName	VARCHAR (40)	The instructor's full name as per IC.	No	-	-
username	VARCHAR (50)	The username of the instructor account. Default: Instructor's IC name	No	-	-
gender	CHAR(1)	The gender of the instructor. E.g.: ‘M’ represents Male and ‘F’ represents Female	No	-	-

Table Name: Classroom

Description: This table stores the classrooms' information that are created by instructors.

Attribute Name	Data Type	Description	Allow Null	Key (PK/FK)	Reference
classID	VARCHAR (8)	The id of the classroom table. E.g.: “CL000001” “CL” refers to a classroom, followed by 6 digit numbers.	No	PK	-
className	VARCHAR (50)	The name of the classroom. E.g.: “202205 MPU3232 Lecture”	No	-	-
classDescription	VARCHAR (100)	A statement that describes the	Yes	-	-

		purpose of the classroom.			
classSubject	VARCHAR (50)	The subject that the classroom will focus on. E.g.: “Entrepreneurship”	No	-	-
classCode	VARCHAR (6)	A random 6-digit code consisting of alphabets and numbers. E.g.: “bQ2h7J”	No	-	-
instructorID	VARCHAR (8)	The id of the instructor table. E.g.: “IN000001” “IN” refers to an instructor, followed by 6 digit numbers.	No	FK	InstructorAccount

Table Name: ClassroomJoined

Description: This table stores the joined classroom of students.

Attribute Name	Data Type	Description	Allow Null	Key (PK/FK)	Reference
classJoinedID	VARCHAR (8)	The id of the joined classroom table. E.g.: “CJ000001” “CJ” refers to a joined classroom, followed by 6 digit numbers.	No	PK	-
joinedDate	DATETIME	The date that the student joined the classroom. E.g.: “2022-12-12 09:30:05”	No	-	-
classID	VARCHAR (8)	The id of the classroom table. E.g.: “CL000001” “CL” refers to a classroom, followed by 6 digit numbers.	No	FK	Classroom
studentID	VARCHAR (8)	The id of the student table. E.g.: “ST000001”	No	FK	StudentAccount

		“ST” refers to a student, followed by 6 digit numbers.			
--	--	--------------------------------------------------------	--	--	--

Table Name: Game

Description: This table stores the game details that are created by instructors.

Attribute Name	Data Type	Description	Allow Null	Key (PK/FK)	Reference
gameID	VARCHAR (8)	The id of the game table. E.g.: “GA000001” “GA” refers to a game, followed by 6 digit numbers.	No	PK	-
quizName	VARCHAR (50)	The name of the game. E.g.: “Quiz 1: Chapter 1”	No	-	-
totalScore	INT	The maximum score that students can get in the game. Default: 0	No	-	-
classID	VARCHAR (8)	The id of the classroom table. E.g.: “CL000001” “CL” refers to a classroom, followed by 6 digit numbers.	No	FK	Classroom

Table Name: GameQuestion

Description: This table stores the question details of the games.

Attribute Name	Data Type	Description	Allow Null	Key (PK/FK)	Reference
questionID	VARCHAR (8)	The id of the game question table. E.g.: “GQ000001” “GQ” refers to a game question, followed by 6 digit numbers.	No	PK	-
questionType	VARCHAR (30)	Refers to how questions and answers are presented. E.g.: “multiple-choice”	No	-	-

		question” allows players to choose one option from multiple options. “true-false question” allows players to choose “True” or “False” for the question. “fill-in-the-blank question” allows players to answer the question in text.			
question	VARCHAR (100)	The text of the question. E.g.: “Which of the following statements is NOT TRUE about fragment?”	No	-	-
duration	INT	The duration in seconds for students to answer the question. The options of duration in the system are “10”, “20”, “30”, “45” and “60”. E.g.: “10” refers to 10 seconds.	No	-	-
scoreAwarded	INT	The score given to the users if they answer the question correctly, for ranking purposes. Minimum is 1 and maximum is 20.	No	-	-
pointEarned	INT	The point given to the users if they answer the question correctly, for claiming power purposes. Maximum is 1 and maximum is 10.	No	-	-
gameID	VARCHAR (8)	The id of the game table. E.g.: “GA000001” “GA” refers to a game, followed by 6 digit numbers.	No	FK	Game

Table Name: AnswerOption

Description: This table stores the answer options for the questions.

Attribute	Data Type	Description	Allow	Key	Reference
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Name			Null	(PK/FK)	
answerID	VARCHAR (8)	The id of the question answer table. E.g.: “QA000001” “QA” refers to a question answer, followed by 6 digit numbers.	No	PK	-
answerText	VARCHAR (50)	The text of the answer option. E.g.: “Fragment manages its own UI and lifecycle.”	No	-	-
correctness	INT	To define whether this answer is correct. E.g.: “1” means correct, “0” means incorrect.	No	-	-
questionID	VARCHAR (8)	The id of the game question table. E.g.: “GQ000001” “GQ” refers to a game question, followed by 6 digit numbers.	No	FK	GameQuestion

Table Name: Power

Description: This table stores the power information for the whole system.

Attribute Name	Data Type	Description	Allow Null	Key (PK/FK)	Reference
powerID	VARCHAR (8)	The id of the power table. E.g.: “PO000001” “PO” refers to a power, followed by 6 digit numbers.	No	PK	-
powerName	VARCHAR (30)	The name of the power. E.g.: “Eliminate Wrong Option”	No	-	-
powerDescription	VARCHAR (100)	A statement that describes the function of the power. E.g.: “Eliminate one wrong option from the options.”	No	-	-

Table Name: GamePower

Description: This table stores the power details for the games.

Attribute Name	Data Type	Description	Allow Null	Key (PK/FK)	Reference
gamePowerID	VARCHAR (8)	The id of the game power table. E.g.: "GP000001" "GP" refers to a game power, followed by 6 digit numbers.	No	PK	-
status	INT	The status of the publication of the power. E.g.: "1" means enabled, "0" means disabled.	No	-	-
pointExchange	INT	The point needed to exchange the game power. Minimum is 1 and maximum is 100. E.g.: If the point needed is 2, it means that 2 points are required to exchange this power.	No	-	-
gameID	VARCHAR (8)	The id of the game table. E.g.: "GA000001" "GA" refers to a game, followed by 6 digit numbers.	No	FK	Game
powerID	VARCHAR (8)	The id of the power table. E.g.: "PO000001" "PO" refers to a power, followed by 6 digit numbers.	No	FK	Power

Table Name: Score

Description: This table stores the total score of students in the games.

Attribute Name	Data Type	Description	Allow Null	Key (PK/FK)	Reference
scoreID	VARCHAR (8)	The id of the score table. E.g.: "SC000001" "SC" refers to a score, followed by 6 digit	No	PK	-

		numbers.			
score	INT	The total score of the student gets in the game.	No	-	-
time	INT	The total time, in seconds, it took students to complete the game. E.g.: 15 means the students took 15 seconds to complete the game.	No	-	-
gameID	VARCHAR (8)	The id of the game table. E.g.: "GA000001" "GA" refers to a game, followed by 6 digit numbers.	No	FK	Game
studentID	VARCHAR (8)	The id of the student table. E.g.: "ST000001" "ST" refers to a student, followed by 6 digit numbers.	No	FK	StudentAccount

4.3 User Interface Design

Student Login and Maintenance Module

TARUMT Game-Based Learning System

TARUMT
TANJU ABDUL RAHMAN UNIVERSITY OF
MANAGEMENT AND TECHNOLOGY

Student Login

Email
eg. xxxx-xx19@student.tarc.edu.my

Password
 abcd1234

Show Password [Forgot Password?](#)

LOGIN

Instructor Login

Figure 4.6 : Student Login Screen Design

TARUMT Game-Based Learning System

TARUMT
TANJU ABDUL RAHMAN UNIVERSITY OF
MANAGEMENT AND TECHNOLOGY

Student Login

Email
yapye-wm19@student.tarc.edu.my

Password
 abcd1234

Show Password [Forgot Password?](#)

LOGIN

Instructor Login

Figure 4.7 : Student Login Screen Design (Password Visible)

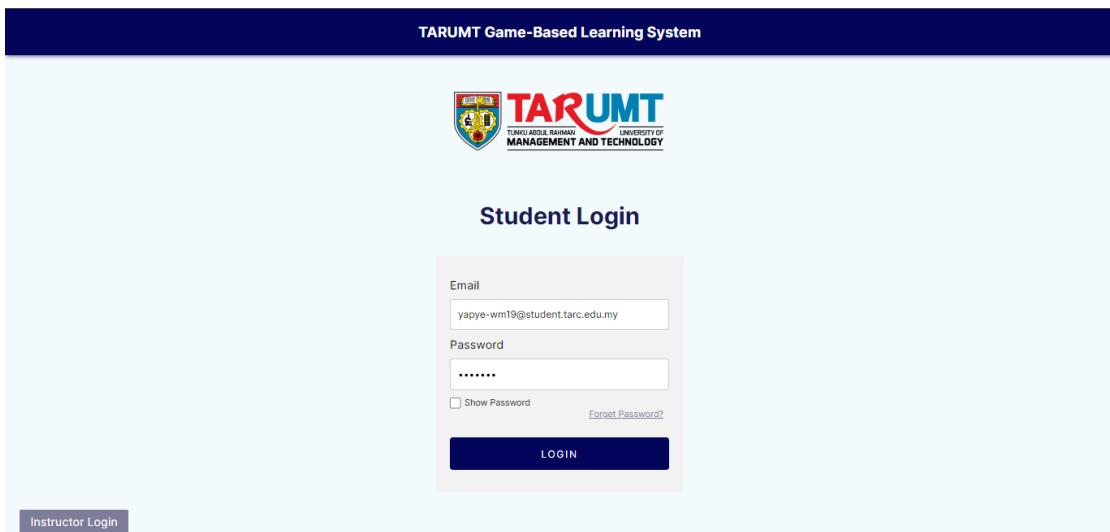


Figure 4.8 : Student Login Screen Design (Password Invisible)

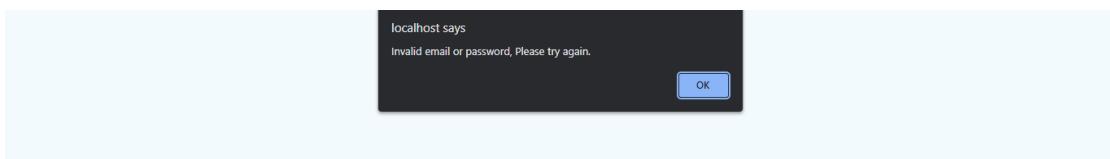


Figure 4.9 : Student Login Screen Design (Invalid Email or Password)

Figure 4.6 shows the Login page of the TARUMT Game-based Learning System, users are required to fill in their email and password in order to login to the system. The password is invisible by default (refer to Figure 4.8) and users can make the password visible by ticking the show password checkbox (refer to Figure 4.7). If users login with incorrect email or password, the error message will be displayed (refer to Figure 4.9).



Figure 4.10 : Verify Email Screen Design for Password Recovery

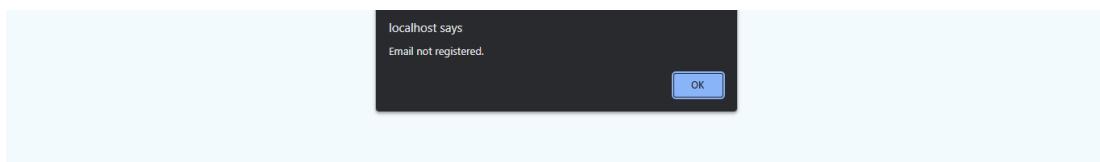


Figure 4.11 : Verify Email Screen Design for Password Recovery (Invalid Email)

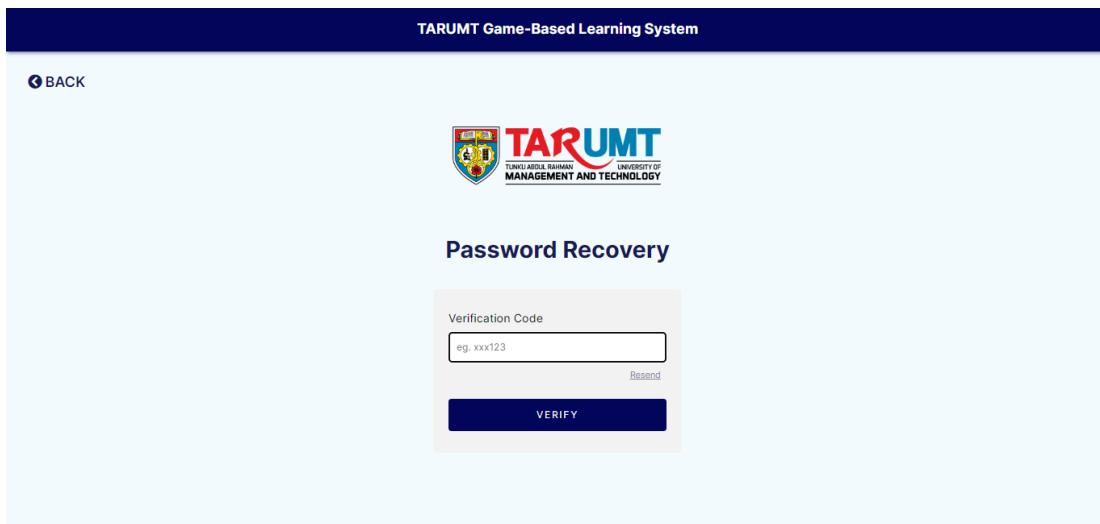


Figure 4.12 : Verify Code Screen Design for Password Recovery

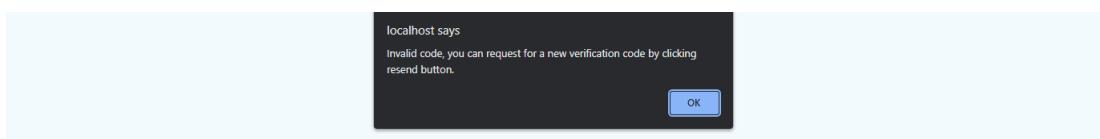


Figure 4.13 : Verify Code Screen Design for Password Recovery (Invalid Code)

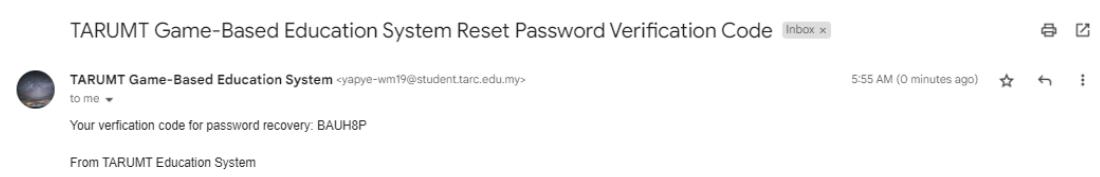


Figure 4.14 : Verification Code Email for Password Recovery

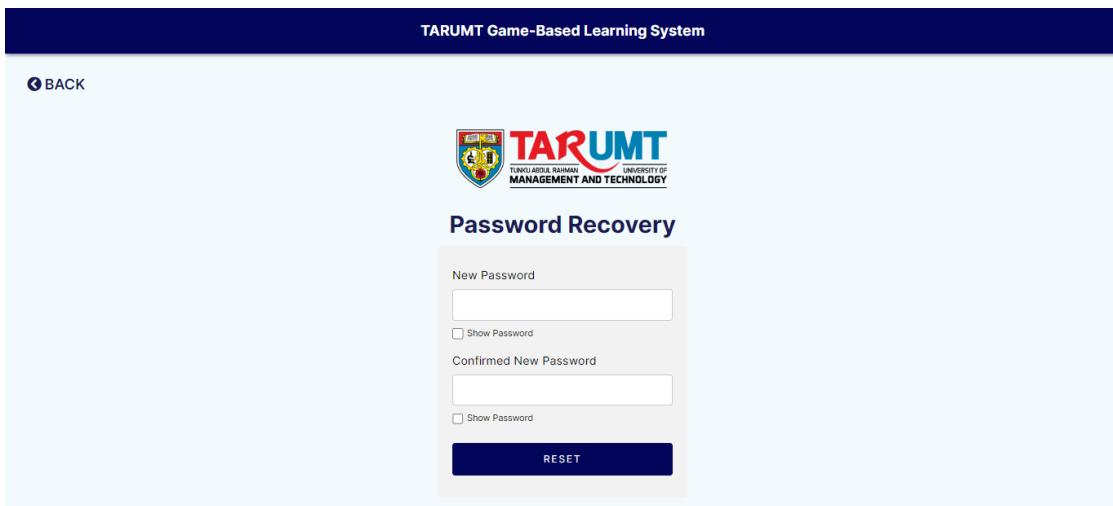


Figure 4.15 : Password Recovery Screen Design

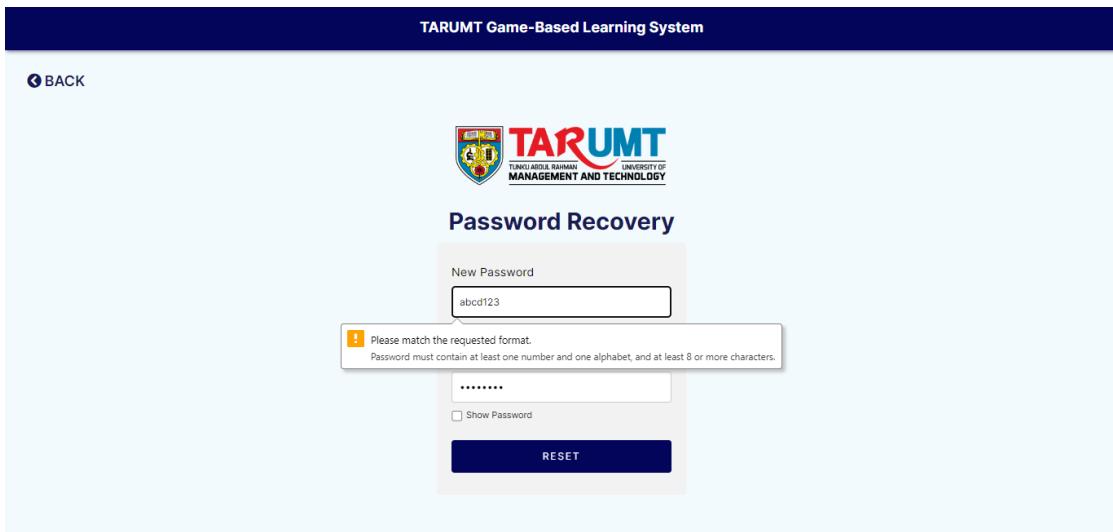


Figure 4.16 : Password Recovery Screen Design (Password Validation)

When users click on the "Forget Password?" button on the Login page (refer to Figure 4.6), the system will redirect the users to the Verify Email page (refer to Figure 4.10). On this page, users are required to provide their email for verifying and verification code sending purposes. If the email entered by users does not exist in the database, the error message will be displayed (refer to Figure 4.11), else users will be redirected to the Verify Code page (refer to Figure 4.12) and users are required to enter the verification code that has been sent to their email.

If users have not received the email, they can click on the "Resend" button on the Verify Code page (refer to Figure 4.12) to receive a new verification code. Figure 4.14 shows the sample of verification code email. If the verification code entered by users is invalid, the error message will be displayed (refer to Figure 4.13), else the system will redirect users to the Password Recovery page (refer to Figure 4.15) and users can reset their password by

providing their new password and confirmed new password. The password format must contain at least one number and one alphabet, and at least 8 characters (refer to Figure 4.16).

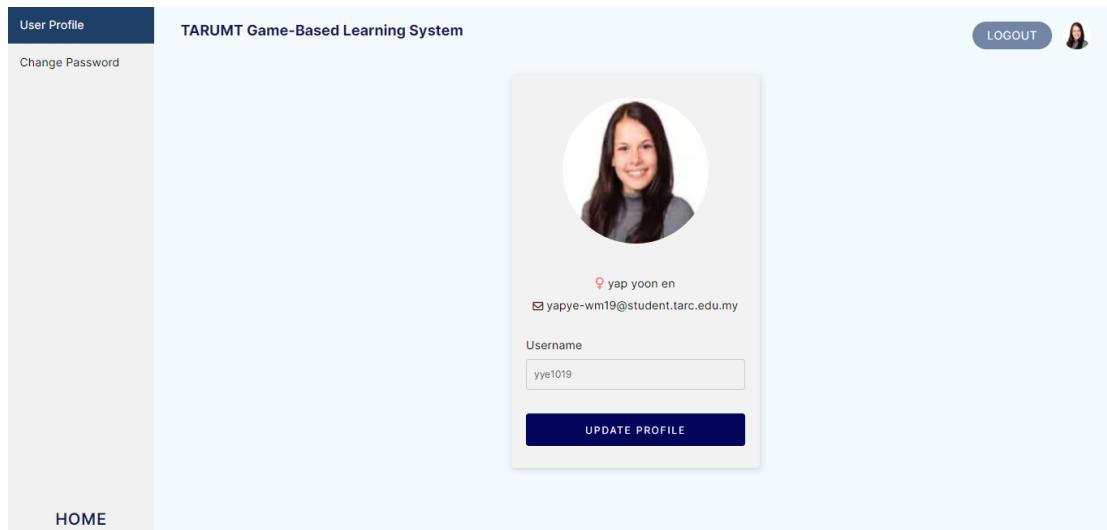


Figure 4.17 : User Profile Screen Design

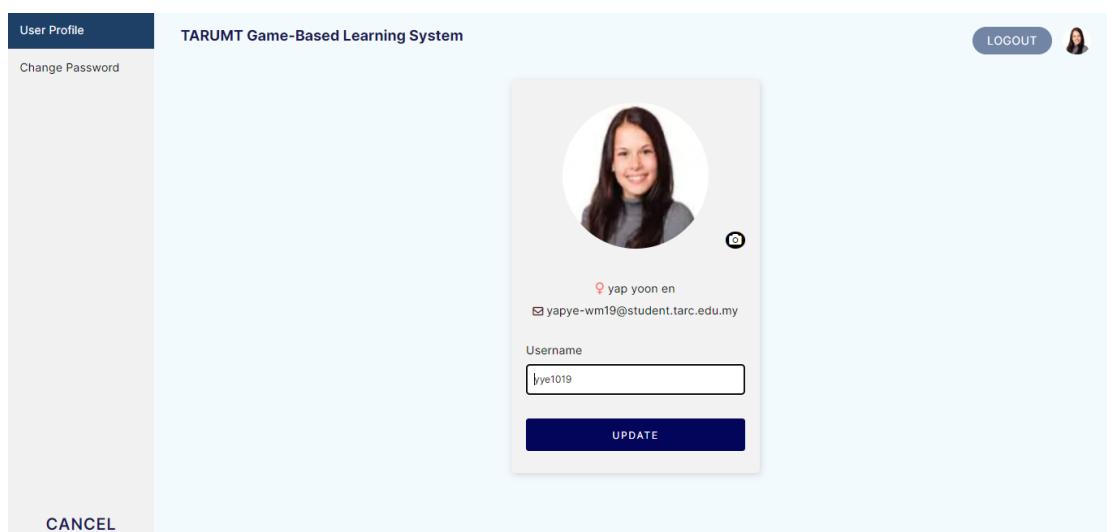


Figure 4.18 : Update User Profile Screen Design

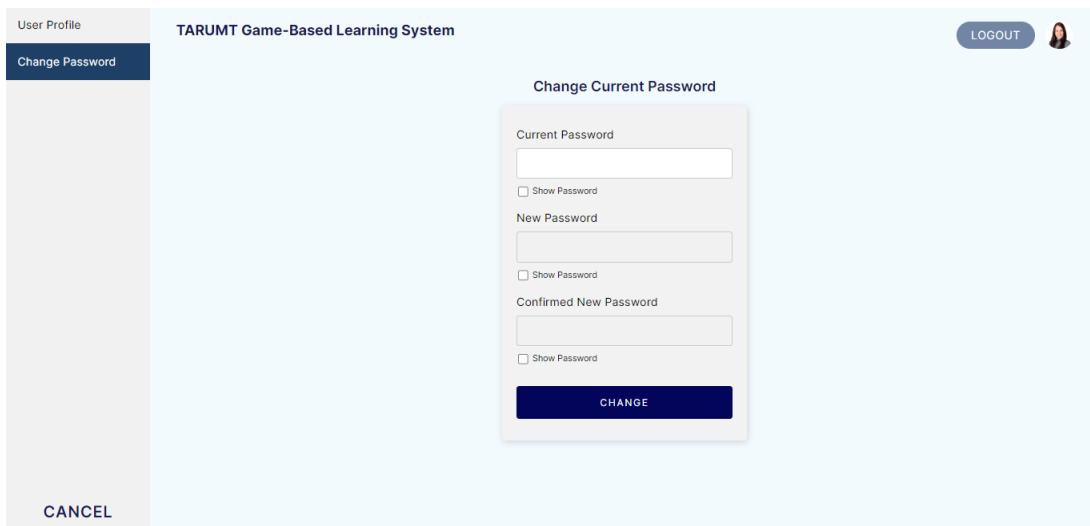


Figure 4.19 : Change Password Screen Design (Current Password Verification)

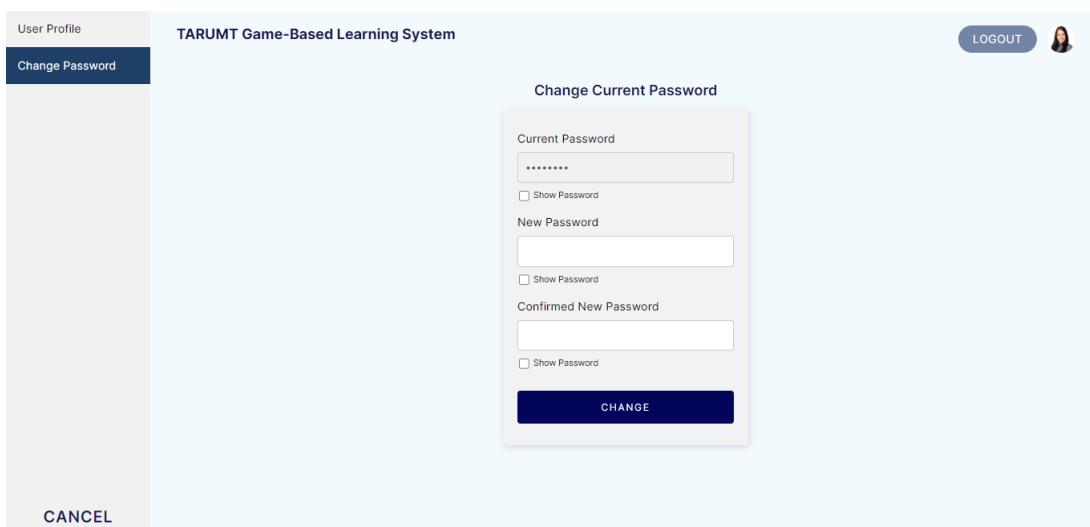


Figure 4.20 : Change Password Screen Design (Change New Password)

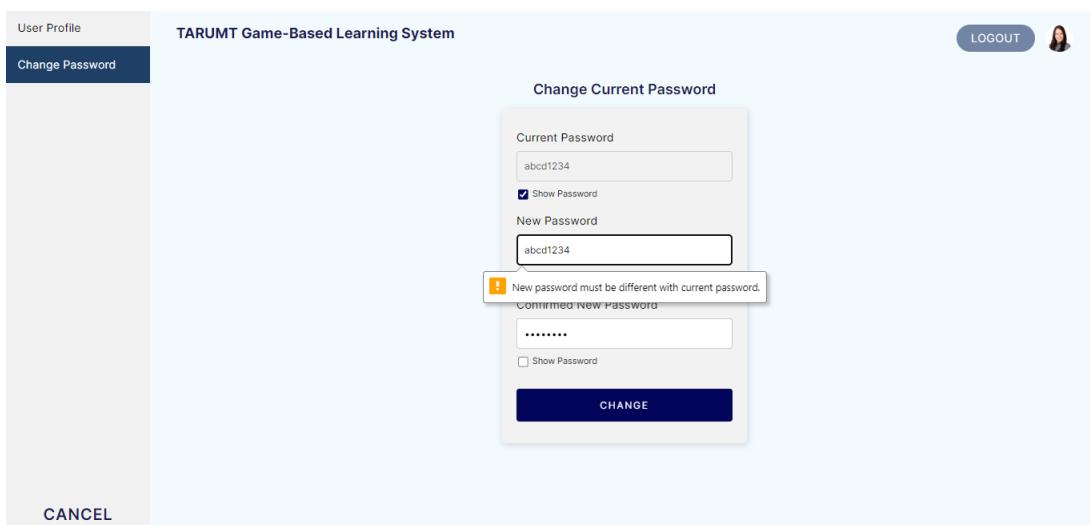


Figure 4.21 : Change Password Screen Design (Password Validation)

After users click on the profile picture in the top-right corner of the Homepage (refer to Figure 4.22), users will be redirected to the User Profile page (Figure 4.17). On the User Profile page, there are two buttons for users to change their password and update their profile. Users can also back to the Homepage by clicking on the “Home” button in the left-bottom corner.

If users click on the “Update Profile” button on the User Profile page, the system will redirect them to the Update User Profile page (refer to Figure 4.18). On this page, users are able to change their username and also their profile picture by clicking on the camera icon beside their profile picture. After they make changes, they can click on the “Update” button to save their updated profile.

If users click on the “Change Password” button on the User Profile page, the system will redirect them to the Change Password page (refer to Figure 4.19) and users are required to provide their current password for verification purposes and click on the "Change" button. If their current password matches with the database, new password and confirmed new password fields will be enabled (refer to Figure 4.20). After they fill in all the fields, they can click on the “Change” button to change their password. The new password is not allowed to be the same with the current password (refer to Figure 4.21).

Participating in Classroom Module

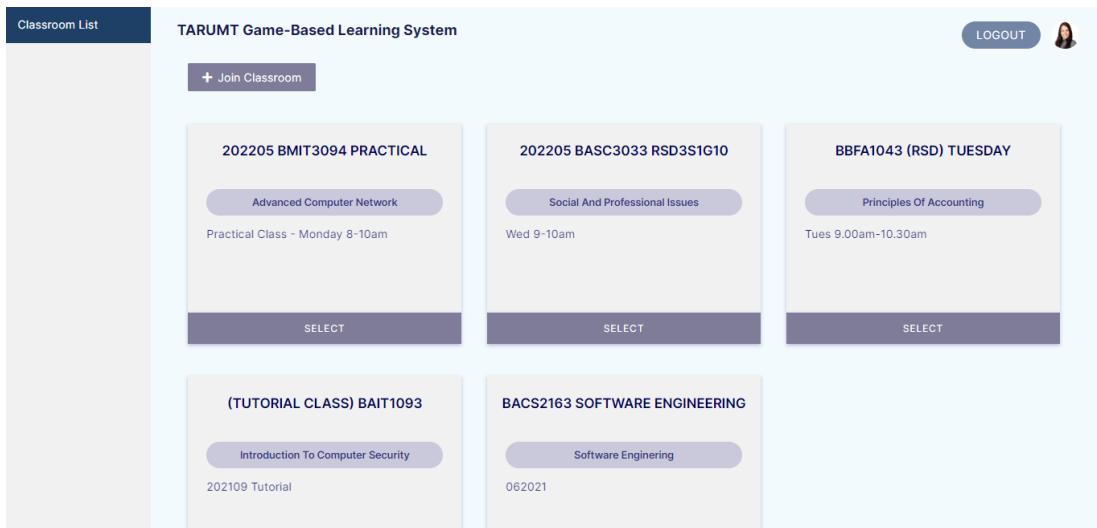


Figure 4.22 : Student Homepage Screen Design

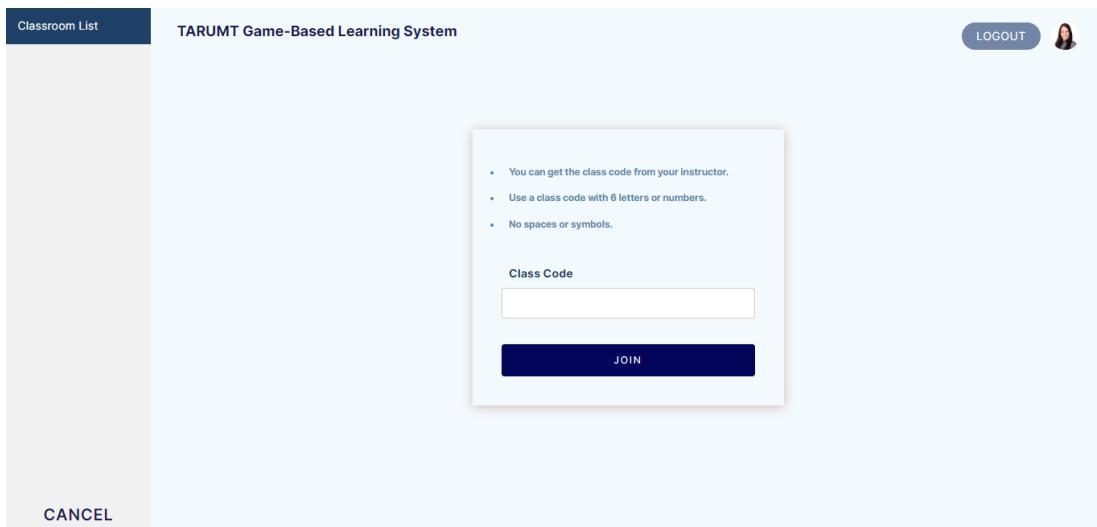


Figure 4.23 : Join Classroom Screen Design

Figure 4.22 shows the Homepage of the TARUMT Game-based Learning System. When users click on the “Join Classroom” button, they will be redirected to the Join Classroom page (refer to Figure 4.23) and they can join a classroom by providing class code that get from their instructors.

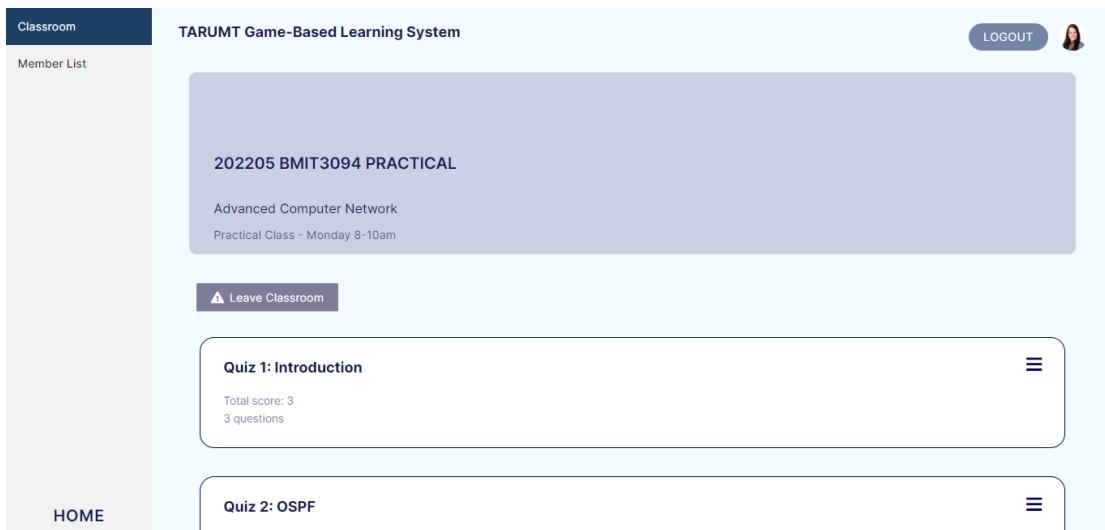


Figure 4.24 : Selected Classroom Screen Design

The screenshot shows the 'Member List' section. It has a similar header and sidebar to the Classroom screen. The main content area is titled 'INSTRUCTOR' and lists 'Ypl (Yap Pooi Lee)' with a small profile picture. Below it is a 'STUDENT LIST' section with three entries: 'Mym (Muk Yin Man)', 'Yye1019 (Yap Yoon En)', and 'Mki (Muk Ka Jun)'. Each student entry includes a small profile picture. Navigation buttons 'HOME' and 'MEMBER LIST' are at the bottom.

Figure 4.25 : Member List Screen Design

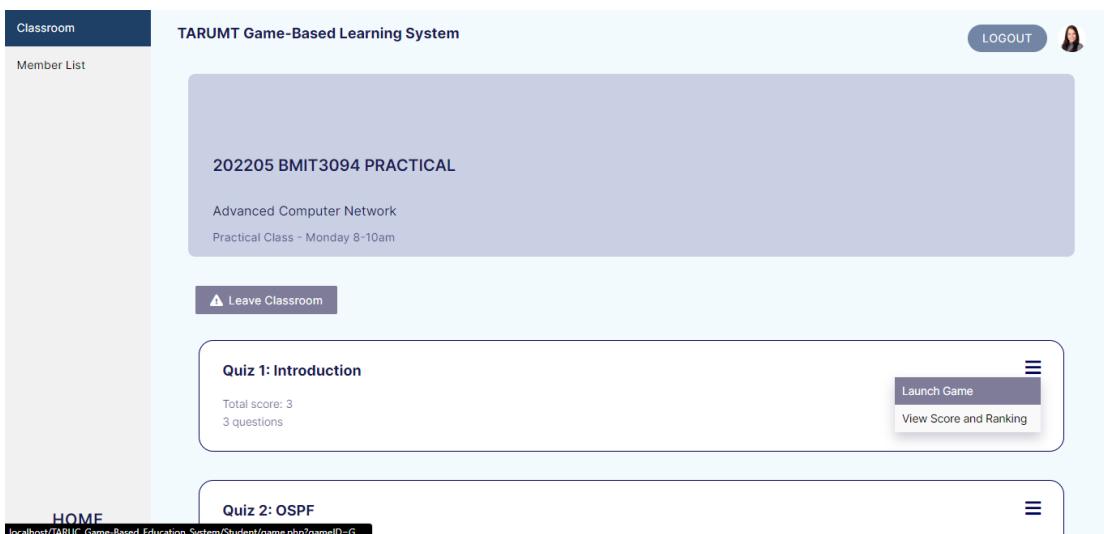


Figure 4.26 : Selected Classroom Screen Design (Hamburger Menu)

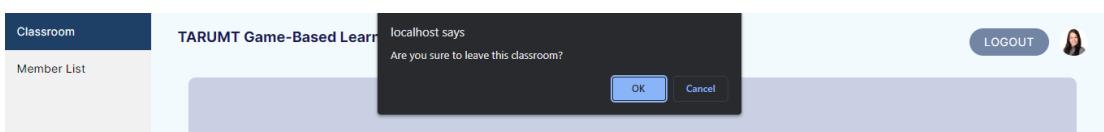


Figure 4.27 : Selected Classroom Screen Design (Leave Classroom Confirmation Box)

When users click on the “Select” button of a classroom (refer to Figure 4.22), they will be redirected to the Selected Classroom page (refer to Figure 4.24). On this page, users can view the contents of the classroom and users can also view the member list of selected classrooms (refer to Figure 4.25) by clicking on the “Member List” button. If users want to launch a game or view score and ranking, they can click on the hamburger menu of the game they want (refer to Figure 4.26). When users click on the "Leave Classroom" button, the confirmation box (refer to Figure 4.27) will appear to avoid accidentally clicking.

Participating in Game Module

The screenshot shows the TARUMT Game-Based Learning System interface. At the top, there's a navigation bar with 'Classroom' and 'Member List' on the left, and 'LOGOUT' and a user profile icon on the right. The main content area has a light blue header with the text '202205 BMIT3094 PRACTICAL'. Below it, there's a sub-header 'Advanced Computer Network' and a note 'Practical Class - Monday 8-10am'. A dark blue button labeled 'Leave Classroom' is visible. In the center, there's a box for 'Quiz 1: Introduction' showing a total score of 3 from 3 questions. To the right of this box are buttons for 'Launch Game' and 'View Score and Ranking'. At the bottom, there's another box for 'Quiz 2: OSPF'. On the far left, there's a 'HOME' link and a URL 'localhost/TARUC_Game-Based_Education_System/Student/game.php?gameID=6...'. The bottom right corner features a three-line menu icon.

Figure 4.28 : Selected Classroom Screen Design (Launch Game Button)

This screenshot shows a true-false question screen. At the top, it says 'Quiz 1: Introduction', 'TARUMT Game-Based Learning System', and 'Question 2'. On the left, there's a circular badge with the number '28'. The main question is 'Is ip route 0.0.0.0 0.0.0.0 s0/0/0 a default static route?'. Below the question are two rectangular buttons: one labeled 'TRUE' and one labeled 'FALSE'.

Figure 4.29 : True-False Question Screen Design

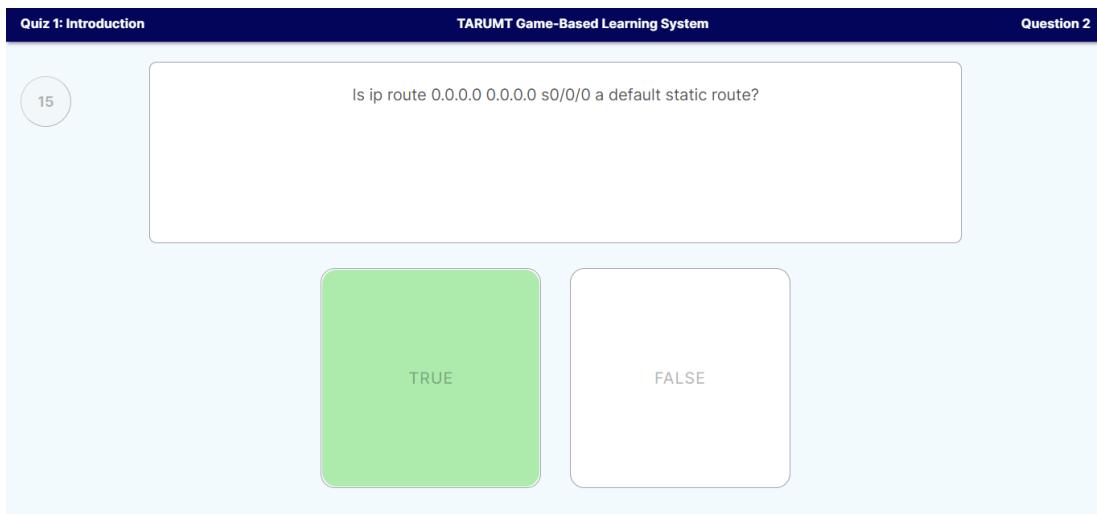


Figure 4.30 : True-False Question Screen Design (Answer Correct)

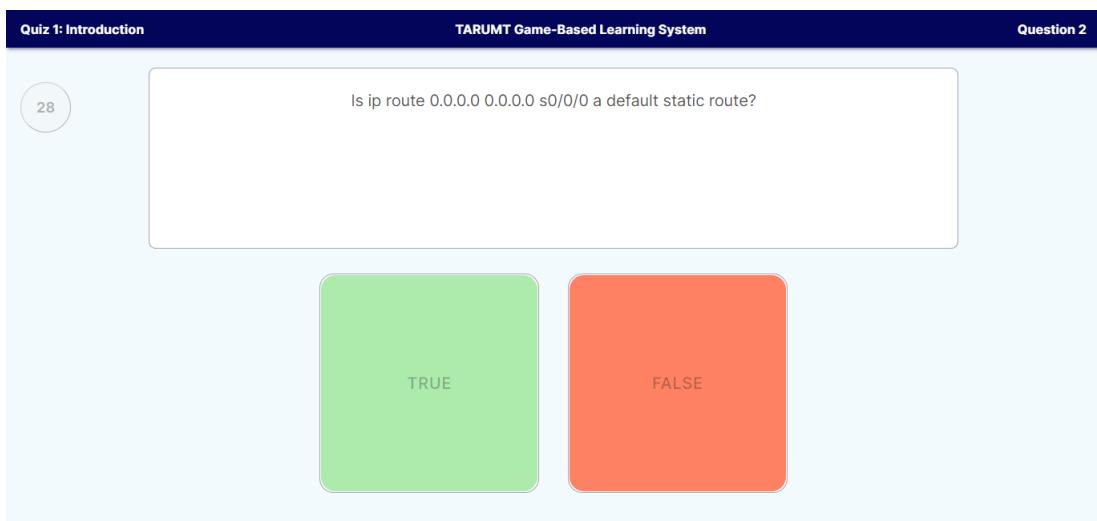


Figure 4.31 : True-False Question Screen Design (Answer Incorrect)

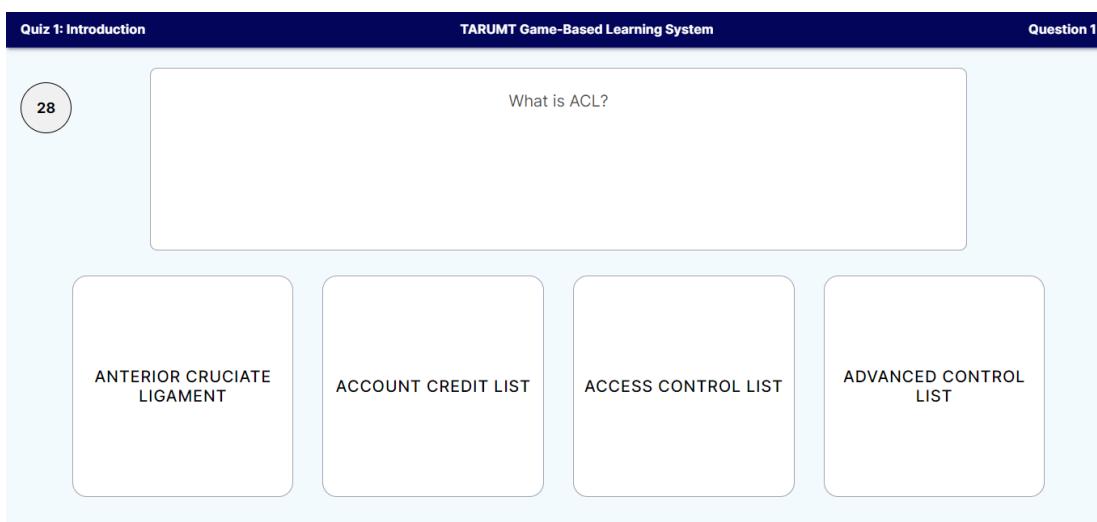
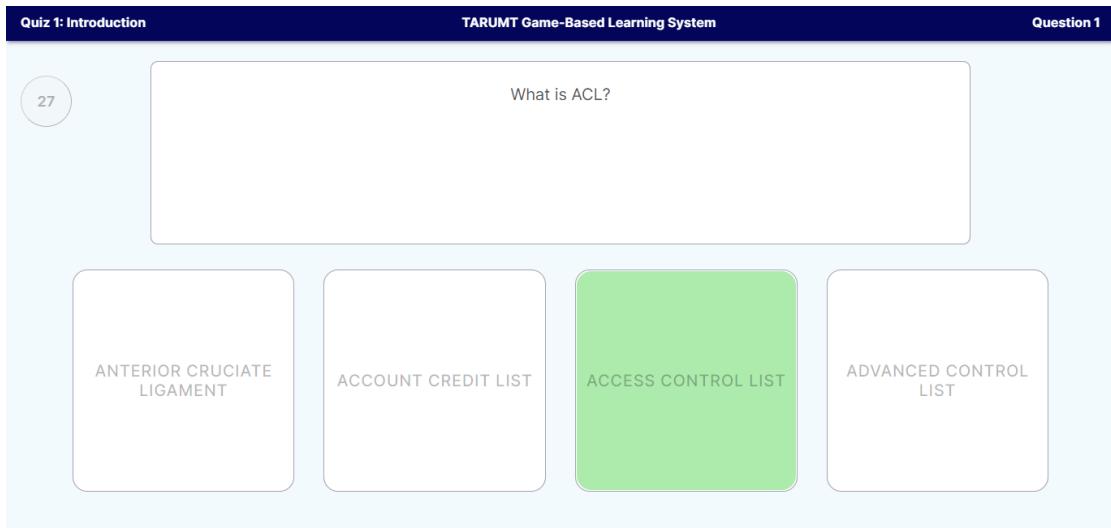


Figure 4.32 : Multiple-Choice Question Screen Design



Quiz 1: Introduction TARUMT Game-Based Learning System Question 1

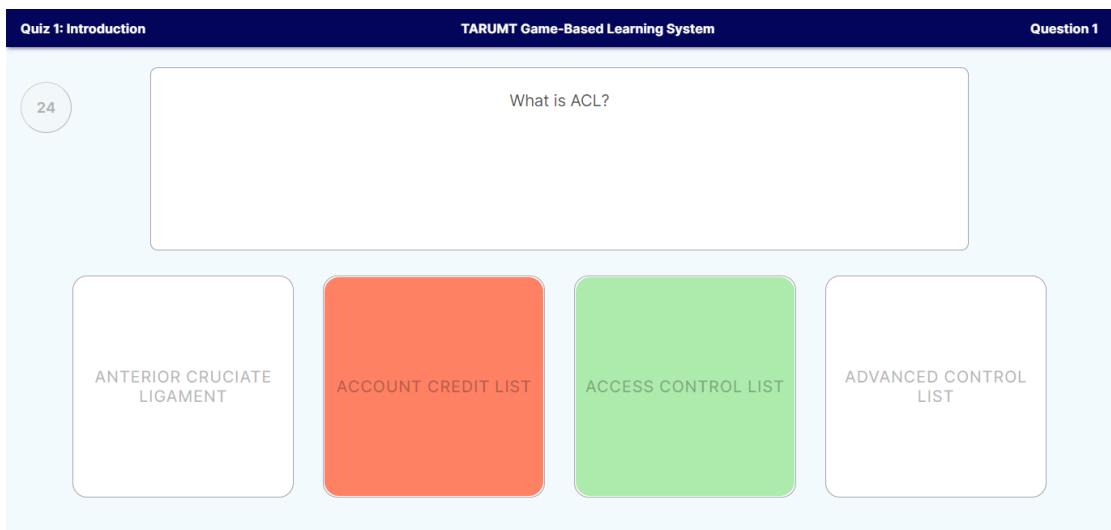
27

What is ACL?

ANTERIOR CRUCIATE LIGAMENT ACCOUNT CREDIT LIST ACCESS CONTROL LIST ADVANCED CONTROL LIST

The screenshot shows a multiple-choice question titled "What is ACL?". There are four options: "ANTERIOR CRUCIATE LIGAMENT", "ACCOUNT CREDIT LIST", "ACCESS CONTROL LIST", and "ADVANCED CONTROL LIST". The correct answer, "ACCESS CONTROL LIST", is highlighted with a green background.

Figure 4.33 : Multiple-Choice Question Screen Design (Answer Correct)



Quiz 1: Introduction TARUMT Game-Based Learning System Question 1

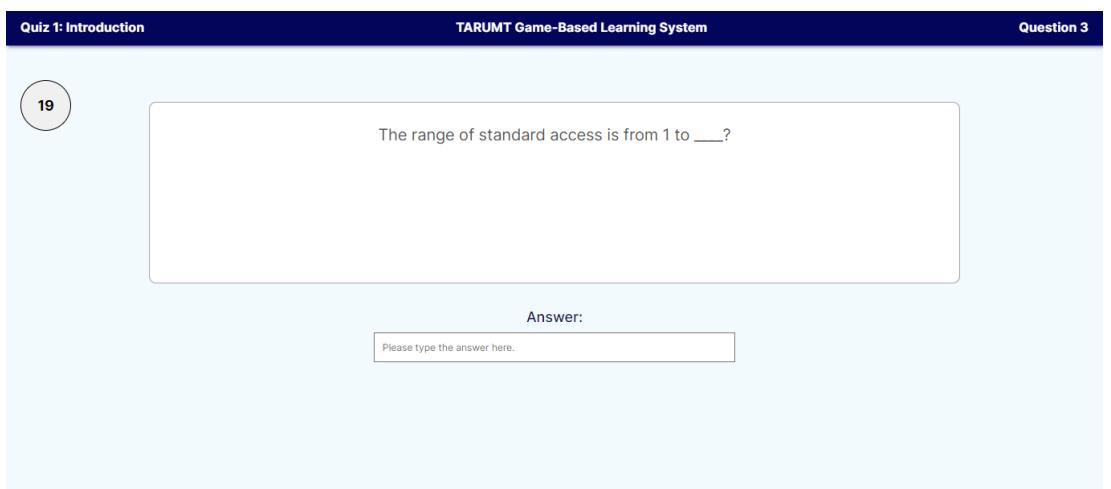
24

What is ACL?

ANTERIOR CRUCIATE LIGAMENT ACCOUNT CREDIT LIST ACCESS CONTROL LIST ADVANCED CONTROL LIST

The screenshot shows a multiple-choice question titled "What is ACL?". There are four options: "ANTERIOR CRUCIATE LIGAMENT", "ACCOUNT CREDIT LIST", "ACCESS CONTROL LIST", and "ADVANCED CONTROL LIST". The incorrect answer, "ACCOUNT CREDIT LIST", is highlighted with an orange background.

Figure 4.34 : Multiple-Choice Question Screen Design (Answer Incorrect)



Quiz 1: Introduction TARUMT Game-Based Learning System Question 3

19

The range of standard access is from 1 to ___?

Answer:

Please type the answer here.

The screenshot shows a fill-in-the-blank question titled "The range of standard access is from 1 to ___?". Below the question is a text input field with the placeholder "Please type the answer here.".

Figure 4.35 : Fill-in-the-blank Question Screen Design

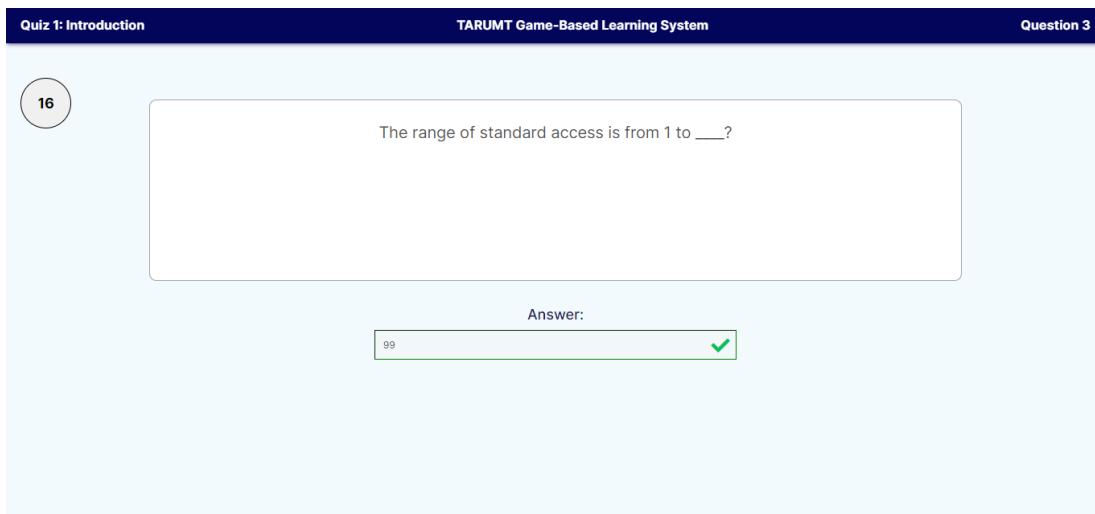


Figure 4.36 : Fill-in-the-blank Question Screen Design (Answer Correct)

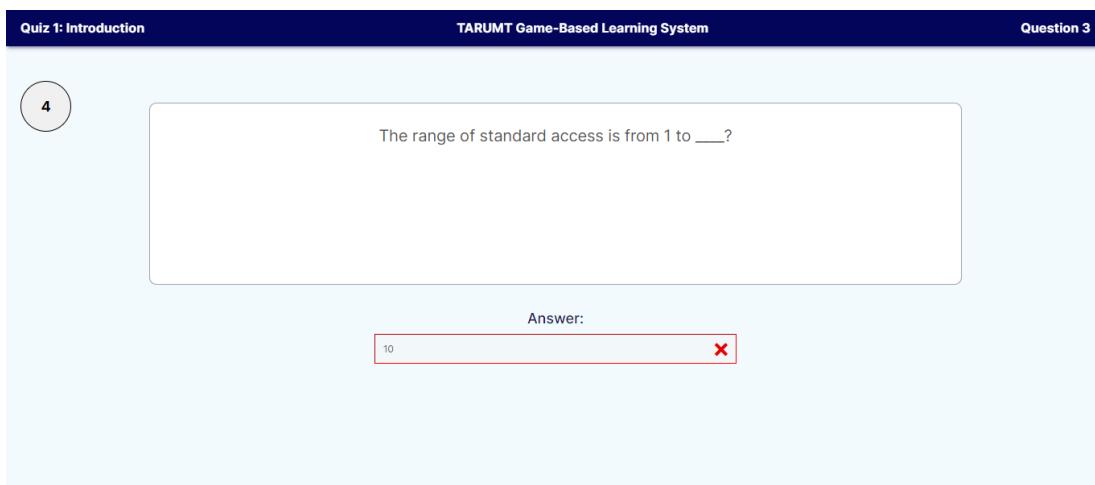


Figure 4.37 : Fill-in-the-blank Question Screen Design (Answer Incorrect)

When users click on the “Launch Game” button on the Selected Classroom page (refer to Figure 4.28), the selected game will be started and there are three types of questions that may be included in the game which are True-False questions (refer to Figure 4.29), Multiple-Choice questions (refer to Figure 4.32) and Fill-in-the-blank questions (refer to Figure 4.35).

For the True-False questions and Multiple-Choice questions, the background colour of the selected option will change to green when the user answers correctly (refer to Figure 4.30, Figure 4.33), and change to red when the user answers incorrectly (refer to Figure 4.31, Figure 4.34). When it comes to Fill-in-the-blank questions, a green tick appears if the user answers correctly (refer to Figure 4.36), while a red cross appears if the user answers incorrectly (refer to Figure 4.37).

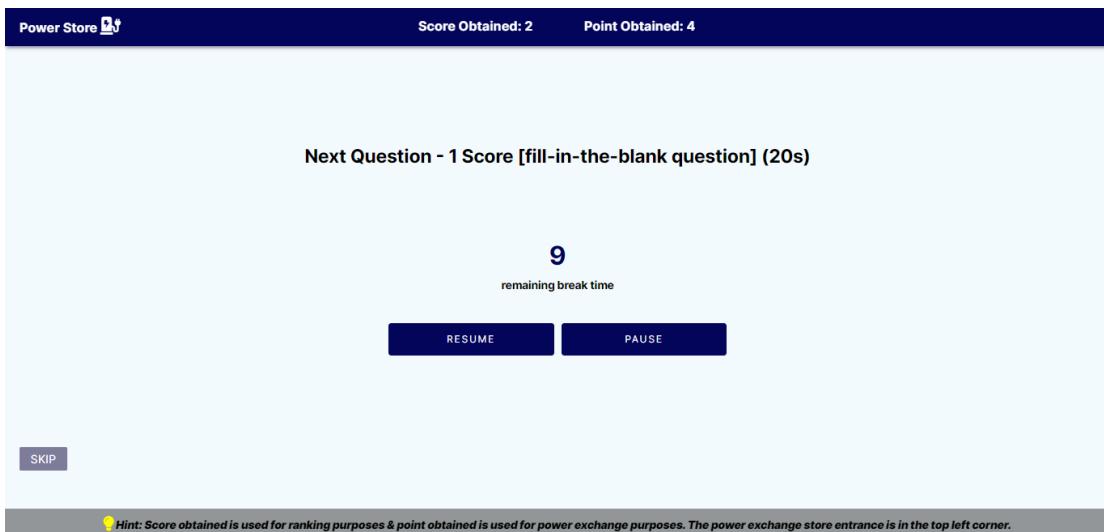


Figure 4.38 : Game Breaks Screen Design

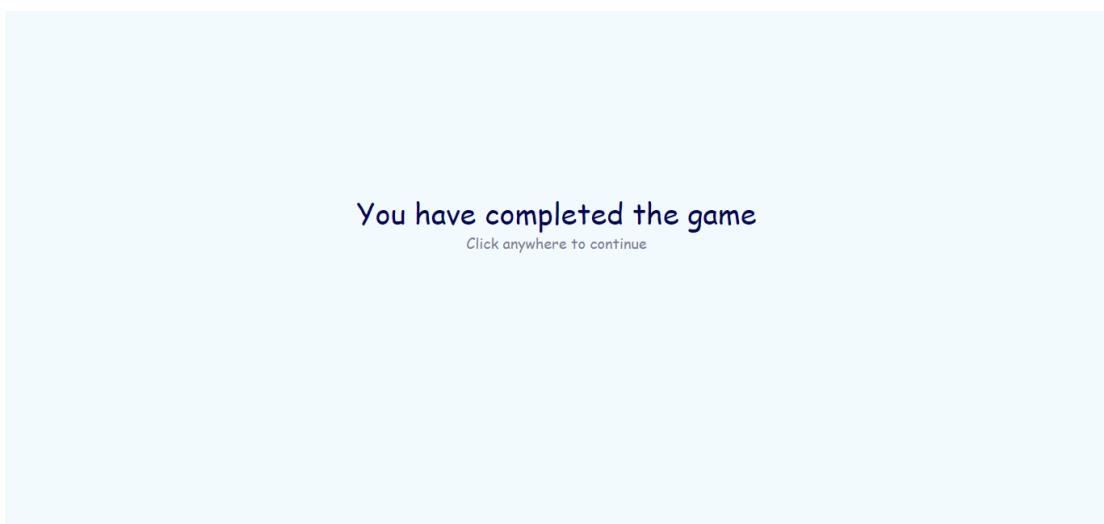


Figure 4.39 : End Game Screen Design

If there is no next question, the system will redirect users to the End Game page (refer to Figure 4.39) and users can click anywhere on the page to view the score and ranking. If there is a next question, users will be redirected to the Game Breaks page, which displays a 10 seconds timer, current score obtained and point obtained, next question details, a skip button, a power exchange store entrance and a pause or resume button (refer to Figure 4.38).

When the 10 seconds timer ends, the next question will start immediately. If users want more time to break, they can click on the "Pause" button before the timer ends to stop the 10 seconds timer and the timer can be continued by clicking the "Resume" button. If users do not want to wait for the timer to end, they can click on the "Skip" button to skip the break and start the next question.

Score and Ranking Module

The screenshot shows the TARUMT Game-Based Learning System interface. On the left, a sidebar titled 'Classroom' contains a 'Member List' link. The main area is titled 'TARUMT Game-Based Learning System'. At the top right are 'LOGOUT' and a user profile icon. Below this, a purple header bar displays '202205 BMIT3094 PRACTICAL', 'Advanced Computer Network', and 'Practical Class - Monday 8-10am'. A dark blue button labeled 'Leave Classroom' is at the bottom of this bar. The central content area features two cards: 'Quiz 1: Introduction' (Total score: 3, 3 questions) with 'Launch Game' and 'View Score and Ranking' buttons, and 'Quiz 2: OSPF' (with a URL: localhost/TARUC_Game-Based_Education_System/Student/viewScoreAndRanking.php?gameID=G4000001). A three-line menu icon is on the right of each card.

Figure 4.40 : Selected Classroom Screen Design (View Score and Ranking Button)

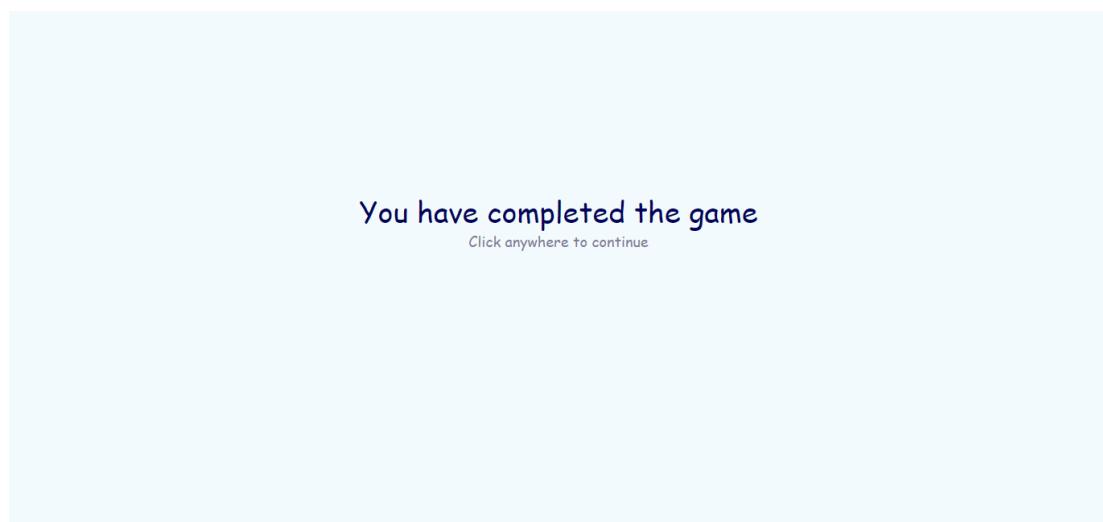


Figure 4.41 : End Game Screen Design



Figure 4.42 : Score and Ranking Screen Design

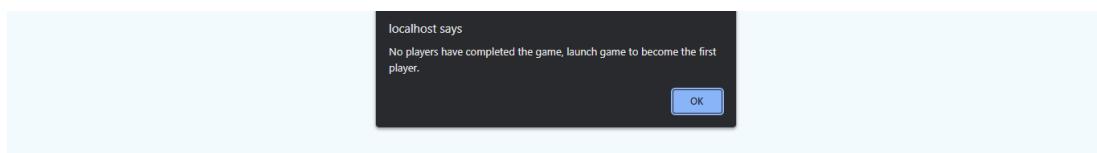


Figure 4.43 : Score and Ranking Screen Design (No Record)

Figure 4.42 shows the Score and Ranking page for a game, which users can access in two ways, the first way is by clicking the “View Score and Ranking” button on the Selected Classroom page (refer to Figure 4.40), the second way is to complete the game and then click anywhere on the End Game page (refer to Figure 4.41). If no user plays the game, users are not allowed to view the Score and Ranking page (refer to Figure 4.43).

Claiming Power Exchange Module

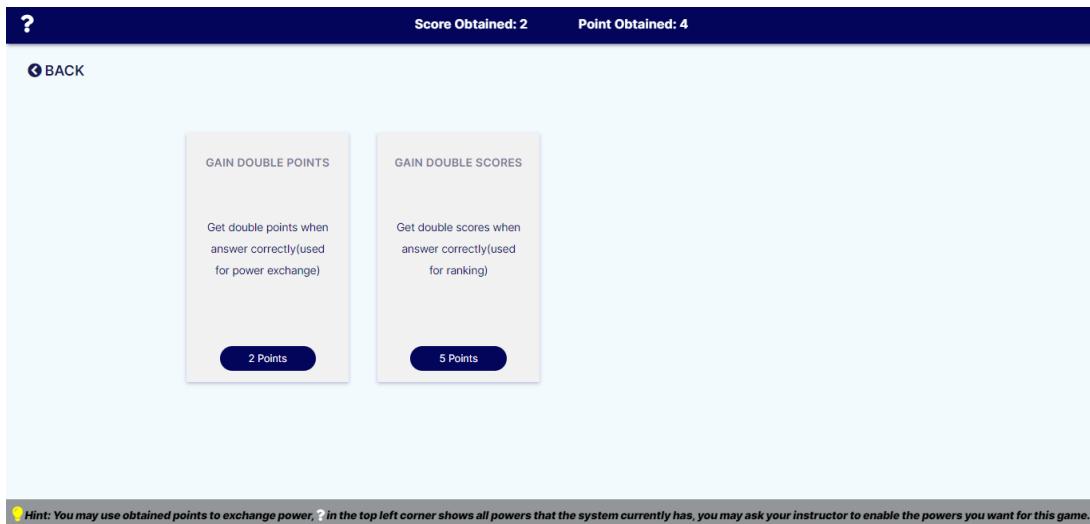


Figure 4.44 : Power Exchange Store Screen Design

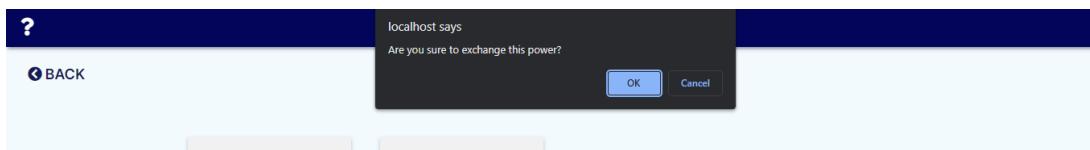


Figure 4.45 : Power Exchange Store Screen Design (Exchange Power Confirmation Box)

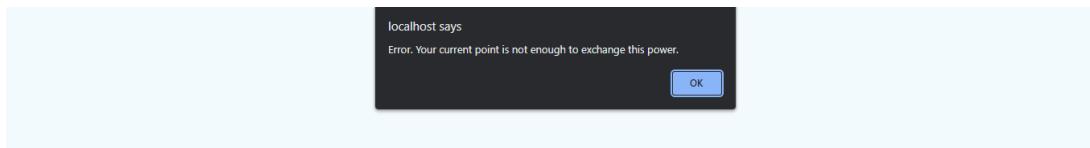


Figure 4.46 : Power Exchange Store Screen Design (Insufficient Points)

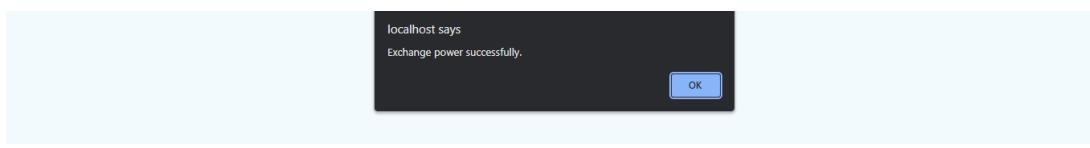


Figure 4.47 : Power Exchange Store Screen Design (Sufficient Points)

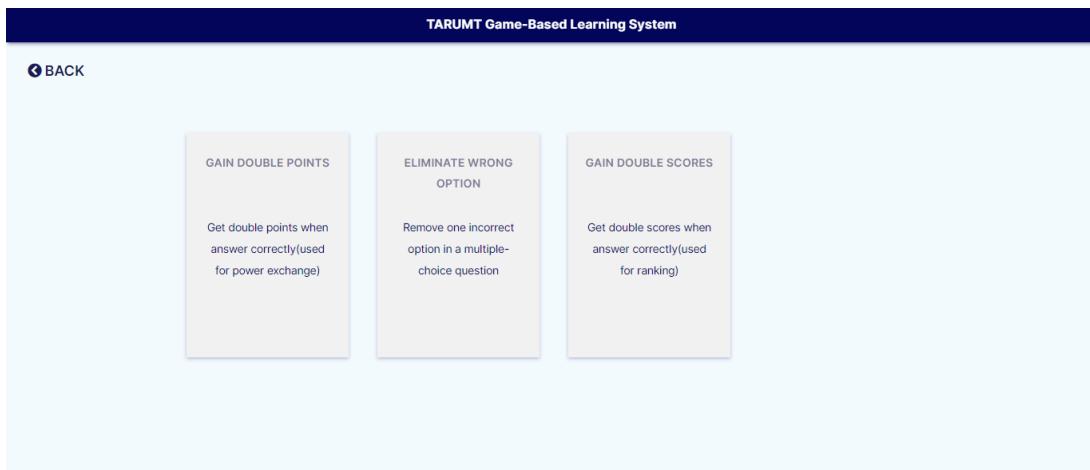


Figure 4.48 : Powers List and Description Screen Design

Figure 4.44 shows the Power Exchange Store page that users can access during game breaks. On this page, users can know how many points they have obtained in the top-middle and they can also access the Powers List and Description page (refer to Figure 4.48) by clicking the question mark button in the top-left corner.

Not only that, users can also exchange one of the powers by clicking the button for the power in the Power Exchange Store page. When they decide to exchange the power, a confirmation box (refer to Figure 4.45) is prompted to avoid accidental clicks. If users insufficient points to exchange the power, the error message will be prompted (refer to Figure 4.46), else if users' point is enough, the success message will be prompted (refer to Figure 4.47) and the power exchanged will be used automatically for the next question.

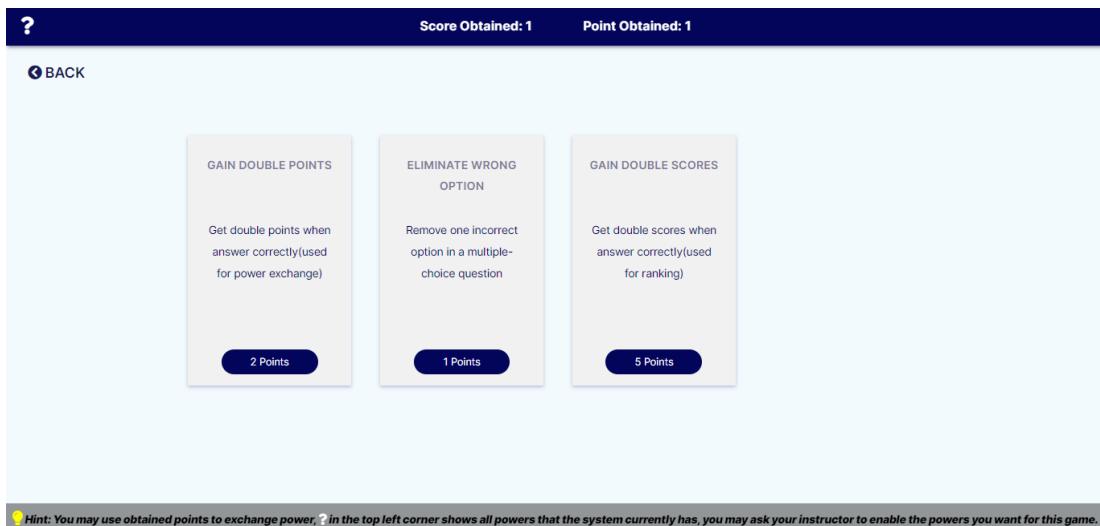


Figure 4.49 : Power Exchange Store Screen Design (Multiple-Choice Question)

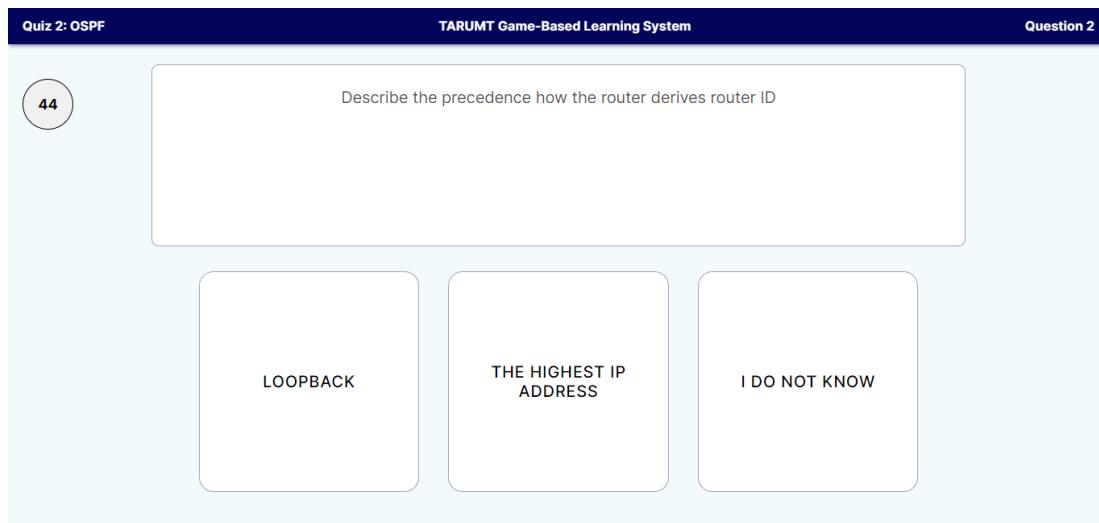


Figure 4.50 : Multiple-Choice Question Screen Design (Eliminate Wrong Option Power)

The Eliminate Wrong Option power will only appear when the next question type is Multiple-Choice Questions and its status is enabled (refer to Figure 4.49). When users successfully exchange the Eliminate Wrong Option power, the next question will start immediately and one of the wrong options will be removed, changing from 4 options to 3 options (refer to Figure 4.50).

4.4 Chapter Summary and Evaluation

In this chapter, the author has discussed the system design which includes activity diagram, database design and user interface design. For the activity diagram, only the modules that are handled by the author have been prepared. For the database design, the author has illustrated the overall database structure and the relationship between sets of entities stored in the database by using an entity relationship diagram (ERD). The author has also prepared a data dictionary to describe the details of entity structure for each database table. Lastly, the user interface design of the proposed system is also introduced.

The problem faced by the author was that since the author has not drawn an activity diagram for a long time, the author forgot how to use symbols and notations when producing an activity diagram for each module. In order to solve the problem, the author did research on Google to understand the function of the notations and also referenced the diagrams that the author did when learning the OOAD subject.

Chapter 5

Implementation and Testing

5 Implementation and Testing

In this chapter, the author will discuss the implementation of the system and the testing applied to the system. The platform used, the programming language, the database, the tools needed when developing and implementing the system as well as how the author integrates the code with the author's partner will be discussed in detail. Main code snippets will also be provided to the readers to understand how the functionality was implemented. Lastly, all the completed module testing will also be included as test plans and test cases.

5.1 Implementation

During the development and implementation of the proposed TARUMT Game-based Learning System, the computers used by the author and the author's partner were running Windows 10 Home, a 64-bit operating system and the IDE used is Apache NetBeans IDE 12.0. All records and data of the proposed system are stored in the local database MySql and it can be managed through phpMyAdmin. Moreover, XAMPP 7.4.27 and above were used by the author to create a web server on the development device.

A few programming languages have been used to develop the proposed system, including PHP, HTML, Javascript and CSS. HTML is used to create the content that is displayed on the web page, PHP is mainly used to interact with the local database and provide data display for HTML, Javascript is used to add some dynamic effects and interaction to the web page, and CSS is used to apply design to the HTML such as colours, font sizes.

Moreover, the browser used by the author and the author's partner was Google Chrome on Windows with version 103.0.5060. Since the proposed system is a web application, Google Chrome was used to run and test the system to ensure that the system was developed as it should be. For code integration, the author and the author's partner combined the project source code into a single zip file and used one computer to execute and debug the project.

5.2 Code Snippets

In this section, main code snippets will be provided to the readers to understand how the functionality was implemented. Every code snippet is followed by a short description of the code.

TARUMT Game-based Learning System Database

Code snippet from connect.php

```
<?php  
$DB_USER = "root";  
$DB_PASSWORD = "";  
$DB_HOST = "localhost";  
$DB_NAME = "TARUMTEducationDB";  
  
$db = new PDO("mysql:host=$DB_HOST; dbname=$DB_NAME", $DB_USER, $DB_PASSWORD);  
$db->setAttribute(PDO::ATTR_ERRMODE, PDO::ERRMODE_EXCEPTION)  
?>
```

Figure 5.1 : Database Connection Code Snippet

Figure 5.1 shows the database configuration of TARUMT Game-based Learning System. The connection is established by providing the database user, database password, database host and database name. After the MySQL database connection is established, the system is allowed to access and interact with the TARUMTEducationDB database.

Student Login and Maintenance Module

Code snippet from login.php

```

<label for="email">Email</label><br>
<input type="email" id="email" name="email"
       placeholder="eg. xxxxx-xx19@student.tarc.edu.my"
       onkeyup='saveInput(this);' autofocus required><br>
<label for="password">Password</label><br>
<input type="password" id="password" name="password" onkeyup="saveInput(this);"
       autofocus required>
<input id="showPwCheckBox" type="checkbox" onclick="showPassword()">
<span id="showPwTxt" onkeyup='saveValue(this);'>Show Password</span>

<script type="text/javascript">
    document.getElementById("email").value = getSavedInput("email");
    document.getElementById("password").value = getSavedInput("password");

    function saveInput(e) {
        var id = e.id;
        var val = e.value;
        localStorage.setItem(id, val);
    }

    function getSavedInput(v) {
        if (!localStorage.getItem(v)) {
            return "";
        }
        return localStorage.getItem(v);
    }
</script>

```

Figure 5.2 : Save and Get User Login Credentials from Local Storage Code Snippet

Figure 5.2 shows the code that remembers the user's login credentials so that the user does not need to re-enter them after logging out. The javascript code saves the login credentials that input by user to local storage using the `localStorage.setItem()` code and gets the saved login credentials from local storage using the `localStorage.getItem()` code. The html code uses the `onkeyup` event (occurs when the user releases a key (on the keyboard)) to call and execute the javascript functions.

Code snippet from login.php

```
<label for="password">Password</label><br>
<input type="password" id="password" name="password"
       onkeyup='saveInput(this);' autofocus required>
<input id="showPwCheckBox" type="checkbox" onclick="showPassword()">
<span id="showPwTxt" onkeyup='saveValue(this);'>Show Password</span>

<script type="text/javascript">
    function showPassword() {
        var x = document.getElementById("password");
        if (x.type === "password") {
            x.type = "text";
        } else {
            x.type = "password";
        }
    }
</script>
```

Figure 5.3 : Password Visible or Invisible Code Snippet

Figure 5.3 shows the code that makes the password entered by the user become visible or invisible. The javascript code first gets the password field by id and checks the password field type. If the field type is password, the system will convert the type to text, otherwise the system will convert the field type to password. The html code uses the onclick event (occurs when the user clicks on the show password checkbox) to call and execute the javascript function.

Code snippet from login.php

```

if (isset($_POST["login"])) {
    $query = "select * from studentaccount where email = :email "
        . "and password = :password";
    $statement = $db->prepare($query);
    $statement->execute(
        array(
            'email' => $_POST["email"],
            'password' => $_POST["password"]
        )
    );
    $count = $statement->rowCount();
    if ($count > 0) {
        $_SESSION["email"] = $_POST["email"];
        header("location:homepage.php");
    } else {
        echo '<script>alert("Invalid email or password, Please '
        . 'try again.")</script>';
    }
}

```

Figure 5.4 : User Login Credentials Verification Code Snippet

Figure 5.4 shows the verification code for user login credentials. The php code first checks to see if the login credentials exist in the system database. If it exists, the system redirects the user to the home page, otherwise a dialog box is prompted to tell the user that the login credentials are invalid.

Code snippet from verifyEmail.php

```

$subject = "TARUMT Game-Based Education System Reset Password Verification Code";
$random = substr(str_shuffle('0123456789ABCDEFGHIJKLMNPQRSTUVWXYZ'), 1, 6);
$_SESSION["verifyCode"] = $random;

```

Figure 5.5 : Generate Random Verification Code Code Snippet

Figure 5.5 shows the php code that generates a random verification code for password recovery purposes. Firstly, all characters in the string "0123456789ABCDEFGHIJKLMNPQRSTUVWXYZ" will be randomly shuffled and then the system will take 6 characters from the shuffled string. The system then saves these 6 characters into a session to use it across multiple pages.

Code snippet from verifyEmail.php

```

require_once 'PHPMailer/PHPMailer.php';
require_once 'PHPMailer/SMTP.php';
require_once 'PHPMailer/Exception.php';

$developmentMode = true;
$mail = new PHPMailer($developmentMode);
try {
    $mail->isSMTP();
    if ($developmentMode) {
        $mail->SMTPOptions = [
            'ssl' => [
                'verify_peer' => false,
                'verify_peer_name' => false,
                'allow_self_signed' => true
            ]
        ];
    }
    $mail->isSMTP();
    $mail->Host = "smtp.gmail.com";
    $mail->SMTPAuth = true;
    $mail->Username = "tarumteducation@gmail.com";
    $mail->Password = 'cjuijyhnpsjbpyhf';
    $mail->Port = 465;
    $mail->SMTPSecure = "ssl";
    $mail->isHTML(true);
    $mail->setFrom("EducationSystem@tarc.edu.my", "TARUMT Game-Based Education System");
    $mail->addAddress($_POST["email"]);
    $mail->Subject = $subject;
    $mail->Body = "Your verification code for password recovery: " . $random . "<br/><br/>" .
        . "From TARUMT Education System";
    if ($mail->send()) {
        echo '<script>window.location.href="verifyCode.php?email=' . $_POST["email"] . "'"
        . '</script>';
    }
} catch (Exception $e) {
    echo "EMAIL SENDING FAILED. INFO: " . $mail->ErrorInfo;
}

```

Figure 5.6 : Send Verification Code Using Email Code Snippet

Figure 5.6 shows the php code that sends the verification code email to the email address entered by users. The system uses a library, PHPMailer, which requires an SMTP server to send the email. After the system gets all the required data, it sends emails through PHPMailer and SMTP server using the provided username and password.

Code snippet from changePassword.php

```
$result = $statement->fetchColumn();  
if ($result == $_POST["currentPassword"]) {  
    $_SESSION["current"] = $_POST["currentPassword"];  
    echo "<script> inputDisabled(); </script>";  
} else {  
    echo '<script>alert("Current Password Incorrect.")</script>';  
}  
?  
<script>  
    function inputDisabled() {  
        document.getElementById("currentPassword").disabled = true;  
  
        document.getElementById("newPassword").disabled = false;  
  
        document.getElementById("confirmNewPassword").disabled = false;  
    }  
</script>
```

Figure 5.7 : Enable and Disable Unnecessary Fields When Changing Password Code Snippet

Figure 5.7 shows the code that enables and disables unnecessary fields depending on the situation. When a user wants to change the account current password, the user first needs to fill in the current password for verification, so only the current password field is enabled, and the new password and confirmed new password fields are disabled. After the current password is successfully verified, the current password field will be disabled and the other required fields will be enabled.

Code snippet from changePassword.php

```

<label for="password" class="changePwTitle">New Password</label><br>
<input type="password" id="newPassword" name="newPassword" value=<?php
if (isset($_POST["newPassword"])) {
    echo $_POST["newPassword"];
}
?>" oninput="invalidNew(this);" pattern="(?=.*\d)(?=.*[a-zA-Z]).{8,}" title="Password must contain at least one number and one alphabet, and at least 8 or more characters." maxlength="100" required disabled>
<script>
    function invalidNew(textbox) {
        var x = document.getElementById("currentPassword").value;
        if (textbox.value === x) {
            textbox.setCustomValidity('New password must be different with current password.');
        } else {
            textbox.setCustomValidity('');
        }
    }
</script>

```

Figure 5.8 : Password Format Validation Code Snippet

Figure 5.8 shows the code that sets the validation to ensure that the user enters a valid password. The html code uses pattern attribute (a regular expression which the input's value must match in order for the value to pass constraint validation) to ensure that the password entered by the user is in correct format.

Next, the javascript code ensures that the new password entered by the user is different from the current password. When new password and current password fields have the same data, the new password field will display a validation message reminding the user that "New password must be different with current password.". The html code uses an oninput event (occurs when a user writes something in the new password field) to call and execute the javascript function.

Code snippet from changePassword.php

```
if ($_POST["password"] == $_POST["confirmNewPassword"]) {  
    $query = "update studentaccount set password = :password where "  
        . "email = :email";  
    $statement = $db->prepare($query);  
    $statement->execute(  
        array(  
            'password' => $_POST["password"],  
            'email' => $_GET["email"]  
        )  
    );  
    header("location:login.php");  
} else {  
    echo '<script>alert("Confirm password not matched with new '  
        . 'password.");</script>';  
}
```

Figure 5.9 : Update Password To Database Code Snippet

Figure 5.9 shows the code for the update database function when a user changes the account password. If the new password has the same data as the confirmed new password field, the sql statement will be executed to update the database, otherwise a dialog box will be prompted to tell the user that the confirmed password is not matched with the new password. .

Code snippet from editUserProfile.php

```

if (isset($_FILES["image"]["name"])) {
    $imageName = $_FILES["image"]["name"];
    $imageSize = $_FILES["image"]["size"];
    $tmpName = $_FILES["image"]["tmp_name"];

    //Image validation
    $validImageExtension = ['jpg', 'jpeg', 'png'];
    $imageExtension = explode('.', $imageName);
    $imageExtension = strtolower(end($imageExtension));
    if (!in_array($imageExtension, $validImageExtension)) {
        echo'<script>alert("Invalid Image Extension!!")</script>';
    } elseif ($imageSize > 1200000) {
        echo'<script>alert("Image Size Is Too Large!!")</script>';
    } else {
        date_default_timezone_set("Asia/Kuala_Lumpur");
        $date = date("His");
        $newImageName = $studentID.$date;
        $newImageName .= '.' . $imageExtension;
        $query = "update studentaccount set profilePicture = :newImageName "
            . "where studentID = :studentID";
        $statement = $db->prepare($query);
        $statement->execute(
            array(
                'newImageName' => $newImageName,
                'studentID' => $studentID
            )
        );
        if ($_SESSION["profilePic"] != "blue.png" &&
            $_SESSION["profilePic"] != "red.png") {
            unlink('img/'. $_SESSION["profilePic"]);
        }
        move_uploaded_file($tmpName, 'img/' . $newImageName);
        $_SESSION["profilePic"] = $newImageName;
        header("location:editUserProfile.php");
    }
}

```

Figure 5.10 : Select a New Profile Picture and Update To Database Code Snippet

Figure 5.10 shows the php code that validates the image selected by the user. When the user finishes selecting a file, the system will validate the file extension to ensure that the user selected an image file, and the system will also validate the file size to avoid oversizing the image. If the selected file is not an image file or the file size is too large, a dialog box will be prompted to tell the user that the file is invalid. If the selected image is valid, the system will update the database and save the selected image to the file where the profile picture is saved.

Code snippet from logout.php

```
|<?php  
| session_start();  
| session_destroy();  
| header("location:login.php");  
| ?>
```

Figure 5.11 : User Logout Code Snippet

Figure 5.11 shows the logout code of the system. The php code destroys all sessions that have been set up and redirects the user to the login page.

Participating in Classroom Module

Code snippet from joinClassroom.php

```

if (isset($_POST["join"])) {
    $query = "select * from classroom where classcode = :code";
    $statement = $db->prepare($query);
    $statement->execute(
        array(
            'code' => $_POST["code"]
        )
    );
    $count = $statement->rowCount();
    if ($count > 0) {
        $result = $statement->fetchColumn();
        $classID = $result;

        $query = "select * from classroomjoined where "
            . "classID = :classID AND studentID = :studentID";
        $statement = $db->prepare($query);
        $statement->execute(
            array(
                'classID' => $classID,
                'studentID' => $studentID
            )
        );
        $count = $statement->rowCount();
        if ($count > 0) {
            echo '<script>alert("Classroom joined before.")</script>';
        } else {
            $query = "select classJoinedID from classroomjoined "
                . "order by classJoinedID DESC LIMIT 1";
            $statement = $db->prepare($query);
            $statement->execute();
            $result = $statement->fetchColumn();
            $result = substr($result, 2);
            $id = (int)$result;
            $id = sprintf("%06d", ++$id);
            $id = "CJ$id";
        }
    }
}

```

Figure 5.12 : Class Code Verification Process When Joining Classroom Code Snippet Part I

Code snippet from joinClassroom.php

```

date_default_timezone_set("Asia/Kuala_Lumpur");
$joinedDate = date("Y-m-d H:i:s");

$query = "insert into classroomjoined (classJoinedID, "
    . "joinedDate, classID, studentID) VALUES "
    . "(:id, :joinedDate, :classID, :studentID)";
$stmt = $db->prepare($query);
$stmt->execute(
    array(
        'id' => $id,
        'joinedDate' => $joinedDate,
        'classID' => $classID,
        'studentID' => $studentID
    )
);
echo '<script>alert("Classroom joined successfully."); '
. 'window.location.href="homepage.php";</script>';
}
} else {
    echo '<script>alert("Class code not found.")</script>';
}
}

```

Figure 5.13 : Class Code Verification Process When Joining Classroom Code Snippet Part 2

Figure 5.12 and 5.13 show the php code of the class code verification process when a user joins a new classroom. After the user submits a class code, the system checks whether the class code exists in the system database. If it does not exist, a dialog box will pop up to remind the user that the class code is not found, otherwise the system will check whether the user has joined the classroom before. If the user has not joined the classroom before, the sql statement will be executed to insert the new joined classroom record into the database.

Code snippet from classroom.php

```

if (isset($classID)) {
    $query = "select * from classroom where classID = :classID";
    $statement = $db->prepare($query);
    $statement->execute(
        array(
            'classID' => $classID
        )
    );
    $count = $statement->rowCount();
}
if ($count > 0) {
    while ($row = $statement->fetch()) {
        ?
        <div class="titleBar">
            <div class="classroom">
                <p class="classroomTxt"><?php echo $row["className"]; ?></p>
                <p class="subjectTxt"><?php echo $row["classSubject"]; ?></p>
                <p class="descTxt"><?php echo $row["classDescription"]; ?></p>
            </div>
        </div>
    }
}

```

Figure 5.14 : Retrieve and Display Selected Classroom Data Code Snippet

The Figure 5.14 shows the php code to retrieve and display selected classroom data. After the user enters into a classroom, the system will execute the sql statement to retrieve the relevant classroom data and display the retrieved data to the user in html format.

Code snippet from classroom.php

```

<script>
    function leaveClassroom() {
        let text = "Are you sure to leave this classroom?";
        if (confirm(text)) {
            return true;
        }
        return false;
    }
</script>
<form method="post" onsubmit="return leaveClassroom()">
    <div class="btnSelections">
        <!-- Leave Classroom -->
        <button type="submit" name="leave" class="shareCodebtn">
            <i style="font-size:16px;margin-right:3px;" class="fa"></i>
            Leave Classroom
        </button>
    </div>
</form>

```

Figure 5.15 : Leave Classroom Confirmation Box Code Snippet

The Figure 5.15 shows the leave classroom confirmation box code. When the user clicks the "Leave Classroom" button, the system will submit a form that will return a javascript function which will prompt a confirmation box. If the user confirms the confirmation box, the javascript will return true, otherwise it will return false.

Code snippet from classroom.php

```
if (isset($_POST["leave"])) {
    $query = "delete from classroomjoined WHERE "
        . "studentID = :studentID AND classID = :classID";
    $statement = $db->prepare($query);
    $statement->execute(
        array(
            'studentID' => $studentID,
            'classID' => $classID
        )
    );
    echo '<script>alert("Classroom left successfully."); '
        . 'window.location.href="homepage.php";</script>';
}
```

Figure 5.16 : Delete Joined Classroom Record from Database Code Snippet

Figure 5.16 shows the php code for the delete record from the database function when a user decides to leave a classroom. If the leave classroom confirmation box returns true, the sql statement will be executed to delete the joined classroom record from the database. After that, the system redirects the user to the home page.

Participating in Game Module

Code snippet from questionFormulate(tf).php

```

<div class="ansTxtArea-container answerTrue">
    <button class="trueFalseBtn answerTrue" id=<?php echo $ansrow["answerID"]; ?>
        type="button" onclick="respond(this.id)">
        <div style="display:block;">
            <div class="answerTxt">
                <p class='trueFalseTxt'><?php echo $ansrow["answerText"]; ?></p>
            </div>
        </div>
    </button>
</div>
<?php
}
?>
<script>
    var isTrue = null;
    function respond(answered_id) {
        var tr = document.getElementsByClassName("trueFalseBtn answerTrue");
        var fl = document.getElementById(answered_id);

        $(':button').prop('disabled', true);
        fl.className = fl.className.replace(" answerFalse", " red");
        tr[0].className = tr[0].className.replace(" answerTrue", " green");
        isTrue = document.getElementsByClassName("trueFalseBtn red");
        window.setTimeout(function () {
            if ($("button").hasClass("trueFalseBtn red")) {
                window.location.href = "game.php";
            } else {
                window.location.href = "game.php?answer=true";
            }
        }, 1000);
    };
</script>

```

Figure 5.17 : Respond to User's Selected Answer Code Snippet

***Note:** This response to the user's selected answer function will be applied to true-false questions and multiple-choice questions. Since their function code is very similar, it will only be explained once here to prevent redundancy.*

Figure 5.17 shows the code that responds to the user when the user selects an answer option. When the user clicks on one of the answer option buttons, the javascript code disables the option buttons to avoid the user answer again, and changes the background colour of the option buttons by replacing the original className of the button with a className that has different css. The html uses onclick event (occurs when the user clicks on the answer option button) to call and execute the javascript function.

Code snippet from questionFormulate(fitb).php

```

<form id="ansForm" style="margin-top: -200px;">
    <div><div class="questionTxtArea">
        <textarea style="resize:none; background-color: white;" id="questionTxt" name="questionTxt" rows="7" cols="90" disabled><?php echo $row["question"]; ?>
    </textarea>
    </div>
    <div class="answerTxtArea">
        <label for="answerTxt">Answer:</label><br>
        <input type="text" id="answerTxt" name="answerTxt" placeholder="Please type the answer here.">
        <span hidden id="correct" class="correctTick"><i style='font-size:25px; cursor: pointer;' class='fas'>&#xf00c;</i></span>
        <span hidden id="wrong" class="redCross"><i style='font-size:25px; cursor: pointer;' class='fas'>&#xf00d;</i></span><br>
    </div></div>
</form>
<script>
    $('#ansForm').on('submit', function (e) {
        e.preventDefault();
        var input = $('#answerTxt').val();
        var ans = '<?php echo $result; ?>';
        $("#answerTxt").attr('disabled', 'disabled');
        if (input.toLowerCase() === ans.toLowerCase()) {
            document.getElementById("answerTxt").style.borderColor = "green";
            $("#correct").show();
            setTimeout(function () {
                window.location.href = "game.php?answer=true";
            }, 1000);
        } else {
            document.getElementById("answerTxt").style.borderColor = "red";
            $("#wrong").show();
            setTimeout(function () {
                window.location.href = "game.php";
            }, 1000);
        }
    });
</script>

```

Figure 5.18 : Respond to User's Submitted Answer Code Snippet

Figure 5.18 shows the code that responds to the user when the user submit an answer text in a fill-in-the-blank question. When the user submits the answer text form, the javascript code first disables the answer text field to avoid the user changing the submitted answer text, and then determines whether the answer text is the same as the correct answer without case sensitivity. If it is the same, the border colour of the answer text field will change to green and the green tick icon will change from invisible to visible, otherwise the border colour of the answer text field will change to red and the red cross will change from invisible to visible.

Code snippet from breakPage.php

```
<div id="timer"></div><h3>remaining break time</h3><br><br>
<div class="container">
    <input type="button" class="play" value="RESUME"/>
    <input type="button" class="pause" value="PAUSE"/>
</div>
<script>
    $(document).ready(function () {
        var isPaused = false;
        var count = <?php echo $_SESSION["time"]; ?>;
        window.setInterval(function () {
            if (!isPaused)
            {
                if (count !== 0) {
                    --count;
                    $("#timer").load('time.php');
                } else {
                    window.location.href = "countdownRedirect.php";
                }
            }
        }, 1000);

        $('.pause').on('click', function (e) {
            e.preventDefault();
            isPaused = true;
        });

        $('.play').on('click', function (e) {
            e.preventDefault();
            isPaused = false;
        });
    });
</script>
```

Figure 5.19 : Timer Countdown, Pause and Resume Timer Function Code Snippet

Code snippet from time.php

```
if (isset($_SESSION["time"])) {  
    $time = $_SESSION["time"];  
  
    echo $time;  
  
    $_SESSION["time"] = $_SESSION["time"] - 1;  
  
    if ($_SESSION["time"] == 0) {  
        unset($_SESSION["time"]);  
    }  
}
```

Figure 5.20 : Php Timer Countdown Function Called By Javascript Code Snippet

Figure 5.19 shows the code of timer countdown, pause and resume timer function. When the user clicks on the html pause button, the timer will be paused and when the user clicks on the html resume button, the timer will be resumed. Every second, the javascript code first checks if the timer is paused and the timer second is greater than 0. If the timer is not paused and the timer second greater than 0, the javascript code will call the php timer countdown function (Figure 5.20) to decrement the seconds in the timer by 1. The javascript code for the timer countdown function will continue to be executed until the seconds in the timer becomes 0 or the timer is paused.

Score and Ranking Module

Code snippet from viewScoreAndRanking.php

```

<?php
$query1 = "select studentName, username, score, time, row_num from (select "
    . "st.studentName, st.username, s.score, s.time, ROW_NUMBER() over "
    . "(order by s.score desc, time asc) as row_num from score s, "
    . "studentaccount st where s.gameID = :gameID and st.studentID = "
    . "s.studentID) nw where row_num = :rownum";
$stmt1 = $db->prepare($query1);
$stmt1->execute(
    array(
        'gameID' => $gameID,
        'rownum' => 1
    )
);
$count1 = $stmt1->rowCount();
?>
<div class="podium_item">
    <p class="podium_score">Score: <?php echo $row1["score"]; ?> <br/>[Time
        Taken: <?php echo $row1["time"]; ?>
        <span style="text-transform: lowercase">s</span>]</p>
    <p class="podium_city"><?php echo $row1["username"]; ?></p>
    <div class="podium_rank first">
        <svg class="podium_number" viewBox="0 0 27.476 75.03"
            xmlns="http://www.w3.org/2000/svg">
            <g transform="matrix(1, 0, 0, 1, 214.957736, -43.117417)">
                <path class="st8" d="M -198.928 43.419 C -200.528 47.919 -203.528 51.819
                    -207.828 55.219 C -210.528 57.319 -213.028 58.819 -215.428 60.019
                    L -215.428 72.819 C -210.328 70.619 -205.628 67.819 -201.628 64.119
                    L -201.628 117.219 L -187.528 117.219 L -187.528 43.419 L -198.928
                    43.419 L -198.928 43.419 Z" style="fill: #fff;" />
            </g>
        </svg>
    </div>
</div>

```

Figure 5.21 : Retrieve and Display the Top 1 Record in Ranking Code Snippet

The Figure 5.21 shows the php code to retrieve and display the top 1 record in ranking. The system will execute the sql statement to retrieve only the data of a student with the highest score and the shortest time taken to complete the game, and then display the retrieved data to the user in html format.

Claiming Power Exchange Module

Code snippet from powerExchangeStore.php

```

if ($_SESSION["questionType"] == "multiple-choice question") {
    $query = "select * from power p, gamepower g where p.powerID = g.powerID "
    . "and g.status = 1 and g.gameID = :gameID";
    $statement = $db->prepare($query);
    $statement->execute(
        array(
            'gameID' => $_SESSION["gameID"]
        )
    );
    $count = $statement->rowCount();
} else {
    $query = "select * from power p, gamepower g where g.status = 1 and p.powerID "
    . "= g.powerID and g.gameID = :gameID except (select * from power p, "
    . "gamepower g where g.status = 1 and p.powerID = g.powerID and "
    . "g.gameID = :gameID and p.powerID = :mcqPower)";
    $statement = $db->prepare($query);
    $statement->execute(
        array(
            'gameID' => $_SESSION["gameID"],
            'mcqPower' => "P0000002"
        )
    );
    $count = $statement->rowCount();
}

```

Figure 5.22 : Exchangeable Power List Depending on Next Question Type Code Snippet

The Figure 5.22 shows the php code for dynamically exchangeable power list depending on the next question type. The system determines the type of next question, and, if the next question is a multiple-choice question, all powers that are enabled by the instructor will be displayed. If the next question is a true-false question or a fill-in-the-blank question, the Eliminate Wrong Option, which is only available for multiple-choice questions, will not be displayed even if the instructor has enabled it.

5.3 Testing

All modules were tested to ensure that all features and functions of the TARUMT Game-based Learning System performed well. All completed module testing for the proposed system will be listed as test plans and test cases. The modules tested are the modules handled by the author including Student login and maintenance module, participating in classroom module, participating in game module, score and ranking module and claiming power exchange module.

5.3.1 Student Login and Maintenance Module

Test Case #: TC5.3.1	Test Case Name: Student Login and Maintenance Module
System: TARUMT Game-based Learning System	Subsystem: Password recovery, login, view user profile, update user profile, change password, and logout
Design By: Yap Yoon En	Design Date: 28/11/2022
Executed By: Yap Yoon En	Execution Date: 28/11/2022
Short Description: Test valid and invalid inputs for password recovery, login, update profile and change password, as well as test the view user profile and logout functionality.	

Pre-conditions:

1. The user is required to access to TARUMT Game-based Learning System Student Login page for password recovery and login purposes.
2. The user is required to login to the student account successfully to view the user profile by clicking the User Profile Picture button.
3. The user is required to login to the student account successfully to update the user profile on the User Profile page.
4. The user is required to login to the student account successfully to change the password on the Change Password page.
5. The user is required to login to the student account successfully to logout the account by clicking the Logout button.

Step	Action/Functions	Test Data	Expected System Response	Actual Response	Pass/Fail	Comments
1	Click on the 'Forget Password?' button	-	The system will redirect the user to the verify email page	The user has been redirected to the verify email page	Pass	-
2	Recovering password with invalid email format	Input email "abcd" and click on the Verify button	The email field will display a validation message showing "Please include an '@' in the email address. 'abcd' is missing an '@'."	The validation message shows "Please include an '@' in the email address. 'abcd' is missing an '@'." is displayed	Pass	-
3	Recovering password with not registered email	Enter email "abcd-wm19@student.tarc.edu.my" and click on the Verify button	A pop-up dialog showing "Email not registered." will be displayed	The pop-up dialog shows "Email not registered." is displayed	Pass	-

4	Recovering password with empty email	Click on the Verify button without filling the email field	The email field will display a validation message showing "Please fill out this field."	The validation message shows "Please fill out this field." is displayed	Pass	-
5	Recovering password with valid email	Enter email "yapye-wm19@student.tarc.edu.my" and click on the Verify button	The system will send an email with verification code to the email and redirect the user to the verify code page	The user has received email and redirected to the verify code page	Pass	-
6	Click on the 'Resend Code' button	-	The system will send an email with verification code to the email and display a pop-up dialog showing "Done resend."	The user has received email and the pop-up dialog shows "Done resend." is displayed	Pass	-

7	Recovering password with empty verification code	Click on the Verify button without filling the verification code field	A pop-up dialog showing “Invalid code, you can request for a new verification code by clicking resend button.” will be displayed	The pop-up dialog shows “Invalid code, you can request for a new verification code by clicking resend button.” is displayed	Pass	-
8	Recovering password with invalid verification code	Enter the code “ABCDEF” and click on the Verify button	A pop-up dialog showing “Invalid code, you can request for a new verification code by clicking resend button.” will be displayed	The pop-up dialog shows “Invalid code, you can request for a new verification code by clicking resend button.” is displayed	Pass	-

9	Recovering password with valid verification code	Check the latest email sent to “yapye-wm19@student.tarc.edu.my” and fill the field with the code written in the email and click on the Verify button	The system will redirect the user to the password reset page	The user has been redirected to the password reset page	Pass	-
10	Resetting password with empty new password field	Click on the Reset button without filling the new password field	The new password field will display a validation message showing “Please fill out this field.”	The validation message shows “Please fill out this field.” is displayed	Pass	-
11	Resetting password with empty confirmed new password field	Click on the Reset button without filling the confirmed new password field	The confirmed new password field will display a validation message showing “Please fill out this field.”	The validation message shows “Please fill out this field.” is displayed	Pass	-

12	Resetting password with invalid new password	Enter the new password “abcdefg” and click on the Reset button	The new password field will display a validation message showing “Please match the requested format. Password must contain at least one number and one alphabet, and at least 8 or more characters.”	The validation message shows “Please match the requested format. Password must contain at least one number and one alphabet, and at least 8 or more characters.” is displayed	Pass	-
13	Showing the entered new password	Enter the new password “abcd1234” and check the Show Password button	The new password field will become visible	The new password field has become visible	Pass	-

14	Resetting password with valid new password and invalid confirmed new password	Enter the new password “abcd1234” and enter the confirmed new password “abcd12345” and click on the Reset button	A pop-up dialog showing “Confirm password not matched with new password.” will be displayed	The pop-up dialog shows “Confirm password not matched with new password.” is displayed	Pass	-
15	Resetting password with valid new password and valid confirmed new password	Enter the new password “abcd1234” and enter the confirmed new password “abcd1234” and click on the Reset button	The system will redirect the user to the login page	The user has been redirected to the login page	Pass	-
16	Login into the student account with empty email field	Click on the Login button without filling the email field	The email field will display a validation message showing “Please fill out this field.”	The validation message shows “Please fill out this field.” is displayed	Pass	-

17	Login into the student account with empty password field	Click on the Login button without filling the password field	The password field will display a validation message showing “Please fill out this field.”	The validation message shows “Please fill out this field.” is displayed	Pass	-
18	Login into the student account with invalid email format	Enter email “abcd” and click on the Login button	The email field will display a validation message showing “Please include an '@' in the email address. 'abcd' is missing an '@'.”	The validation message shows “Please include an '@' in the email address. 'abcd' is missing an '@'.” is displayed	Pass	-
19	Login into the student account with not registered email	Enter email “abcd-wm19@student.tarc.edu.my” and enter password “abcd1234” and click on the Login button	A pop-up dialog showing “Invalid email or password, Please try again.” will be displayed	The pop-up dialog shows “Invalid email or password, Please try again.” is displayed	Pass	-

20	Login into the student account with invalid password	Enter the valid email “yapye-wm19@student.tarc.edu.my” and enter invalid password “abcdefg” and click on the Login button	A pop-up dialog showing “Invalid email or password, Please try again.” will be displayed	The pop-up dialog shows “Invalid email or password, Please try again.” is displayed	Pass	-
21	Login into the student account with a valid email and password	Enter the valid email “yapye-wm19@student.tarc.edu.my” and enter the valid password “abcd1234” and click on the Login button	The system will redirect the user to the home page	The user has been redirected to the home page	Pass	-
22	Click on the small user profile picture button in the top-right corner of the homepage	-	The system will redirect the user to the user profile page and display all the relevant data	The user has been redirected to the user profile page with all the relevant data shown	Pass	-

23	Click on the camera icon and select an image for update profile picture purpose	-	The new profile picture will be shown	The new profile picture has been shown	Pass	-
24	Updating the user profile with empty username	Click on the Update button without filling the username field	The username field will display a validation message showing “Please fill out this field.”	The validation message shows “Please fill out this field.” is displayed	Pass	-
25	Updating the user profile with a new username	Enter username “yap” and click on the Update button	The system will display a pop-up dialog showing “User Profile Updated Successfully.” and redirect the user back to the user profile page	The pop-up dialog shows “User Profile Updated Successfully.” is displayed and the user has been redirected to the user profile page with updated data shown	Pass	-

26	Changing password with invalid current password	Enter the invalid current password “abcdefg” and click on the Change button	The system will display a pop-up dialog showing “Current Password Incorrect.”	The pop-up dialog shows “Current Password Incorrect.” is displayed	Pass	-
27	Changing password with valid current password	Enter the valid current password “abcd1234” and click on the Change button	The current password field will be disabled and both of the new password and confirmed new password fields will be enabled	The current password field is disabled and both of the new password and confirmed new password fields are enabled	Pass	-
28	Changing password with empty new password field	Click on the Change button without filling the new password field	The new password field will display a validation message showing “Please fill out this field.”	The validation message shows “Please fill out this field.” is displayed	Pass	-

29	Changing password with empty confirmed new password field	Click on the Change button without filling the confirmed new password fields	The confirmed new password field will display a validation message showing "Please fill out this field."	The validation message shows "Please fill out this field." is displayed	Pass	-
30	Changing password with invalid new password	Enter the new password "abcdefg" and click on the Change button	The new password field will display a validation message showing "Please match the requested format. Password must contain at least one number and one alphabet, and at least 8 or more characters."	The validation message shows "Please match the requested format. Password must contain at least one number and one alphabet, and at least 8 or more characters." is displayed	Pass	-

31	Changing password with valid new password and invalid confirmed new password	Enter the new password “abcd12345” and enter the confirmed new password “abcd1234” and click on the Change button	A pop-up dialog showing “Confirm password not matched with new password.” will be displayed	The pop-up dialog shows “Confirm password not matched with new password.” is displayed	Pass	-
32	Changing password with the same password as the current password	Enter the new password “abcd1234” and click on the Change button	The new password field will display a validation message showing “New password must be different with the current password.”	The validation message shows “New password must be different with the current password.” is displayed	Pass	-

33	Changing password with valid new password and valid confirmed new password	Enter the new password “abcd12345” and enter the confirmed new password “abcd12345” and click on the Change button	The system will display a pop-up dialog showing “Password updated successfully, please login again.” and redirect the user to the login page	A pop-up dialog shows “Password updated successfully, please login again.” is displayed and the user has been redirected to the login page	Pass	-
34	Logout the student account	Click on the Logout button in the top-right corner of the home page	The system will redirect the user to the login page	The user has been redirected to the login page	Pass	-

Post-conditions:

1. The new password is updated to the system database when the user inputs are valid for password recovery and change password purposes.
2. The profile picture and username are updated to the system database when the user inputs are valid for update user profile purposes.

5.3.2 Participating in Classroom Module

Test Case #: TC5.3.2	Test Case Name: Participating in Classroom Module
System: TARUMT Game-based Learning System	Subsystem: Join classroom, enter into classroom, view selected classroom member list, leave classroom
Design By: Yap Yoon En	Design Date: 28/11/2022
Executed By: Yap Yoon En	Execution Date: 28/11/2022
Short Description: Test valid and invalid inputs for join classroom, as well as test the enter into classroom, view member list and leave classroom functionality.	

Pre-conditions:

1. The user is required to login to the student account successfully to join a classroom by clicking the Join Classroom button on the Home page.
2. The user is required to login to the student account successfully to enter into a classroom by clicking the Select button on the Home page.
3. The user is required to login to the student account successfully to view the selected classroom member list by clicking the Member List button on the Classroom page.
4. The user is required to login to the student account successfully to leave the classroom by clicking the Leave Classroom button on the Classroom page.

Step	Action/Functions	Test Data	Expected System Response	Actual Response	Pass/Fail	Comments
1	Click on the Join Classroom button on the home page	-	The system will redirect the user to the join classroom page	The user has been redirected to the join classroom page	Pass	-
2	Click on the Cancel button on the join classroom page	-	The system will redirect the user to the home page	The user has been redirected to the home page	Pass	-
3	Joining the classroom with empty classroom code	On the join classroom page, click on the Join button without filling the class code field	The class code field will display a validation message showing “Please fill out this field.”	The validation message shows “Please fill out this field.” is displayed	Pass	-
4	Joining the classroom with invalid classroom code	Enter the invalid class code “abcdef” and click on the Join button	A pop-up dialog showing “Class code not found.” will be displayed	The pop-up dialog shows “Class code not found.” is displayed	Pass	-

5	Joining the classroom with the joined classroom code	Enter the class code "eY2Mn9" and click on the Join button	A pop-up dialog showing "Classroom joined before." will be displayed	The pop-up dialog shows "Classroom joined before." is displayed	Pass	-
6	Joining the classroom with the valid classroom code	Enter the class code "AwEfn9" and click on the Join button	The system will display a pop-up dialog showing "Classroom joined successfully." and redirect the user to the home page	A pop-up dialog shows "Classroom joined successfully." is displayed and the user has been redirected to the home page	Pass	-
7	Enter into a classroom	Select a classroom and click on the Select button	The system will redirect the user to the selected classroom page	The user has been redirected to the selected classroom page	Pass	-
8	Click on the Member List button on the classroom page	-	The system will redirect the user to the selected classroom member list page	The user has been redirected to the selected classroom member list page	Pass	-

9	Click on the Leave Classroom button on the classroom page	-	The system will display a confirmation box showing "Are you sure to leave this classroom?"	A confirmation box shows "Are you sure to leave this classroom?" is displayed	Pass	-
10	Click on the Cancel button on the leaving classroom confirmation box	-	The confirmation box shows "Are you sure to leave this classroom?" will disappear	The confirmation box shows "Are you sure to leave this classroom?" disappeared	Pass	-
11	Click on the OK button on the leaving classroom confirmation box	-	The system will display a pop-up dialog showing "Classroom left successfully." and redirect the user to the home page	A pop-up dialog shows "Classroom left successfully." is displayed and the user has been redirected to the home page	Pass	-

Post-conditions:

1. The classroom is joined and the record inserted into the system database when the user inputs are valid for joining the classroom.

2. The joined classroom record is removed from the system database when the user clicks on the OK button on the leaving classroom confirmation box.

5.3.3 Participating in Game Module

Test Case #: TC5.3.3	Test Case Name: Participating in Game Module
System: TARUMT Game-based Learning System	Subsystem: Start and play game, game break and end game
Design By: Yap Yoon En	Design Date: 28/11/2022
Executed By: Yap Yoon En	Execution Date: 28/11/2022
Short Description: Test the start and play game, game break and end game functionality.	

Pre-conditions:

1. The user is required to login to the student account successfully to start and play a game by clicking the Launch Game button on the Classroom page.
2. The user is required to login to the student account successfully to enter the game break page during the game.
3. The user is required to login to the student account successfully to end the game on the End Game page.

Step	Action/Functions	Test Data	Expected System Response	Actual Response	Pass/Fail	Comments
1	Start a game on the selected classroom page	Click on the hamburger menu of a game and click on the Launch Game button	The system will redirect the user to the first question of the selected game	The user has been redirected to the first question of the selected game	Pass	-

2	Select the wrong option for a true-false question	Click on the wrong option of the question	The background colour of the selected option will change to red and the background colour of the correct option will change to green. If there is no next question, the user will be redirected to the end game page, else the user will be redirected to the game break page	The background colour of the selected option changed to red and the background colour of the correct option changed to green, and the user has been redirected to the end game page / game break page	Pass	-
---	---------------------------------------------------	-------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	------	---

3	Select the correct option for a true-false question	Click on the correct option of the question	The background colour of the selected option will change to green. If there is no next question, the user will be redirected to the end game page, else the user will be redirected to the game break page	The background colour of the selected option changed to green, and the user has been redirected to the end game page / game break page	Pass	-
---	-----------------------------------------------------	---------------------------------------------	------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------	------	---

4	Select the wrong option for a multiple-choice question	Click on the wrong option of the question	The background colour of the selected option will change to red and the background colour of the correct option will change to green. If there is no next question, the user will be redirected to the end game page, else the user will be redirected to the game break page	The background colour of the selected option changed to red and the background colour of the correct option changed to green, and the user has been redirected to the end game page / game break page	Pass	-
---	--------------------------------------------------------	-------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	------	---

5	Select the correct option for a multiple-choice question	Click on the correct option of the question	The background colour of the selected option will change to green. If there is no next question, the user will be redirected to the end game page, else the user will be redirected to the game break page	The background colour of the selected option changed to green, and the user has been redirected to the end game page / game break page	Pass	-
---	----------------------------------------------------------	---------------------------------------------	------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------	------	---

6	Input the wrong answer for a fill-in-the-blank question	Input the wrong answer of the question	The answer text field border colour will change to red and a red colour cross will appear in the answer field. If there is no next question, the user will be redirected to the end game page, else the user will be redirected to the game break page	The answer text field border colour changed to red and a red colour cross appeared in the answer field and the user has been redirected to the end game page / game break page	Pass	-
---	---------------------------------------------------------	----------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	------	---

7	Input the correct answer for a fill-in-the-blank question	Input the correct answer of the question	The answer text field border colour will change to green and a green colour tick will appear in the answer field. If there is no next question, the user will be redirected to the end game page, else the user will be redirected to the game break page	The answer text field border colour changed to green and a green colour tick appeared in the answer field and the user has been redirected to the end game page / game break page	Pass	-
8	Not answering the question	Do not click on any option or submit any answer and wait until the timer ends	If there is no next question, the user will be redirected to the end game page, else the user will be redirected to the game break page	The user has been redirected to the end game page / game break page	Pass	-

9	Click on the Pause button on the game break page	-	The timer will be paused	The timer has been paused	Pass	-
10	Click on the Resume button on the game break page	-	The timer will be continued	The timer has been continued	Pass	-
11	Click on the Skip button in the bottom-left corner on the game break page	-	The user will be redirected to the next question	The user has been redirected to the next question	Pass	-
12	Click anywhere on the end game page	-	The user will be redirected to the score and ranking page	The user has been redirected to the score and ranking page	Pass	-

Post-conditions: -

5.3.4 Score and Ranking Module

Test Case #: TC5.3.4	Test Case Name: Score and Ranking Module
System: TARUMT Game-based Learning System	Subsystem: View score and ranking
Design By: Yap Yoon En	Design Date: 28/11/2022
Executed By: Yap Yoon En	Execution Date: 28/11/2022
Short Description: Test the view score and ranking functionality.	

Pre-conditions:

1. The user is required to login to the student account successfully to view score and ranking by clicking the View Score and Ranking button on the Classroom page.
2. The user is required to login to the student account successfully to view score and ranking by clicking anywhere on the End Game page.

Step	Action/Functions	Test Data	Expected System Response	Actual Response	Pass/Fail	Comments
1	Access to the score and ranking page with player records on the selected classroom page	Click on the hamburger menu of a game and click on the View Score and Ranking button	The system will redirect the user to the score and ranking page of the selected game	The user has been redirected to the score and ranking of the selected game	Pass	-

2	Access to the score and ranking page with no player records on the selected classroom page	Click on the hamburger menu of a game and click on the View Score and Ranking button	The system will display a pop-up dialog showing “No players have completed the game, launch game to become the first player.”	A pop-up dialog shows “No players have completed the game, launch game to become the first player.” is displayed	Pass	-
3	Access to the score and ranking page on the end game page	Click on anywhere on the end game page	The system will redirect the user to the score and ranking page of the selected game	The user has been redirected to the score and ranking of the selected game	Pass	-
4	Back to the classroom page	Click on the Back button of the score and ranking page	The system will redirect the user to the classroom page	The user has been redirected to the classroom page	Pass	-

Post-conditions:

1. The user's score and time taken for the game are inserted into the system database when the user clicks on anywhere on the end game page.

5.3.5 Claiming Power Exchange Module

Test Case #: TC5.3.5	Test Case Name: Claiming Power Exchange Module
System: TARUMT Game-based Learning System	Subsystem: Enter into power exchange store, enter into power list and description page, exchange power
Design By: Yap Yoon En	Design Date: 28/11/2022
Executed By: Yap Yoon En	Execution Date: 28/11/2022
Short Description: Test the enter into the power exchange store, enter into power list and description page, exchange power functionality.	

Pre-conditions:

1. The user is required to login to the student account successfully to enter into the power exchange store by clicking the Power Store button on the Game Break page.
2. The user is required to login to the student account successfully to enter into the power list and description page by clicking the ? button on the Power Exchange Store page.
3. The user is required to login to the student account successfully to exchange a power on the Power Exchange Store page.

Step	Action/Functions	Test Data	Expected System Response	Actual Response	Pass/Fail	Comments
1	Entering into the power exchange store during the game break	Click on the Power Store button in the top-left corner of game break page	The system will redirect the user to the power exchange store of the selected game	The user has been redirected to the power exchange store of the selected game	Pass	-

2	Entering into the power list and description page	Click on the '?' button in the top-left corner of the power exchange store page	The system will redirect the user to the power list and description page	The user has been redirected to the power list and description page	Pass	-
3	Back to the power exchange store	Click on the Back button of the power list and description page	The system will redirect the user to the power exchange store of the selected game	The user has been redirected to the power exchange store of the selected game	Pass	-
4	Exchange power with insufficient points	Click on the Exchange button for a power that requires more points than the user's current obtained points	The system will display a confirmation box showing "Are you sure to exchange this power?"	A confirmation box shows "Are you sure to exchange this power?" is displayed	Pass	-

5	Confirm on exchange power with insufficient points	Click on the OK button on the confirmation box	The system will display a pop-up dialog showing "Error. Your current point is not enough to exchange this power."	A pop-up dialog shows "Error. Your current point is not enough to exchange this power." is displayed	Pass	-
6	Exchange power "Gain Double Points" with sufficient points	Click on the Exchange button for the power	The system will display a confirmation box showing "Are you sure to exchange this power?"	A confirmation box showing "Are you sure to exchange this power?" is displayed	Pass	-
7	Exchange power "Eliminate Wrong Option" with sufficient points	Click on the Exchange button for the power	The system will display a confirmation box showing "Are you sure to exchange this power?"	A confirmation box showing "Are you sure to exchange this power?" is displayed	Pass	-

8	Exchange power “Gain Double Scores” with sufficient points	Click on the Exchange button for the power	The system will display a confirmation box showing “Are you sure to exchange this power?”	A confirmation box showing “Are you sure to exchange this power?” is displayed	Pass	-
9	Click the Cancel button on the exchange power confirmation box	-	The confirmation box shows “Are you sure to exchange this power?” will disappear	The confirmation box shows “Are you sure to exchange this power?” disappeared	Pass	-
10	Confirm on exchange power “Gain Double Points” with sufficient points	Click the OK button on the confirmation box	The system will display a pop-up dialog showing “Exchange power successfully.” and redirect the user to the next question	A pop-up dialog shows “Exchange power successfully.” is displayed and the user has been redirected to the next question	Pass	-

11	Confirm on exchange power “Eliminate Wrong Option” with sufficient points	Click the OK button on the confirmation box	The system will display a pop-up dialog showing “Exchange power successfully.” and redirect the user to the next multiple-choice question with only three options	A pop-up dialog shows “Exchange power successfully.” is displayed and the user has been redirected to the next multiple-choice question with only three options	Pass	-
12	Confirm on exchange power “Gain Double Scores” with sufficient points	Click the OK button on the confirmation box	The system will display a pop-up dialog showing “Exchange power successfully.” and redirect the user to the next question	A pop-up dialog shows “Exchange power successfully.” is displayed and the user has been redirected to the next question	Pass	

Post-conditions:

1. The user's current obtained points deducted when the user exchanged a power successfully.

5.4 Chapter Summary and Evaluation

In this chapter, the author has discussed the implementation of the system which includes the platform used, the programming language, the database, the tools needed and how the author integrates the code with the author's partner. This chapter has also provided the main code snippets and short description for code snippets. Moreover, the test plans and test cases for all modules handled by the author are also included.

The problem faced by the author was that there were too many module features to test and it was difficult for the author to test all of them because it was easy to miss some small features. In order to solve the problem, the authors ran each module repeatedly and kept logging the tested results into the test cases to ensure that no features were missed.

Chapter 6

Discussions and Conclusion

6 Discussions and Conclusion

In this chapter, the author will summarise what has been done throughout the project. The objectives that have been achieved will also be discussed in detail. Moreover, the author will explain what this system can contribute to the target market. This chapter will also mention the limitations and future improvements that can be made to improve the system in the future. Lastly, the problems that the author faced during the project development and the ways to solve them will also be discussed.

6.1 Summary

The main problem faced by the authors is that the authors and the author's partner use a local database, which is not accessible from other people's computers, therefore the author and the author's partner use their own independent database. The inability to use the same database leads to possible differences in the data between the two databases and also increases the workload of the author and the author's partner because the database has to be updated manually from time to time. Forgetting to update can also cause problems with some system functions, such as photos not being displayed. In order to solve this problem, the proposed solution is to convert the local database to a cloud database, which allows multiple devices to connect. Connecting to the same database can effectively avoid the problem of different data in databases.

As described in Chapter 3 Section 3.5 and Chapter 4 Section 4.1, the author produced the use case diagrams, detailed use case descriptions and activity diagrams for every module that is handled by the author. These techniques have helped the authors to make the functional flow of the modules more logical and smooth, and these techniques also help to ensure that all features are fully developed and tested during the development process, as the authors run and test the system as illustrated. All test results have also been documented using test plans and test cases techniques.

In addition, the author chose to use the php, html, javascript and css programming languages to develop the system not only because the author has knowledge about them, but also because the tools and software needed for these programming languages are free and the ram and rom needed to run and execute the project is very low. Other than that, the author and the author's partner also chose to use the prototyping model as the approach for system development. This is because the prototyping model is effective in helping the author identify bugs and find missing features earlier, and helps the author come up with an acceptable prototype before the actual system development.

6.2 Achievements

With the successful development of the system, all the objectives mentioned in Chapter 1 Section 1.1 have been achieved. First and foremost, the players have more control over the game in the TARUMT Game-based Learning System. In this system, there is no automatic assignment of power to players. If players have enough points, they are allowed to decide and exchange the power they want.

Besides, the system provides a more competitive atmosphere for students than traditional learning methods. For every game that has been created by instructors, members in the classroom have the right to view scores and rankings. Since all of their scores and records are public to every member in the classroom, this easily motivates students to want to win and they will try to put in more effort to get higher scores and higher rankings.

Moreover, the user experience is enhanced because all features of the TARUMT Game-based Learning System are completely free of charge, without any additional fees. Currently, most similar systems on the market charge extra for unlocking additional features, which has degraded the user experience. Overall, the users of the TARUMT Game-based Learning System will not face any issues that are similar to limiting the games they can play.

Lastly, the user interface of the TARUMT Game-based Learning System is much less complex than other systems. Since there are no other redundant features in the system, it is easier for users to find the features they need.

6.3 Contributions

Due to the Covid-19 pandemic, TARUMT has switched most of its courses from face-to-face learning mode to hybrid or online learning mode. Online learning resulted in students not being able to focus in class and also made the course boring because it was difficult for students to interact with others. With less interaction during the class, students are less engaged in the course and they are not motivated to learn new things. Therefore, the TARUMT Game-based Learning System is necessary in order to solve these problems.

By using this system, students will be able to interact with other students by competing against them in a game. By participating in the game, lessons will be more fun and students will be more likely to focus on their learning. Students will also be motivated to learn new things in order to get higher scores in the game. In addition, this system helps students to have a deeper impression of what they have learned, and the more they do, the more they learn. Thus, this system can help improve the overall learning experience of students.

Moreover, most similar systems available in the market do not provide users with power-ups features such as the Kahoot! platform. Some of the existing systems do offer power-up features, but the powers that users get are random and users are not allowed to choose which power-ups they prefer to use. This is unfair to some users who always get useless power-ups. Therefore, the TARUMT Game-based Learning System has a feature that provides students with a power exchange store that allows them to exchange the power they want.

6.4 Limitations and Future Improvements

There are some limitations and areas where the proposed TARUMT Game-based Learning System can be improved in the future. First of all, the types of questions offered to students to play are limited to three, including true-false questions, multiple-choice questions and fill-in-the-blank questions. In order to improve the entertainment aspect of the system, more question types could be added such as multi-select multiple-choice questions (allow players to select multiple options as answer for one question) or drag-and-drop questions (allow players to drag objects and drop them to the proper place).

The second improvement is that the number of scores earned for a question can be designed to be calculated based on accuracy and speed, with the maximum number of scores earned decreasing by 1 score for every 10 seconds. For example, if a question is worth 10 scores and the answer duration is 60 seconds, a student who answers correctly within 10 seconds will earn 10 scores, while a student who answers correctly between 10 and 20 seconds will only earn 9 scores, and so on. This improvement can help increase the challenge and tension of the game, and students will try their best to complete each question in the shortest time possible to get a high score.

Besides, the proposed system does not have the ability to check if a game has been completely set up by the instructor. In the proposed system, if students join the classroom, they can see and play all the games that have at least 1 question in the classroom, even if some of the games are not fully set up yet. To overcome this limitation, a column "completion" should be added to the Game table in the database to indicate whether the game is completed or not, with 1 indicating completed and 0 indicating incomplete. The student can only access the game when the column "completion" is 1.

Furthermore, the proposed system is limited to three default powers, including double scores power, double points power and eliminating a wrong option power. In order to increase student engagement, additional types of power could be added, such as freeze timer (when a question starts, the timer is frozen for 20 seconds), first character hint (display the first character of the answer in a fill-in-the-blank question) or one more chance (allow 2 attempts to answer the same question (not allowed for true-false questions)).

Last but not least, the proposed system allows students to play the same game an unlimited number of times. Typically, the number of times a student can play the same game should vary from situation to situation, for example, a student should only be allowed to access that game once during a midterm or test. Therefore, the system should add a column to the Game table in the database to limit the number of times students can play.

6.5 Issues and Solutions

Throughout the project, the author encountered a lot of issues and found solutions to solve the issues. The first problem the authors faced was that the user interface was not designed to be user-friendly. Some buttons or information were placed in inconspicuous places making it difficult to be found by users. Fortunately, the supervisor helped the author to test the system and gave suggestions about the user interface during the development of the system, which made the system much more user-friendly.

In addition, the author is not good at time management and has difficulty juggling final year project and semester assignments at the same time, which causes the project to fall behind schedule than expected. In order to catch up with the expected progress, the author tried to make a schedule and forced herself to follow it exactly. Through this method, the author managed to catch up and finish the project on time.

Lastly, the issue faced by the author is that the database used by the author and author's partner is local databases which requires the author and the author's partner to constantly update both databases manually. This is annoying for the author because accidentally forgetting to update it can lead to some problems with the system. The best way to solve this issue is to switch to a cloud database, which allows two computers to connect to the same database.

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Appendices

Appendix A: System Document

Table A.1 : Hardware and software specification for system development

	Component	Specification
Hardware	Operating System	Windows 10 Home, 64-bit OS
	Processor	Intel I5 Processor, 7th Generation with 330 Megahertz(MHz) or above
	RAM	192 Megabytes(MB) or above
	Hard Disk Space	75 Megabytes(MB) of HDD Storage Space or above
	Screen Resolution	800(width) x 600(height)
Software	Operating System	Windows 10 Home, 64-bit OS
	IDE	Apache NetBeans IDE 12.0
	Programming Language	PHP 7.4.27, HTML, Javascript, CSS
	Database	MySQL
	Web Server	XAMPP 7.4.27 and above
	Browser	Google Chrome on Windows with version 103.0.5060.134(64-bit)

For the frontend of TARUMT Game-based Education System, the minimum hardware requirement for the development device is Windows 10 Home with 64-bit operating system. The recommended processor is Intel I5 Processor, 7th Generation with 330 Megahertz(MHz) or above at least 192 Megabytes(MB) of RAM. Next, a development device also requires at least 75 Megabytes(MB) of HDD storage space and a screen resolution of 800(width) x 600(height).

The minimum software requirement for the development device is Windows 10 Home with 64-bit operating system. The programming languages are PHP 7.4.27, HTML, Javascript and CSS, which are used to develop web-based applications with Apache NetBeans IDE 12.0. MySQL is used as the database for the proposed system and it can be managed through phpMyAdmin. XAMPP 7.4.27 and above used by the author to create a web server on the development device and browses the proposed system using Google Chrome on Windows with version 103.0.5060.134(64-bit).

Apache NetBeans IDE, Java SE Development Kit (JDK), XAMPP Installation

1. Downloading Apache NetBeans 12.0.

<https://netbeans.apache.org/download/nb120/nb120.html>

The screenshot shows the Apache NetBeans 12.0 download page. At the top, there's a navigation bar with links for Community, Participate, Blog, Get Help, and Plugins. Below the header, the title 'Downloading Apache NetBeans 12.0' is displayed in large blue text. A paragraph below the title states that Apache NetBeans 12.0 was released on June 4, 2020, and links to 'Apache NetBeans 12.0 Features'. To the right, there's a sidebar with links for 'Deployment platforms', 'Community approval', 'Known problems', and 'Earlier releases'. The main content area lists download options under 'Binaries' and 'Source'. Under 'Installers', it lists four options: 'Apache-NetBeans-12.0-bin-windows-x64.exe', 'Apache-NetBeans-12.0-bin-linux-x64.sh', 'Apache-NetBeans-12.0-bin-macosx.dmg', and 'Javadoc'. The first item is highlighted with a red box. A note at the bottom encourages users to verify file integrity using PGP signatures or hashes.

Figure A.1 : Apache NetBeans IDE Download Page

2. The Apache NetBeans IDE Installer requires the Java SE Development Kit (JDK) 8 or newer to be installed and run.

The screenshot shows the Apache NetBeans IDE Installer window. The title bar says 'Apache NetBeans IDE Installer'. The main content area displays an error message: 'Java SE Development Kit (JDK) was not found on this computer'. It explains that JDK 8 or newer is required and provides a link to download it from Oracle's website. At the bottom right, there's a button labeled 'Exit Installer'.

Figure A.2 : Apache NetBeans IDE Error Handling Page

3. Downloading Java SE Development Kit (JDK).

<https://www.oracle.com/my/java/technologies/javase/jdk14-archive-downloads.html>

Note: To prevent misconfiguration, Java JDK 14 should be installed on the C drive.

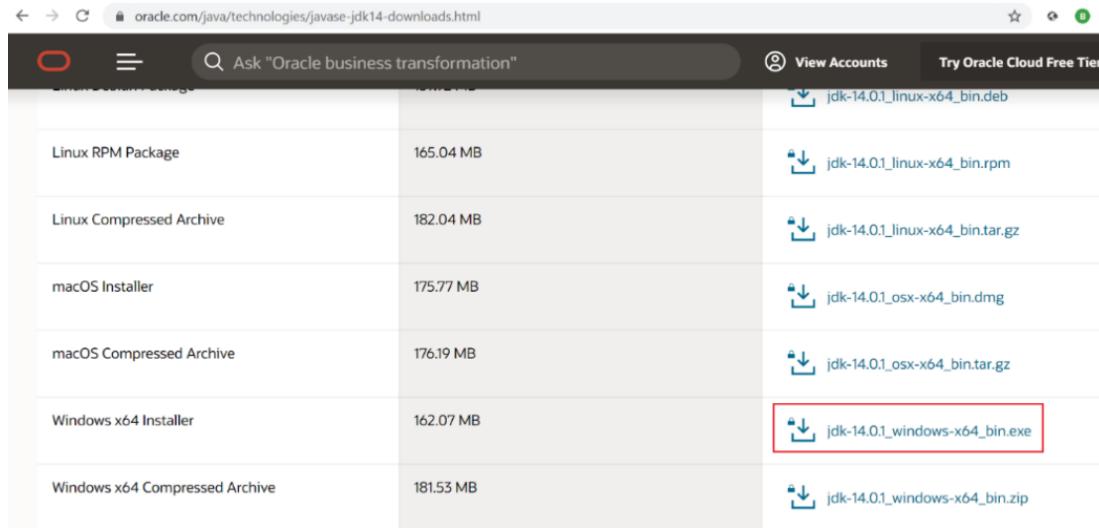


Figure A.3: Java SE Development Kit (JDK) Download Page

4. Run the Java SE Development Kit (JDK) installer.

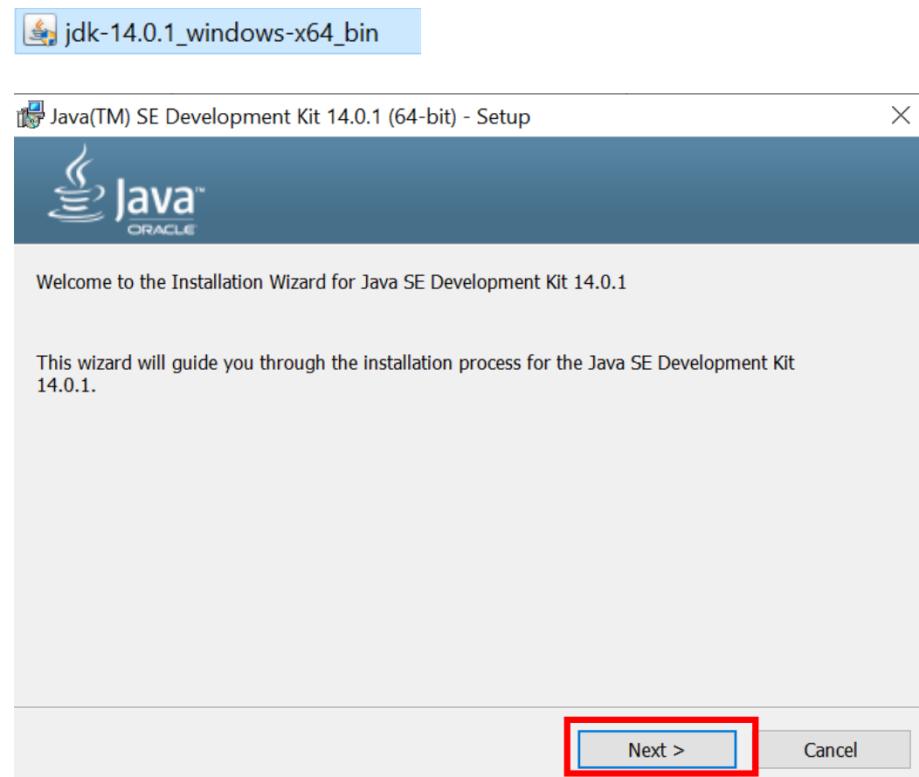


Figure A.4 : Java SE Development Kit (JDK) Installer Setup Page 1

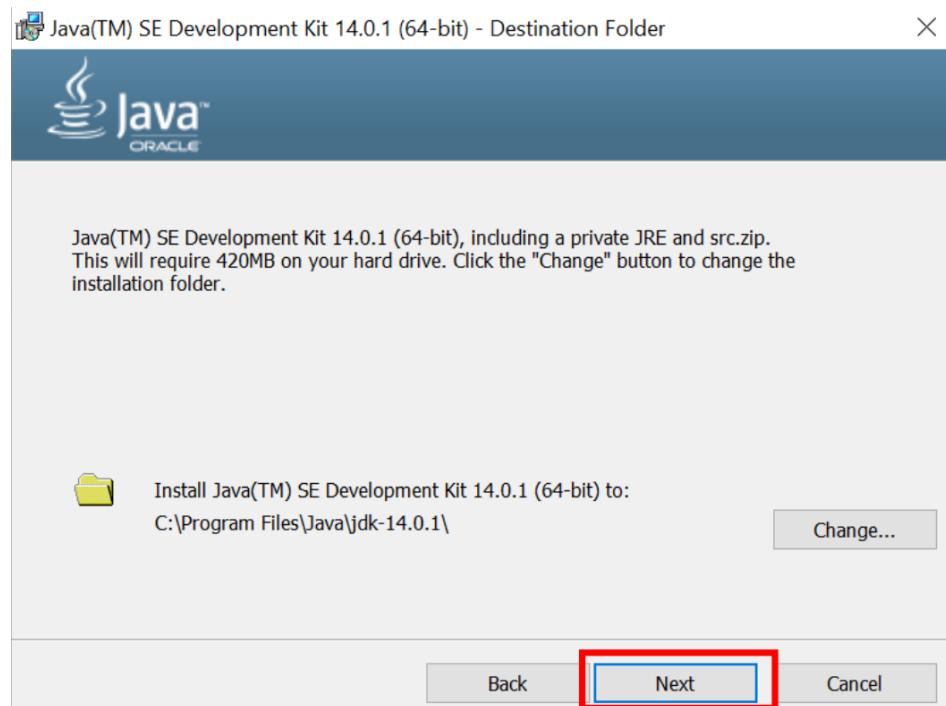


Figure A.5 : Java SE Development Kit (JDK) Installer Setup Page 2



Figure A.6 : Java SE Development Kit (JDK) Installer Setup Page 3

5. Run the Apache NetBeans IDE installer.

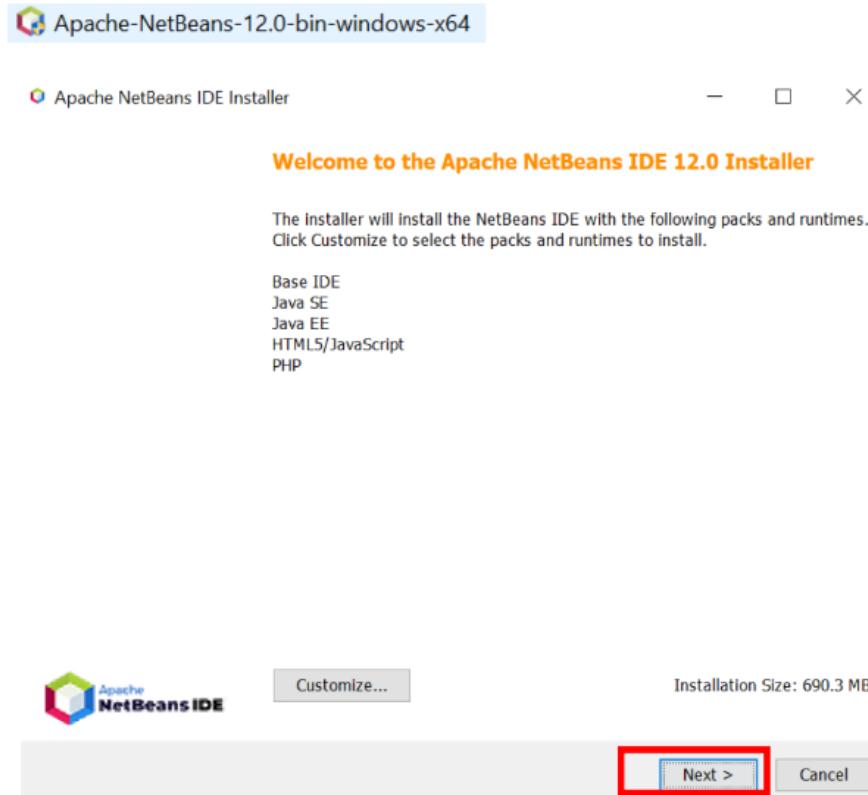


Figure A.7 : Apache NetBeans IDE Installer Setup Page 1

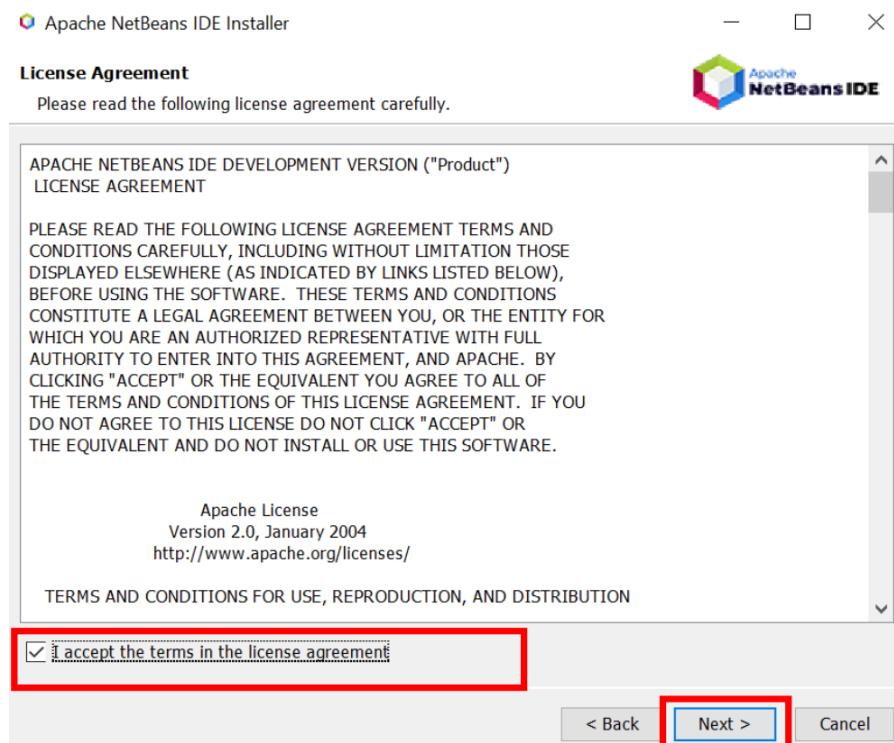


Figure A.8 : Apache NetBeans IDE Installer Setup Page 2

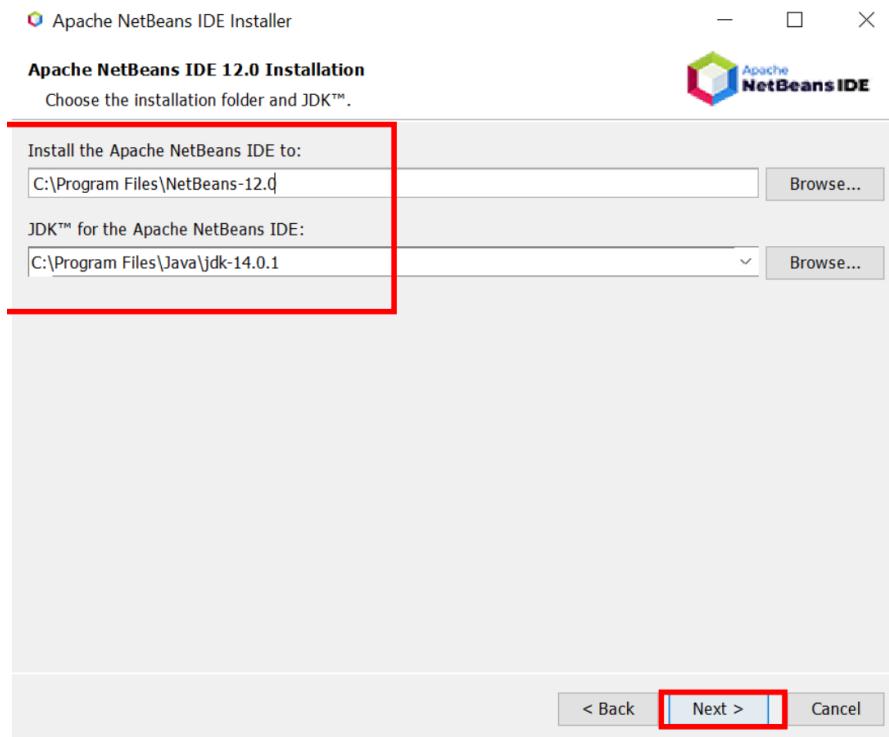


Figure A.9 : Apache NetBeans IDE Installer Setup Page 3

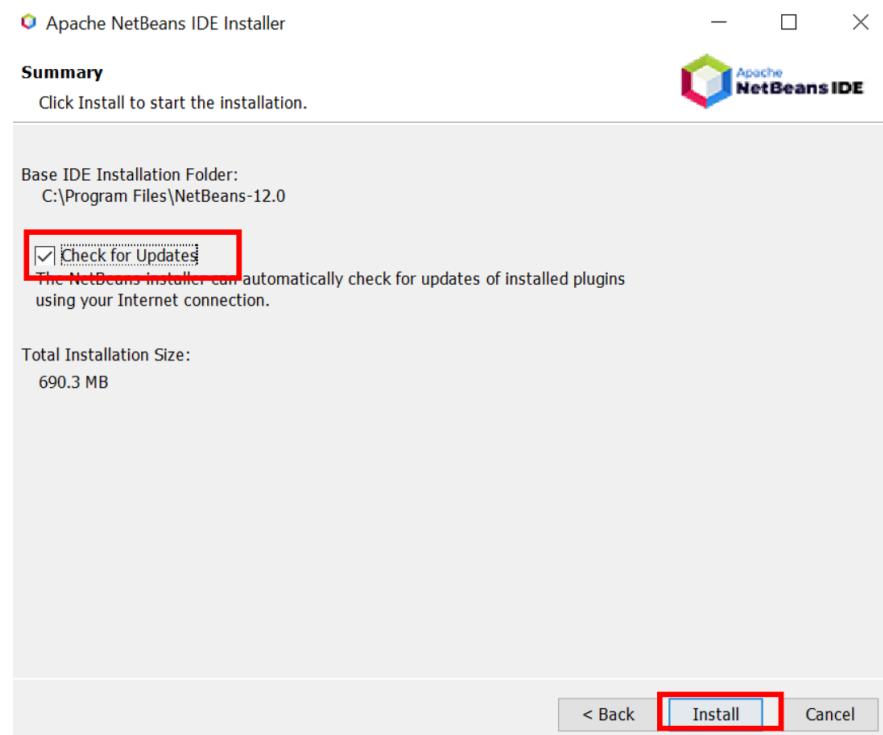


Figure A.10 : Apache NetBeans IDE Installer Setup Page 4

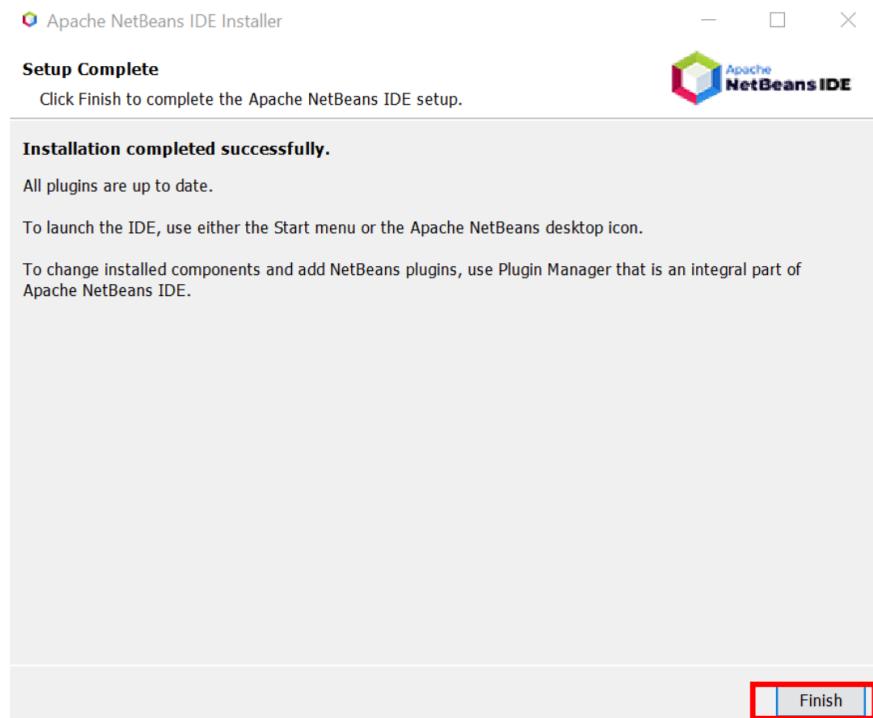


Figure A.11 : Apache NetBeans IDE Installer Setup Page 5

6. Downloading XAMPP.

<https://www.apachefriends.org/download.html>

The screenshot shows the Apache Friends website's download page. The main heading is 'Download'. Below it, a section titled 'XAMPP for Windows' lists three versions: 7.2.31, 7.3.18, and 7.4.6. Each row in the table includes links for 'What's Included?', 'md5', 'sha1', and 'Download (64 bit)'. The first row (7.2.31) has its entire row highlighted with a red box.

Version	What's Included?	Checksum	Download (64 bit)	Size
7.2.31 / PHP 7.2.31	What's Included?	md5 sha1	Download (64 bit)	147 Mb
7.3.18 / PHP 7.3.18	What's Included?	md5 sha1	Download (64 bit)	147 Mb
7.4.6 / PHP 7.4.6	What's Included?	md5 sha1	Download (64 bit)	148 Mb

Figure A.12 : XAMPP Download Page

7. Run the XAMPP installer.

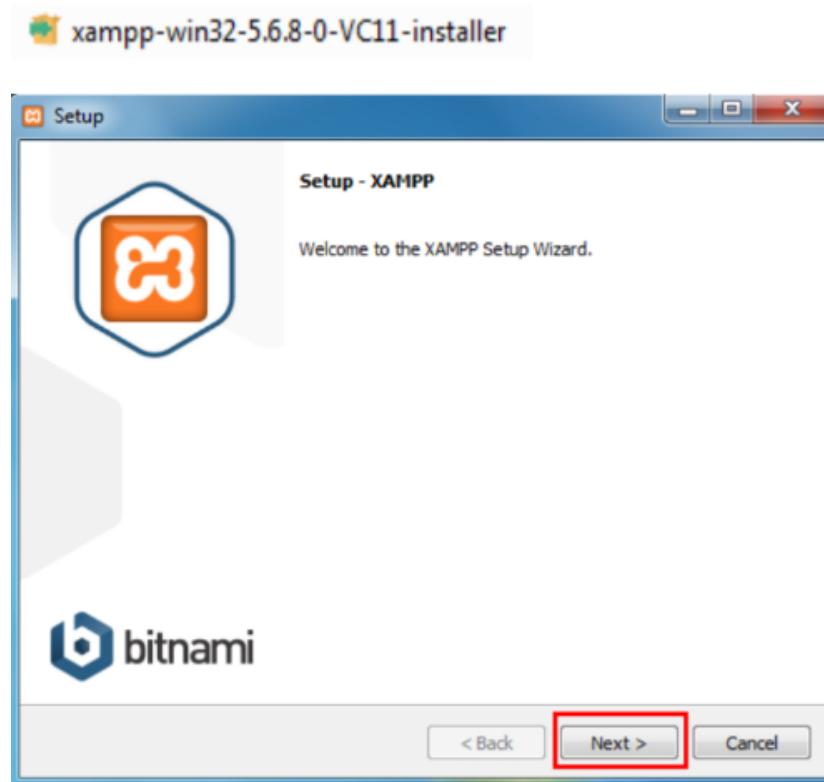


Figure A.13 : XAMPP Installer Setup Page 1

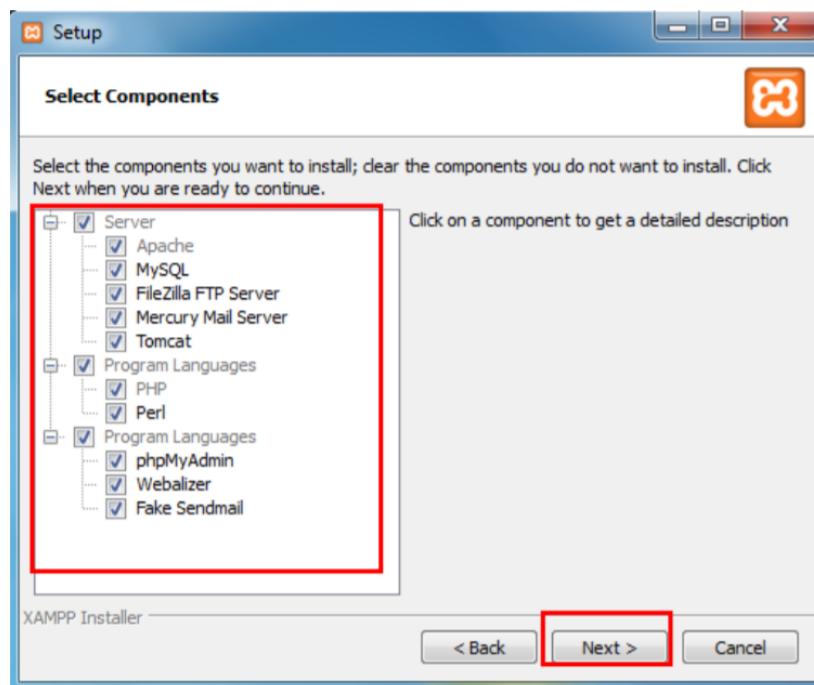


Figure A.14 : XAMPP Installer Setup Page 2

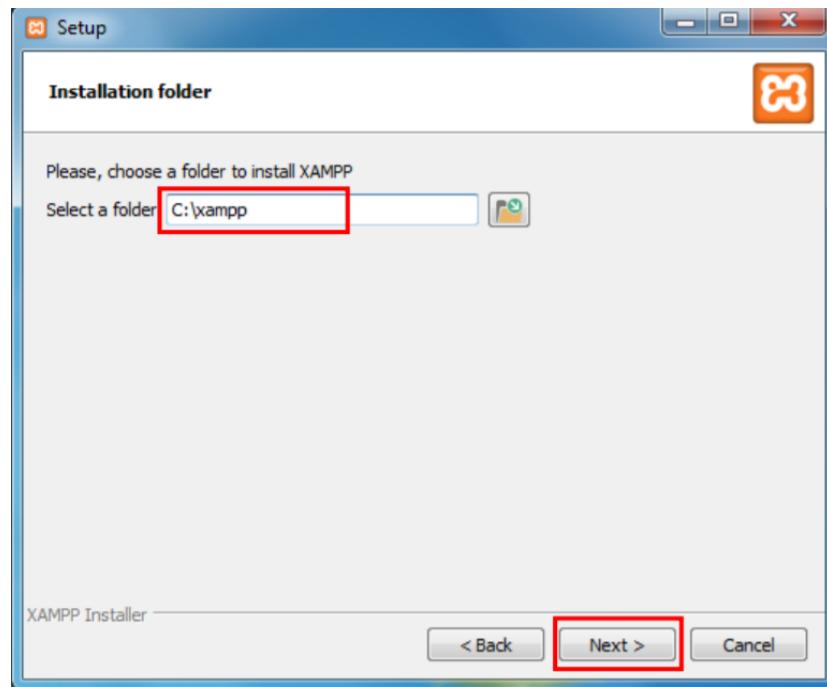


Figure A.15 : XAMPP Installer Setup Page 3

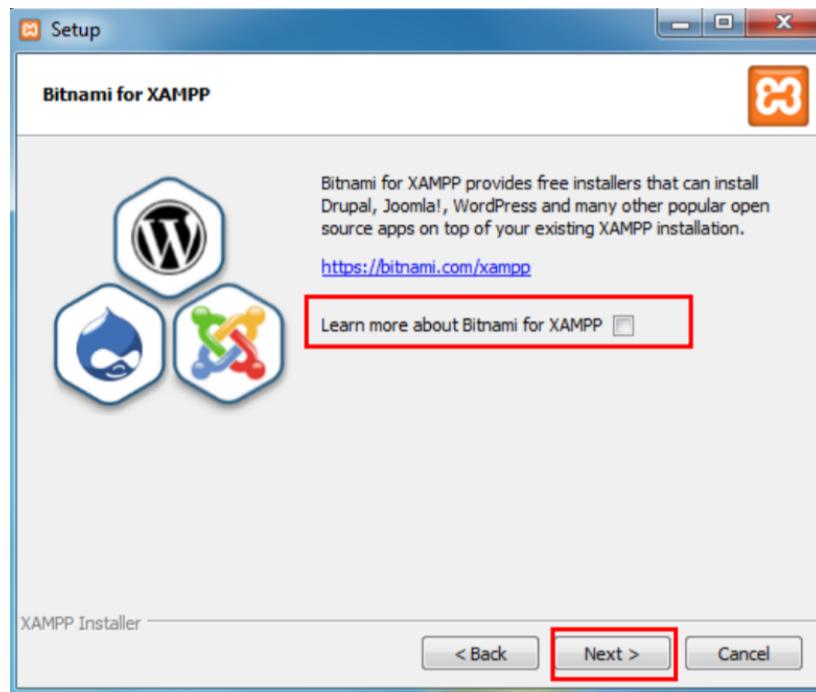


Figure A.16 : XAMPP Installer Setup Page 4

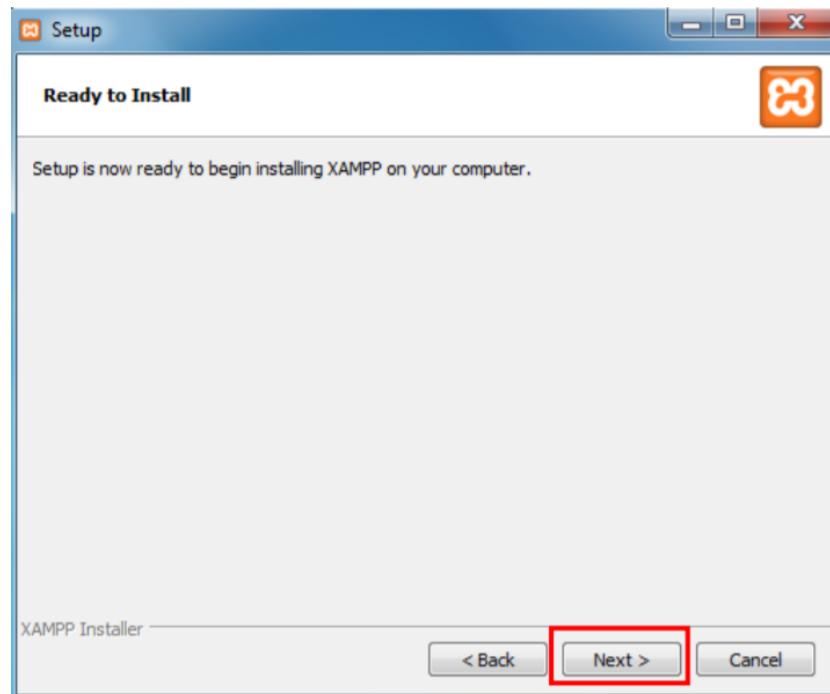


Figure A.17 : XAMPP Installer Setup Page 5



Figure A.18 : XAMPP Installer Setup Page 6

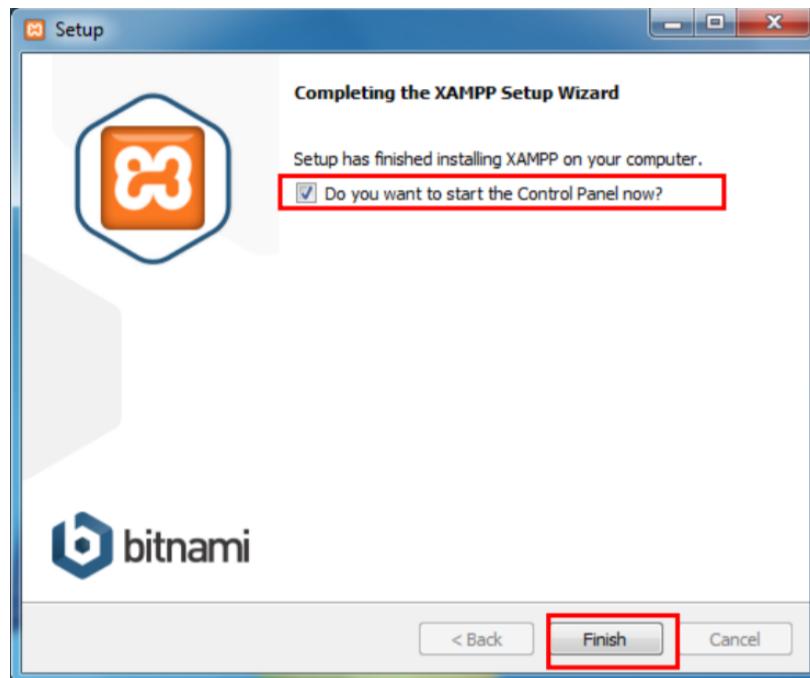


Figure A.19 : XAMPP Installer Setup Page 7

8. Start Apache and MySQL in XAMPP.

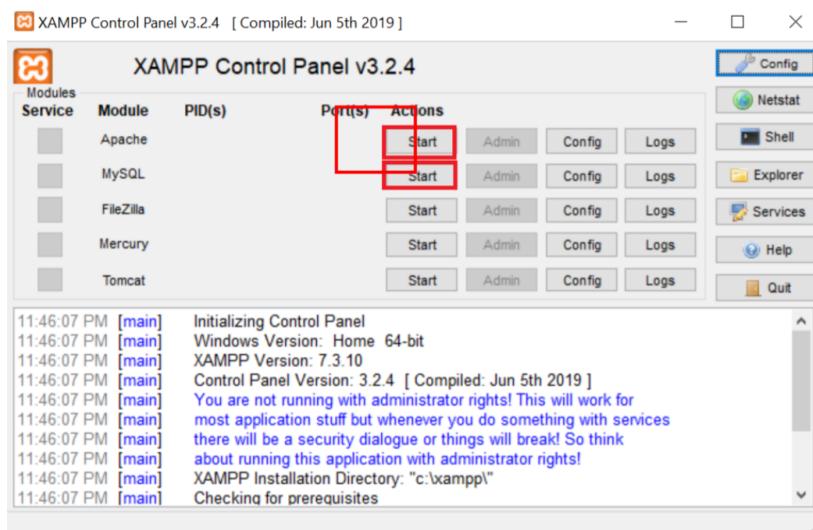


Figure A.20 : XAMPP Control Panel Page

9. Enter localhost as address url using any browser.

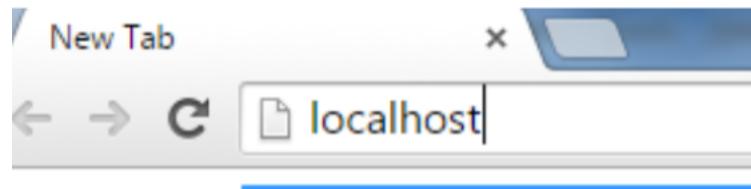


Figure A.21 : Browser URL Sample Page

10. When you see the page, you are now successfully installing the XAMPP package.



Figure A.22 : Brower Result Sample Page

Source Code Download

1. Scan the QR code and download the TARUMT Game-based Education System source code zip file from github.

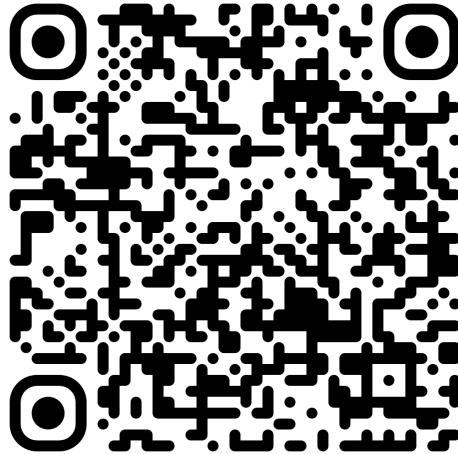


Figure A.23 : Source Code Github QR Code

2. Extract the file and place it into the C:\xampp\htdocs folder.
3. Run the Apache NetBeans IDE and start the Apache and MySQL in XAMPP.

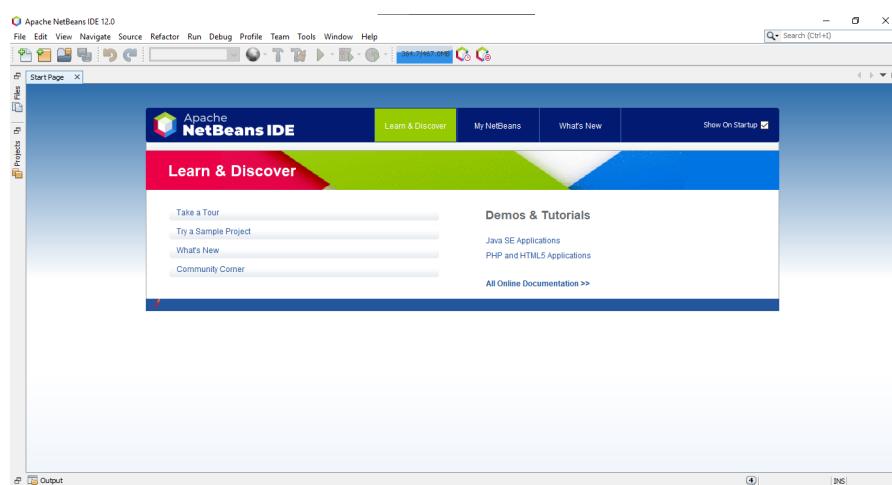


Figure A.24 : Apache NetBeans IDE

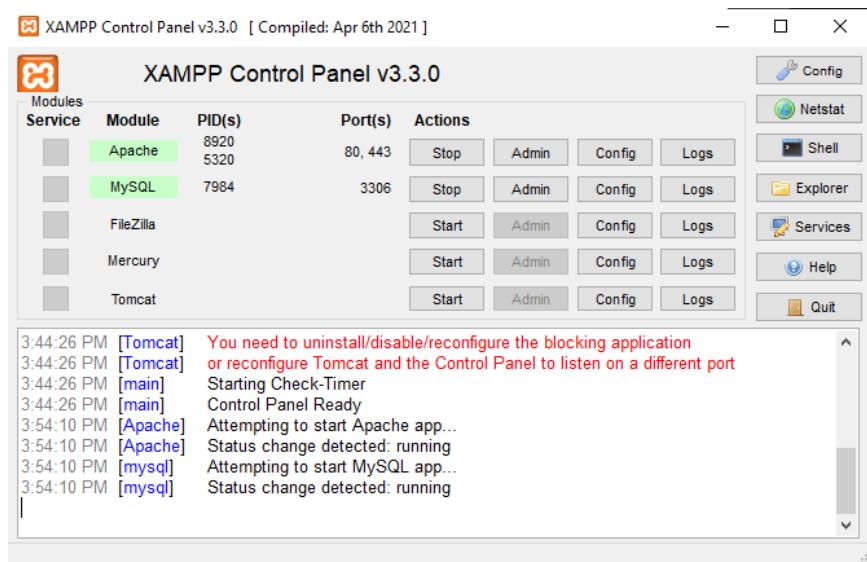


Figure A.25 : XAMPP Control Panel

4. Open the TARUMT_Game-Based_Education_System-main folder from Apache NetBeans.

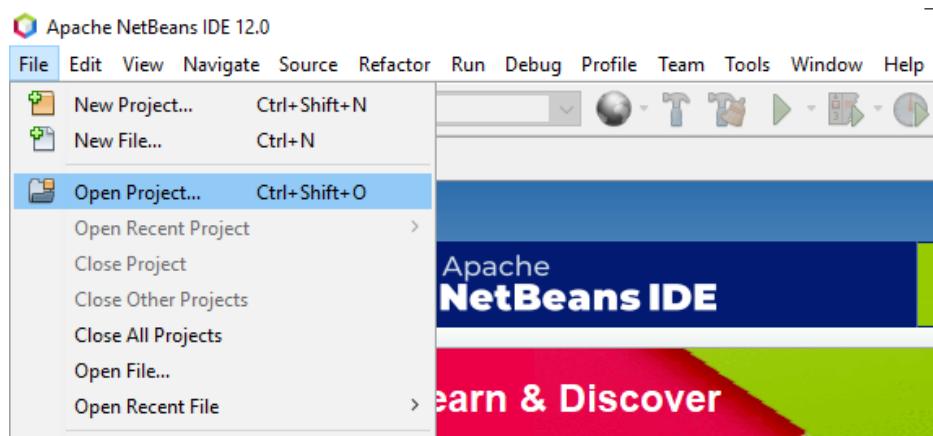


Figure A.26: Apache NetBeans IDE Open Project

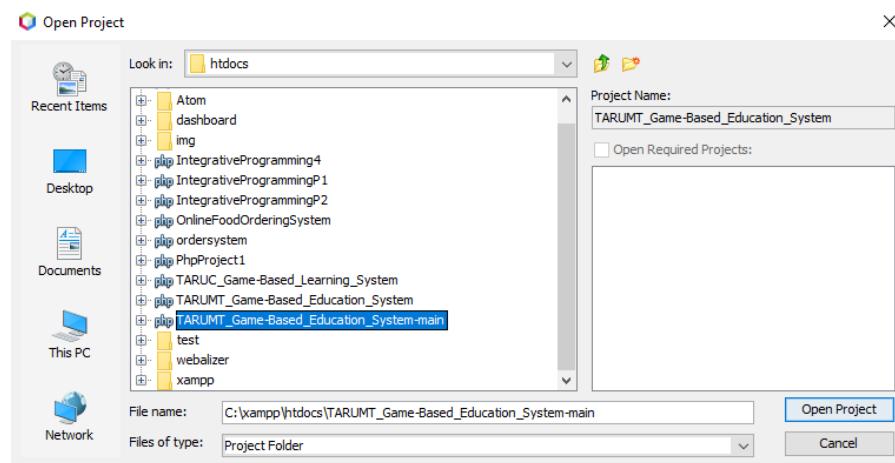


Figure A.27 : Apache NetBeans IDE Select Project

5. Open the tables.php file on the left sidebar.

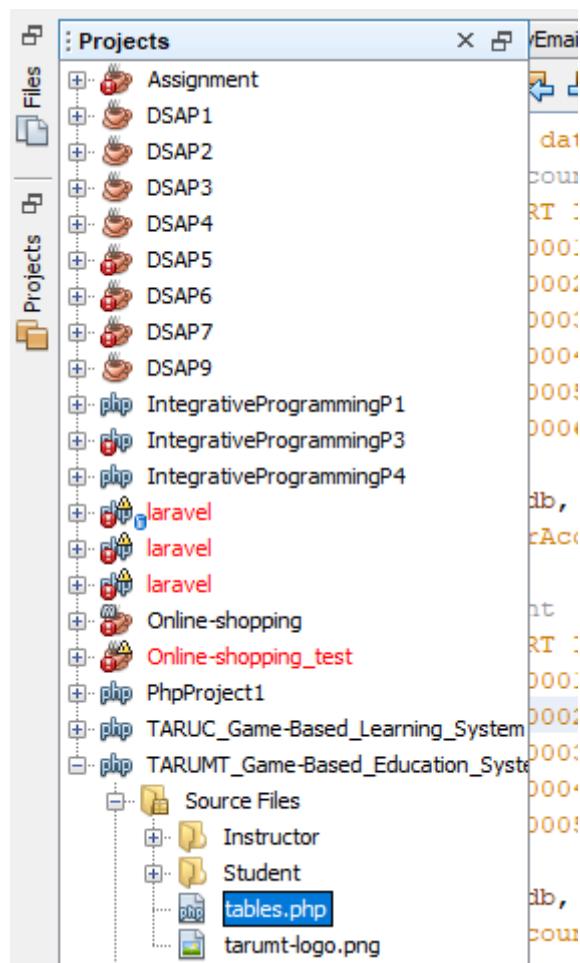
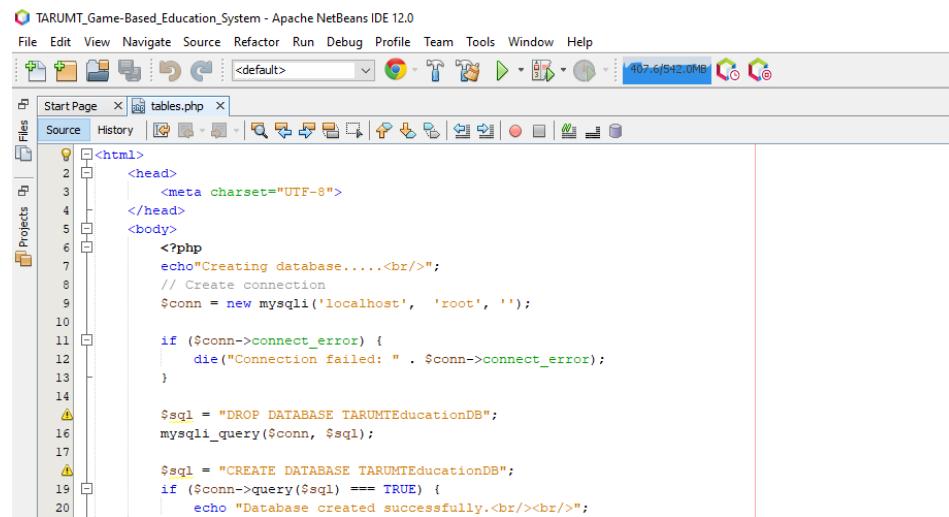


Figure A.28 : Apache NetBeans IDE Sidebar



```

<?php
echo"Creating database....<br/>";
// Create connection
$conn = new mysqli('localhost', 'root', '');
if ($conn->connect_error) {
    die("Connection failed: " . $conn->connect_error);
}

$sql = "DROP DATABASE TARUMTEducationDB";
mysqli_query($conn, $sql);

$sql = "CREATE DATABASE TARUMTEducationDB";
if ($conn->query($sql) === TRUE) {
    echo "Database created successfully.<br/><br/>";
}

```

Figure A.29 : Apache NetBeans IDE tables.php Code

6. Run the tables.php file using any browser.

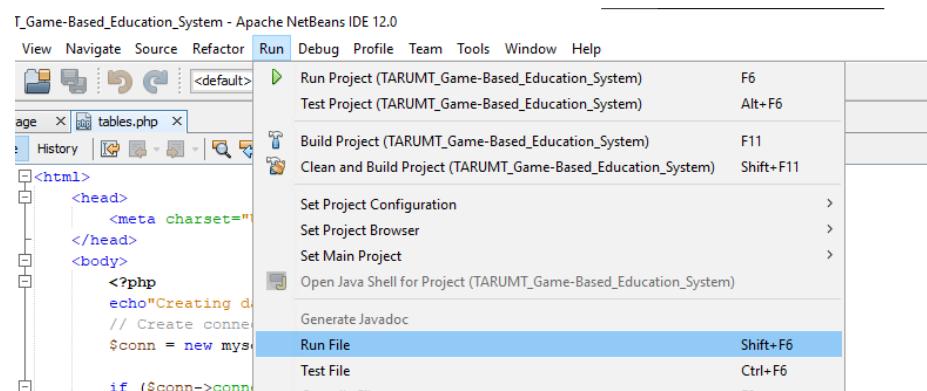
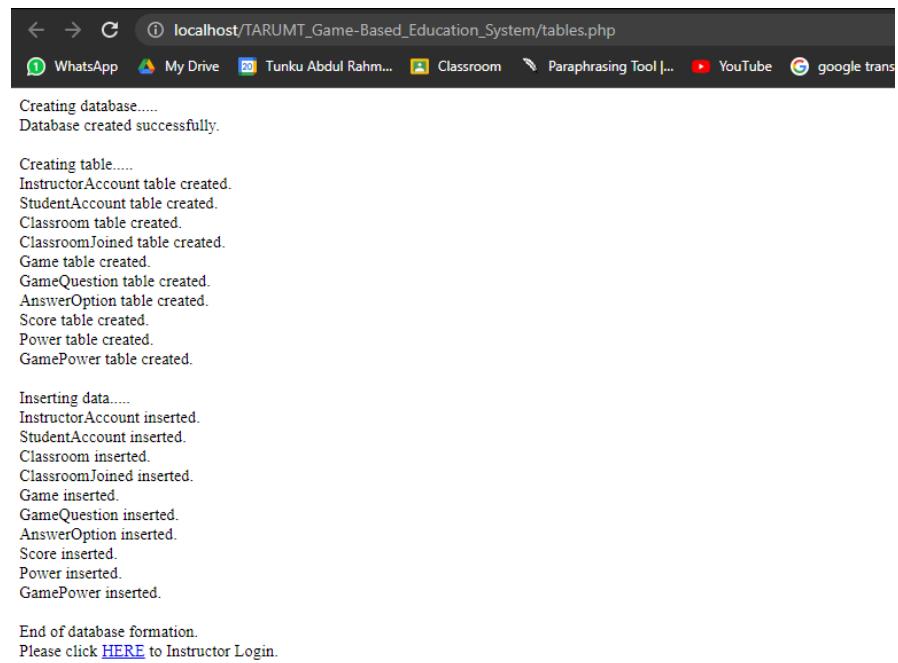


Figure A.30 : Apache NetBeans IDE Run File



```

← → C ⓘ localhost/TARUMT_Game-Based_Education_System/tables.php
WhatsApp My Drive Tunku Abdul Rahm... Classroom Paraphrasing Tool |.. YouTube google trans

Creating database.....
Database created successfully.

Creating table.....
InstructorAccount table created.
StudentAccount table created.
Classroom table created.
ClassroomJoined table created.
Game table created.
GameQuestion table created.
AnswerOption table created.
Score table created.
Power table created.
GamePower table created.

Inserting data.....
InstructorAccount inserted.
StudentAccount inserted.
Classroom inserted.
ClassroomJoined inserted.
Game inserted.
GameQuestion inserted.
AnswerOption inserted.
Score inserted.
Power inserted.
GamePower inserted.

End of database formation.
Please click HERE to Instructor Login.

```

Figure A.31 : Run tables.php Result Sample Page

7. Enter the url below to redirect to the student login page.

http://localhost/TARUMT_Game-Based_Education_System-main/Student/login.php

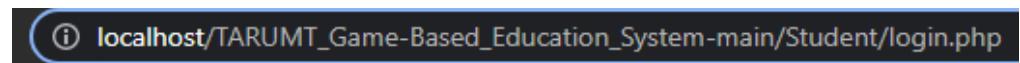


Figure A.32 : Browser Student Login URL Sample Page

8. Users can login the email address below using Gmail to test the password recovery function (get verification code).

Email: tarumteducationstudent@gmail.com

Gmail Password: aaabb123

Appendix B: User Guide

Figure B.1 : Screenshot of Student Login Page

1. Click on the "Login" button to log into the account and will be redirected to the home page if inputs are valid.
2. Click on the "Forgot Password?" button to redirect to the verify email page to recover the password.
3. Click on the "Show Password" button to make the password visible.

Student Login Data	
1	Email: mukym-wm19@student.tarc.edu.my Password: 012345678900
2	Email: yapye-wm19@student.tarc.edu.my Password: 001122334455
3	Email: mukkj-wm19@student.tarc.edu.my Password: 987654321234
4	Email: cliffcy-wm19@student.tarc.edu.my Password: 998877665544
5	Email: yongjk-wb21@student.tarc.edu.my Password: 098765432101
6	Email: tarumteducationstudent@gmail.com Password: 011223344567



Figure B.2 : Screenshot of Password Recovery Verify Email Page

1. Click on the "Verify" button to verify the email and will be redirected to the verify code page if input is valid.
2. Click on the "Back" button to redirect to the student login page.

Student Email Data	
1	Email: tarumteducationstudent@gmail.com

Login the email address using Gmail to get the verification code email.

Email: tarumteducationstudent@gmail.com

Gmail Password: aaabb123

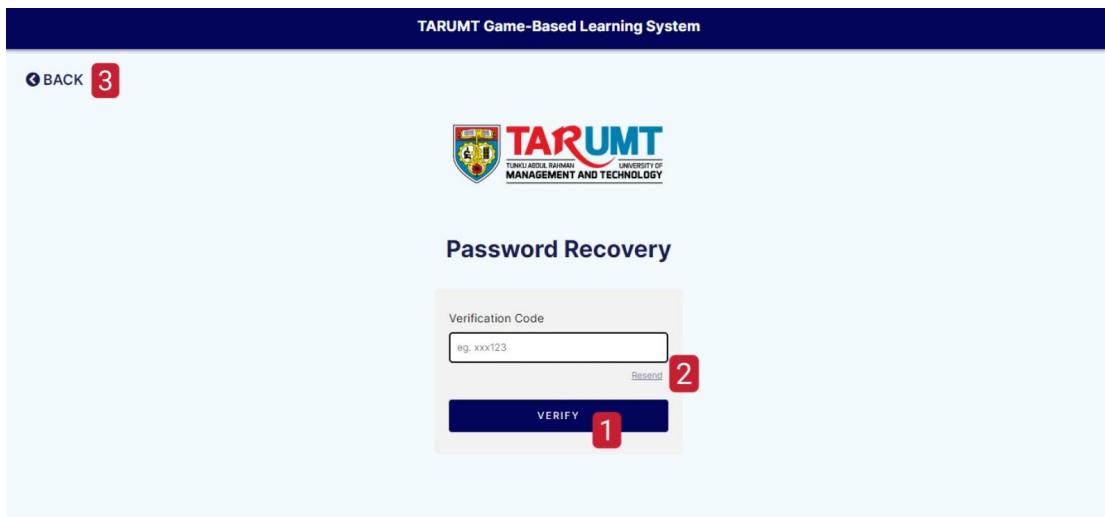


Figure B.3 : Screenshot of Password Recovery Verify Code Page

Check the email sent to the email address to get the verification code.

1. Click on the "Verify" button to verify the verification code and will be redirected to the reset password page if input is valid.
2. Click on the "Resend" button to request for verification code email.
3. Click on the "Back" button to redirect to the verify email page.



Figure B.4 : Screenshot of Password Recovery Reset Password Page

Reset the password by providing a new password and confirmed new password. The password should be between 8 and 100 in length and must include at least 1 number and 1 alphabet.

1. Click on the "Reset" button to reset the account password and will be redirected to the student login page if inputs are valid.
2. Click on the "Show Password" button to make the password visible.
3. Click on the "Back" button to redirect to the verify email page.

Sample of Valid Password Format Data	
1	Password: abcd1234
2	Password: Ab123Ab123

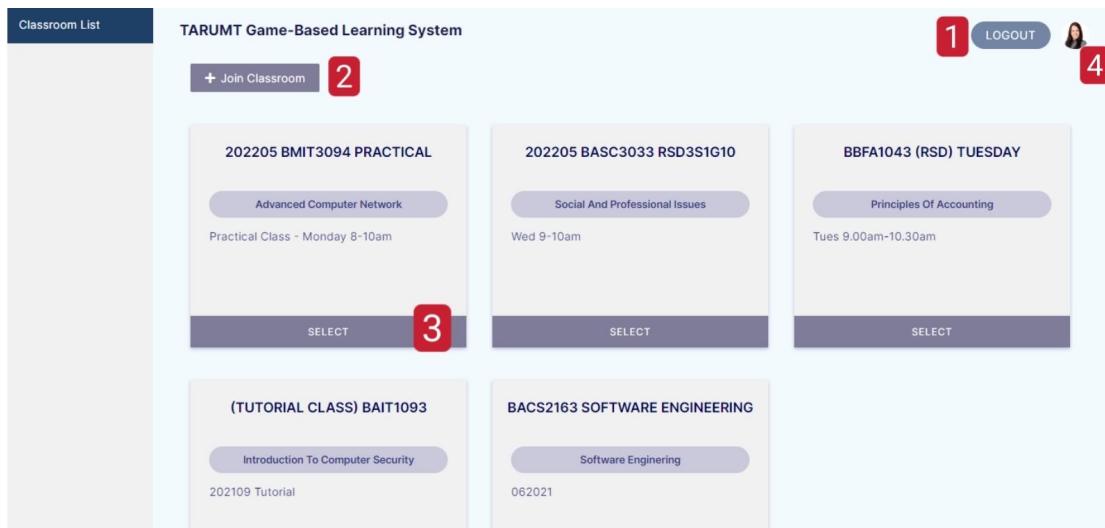


Figure B.5 : Screenshot of Home Page

1. Click on the "Logout" button to logout the current account and will be redirected to the student login page.
2. Click on the "Join Classroom" button to redirect to the join classroom page.
3. Click on the "Select" button to select a classroom and redirect to the selected classroom page.
4. Click on the "Profile Picture" button to redirect to the user profile page.

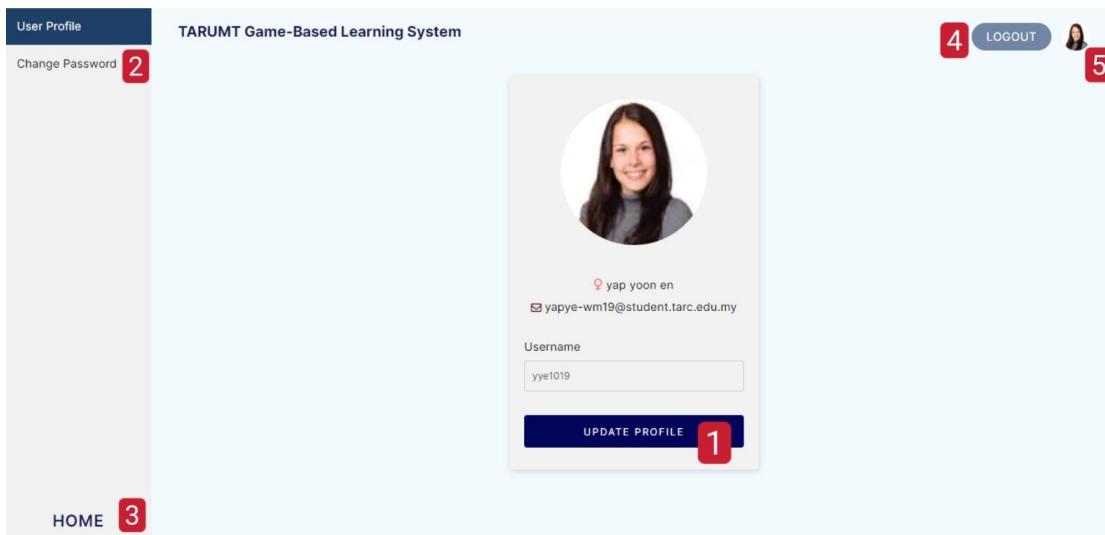


Figure B.6 : Screenshot of User Profile Page

1. Click on the "Update Profile" button to redirect to the edit user profile page.
2. Click on the "Change Password" button to redirect to the change password page.
3. Click on the "Home" button to redirect to the home page.
4. Click on the "Logout" button to logout the current account and will be redirected to the student login page.
5. Click on the "Profile Picture" button to redirect to the user profile page.

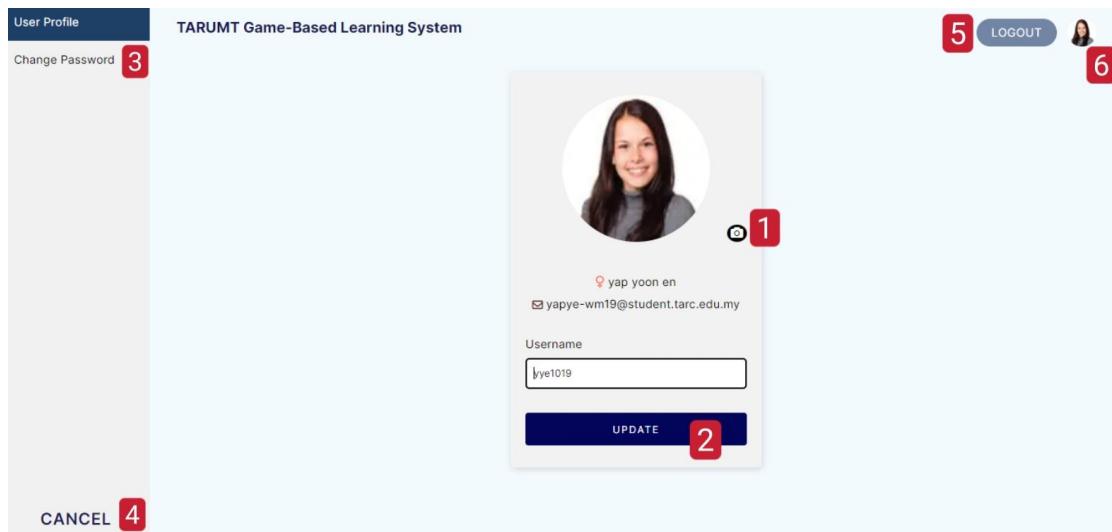


Figure B.7 : Screenshot of Edit User Profile Page

1. Click on the "Camera" button to select a picture and update the profile picture.
2. Click on the "Update" button to update the profile data and will be redirected to the user profile page if input is valid.
3. Click on the "Change Password" button to redirect to the change password page.
4. Click on the "Cancel" button to redirect to the user profile page.
5. Click on the "Logout" button to logout the current account and will be redirected to the student login page.
6. Click on the "Profile Picture" button to redirect to the user profile page.

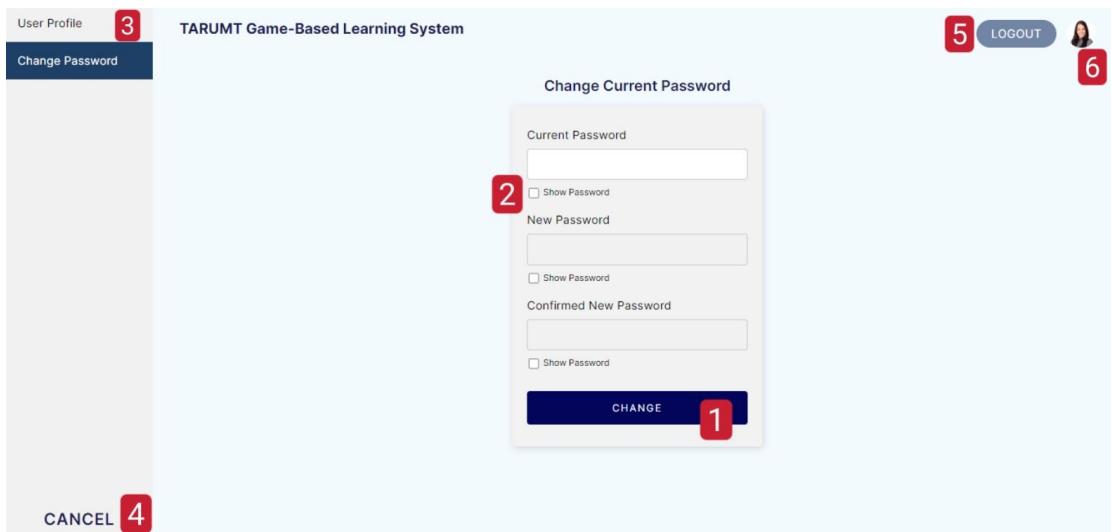


Figure B.8 : Screenshot of Change Password Verify Current Password Page

1. Click on the "Change" button to verify the input field, the new password field and the confirmed new password field will be enabled if input is valid.
2. Click on the "Show Password" to make the password visible.
3. Click on the "User Profile" button to redirect to the user profile page.
4. Click on the "Cancel" button to redirect to the user profile page.
5. Click on the "Logout" button to logout the current account and will be redirected to the student login page.
6. Click on the "Profile Picture" button to redirect to the user profile page.

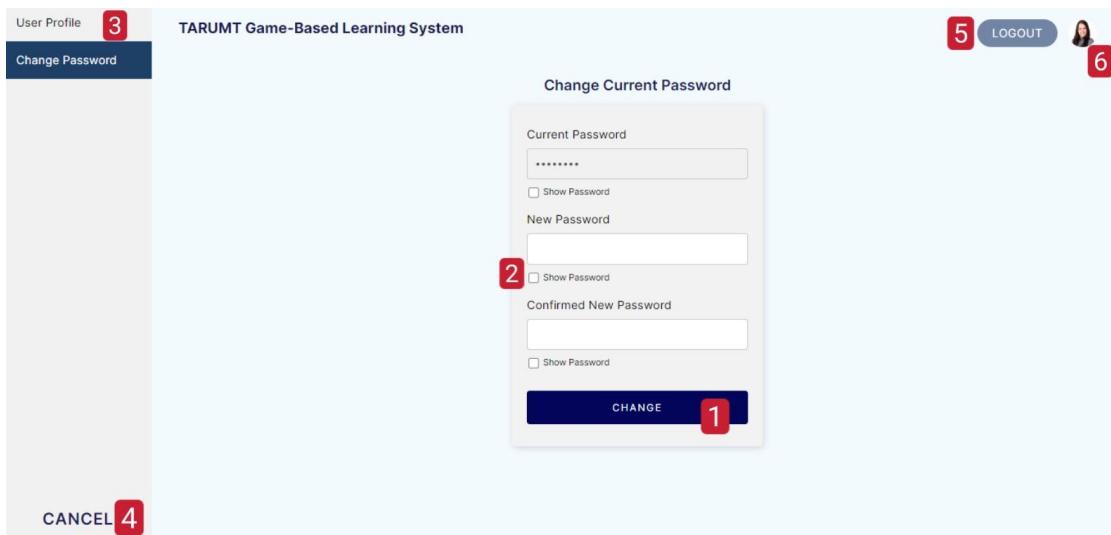


Figure B.9 : Screenshot of Change Password Page

The new password cannot be the same as the current password.

1. Click on the "Change" button to change the password and will be redirected to the student login page if inputs are valid.
2. Click on the "Show Password" to make the password visible.
3. Click on the "User Profile" button to redirect to the user profile page.
4. Click on the "Cancel" button to redirect to the user profile page.
5. Click on the "Logout" button to logout the current account and will be redirected to the student login page.
6. Click on the "Profile Picture" button to redirect to the user profile page.

Sample of Valid Password Format Data	
1	Password: abcd1234
2	Password: Ab123Ab123

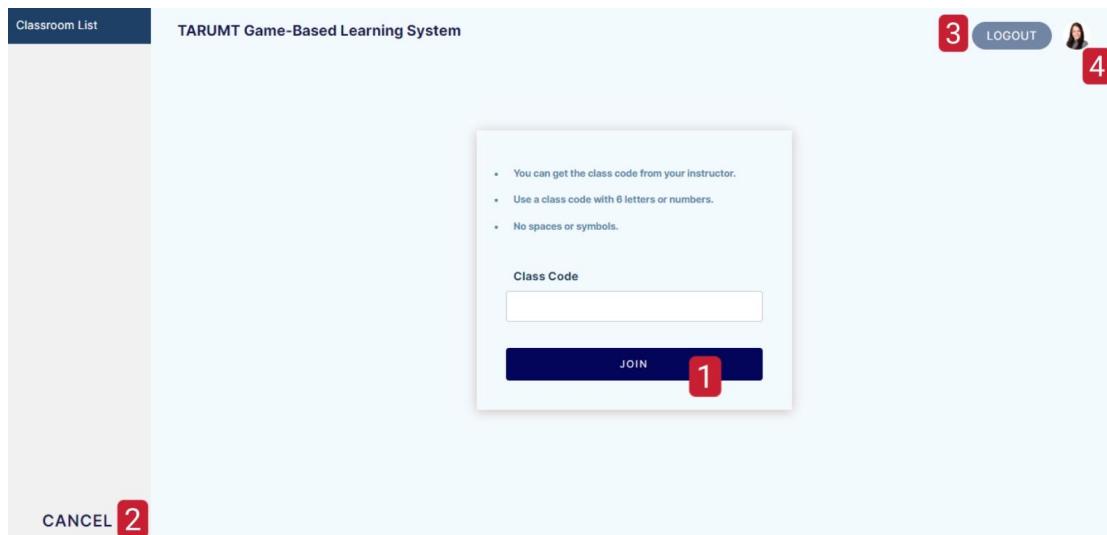


Figure B.10 : Screenshot of Join Classroom Page

1. Click on the "Join" button to join a classroom and will be redirected to the home page if input is valid.
2. Click on the "Cancel" button to redirect to the home page.
3. Click on the "Logout" button to logout the current account and will be redirected to the student login page.
4. Click on the "Profile Picture" button to redirect to the user profile page.

Class Code Data	
1	Class code: eY2Mn9
2	Class code: De77m0
3	Class code: RXZb3a
4	Class code: 5kUU1p
5	Class code: djOO94
6	Class code: AwEf9

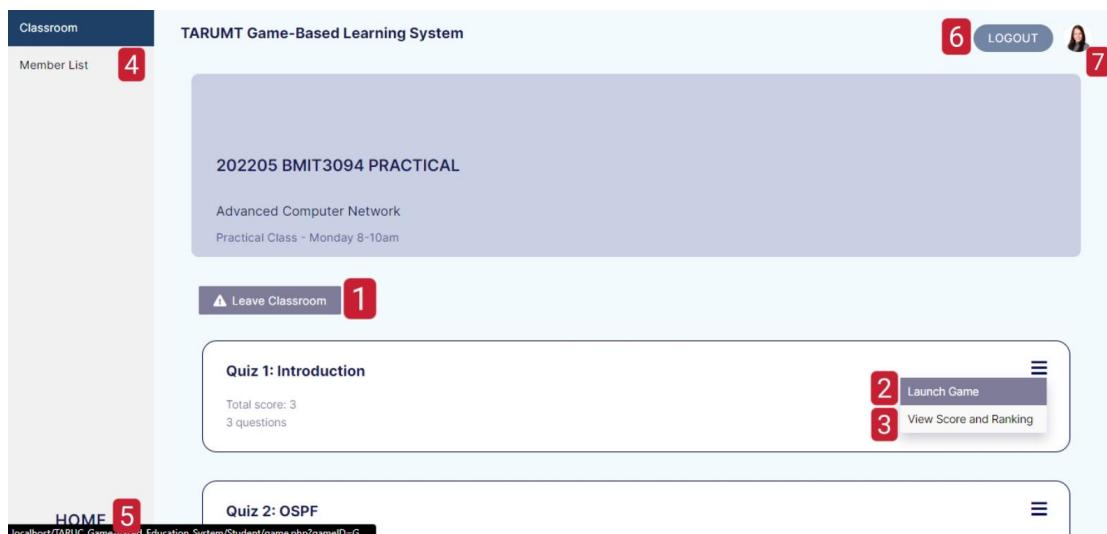


Figure B.11 : Screenshot of Selected Classroom Page

1. Click on the "Leave Classroom" button to leave the selected classroom and will prompt out the confirmation box.
2. Click on the "Launch Game" button to start the game and will be redirected to the first question of the game.
3. Click on the "View Score and Ranking" button to redirect to the score and ranking page.
4. Click on the "Member List" button to redirect to the selected classroom member list page.
5. Click on the "Home" button to redirect to the home page.
6. Click on the "Logout" button to logout the current account and will be redirected to the student login page.
7. Click on the "Profile Picture" button to redirect to the user profile page.

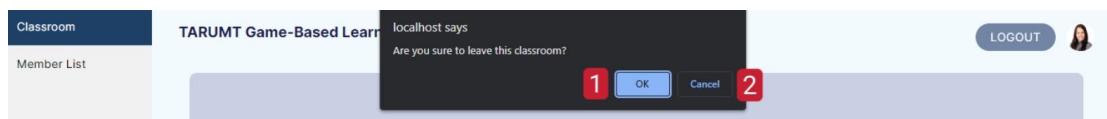


Figure B.12 : Screenshot of Leave Classroom Confirmation Box Page

1. Click on the "OK" button to confirm on leaving the selected classroom and will be redirected to the home page.
2. Click on the "Cancel" button to cancel the leave classroom action.

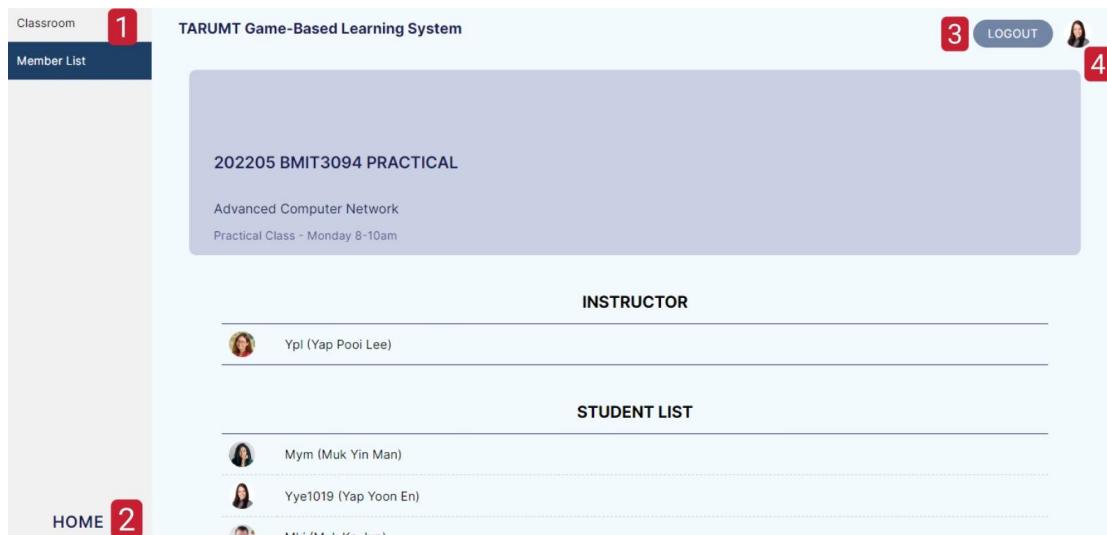


Figure B.13 : Screenshot of Selected Classroom Member List Page

1. Click on the "Classroom" button to redirect to the selected classroom page.
2. Click on the "Home" button to redirect to the home page.
3. Click on the "Logout" button to logout the current account and will be redirected to the student login page.
4. Click on the "Profile Picture" button to redirect to the user profile page.

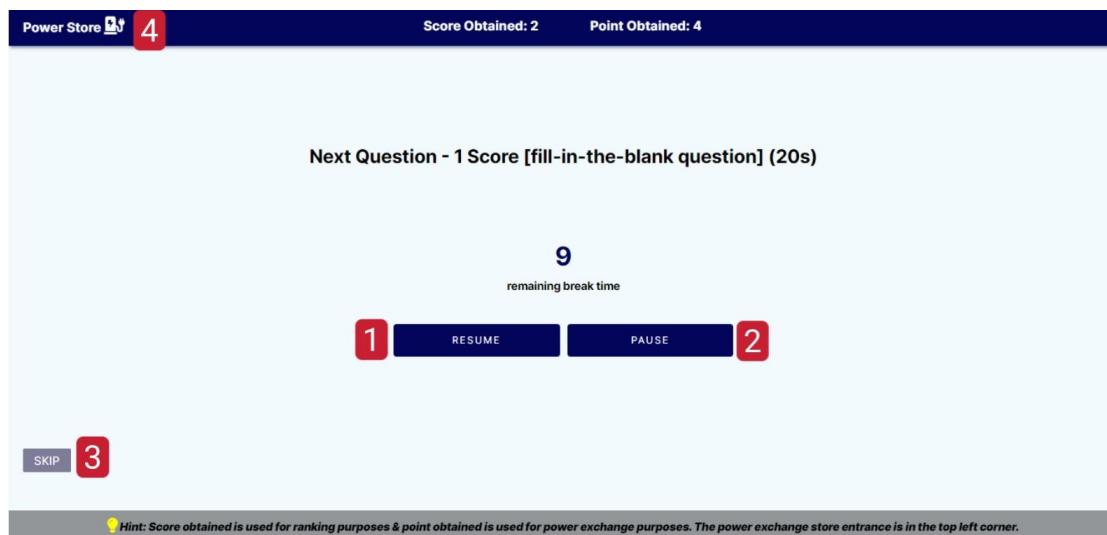


Figure B.14 : Screenshot of Game Break Page

1. Click on the "Resume" button to continue the timer when the timer is paused.
2. Click on the "Pause" button to stop the timer when the timer is resumed.
3. Click on the "Skip" button to skip the break time and will be redirected to the next question of the game.
4. Click on the "Power Store" button to redirect to the power exchange store page.



Figure B.15 : Screenshot of Score and Ranking Page

1. Click on the "Back" button to redirect to the selected classroom page.

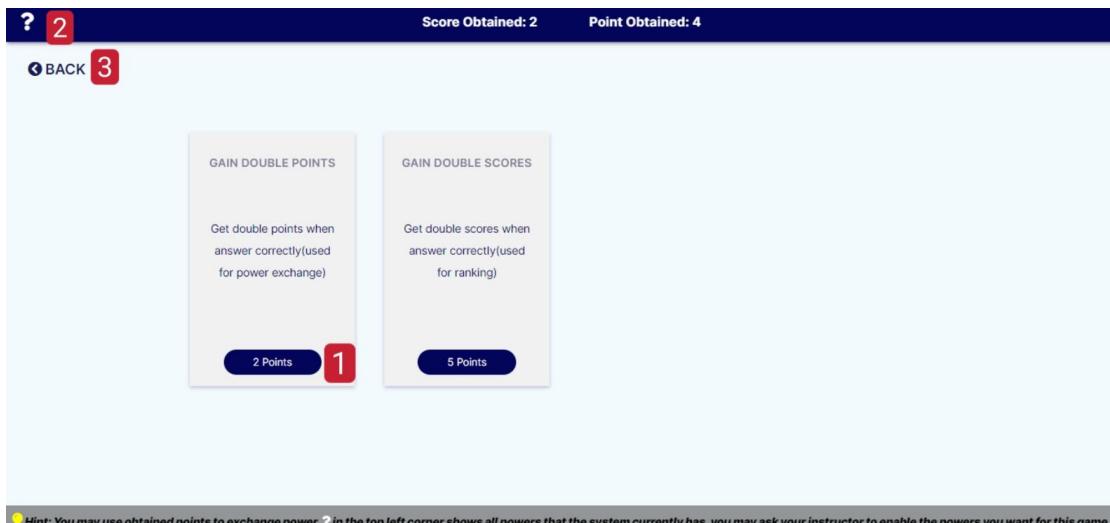


Figure B.16 : Screenshot of Selected Game Power Exchange Store Page

1. Click on the "Exchange" button to exchange the power and will prompt out the confirmation box.
2. Click on the "?" button to redirect to the power list and description page.
3. Click on the "Back" button to redirect to the game break page.

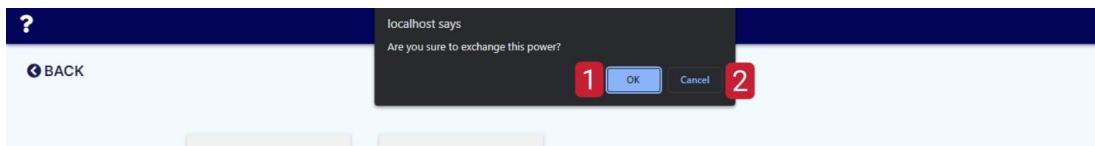


Figure B.17 : Screenshot of Exchange Power Confirmation Box Page

1. Click on the "OK" button to confirm on exchanging the selected power and will be redirected to the next question of the game.
2. Click on the "Cancel" button to cancel the exchange power action.



Figure B.18 : Screenshot of Power List and Description Page

1. Click on the "Back" button to redirect to the power exchange store page.

Appendix C: Other Appendices

Originality report

COURSE NAME

2022/23 FYP-13 Students

STUDENT NAME

YOON EN YAP

FILE NAME

YOON EN YAP - FYP Documentation - Originality Reports

REPORT CREATED

Dec 30, 2022

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