UROOM: CONNECTING TEACHERS AND STUDENTS FOR CLASS ASSIGNMENT

BY

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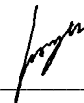I _____LIM JING XIANG_____

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Date   : _____22/07/2022_____ _ ___

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ABSTRACT

In this report, a web application will be developed to help the teachers and students to do the assignment and form and manage the assignment group in a more convenient way. Moreover, some problems like free rider problem that the teachers and students may meet during doing the assignment will be one of the main focuses in this project. Some solutions will be proposed to reduce the likelihood of free rider problem occurring. This application will have six modules which are Assignment Room module, Assignment module, Assignment Group module, Chatroom module, Real Time Collaborative module, and Assignment Submission module. The Assignment Room module will enable the teachers to create a room and invite students to the room. The Assignment module will enable the teachers to upload assignment and create the task templates. The Assignment Group module will enable the teachers to manage the students' assignment group and use the auto assign assignment group function to assign assignment group for students automatically. Meanwhile, the students can form the assignment group manually by sending a group forming request and manage the assignment group. A task management function will be integrated into this Assignment Group module. Students can manage the tasks that they have done. Every task will have a task history. This task history can be used to track the students' work. The Chatroom module will enable the students to discuss assignment. Hence, they no need to create a group chat in another application anymore. The Real Time Collaborative module will enable the students to do the assignment together in real time. The Assignment Submission Module will enable the students to submit assignment and write reviews to their groupmates while teachers can view the submission and upload the marks. Furthermore, this application will also store the ratings of the students. Hence, students can have something to refer before forming the assignment group. This project will use React.js for the frontend development and Node.js for the backend development.

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LIST OF ABBREVIATIONS

CRDT   Conflict-Free Replicated Data Type

WebRTC   Web Real Time Communication

P2P   Peer-to-Peer

UDP   User Datagram Protocol

PXP   Personal Extreme Programming

OS   Operating System

RAM   Random Access Memory

CPU   Central Processing Unit

GPU   Graphics Processing Unit

PaaS   Platform as a Service

URL   Uniform Resource Locators

Chapter 1

Introduction

In this chapter, the problem statement and motivation will be discussed to find out the key concern of this project. The project objectives will also be presented to describe what will be done in this project. After that, the project scope and direction will be discussed with the purpose of determining the project goals, outcomes of the project and so on. Contributions will be presented to highlight the features and significances of this project. Lastly, report organization will be provided to describe the organization of this report with the purpose of gaining a better understanding.

1.1 Problem Statement and Motivation

Teachers usually will assign some assignments or tasks to their students to check their students' understanding after attending their classes. Thus, whether that student is a college student or a middle school student or even a primary school student, he or she will always have the chance to collaborate with others to finish their assignments or tasks. Students will be requested to form their assignment group to do their assignment or even the teacher assign them into an assignment group. Every student in that group will be requested to finish their own parts and then combine it as a group assignment project. Hardin [1] said that the activities of each individual group member can help the entire group, and the group can gain significantly from collective activity. For example, if each of the group members can separate an assignment into few parts and then assign it to different members, the whole group can finish their assignment within a short period of time or faster than doing the assignment individually. Thus, students can benefit from the assignment group. Nevertheless, forming an assignment group for students is a tough task for teachers. Currently, teachers will likely do the group formation physically in the classroom or virtually via the internet such as Google Form. Students will be asked to fill in their information online and then form the group with the information provided such as phone number. Although some of the teachers are using Google Classroom to assign assignments and form the assignment Group. However, from Lynch [4] article, teachers still have plenty of works to do for the group forming stuff. Even if the students can form a group with others, there may occur free rider problem. This is because some students in the group

enjoy the convenience of doing nothing while others need to handle that group member's workload in order to complete the group assignment. Hence, in the broadest sense, a free rider is someone who enjoys a benefit without contributing to the expense of its creation [1]. Some of the teachers had tried to solve this problem by structuring the process, activities, and groups. However, when students who do not contribute to the best of their abilities still have the potential to become free riders [2]. Therefore, there occurs a need to identify who is the free rider in the group and reduce the possibility of a single student becoming a free rider. If the teachers can find out who is the free rider or able to reduce the possibility of a free rider occurring in the group, it can increase the efficiency of learning.

However, there may consist of a bunch of reasons why a free rider problem is happening. From John Lamer article, the group structure may be one of the reasons that made the free rider problem occur [3]. The group of the assignment may not be poorly organized as well as most members of the group are weak in the same set of skills such as communication skills. Thus, in this situation, if the group can have some members who are good at communication skills and some members are weak at communication skills, every member in the group will receive support for success. For that reason, forming a heterogeneous group strategically will be the main concern for this problem. Hence, the problems statement can be shown as below:

1. When the students need to form an assignment group to do the assignment together, some of the members of the group may not contribute to their tasks and wait for others to help them to complete or not even care about the assignment. Hence, **free rider problem** occurs.

2. When the teachers want to assign a group assignment, the teachers need to find a way to let the students form an assignment group. Some of the teachers may distribute an online form to let their students fill in and form the group. However, some of the students might be hard to form the assignment group. When a student is an introvert, this student might shy to communicate with others and need teachers to help this student to form the group. However, it is still a hard task for the teachers when the teachers cannot always promise that the data in the online form is the latest version. Some of the students may not fill in the details although they already have a group. Thus, the **problem of managing the assignment group** occurs. Moreover, some of the teachers will help to form the group directly by the teachers. However, it is hard for a teacher to form the group when the teachers do not have any understanding on their students. Hence, it will easily occur imbalanced group problem. This is because some of the

teachers will assign randomly while some of the teachers will assign sequentially. Hence, some of the group may have the members all good at problem solving but bad at document writing and vice versa. Therefore, **imbalanced group problem** occurs. Therefore, this project has the motivation to create an application that can allow teachers to form a heterogenous group for students and manage the assignment groups easily and effectively while the students can form their assignment group manually and easily. Also, reducing the likelihood of free rider problem happening. Hence, the motivation of this project can be summarized below:

1. To provide a function to allow the teachers and students to gain some basic understanding on a single person before forming the assignment to reduce the likelihood of free rider problem occurs or identify who is the free rider.
2. To find a way that can help teachers to form heterogenous assignment group for students automatically to avoid imbalanced group problem.
3. To develop a method that can allow the teachers to manage the students' assignment groups data easily and effectively to avoid the problem of managing the students' assignment group data.

1.2   Objectives

The main objective for this project is to develop an assignment and group management system that can let students form group manually and teachers assign assignment, form group for students automatically and manage the students' assignment group data effectively. The proposed system should be able to help reducing the likelihood of free rider problem happens or identifying who is the free rider in the group. Hence, the proposed system can **reduce the likelihood of free rider problem happens**, **solve the students' assignment group management problem in a structural way**, and **avoid imbalanced or homogenous group problem**. Thus, the objectives can be shown below:

1. To develop a free rider report function and user ratings and reviews feature that can be used to **reduce the likelihood** of free rider problem happens. The proposed solution should be able to let the students report their group member as a free rider and teachers have the power to do the decision based on the reported case. Moreover, a user ratings and reviews should be used to show the user ratings and reviews which containing the details of the ratings of the user skillsets and free rider records.

2. To develop an assignment group module that can let the teachers keep tracking on the students' assignment group data easily and effectively in a **structural way**. In addition, the teachers are also can assign a **heterogenous** assignment group for students automatically. This module should have a function to help the teacher to form the assignment group heterogeneously based on the students' ratings and reviews and display and manage the assignment group data in a more convenient way. Hence, imbalanced or homogenous group problem and managing problem can be avoided.

1.3   Project Scope and Direction

The final goal of this project is to develop a web application that can help the teachers to assign assignment and manage student assignment groups easier and the students to form their assignment group easier by using the features provided in this project. Below is showing some assumptions should be made for this project.

1. Authentication module will be built in this system to authenticate the user identification. Hence, testing is not required for this module.
2. User ratings and reviews feature will be built in this system to show the ratings and reviews of the user.

The project scope of this project can be separated into six modules based on the assignment life cycle which are Assignment Room Module, Assignment Module, Assignment Group Module, Chatroom Module, Real Time Collaborative Module and Assignment Submission Module. The following is showing the scope for each of the module:

1. Assignment Room Module

   The user should be able to create an assignment room or join the assignment room with the invitation link.

2. Assignment Module

   The user should be able to assign an assignment and view the assignment details. Moreover, task templates should also be provided in this module.

3. Assignment Group Module

   The student should be able to form the assignment group manually while the teacher can assign assignment group for students automatically. The teacher should also be able to manage the students' assignment group data while the students should also be able to manage their assignment group.

4. Chatroom Module

   The user should be able to chat with each other's.

5. Real Time Collaborative Module

   The user should be able to do the assignment together in real time.

6. Assignment Submission Module

   The student should be able to submit the assignment and write reviews for their groupmates. The student should also be able to view the submission and result. The teacher should be able to upload the mark for the submission.

Moreover, the following requirements should also be fulfilled:

1. Create an assignment room module that can be used as a classroom to manage assignments.

2. Create a user rating module that can be used for the students' assignment group auto assign function.

3. Develop a students' assignment group auto assign function.

4. Develop a group forming system for students to let them form the groups manually.

5. Develop a task system that can be used to handle the free rider problems.

In addition, the following acceptance criteria should also be fulfilled to show the system can be well-accepted:

1. Successfully created a module that can let teachers manage students and assignments while students can join and do the assignment group formation.

2. Successfully assigning the students into groups based on the given ratings automatically.

3. Successfully created a system that can let students form their assignment groups manually without any operations from the teachers.

4. Successfully developed a solution can be used to identify who is the free rider or reduce the probability of a free rider problem happening in a single group.

However, in this project, some of the areas or scopes will not be covered. Hence, the following shows the exclusions of this project:

1. Since the free rider problem is happening due to the artificial of humankind. Human behaviour is hard to be controlled with a system. Thus, in this project, the proposed solution to identify who is the free rider or reduce the chances of the free rider problem happening will only try to find out the best solution instead of solving it.

2. The students' assignment group auto assign function will be used to find out the best or nearly the best solution for students to do the group assignment. Thus, it will not come out with any result such as the most balanced or best matching of group for students. This is because the purpose of this project is focusing more on finding out how to form the assignment group in a more reasonable way in order to increase the efficiency of learning instead of increasing the speed of doing the assignment and so on.

3. The proposed solution in this project is focusing more on how to achieve the goals mentioned above. Thus, this project will not have heavy focus on unimportant functions such as upload user image, profile management, notification and so on.

The exclusions mentioned above are written due to the constraints of time, developer's technical skills and limited capital and resources. Thus, the scope and direction of this project will focus more on how to implement the proposed solution to achieve the project goals.

1.4   Contributions

Teachers and students are always facing some problems on a group assignment. Normally, teachers will try to reduce the burden of the students while forming the assignment group with different methods such as using a Google Form for students to contact each other to form the group and so on. For example, student A will try to join group B by contacting the leader with the phone number that is listed in the Google Form. Sometimes, teachers will help to form the assignment group manually. However, even though the teacher is using some applications such as Google Classroom, forming the groups for students is still a tough task for them. Lynch [4] had shown the steps to assign groups for students in his article. It is clearly showing that forming the assignment group will become an additional job for teachers. Furthermore, teachers do not have any relevant information regarding their students before forming the groups. Thus, it may easily occur some situation like imbalanced group which means all the students in the group may be strong in the same area and weak in the same area. In addition, the free rider problem is another problem that is always faced by the teachers when assigning a group assignment to students. Some of the students will not contribute anything to the assignment. Thus, how to reduce the likelihood of free rider problem happening and identify who is the free rider is an interesting case to study. Hence, after completing this project, the main contribution to the phenomenon mentioned above is teachers will have another better platform to assign the group assignment to their students. Teachers no longer need to form the assignment groups manually or automatically with a high probability of forming imbalanced

groups for students. This project will record the rating of the students every time after completing an assignment. Every member in the groups will be given a chance to do a review for their groupmate. Thus, it may help students and teachers as they will have some things to refer to before forming the assignment group in their next group assignment. Besides, this project will also contribute to reducing the chances of the free rider problem happening. Students in the group will always have the chance to report their groupmate as a free rider and teachers always have the power to make the decision. In a nutshell, teachers and students will enjoy the benefits of forming the assignment group easier and having a healthier group assignment workplace.

1.5   Report Organization

This report will contain seven chapters. The first chapter will be the Introduction chapter. This chapter will discuss about the problem statement, project objectives, project scope and direction, contribution, and the report organization. After that, the second chapter will be the literature review. Some similar applications will be studied and compared in this chapter. However, in order to have better understanding on the techniques that can be applied in this project, some studies will be done and discussed. The third chapter will mainly focus on the discussion of the implemented project methodology in this project. The workflow, project timeline, user requirements and verification plan will be discussed in this chapter. The fourth chapter will be the system design. The system architecture, overview of the system, system model, database design, algorithm design, and deployment of the system will be discussed. The fifth chapter will be the system implementation. In this chapter, the setup of the hardware and software, and the system operation results will be presented. In Chapter Six, the system evaluation and discussion will be done. System testing, system evaluation, project challenges and objectives evaluation will be discussed. Lastly, the last chapter will be the conclusion and recommendation.

Chapter 2

Literature Review

In this chapter, some reviews on similar applications will be discussed first in order to do the comparison to find out the differences between this project and other applications. After that, some reviews on techniques that will be implemented in this project will be done as a discussion.

2.1   Study on Similar Applications

2.1.1   Google Classroom

Google Classroom [11] is a one-stop application for teaching and learning. It is available on the web and mobile. In addition, it also has a user-friendly and secure platform and can assist the instructors in organizing, evaluating, and enhancing learning opportunities. Teachers can streamline the assignments, boost collaboration, and foster communication within this application. Thus, Google Classroom can help the teachers and instructors to utilize their jobs easily while it is also integrated with other different tools such as Google Docs and so on.

In Google Classroom, there are four types of users which are Teachers, Students, Guardians and Administrators. Users can perform different functions according to their user roles.

Table 2.1.1   Google Classroom Functions based on User Role [11]

Roles	Functions
Teachers	• Conduct a video meeting. • Create and manage classes, assignments, and grades online. • Add content in the assignments such as YouTube videos, surveys, and other files from Google Drive. • Give feedback directly in real-time. • Post announcements in the class stream and start discussions with questions to get students talking. • Encourage guardians and parents to sign up for email summaries that contain upcoming or overdue tasks from pupils.

Students	• Stay informed about classwork and do the assignment submission. • Verify the originality, reviews, and grades. • Exchange resources and communicate via email or the class stream.
Guardians	• Receive a summary of your student's work via email. • Examine the events and announcements.
Administrators	• Set user permissions and secure data. • Create rosters and classes. • Manage the students and teachers in the classes. • Receive assistance round-the-clock.

From the table above, it is clearly showing that Google Classroom is focusing more on the learning process. Teachers can create a classroom and conduct the class in the room while students can join the room and attend the class. Guardians can also easily track the student's work to check whether the students are doing well or not. Administrators can manage the permission and data of their organizations.

However, from the website, it is easy to find that forming an assignment group for students is not the main feature of this application as it is hard to find the information regarding this feature. The features of Google Classroom can be listed as below according to the website [12]:

1. Time-saving features
2. Enhanced grading and feedback features
3. Personalized learning features
4. Organization features
5. Originality features
6. Analytics features
7. Security features

Therefore, according to the provided description of these features on the website, group forming is mainly focused feature in Google Classroom. Moreover, free rider problem is not considered in this application. In a nutshell, Google Classroom is a good learning management system that can help teachers in managing and teaching but not focusing on helping teacher to solve the group forming problem.

2.1.2 Microsoft Team Education

Microsoft Team Education [12] is a team collaboration software that is used to let teachers and students to work together on the Microsoft Teams. It is also available on web and mobile. Users can use Microsoft Team Education to collaborate with each other's in order to engage the learners. Moreover, Microsoft Team Education is providing a lot of functions for users' daily tasks. Users can do a meeting on this application and then allocate the assignments or tasks easily. Thus, the features of Microsoft Team Education can be listed as below:

Table 2.1.2   Features of Microsoft Team Education [12]

Features	Description
Assignments	Users can upload, track, and mark the class assignment.
Screensharing	Users can share their screen in real time to teacher their students.
Immersive Reader	Users can quickly read conversations and chats in a more individualised way.
Whiteboard	Utilize a digital canvas that is unlimited and freeform to collaborate in Microsoft Teams.
Raise your hand	Users can make their point while avoiding upsetting other classmates.
Together Mode	For debates and presentations, adopt a fresh perspective of the entire class.
Accessibility	Get Immersive Reader, live closed captions (US only), and ASL visibility features.
LMS Integrations	With Teams and LMS integrations, users can design unique instructional experiences.
Custom Background	Blur the background of users' meeting, use a free image, or upload own image.
Insights	Users may access student engagement information via a simple dashboard.

From the table above, it is clearly showing that Microsoft Team Education is putting a lot of effort on collaboration area. Most of the features are designed to ease the process of collaboration online. Users can raise their hands and use the whiteboard for discussion during a meeting. Therefore, it is not hard to know that Microsoft Team Education is a system that can be used for teaching and learning virtually.

In addition, Microsoft Team Education is also providing a function to allocate assignment to students by group. From the website [12], users can choose to assign the assignment randomly or manually to a small group. If users choose to assign randomly, users just need to fill in the size of the group and then Microsoft Team will assign the students into groups randomly. However, Microsoft Team Education does not have any other extra functions on group forming topics. Thus, it is clearly showing that Microsoft Team Education is focusing more on the collaboration area instead of user experience of doing and forming assignment groups.

In a nutshell, Microsoft Team Education is a good collaboration application for teachers to teach and students to learn virtually. However, it may still lack some features to enhance the learning process such as group forming issue and free rider problem.

2.1.3   Moodle

Moodle [13] is an online learning management system that can be used to create a private website with a list of dynamic courses that can extend the learning progress by the educators. It is also available on web and mobile. Moodle is providing a lot of different features for users to manage the online learning stuff. Teachers and students will have different features in this application. However, due to the huge number of features that are available in this application, only main focusing features will be studied. Thus, the studied course development and management features for teachers can be shown as below:

1. Direct Learning Paths
2. Encourage Collaboration
3. Embed External Resources
4. Multimedia Integration
5. Group Management
6. Marking Workflow
7. In-line Marking

From the list above, it is clearly showing that Moodle is also having a lot of features to support the teachers teaching task. Moreover, teachers still can assign a group assignment to their students. Moodle do support teachers to create an assignment group manually or automatically. The auto creates assignment group's function can only create the group randomly or alphabetically based on the first name or last name of the students. In a nutshell, Moodle is another application that can help teachers to manage the learning progress but not focus more on group forming issue as students also not having the functions to form group manually.

2.1.4 The Difference between URoom and Other Similar Applications

After studying three different applications, the differences can be listed below:

Table 2.1.3   Comparison between URoom and Studied Applications

	Google Classroom	Microsoft Team Education	Moodle	URoom
Type	Learning Management System	Team Collaboration Software	Learning Management System	Assignment and Group Management System
Virtual Classroom	Focus on Learning	Focus on Collaboration	Focus on Learning	Focus on Assignment and Group Forming
Usage	Teaching and Interaction	Interaction	Teaching and Interaction	Doing Assignment and Group Forming
Flexibility Focus	Teaching and Learning	Collaboration and Interaction	Teaching and Learning	Assignment Life Cycle and Group Experience
Position of Assignment Module	Subset	Subset	Subset	Superset

2.2 Skills for Teamwork

Every member in the assignment group should take the responsibility to contribute their skills and hard work to the group. Thus, being an effective member will be an interesting topic to be discussed in this project. This is because the group member must obtain some necessary skillsets or attributes in order to become an effective member. Therefore, by finding out these attributes and skillsets, it can be used as a reference for teachers and students to form the assignment group.

One of the papers from the University of Waterloo [5] studied about what teamwork skills are needed to be an effective member in a group. In the paper, they had listed down some of the necessary skills that were important to be an effective group member and make the group function effectively in their courses. Therefore, the most important skill will be communication skills. The paper said that the members of the group should be able to communicate well in order to make the group successful. Members should be able to propose their ideas and express

their feelings well. After that, the paper also presented how to build a healthy group climate when they worked together. The skills can be summarized below:

1. Openness
2. Trust and self-disclosure
3. Support
4. Respect

Every member in the group should be trusted and willing to accept the ideas from other members. In addition, the members in the group should try to help and support each other's to achieve their goals instead of viewing others as competitors and not willing to help. Moreover, they should respect each other and focus more on what they can learn instead of blaming each other. Therefore, with these skills mentioned above, a good and healthy group climate can be built and promised. However, in order to be efficient and successful in the group, group members still need to know how to function well in the group. Therefore, this paper had shown some important skills to achieve this goal which can be shown as below:

1. Constructive Criticism
2. Individual Responsibility and Accountability
3. Problem-solving
4. Knowledge of roles
5. Management and organization

All the group members should make an agreement on what needs to be done by whom. After that, the members of the group choose the tasks that they want to take responsibility for finishing it. They are responsible for their own work and hold others responsible for theirs. Besides, feedback on group ideas and members' tasks could be given and received by every group member. Making suggestions for improvement and presenting concepts and behaviours to others are necessary components of constructive criticism. Moreover, members of the group contribute to the development and implementation of crucial tactics for the group's goals. Thus, they can support group decision-making and help people dispute in a positive way. In addition, members of the groups should be proficient in task planning and management. For instance, a member can establish a meeting and meeting objectives and make sure that every member is involved in the meeting. Furthermore, the group's members should be aware of the many roles that can be played therein, including those of facilitator, idea generator, and so on, as well as the role(s) that they and others are most fit for. Therefore, with these skills, the group will be successful and efficient.

This paper also mentioned that the instructors could also take some actions to develop a healthy climate within the group or help them to success in the group. The instructors can try to group them into a diverse group. Therefore, every group member will have a different background. This will make the group easier to success as every group member may be good at different areas instead of same areas. Moreover, the instructors can also develop a series of tasks for them. In this case, they can distribute their tasks easier and can work together better. Thus, actions from the instructors are having impact towards the group result.

2.3   Impact of Negative Reviews towards Users

If one of the group members is not trying to contribute their skills to their group assignment, this group member can be called a free rider. Thus, this is another interesting topic that can be discussed to find out a way to reduce chances of free rider problem happening. If the system can mark down or record this case down into the database and then show it to other users, will that student face any impact on their school life? Therefore, by finding out the impact of negative reviews, it may be helpful to find out a way to reduce the likelihood of free rider problem.

A paper from Colorado State University which is written by Alllson Sylte [6] had studied about the reason of negative reviews could have more of an impact on some of the most important customers. Alllson Style said that when someone receives a bad review, this bad review will provide the person with more indications for he or she to do decision making than the anticipated favourable does. A person's mindset is more drastically altered. Thus, the negative and positive reviews regarding the online services can be applied with the same theory. Besides, from the paper, it had proved that negative reviews will have higher impact than positive reviews. Moreover, these negative reviews will be valued more by future potential customer or user. Thus, any experienced or potential customer or user will likely be affected by the negative reviews and rather to choose other products or services. This is because a negative review may contain more information than a positive review. People would like to talk more about the product or service when they do not like it. However, if the bad reviews are already existed for a long time, it may have lesser impact to the potential customer or user. In a nutshell, negative reviews will have more impact than positive impact and it will affect the potential customer or user decision making.

2.4   Possible Algorithms' Implementation for Auto Assign Function

Teachers always can assign the students' assignment group automatically with the auto assign function. However, the concern on how to assign the students into a series of group within a short period with an acceptable result should be resolved. Thus, in this section, three algorithms will be studied to find out an idea to develop the function.

2.4.1   Greedy Algorithm

Greedy Algorithm is an algorithm that is usually used on optimization problems. Dipta Roy [7] said that this kind of algorithm will be used to solve the problem by selecting a solution that can be shown as the most appropriate at a particular moment. Greedy Algorithm usually produces the effective solutions that are close to optimal under two conditions. The first condition will be the "Optimal Structure", which contains solutions to subproblems of an optimal solution. The second condition will be the "Greedy Choice Property", which makes locally optimal decisions based on its current situation. However, Greedy Algorithm often fail to find a global optimal solution as the algorithm do not exhaustively work on all the data at once. This is problematic because some decisions that had been done on a early stage may prevent the algorithm to find the best global solution instead of the best local solution. Therefore, if Greedy Algorithm can be proven to come out a global optimum in a system, it can be the first choice for that system.

A paper from ResearchGate with the title of "Carousel Greedy: A Generalized Greedy Algorithm with Applications in Optimization" [8] had proposed an improved version of Greedy Algorithm called Carousel Greedy Algorithm. The proposed algorithm can investigate a larger space of potential solution than a normal Greedy Algorithm while only slightly and predictably increasing processing effort. The paper had also proved that the proposed algorithm had a significant improvement compare with other algorithms. The outline of this proposed algorithm can be shown as below:

1. Using Greedy Algorithm to provide a partial solution.
2. Modify the partial solution using the same Greedy Algorithm in a deterministic manner.
3. Using the Greedy Algorithm to create a full, workable solution.

It is having the similar idea with the algorithm that is proposed by Ruiz and Stutzle [9] in 2007. The idea can be tabled as below:

Table 2.4.1   Basic steps of Ruiz and Stuzle's Algorithm [9]

Steps	Process
1	Use Greedy Algorithm to come out a feasible solution.
2	Modify and remove some elements of the solution and save it as a partial solution.
3	Use Greedy Algorithm to come out another feasible solution from the partial solution.
4	Keep repeating Step 2 and Step 3 while the stopping condition is not met.

They had applied this proposed algorithm to solve the permutation flow shop scheduling problem. Thus, from the studies above, it is clearly showing that Greedy Algorithm can be modified based on the requirement of the system or project. Therefore, if the original version of Greedy Algorithm cannot be proved that it will come out a global optimum solution, some modifications should be done to meet the expectations.
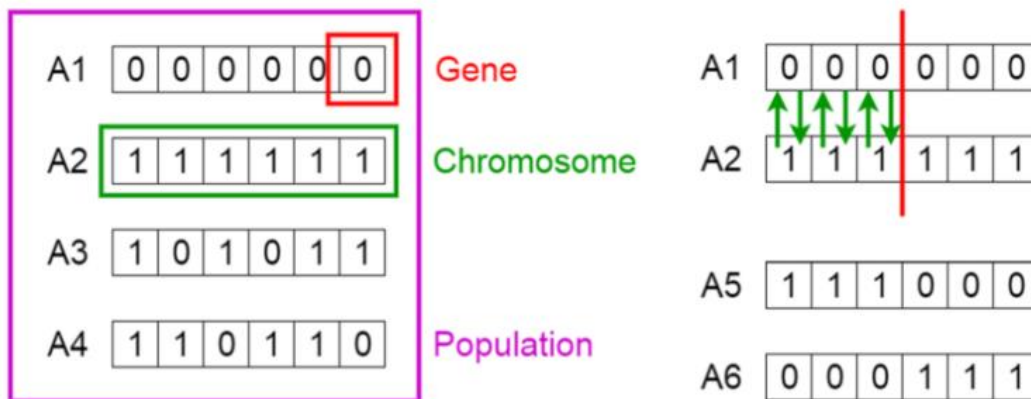
2.4.2 Genetic Algorithm

Figure 2.4.1 Genetic Algorithm Overview [10]

Genetic Algorithm is a search algorithm. Vijini Mallawaarachchi [10] said that this algorithm can be understood as the fittest people are chosen for reproduction in order to give rise to the next generation's children which is like how the natural selection works. The initial stage of natural selection is the selection of the population's fittest members. They have children who inherit their parents' characteristics and become a part of the next generation. Children born to parents who are physically fitter will perform better and have a better chance of surviving. The constant rounds of this process will finally lead to the emergence of the fittest generation. Therefore, it can be concluded into five phases.

1. Population Initialization Phase
2. Fitness Phase
3. Selection Phase
4. Crossover Phase
5. Mutation Phase

In the first phase, population refers to the set of individuals. Every individual in the population is the solution of the problem. A set of parameters will be used to characterize the individual in the population which is also called as Genes. A chromosome is made up of a string of genes. Thus, a string, or an alphabet, is used in a genetic algorithm to represent a person's collection of genes. In the second phase, the fitness function gauges a person's level of fitness. The system assigns a fitness level to each individual. An individual's chance of being selected for reproduction is calculated based on its fitness score. After that, Selection Phase will be conducted. The third phase's goal is to choose the fittest individuals so they can pass on their genes to the next generation. Using the results of their fitness tests, two groups of people are chosen. People that are physically fit are more likely to be selected for reproduction. The crucial stage of a genetic algorithm is the fourth phase, Crossover Phase. For each pair of parents to mate, a crossover site is chosen at random from the DNA. An example from Vijini Mallawaarachchi's article, assuming the crossover point to be 3.
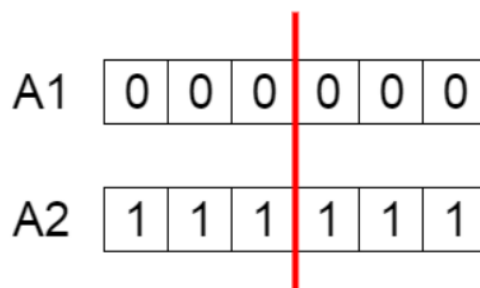

Figure 2.4.2 Crossover Point [10]

Parents' genes are exchanged among one another until the crossover point is achieved, at which point offspring are produced.
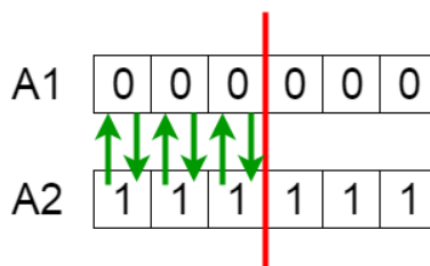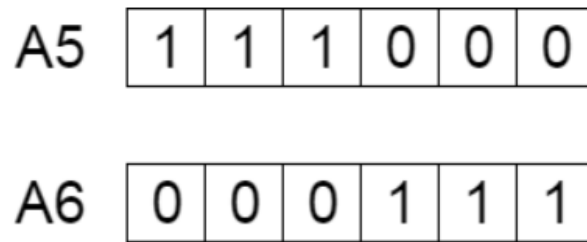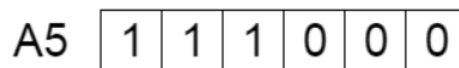

Figure 2.4.3 Exchanging Genes [10]

Figure 2.4.4 Result (New Offstring) [10]

Lastly, it will be the fifth phase which is the Mutation Phase. Some newly generated offspring genes are susceptible to random mutations with low probability. This indicates that some bits in the bit string can be reversed.
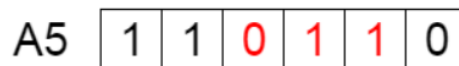

Figure 2.4.5 Mutation [10]

Usually, mutation is used to preserve diversity throughout the population and avoid early convergence. Until now, if the population has converged, the algorithm is finished else repeat phase two to five.

2.5   Implementing Real Time Collaborative Text Editor with WebRTC and CRDT

In this project, a real time collaborative text editor will be built for students to do their group assignment together. Thus, finding a way to build this module is an important topic. An article from Sunny Beatteay [16] had discussed about how to build a real time collaborative text editor in the article. He had also mentioned that there are having three difficult parts to build a real time collaborative text editor.

The first difficult part is combining incompatible actions while upholding consistency among all users. Consistency among all users is important for a collaborative text editor. All users must view the same contents in order to avoid redundancy. For an example, a text "HAT" is having a value "H" at the first place with the value of position 0, "A" at the second place with the value of position 1 and "T" at the last place with the value of position 1. One of the users is trying to insert a "C" in front of the first place "H" while another user is trying to delete the

letter of "H". The system needs to show the result of "CAT". Thus, the system always needs to ensure that every operation that made by users can be consistent.
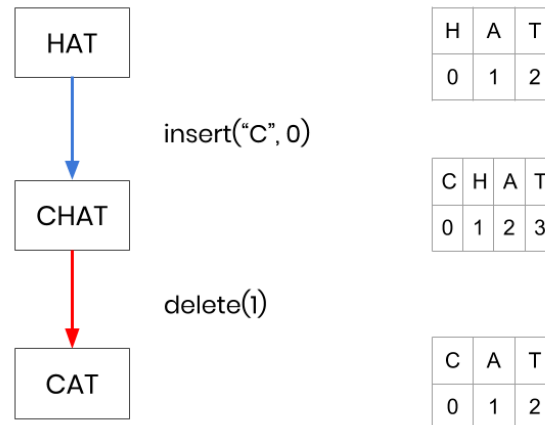

Figure 2.5.1 Visualization for "HAT" [16]

Therefore, when there are multiple concurrent users are accessing the same document, the system needs to provide a local copy of the document to every user. The users must also have the ability to make edits to the document. After that, in order to communicate with others to combine the modification of each user, a Central Relay Server will be used to do the communication.
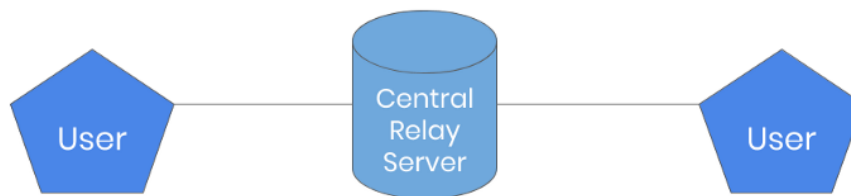

Figure 2.5.2 Two concurrent user communicate through a central relay server [16]

However, inconsistent may be met especially when the systems do not fulfil the requirements below:

- Commutativity

  No matter what order they are used, concurrent insert and remove operations produce the identical outcome.

- Idempotency

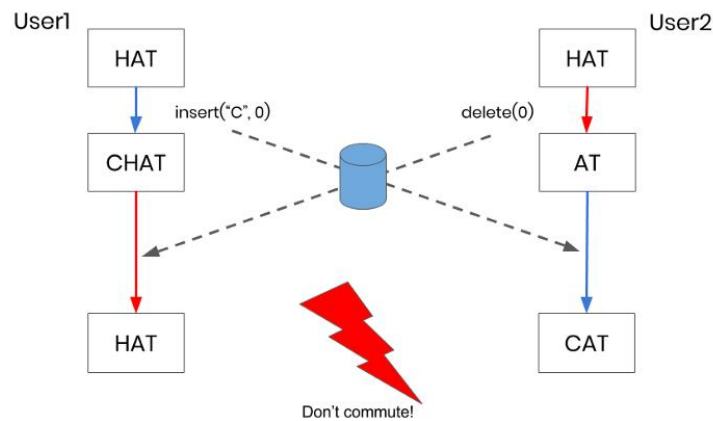 The same outcome is obtained from repeated delete operations.

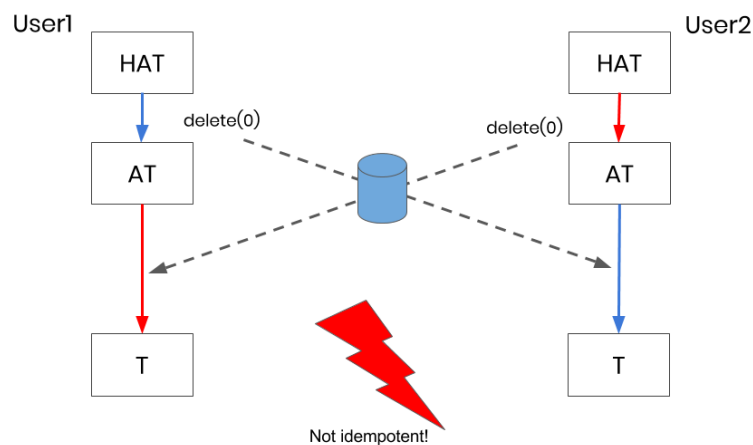Figure 2.5.3 Example of the system does not commute [16]

Figure 2.5.4 Example of the system does not idempotent [16]

However, Sunny Beatteay [16] had introduced a solution to solve the problem mentioned above. CRDT technique will be implemented as the solution of the inconsistency problem. CRDT is Conflict-Free Replicated Data Type which is operating by making each character in the document a distinct object with a set of predetermined qualities.

- Site Id

  It is used to identify the individual who built it.

- Value

  The letter that the object stands for.

- Position

  a collection of integers that indicate the character's location within the document. This location is in relation to the nearby characters.
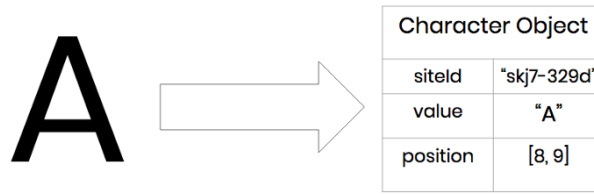
Figure 2.5.5 CRDT objects' example [16]

It can be used to stop any character from being added or removed more than once since each character is distinct and can be recognised by these features. Commutativity and idempotency are thus made possible. Additionally, even if the characters around the characters are erased, the locations of characters in the CRDT remain constant. Hence, the position of the character is also called as relative position. The relative position can always be used to pinpoint a character's placement within a document.
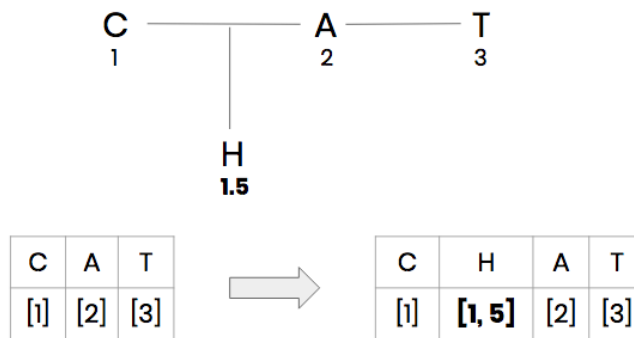

Figure 2.5.6 Example of relative position [16]

Hence, by implementing CRDT, the system will fulfil the requirements of Commutativity and Idempotency.
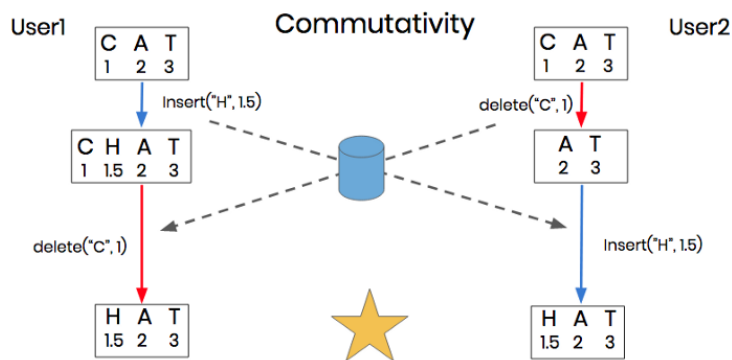

Figure 2.5.7 Example of Commutativity with CRDT [16]

The system can be more precise about the letter that the user is deleting and its location by using relative positions. Commutativity is promised.
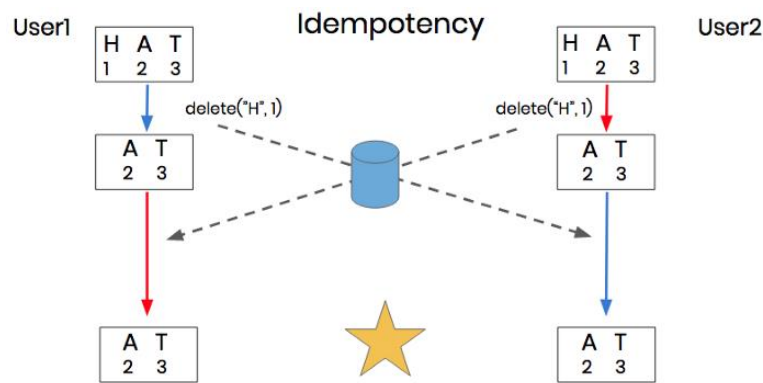
Figure 2.5.8 Example of Idempotency with CRDT [16]

In addition, due to each character is distinct, the system is unable to remove it more than once by implementing CRDT.

The second difficult part is minimising delay as much as possible to produce effects in real time and the third difficult part is the real-time application's scaling. Thus, these two parts can be summarized as the latency and the scaling of the system. The client-server model of communication is the foundation of the present system architecture of Sunny Beatteay [16]. Each user establishes a WebSocket connection with a Central Relay Server. By relaying all network operations from one user to every other user, the central server serves as a hub. However, the Central Relay Server is having some limitations. Firstly, a disproportionately large latency between users is the first restriction. The server serves as the conduit for all operations. Users must use the server to communicate even if they are seated next to one another. The second limitation is that scaling a central server might be expensive. The amount of work required by the server increases as the number of users does. The server would need more resources and cost more money to support it. Lastly, relying solely on a single server result in a single point of failure. All users would be unable to communicate with one another immediately if the server were to crash. Hence, Sunny Beatteay [16] had proposed a solution to resolve the limitations by using the peer-to-peer architecture. Each user can function as both the client and the server instead of having one server and multiple clients. A user can inform all other users to whom they are linked whenever they make a modification or receive an action from another user. Therefore, WebRTC will be used to achieve this goal. WebRTC is Web Real Time Communication and usually used for communication through peer-to-peer connections. Although WebRTC allows for direct connections, the "signaling" process that starts these peer-to-peer connections needs to be started by a tiny server. Although WebRTC depends on this signalling server, no document content is ever transmitted via it. It serves only to establish the link. The signalling server is not required after a connection has been made.
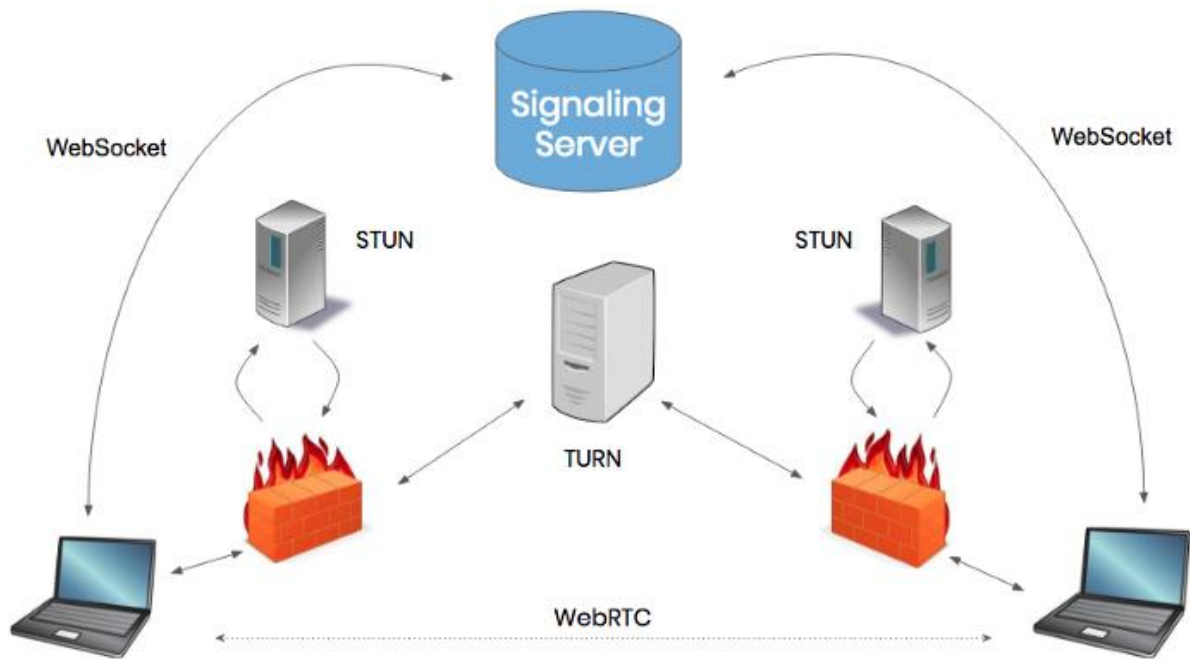
Figure 2.5.9 Peer-to-Peer with WebRTC [16]

On the other hand, there is still have a concern about maintaining the causality. To ensure causality in the context of a collaborative text editor is to ensure that all operations are executed in the order they were submitted. However, it is hard to maintain the causality in a P2P system that is using WebRTC. This is because WebRTC is using the UDP transport protocol. UDP enables users to transmit messages fast without waiting for a response from the recipient, which reduces latency. The disadvantage is that it does not ensure packet delivery in the correct order. Therefore, the system cannot promise that the received operations are in order. However, Sunny Beatteay [16] had proposed a technique called Version Vector as a solution to this problem. The system sends the character's Site ID and Site Counter value together with the character object and operation type whenever an operation is sent out. The Site ID identifies the user who sent the operation in the first place, and the Counter shows which operation number came from that specific user. A delete operation is instantly put in a deletion buffer when it is received by a peer. If it is an insert operation, the system could insert it right away. However, if it is a delete operation, the system must first ensure that the character has been added. The deletion buffer is "processed" after each operation by another user to see if the relevant character has been inserted. If so, the deletion procedure can be carried out. Hence, until now the system design is completed.
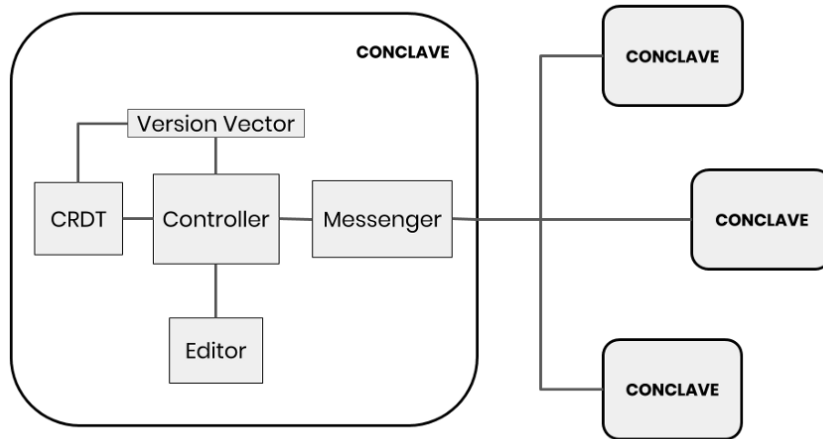
Figure 2.5.10 Final System Design [16]

An illustration of one of the user flows might resemble as the following:

1. In the user's text editor, the user enters a letter.

2. That modification is made into a character object and added to their CRDT.

3. Using a Messenger class, which is effectively a WebRTC wrapper, that local insertion is propagated out to the other users.

4. Operations from other users are likewise received by that same Messenger class. Before being added to the editor, the received operations are checked against the Version Vector and CRDT.

To coordinate all the various parts and guarantee flawless operation, a Controller class is implemented.

Chapter 3

System Methodology/Approach

In this chapter, the approach that has been implemented in this project will be discussed. Hence, the project methodology will be presented.

3.1   Project Methodology

In this project, the system development methodology that had been applied is Personal Extreme Programming (PXP). From Yani Dzhurov, Iva Krasteva, and Sylvia Ilieva [17], PXP is a development approach that can be implemented by a programmer who is alone. The process phases of the PXP can be shown as below:
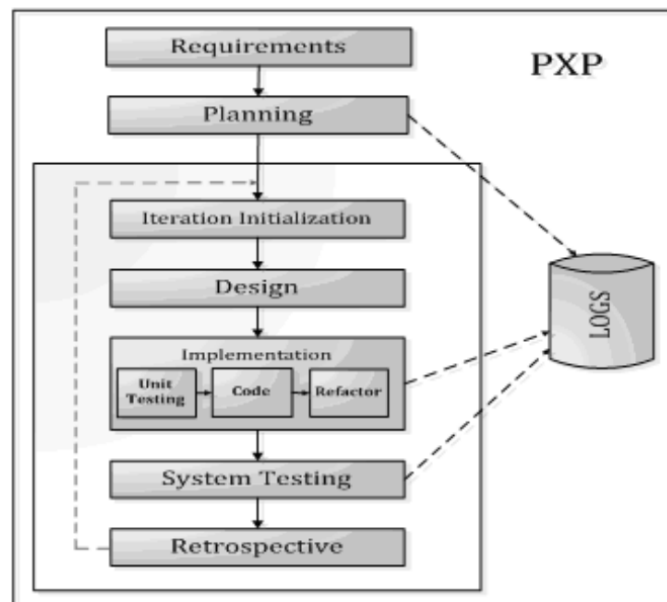

Figure 3.1.1 Process phases of PXP [17]

Firstly, the requirements for this project will be assembled. The requirements are extracted from the study of previous works and the goals of this project. Thus, the problem statement and objectives of this project will be proposed at this moment. Later, planning phase will be conducted to arrange and plan the development timeline. Project scope and direction will be defined in this phase. After that, the development of the project will be conducted. The developer will start to initialize the interaction of the task and design the system model. When the design phase is completed, implementation phase will be conducted to do the coding jobs. Unit testing, code generation and code refactoring will be done at this moment. When the

building module can be executed without any error which means pass the unit testing, a system testing will be conducted to verify whether the built module meets the requirement or not. Lastly, the retrospective phase will be conducted as a last checking to the built module to check whether the built module is met the expectation of the design such as performance. After that, the developer can continue to the next development task until all tasks are built successfully. Thus, the workflow of this project will base on the process phases of PXP. Therefore, the workflow of this project can be divided into five parts which are Requirements Gathering, Planning, Implementation, Testing and Deployment.
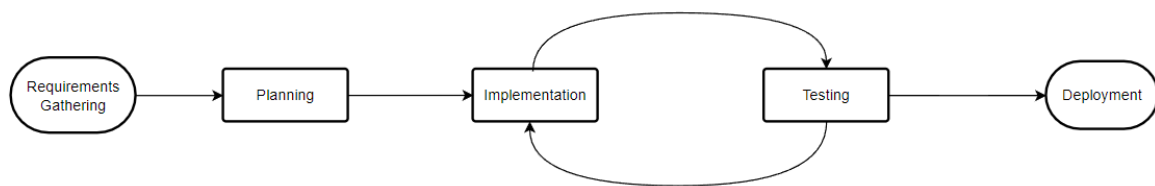

Figure 3.1.2 Workflow

The first part will be the Requirement Gathering. All necessary requirements should be clearly defined and listed at this moment. When all of the requirements are collected successfully, Planning will be conducted. The project scope and direction of this project should be defined clearly at this point. The result of this Planning part will be used as the development direction of this project. The timeline of the development should also be proposed at this moment. After that, the implementation of the system should be started. All the requirements of this project should be developed well and can operate without error. However, every single state of the implementation should comprise with a Testing part. When the developer finished developing a single module, it should directly start doing the Testing. When all the modules and requirements have been fully developed, Deployment should be conducted right after that.

3.1.1 Requirements

Before developing the system, requirements should be gathered. Hence, based on the scope of this project, the requirements of this project can be separated into six parts. The owner refers to the owner of the room while the member refers to the member of the room.

1. Assignment Room Module
   a. The user can create a room.
   b. The user can view the room.
   c. The user can join the room with an invitation link.
   d. The owner can make announcements in the room and members can view it.

2. Assignment Module
   a. The owner can upload an assignment.
   b. The owner can set the due date, download link of the assignment and the required group size of the assignment.
   c. The owner can create some task templates for the assignment.
   d. The member can view the assignment details.
   e. The member can download the assignment with link provided.
   f. The member can view the task templates.

3. Assignment Group Module
   a. The owner can view and manage the students' assignment group data.
   b. The owner can assign assignment group for the students based on the ratings of students' skillset automatically.
   c. The owner can assign assignment group for the students manually.
   d. The owner can manage the permissions of the students in the group.
   e. The owner can view the students' reported free rider cases.
   f. The owner can mark a student as free rider.
   g. The owner can assign leader and moderator for the students' group.
   h. The owner can view the tasks that have been done by the students in the group.
   i. The owner can view the task history.
   j. The member can view and send a group forming request to form assignment group manually.
   k. The member can view the reported free rider cases and ratings and reviews of other members before sending the group forming request.
   l. The member can accept or reject the group forming request.
   m. The members can manage their assignment group.
   n. The member of the group can create some activities as the announcements.
   o. The member of the group can view the assignment group member list.
   p. The member of the group can become a leader.
   q. The member of the group can report other group members as free rider.
   r. The member of the group can create different types of tasks and assign to other group members.
   s. The member of the group can accept or reject the assigned task.

t. The assigned member can update or delay the task completion date.

u. The members of the group can reopen the task.

v. The member of the group can view the recent activities of the tasks.

w. The member of the group can view the task histories.

x. The moderator can approve the task update.

y. The system can prevent the free rider to update the tasks.

4. Chatroom Module

a. The system can create the group chat automatically after assignment group has been formed.

b. The user can view a list of group chats.

c. The user can send message in the group chat.

d. The user can view the messages in the group chat.

e. The user can view who is online in the group chat.

f. The user can manage tasks in the group chat.

5. Real Time Collaborative Module

a. The user can do assignment in real time together.

6. Assignment Submission Module

a. The owner can view all submissions of the assignment.

b. The owner can view the submission details and update the mark of the submission.

c. The member can submit the assignment with the document in the real time collaborative module or by an URL.

d. The member can view the summary of the submission before submitting the assignment.

e. The member can write some reviews for other groupmates.

f. The member can view the reviews from the other members.

g. The system can update the ratings of the user after some reviews have been made.

3.1.2 Project Timeline

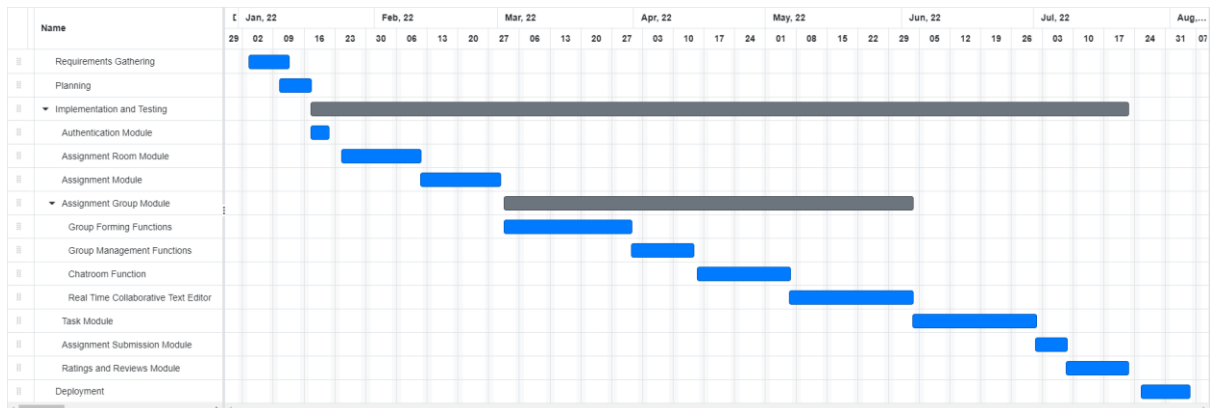Based on the workflow of PXP, the project timeline should be planned as below.

Figure 3.1.3 Project Timeline

The Requirement Gathering phase shall be conducted on 03 January 2022 and end on 12 January 2022. The Planning phase shall be conducted on 10 January and end on 17 January 2022. The Implementation and Testing phase shall be conducted on 17 January and end on 22 July 2022. The Deployment phase shall be conducted on 25 July 2022 and end on 05 August 2022.

3.1.3 Tools used

The development of this system is involving three important parts which are the frontend development, the backend development, and the database. Therefore, different tools have been used in this project based on the development type. Hence, the following table is showing all the tools that have been used in this project based on the type.

Table 3.1   Tools Used

Type	Tools Used
Frontend	- React.js (Library) - MUI (UI Design) - XState (State Machine) - Tiptap (Text Editor) - Axios (Make HTTP/HTTPS Request) - YJS (For Real Time Collaborative) - Socket.IO – Client (Chatroom)
Backend	- Node.js - Express.js

		• Crypto.js
		• Mongoose
		• Redis
		• Socket.io
		• YJS
		• Y-protocol
		• Y-leveldb
		• WS
Database		• MongoDB
		• LevelDB

According to the table above, React.js will be used in the frontend side as the main library for the development of the web application as this web application will be a single page application. Hence, React.js will be helpful to build a single page application easier. MUI will be used as the primary tools of the web application UI/UX design. MUI provides a lot of styled components and can be used immediately in the project. Hence, it can save the times of designing the user interface. XState will be used to control and manage the behaviour of the web application. It will be used as a state machine of this project. Axios will be used to make the HTTP/HTTPS request in order to communicate with the API. YJS is a tool which is using the CRDT concept to achieve real time collaboration. Hence, it has the ability to be a helping tool to achieve the goals of building a real time collaborative text editor. Socket.IO offers bidirectional, event-based, low-latency communication between a client and a server. Therefore, by using this tool, the web application can communicate with backend server and enable the users to do the chatting. The web application will send a request to the socket and the socket will emit all the updates to every user in the same room.

For the backend side, Node.js will be used as the environment of the servers. Express.js will be used as the framework to build the servers faster. Cryto.js will be used to encrypt some important data before using it. Mongoose will be used as a bridge to communicate with the MongoDB database. Redis will be used to store some important data temporarily. Hence, Redis will be used as a cache. For example, storing the user that is online in the chatroom. YJS, Y-protocol, Y-leveldb and WS will be used in the signaling server. These tools will be used as a bridge to communicate the users in order to achieve real time collaboration. The main database that will be used in this project will be MongoDB while LevelDB will be used in the signaling server to store the document data.

3.1.4 Verification Plan

Unit Testing and System Integration Testing (SIT) will be conducted to verify overall functionalities of this project. After every single component or module is developed, Unit Testing will be conducted to check the functionality to avoid fatal error occur in the developed unit. When all the modules are completed, SIT will be conducted to verify the integration of the system is functionally capable to operate. If the system is proved as workable and functionable with the test above, this system will be considered as completed. However, in order to verify the system is achieving the objectives, the following criteria should be fulfilled. The evaluation of the objectives based on this plan will be done in Chapter 6.

1. Plan for verifying the reduce the likelihood free rider problem occurs objective.
   a. The system is providing a page to view user's reported free rider cases and the ratings and reviews.
   b. The system is providing a function to report free rider and mark a student as free rider.
2. Plan for verifying the imbalanced group problem and the problem of managing students' assignment group data can be avoided objective.
   a. The system is providing a function to assign assignment group automatically based on the selected skillsets and the result of every assignment group is heterogenous.
   b. The system is providing a module to view and manage the students' assignment group data.
   c. The system is providing a function to manage the student in the assignment group.

Chapter 4

System Design

In this chapter, the design of this system will be discussed. Thus, the system overview will be presented. After that, the system flow and the design of the NoSQL database will also be discussed. Besides, the design of the auto assign function will be discussed in the algorithm design section. Lastly, the design for the deployment will be proposed.
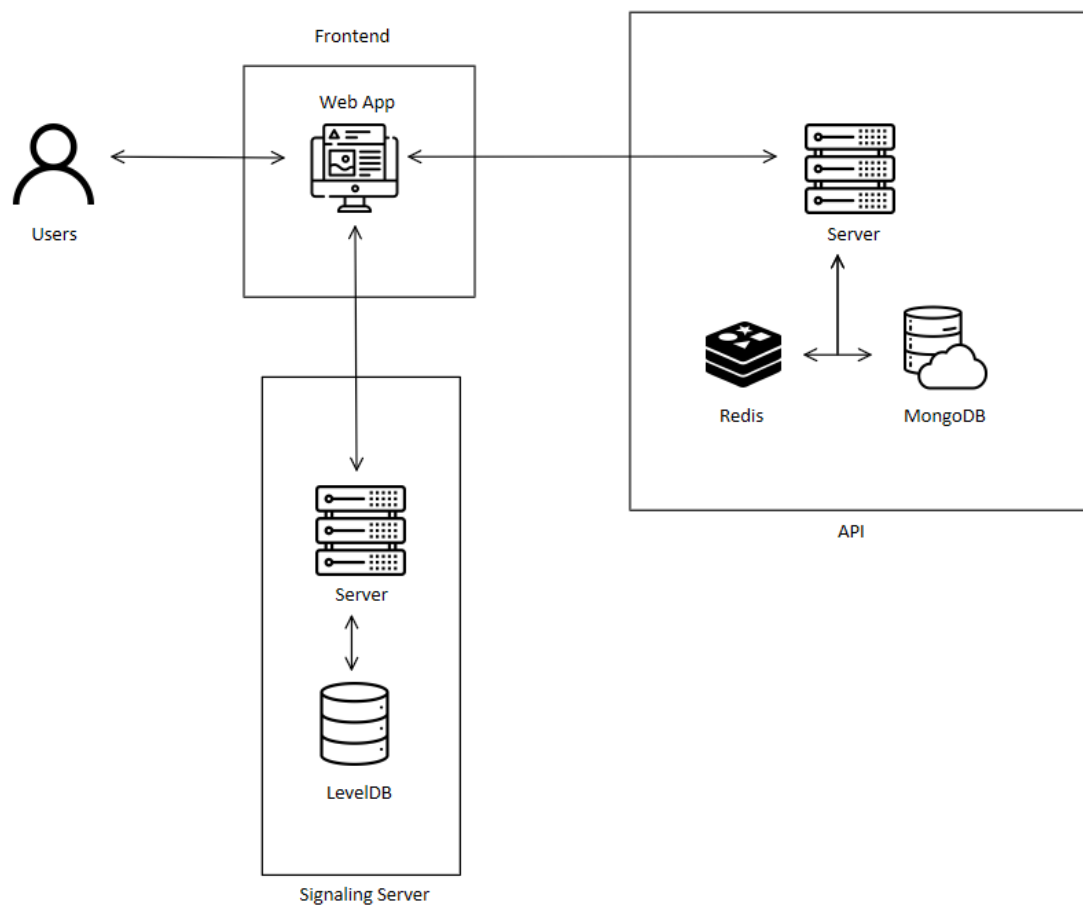
4.1 System Architecture

Figure 4.1.1 System Architecture Diagram

From the figure above, it clearly shows that the users can access the system with a web browser that is installed on their computer. Users always can access the system with a valid link. The frontend application will take the responsibility to communicate with the backend servers. Thus, the frontend application which means the web app will mainly focus on displaying the interface to the users to interact with. Hence, users can input data or view the data easily via

the web app. When the users want to request some data from the database, the web app will send a request to the backend which is the API. The API will then communicate with the database, MongoDB, to get the relevant data. The API server will process the data from the database and then send a response with the data back to the frontend side. Once the frontend application receives the response, it will display the data to the users. This is the general overview of how the system works.

However, this system also contains a chat system. Therefore, a web socket is necessary in order to enable the users to chat in real time. Therefore, the server will open a port to do the communication between the client (frontend) and the server (backend). Hence, Redis will be used to store the data to find out who is online as a cache. Thus, Redis will continuously communicate with the server and then store the chat messages into the database.

On the other hand, a signaling server will also be built in this project. This server will be used for the real time collaborative text editor feature. Users will be able to do their assignment in this system in real time. Thus, there is a need to connect the users together to do the assignment. Hence, this server will be used as a bridge to connect the users. Therefore, when the users are doing the assignment in the frontend application, the frontend application will keep communicating with the signaling server to communicate the user with other users. All the modifications that have been done on the frontend side will be stored in a database called LevelDB. Hence, with this signaling server, users will be able to collaborate easily to do the assignment in the web app.

Hence, based on the discussion above, it is not hard to find that the system architecture that has been implemented in this project is a three-tier architecture. A frontend endpoint which can be shown as a presentation tier will be used for displaying the data and two backend endpoints will be used to process the data. Each of the backend endpoints will have a server which can be shown as a logic tier and a database which can be shown as data tier.

4.2   System Overview

In this project, it will be separated into three parts which are frontend, backend, and database. The frontend application will focus on data display while the backend applications are focusing on the data processing. Databases will be used to store and retrieve the data. Hence, the system can be virtualized as below.
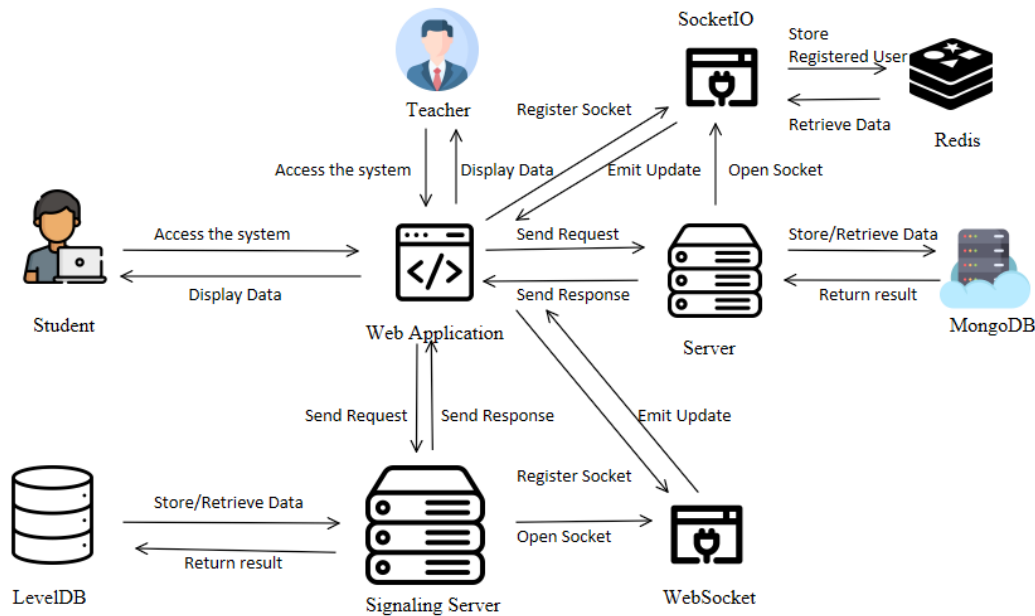

Figure 4.2.1 System Overview

According to the figure above, there will have two users that can access to this system which are the student and the teacher. However, in this system, these two users will be generalized as one user. The user can access to the web application with a browser. The web application will ask the user to do the authentication and then call the server to check the user identity. The server will retrieve relevant data from the MongoDB database and process the data to verify the user identity. Hence, it is clearly telling that the web application will be used to display the data and receive the inputs from the user. After that, the web application will send a request to the backend server and the backend server will process the request and return the response.

This system is also having a chatroom module. Thus, a web socket will be used. In this system, Socket IO will be used to achieve the chatroom feature. The web application will firstly call the server and then the server will open the port to listen the message. After that, the web application will register as an active user at the port. The port will store the active user data into a Redis cache. Hence, every time the web application wants to display who is online to the user, it will send a request to the port and then the port will find who is online from the cache

and send back to the web application. Additionally, every time a user sends a chat message to the server, the server will call the web socket to emit the messages to all the users in the same chatroom before storing message to the database. The web socket will then emit an update of the messages to every user in the same chatroom.

Besides, this system is also implementing the real time collaborative module. This is a module that have a text editor to let users do assignment together in real time. Hence, a signaling server will be built. This signaling server will be used as a bridge to let the users to communicate and do the assignment in real time. Therefore, every time a user opens this module, the web application will firstly send a request to the server to get the document first. After that, it will send a request to the signaling server to build the bridge. Other users can do the assignment together by opening the same module and build the bridge and connect together. It will focus on solving the concurrency issue in order to promise that every user will see the same result and no race condition happens. The generated data of this server will be stored into LevelDB. In a summary, the web application will focus on display data and then communicate to the servers based on the opened module. If the module is using a web socket to achieve real time feature, the web application will keep listen to the web socket port. By implementing this design, all the modules that mentioned in the project scope can be built without errors and workable.

4.3   System Model

4.3.1   Use Case Diagram
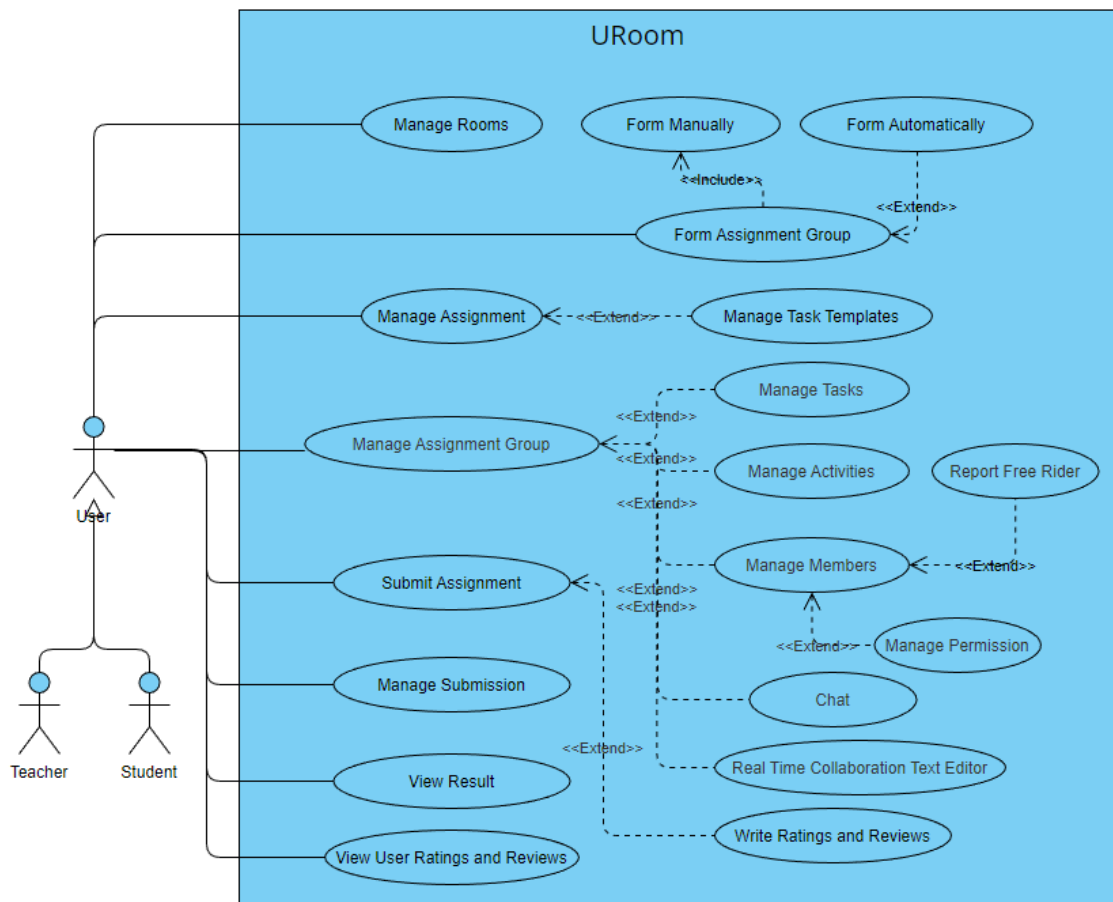
Figure 4.3.1 URoom Use Case Diagram

From the use case diagram above, it is showing all the features that will be developed in this project. Students and teachers will be using this system as a normal for their class assignment. However, in this system, teacher and student will be generalized as a single user. The users will have different permissions based on the ownership of the room they joined only. Hence, the owner refers to the owner of the room while the members refer to the member of the room they joined. Firstly, a user will be able to manage the rooms which mean the classroom of the system. The user can create and invite other users to join the room. After having a room, the owner of the room can upload some assignments in the room. While uploading the assignment, the owner of the room can also create some task templates for the members of the room. After the assignment has been uploaded successfully, the members of the room will be able to view the uploaded assignment and also the task templates of the assignment. The members also can form an assignment group for the assignment based on the assignment requirements. The owner

of the room can choose to assign the assignment group for the members automatically or letting the members to form their assignment groups manually. Additionally, the members of the room always can view other ratings and reviews before forming the assignment group. When the members of the room have formed an assignment group successfully, they will be able to manage their assignment group. They will have the permission to create an activity, create some tasks or import the task templates and view the members of the group. The members of the group are also allowed to select a leader and report the free rider in the case of managing assignment group. On the other hand, the owner of the room will be able to view and manage all the assignment groups of the assignment in the room. He or she can manage the members of the assignment group by adding or removing permission, view the tasks that had been done by the member and identify who is the free rider. Moreover, the members of the assignment group will be able to do their group discussion by chatting and do their assignment together in a real time collaborative text editor. After they have finished doing the assignment, one of the members of the group can submit the assignment. When the assignment has been submitted, all the members of the group will be able to give some rating and reviews to their groupmates. At this moment, the owner of the room will be able to manage the submission. He or she can view the submission and upload the result of the submission. When the result has been uploaded, all the members of the group will be able to view the result.

4.3.2 Activity Diagram

In this section, a few activity diagrams of the important features of this system will be presented. However, some of the features which are only involved with some simple operations such as creating a new object and then viewing it will not be included in this section.

The first diagram will be the room creation and assignment upload activity. This diagram shows how to create a new room and upload an assignment.
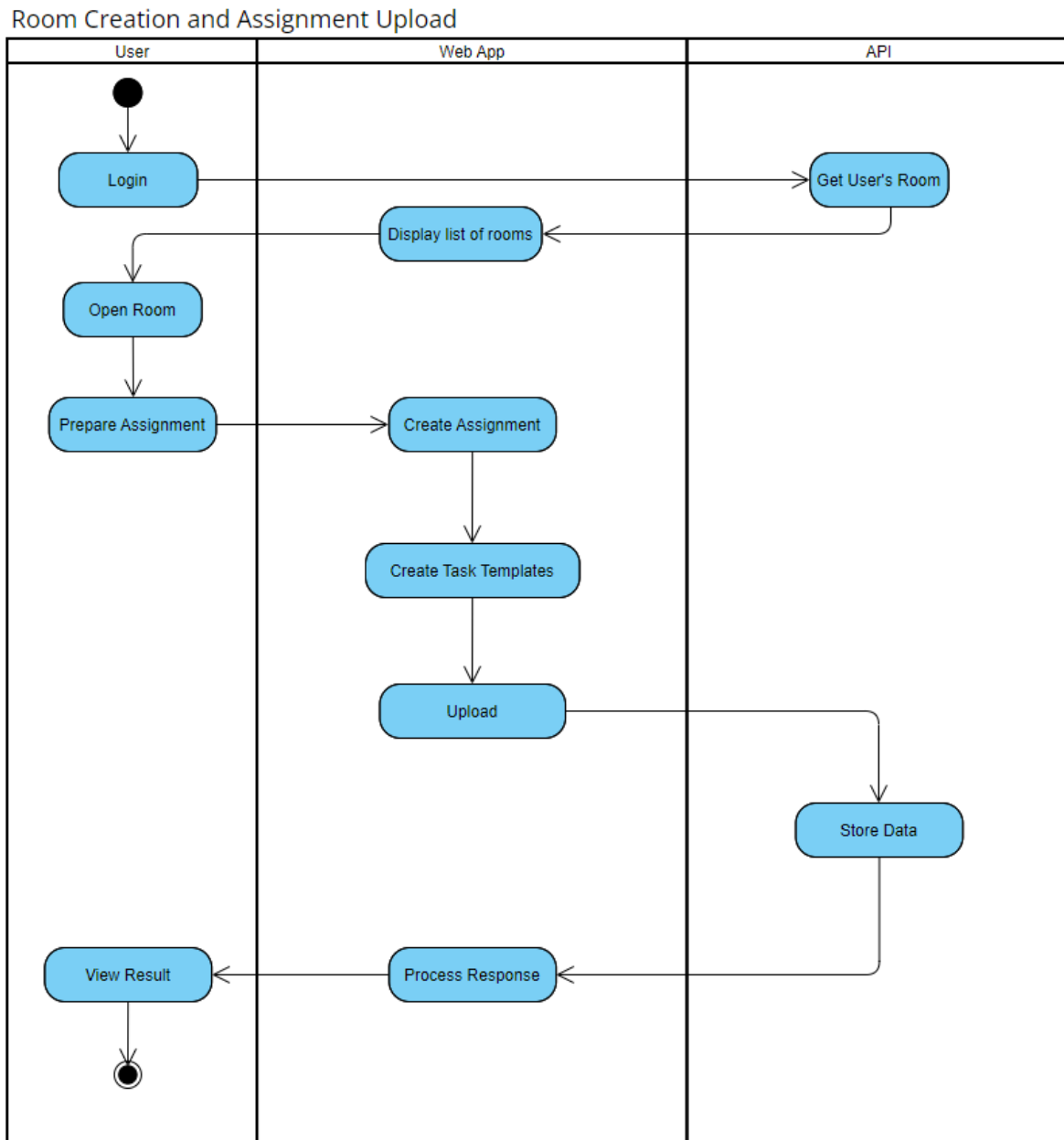
Figure 4.3.2 Room Creation and Assignment Upload

The second diagram will be a group forming diagram from the owner perspective. The owner will be able to assign the assignment group for his or her students automatically.
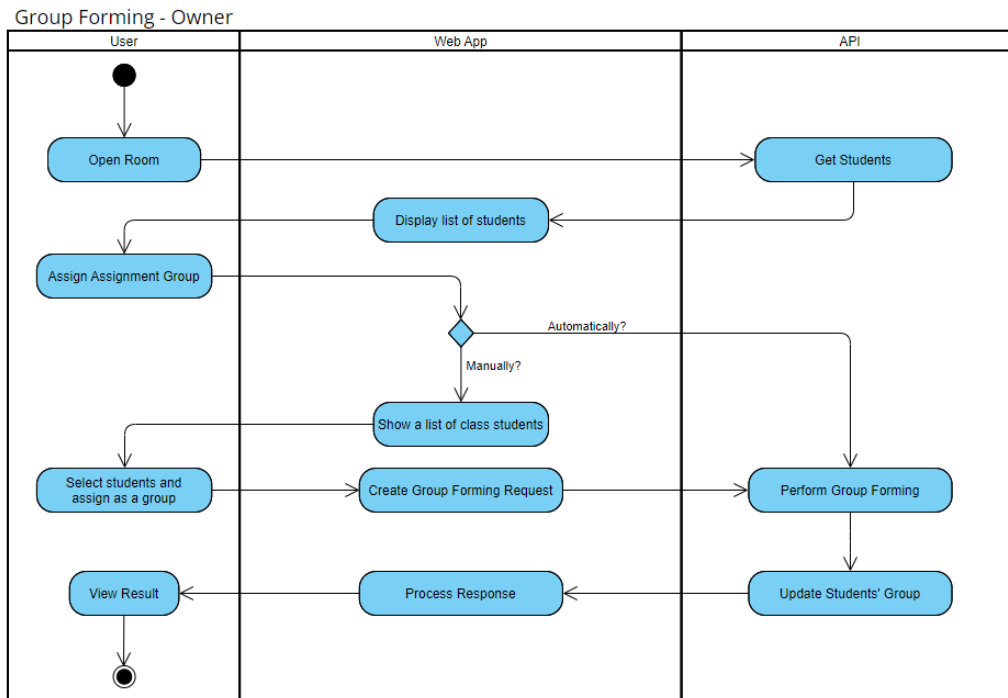
Figure 4.3.3 Group Forming (Owner)

The following diagram shows the activity of forming assignment groups manually by students. They will need to send a group forming request to the students that they are intended to form the group together. Thus, it will be separated into two parts which are sending a forming request part and accepting the request part. Group will be formed when the students accept the request.
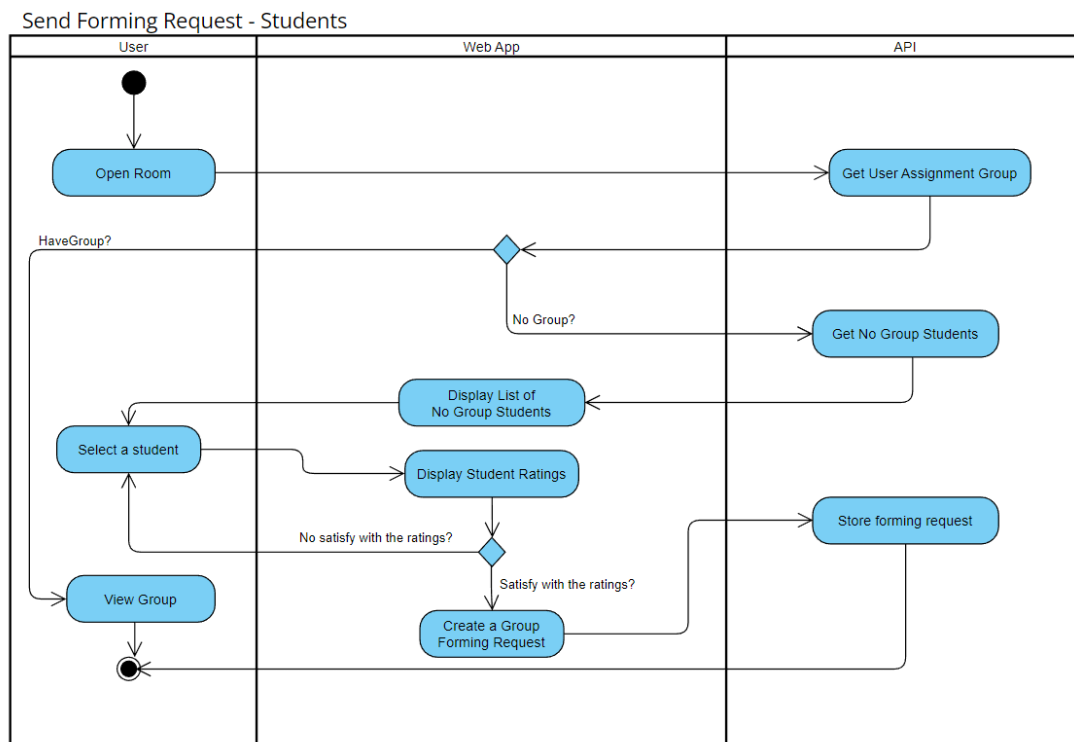
Figure 4.3.4 Group Forming (Student) 1
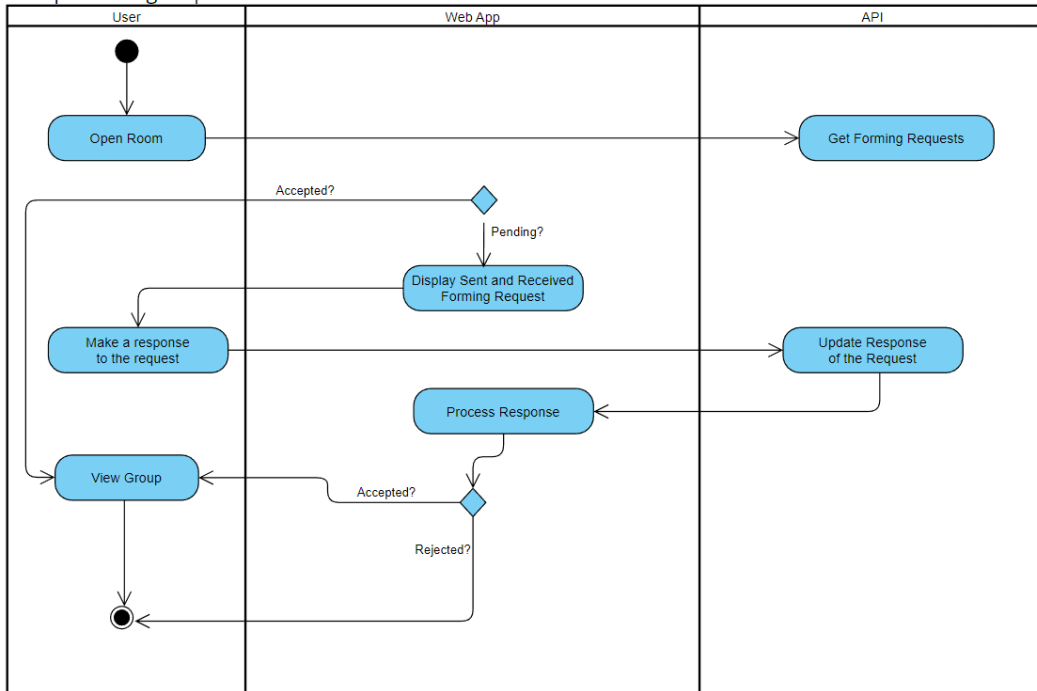
Figure 4.3.5 Group Forming (Student) 2

Figure 4.3.6 Create and update task (Students)

The figure above shows the activity of creating a new task and how to update the task. The members of the group will be able to create a new task and assign the task to one of the members of the group. The assigned task member will need to accept the task to confirm the assignment. Later, when the member finishes doing the task, he or she can update the task status to be completed. However, the system will check whether that member has been marked as free rider or not. Free rider will not have the permission to update the task status. Leader and moderator only have permission to update task status for free riders. Additionally, the moderator will have another permission to approve a task that is assigned to a free rider as a verification. The figure below implements the same logic but shows how to reopen a task.
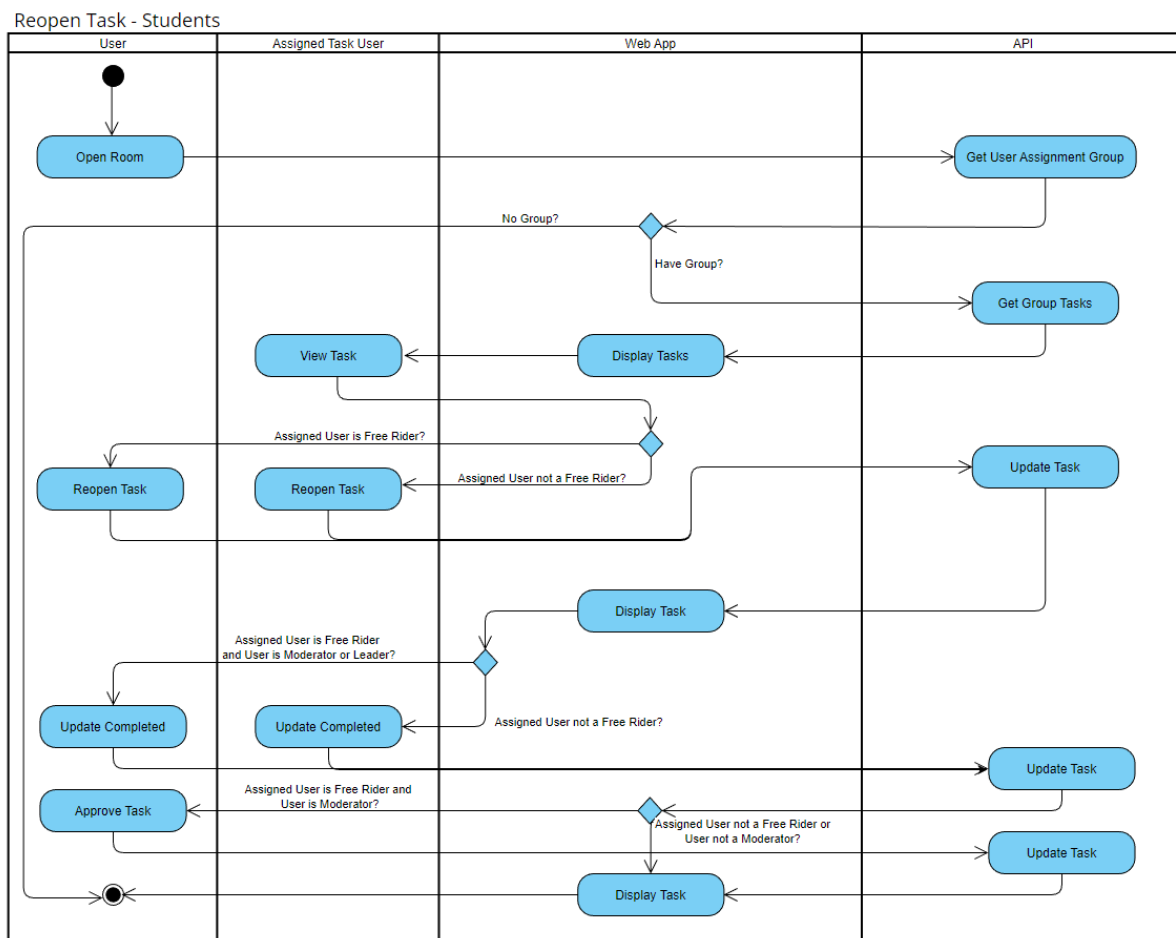
Figure 4.3.7 Reopen task (Students)

However, the owner of the room will always have the ability to view all of the history of the tasks that are done by any student. The owner can select a student and view the tasks of the student. The system will show the history of the task to the owner. The activity diagram of this activity can be shown below:

Figure 4.3.8 View Task History (Owner)

Submit Assignment
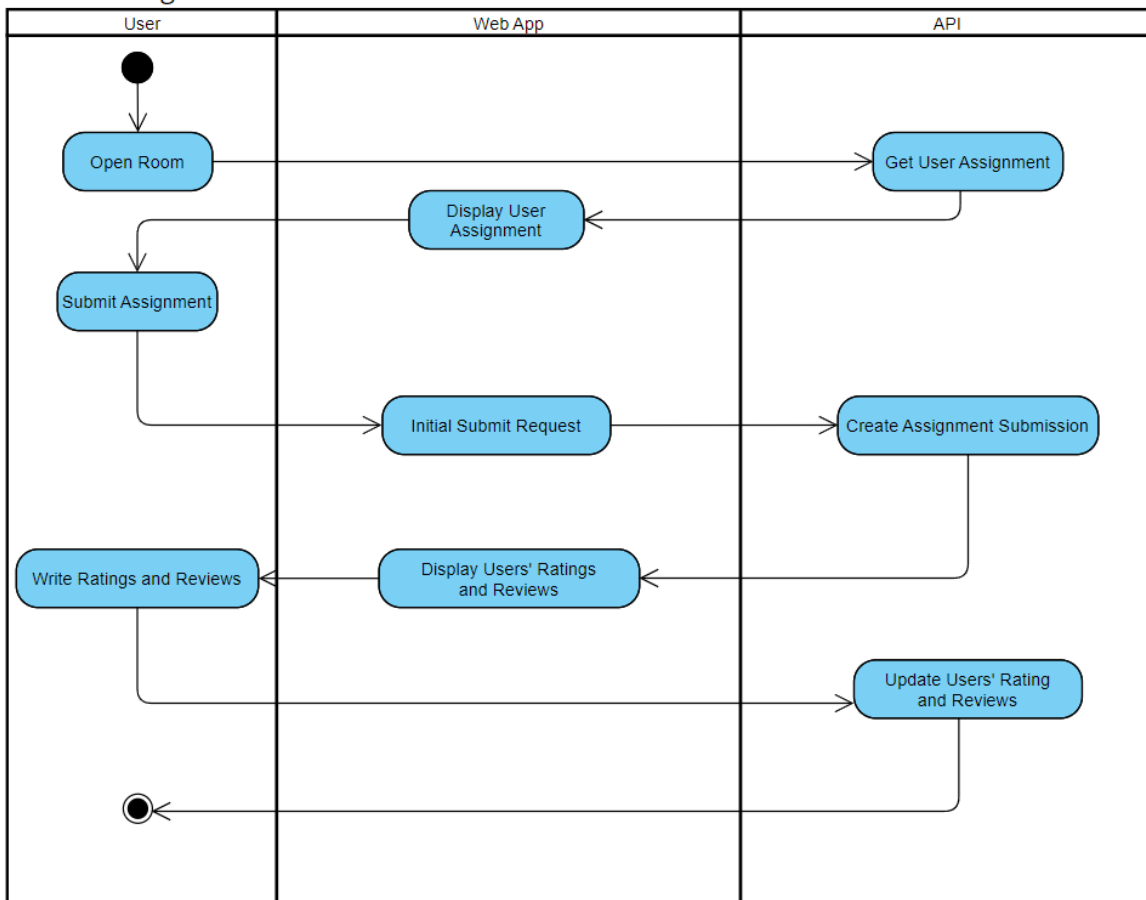
Figure 4.3.9 Submit Assignment

The figure above shows the logic of submitting an assignment. Students always can write a rating and review to his or her groupmates after the assignment is submitted. On the other hand, the owner will be able to mark the assignment after the students have submitted the assignment.

Figure 4.3.10 Assignment Marking

4.3.3 System Flow

This system will have six main modules which are Assignment Room Module, Assignment Module, Assignment Group Module, Chatroom Module, Real Time Collaborative Module, and Assignment Submission Module. Hence, every module will have different flow which can be shown as below.
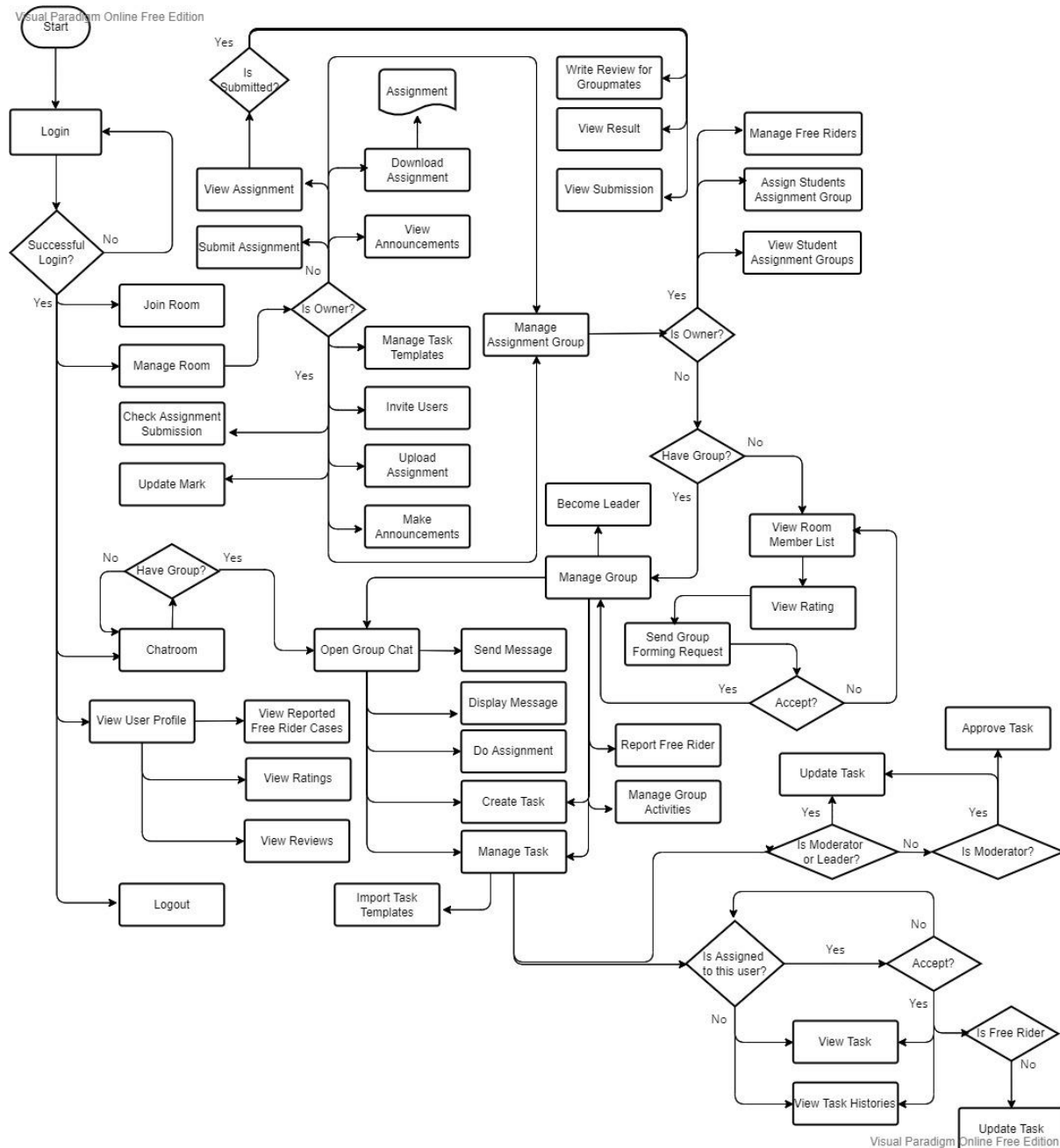
Figure 4.3.11 URoom Flowchart

The figure above shows the flowchart of this system. The user will need to login to the system before accessing the modules of the system. If the user is not having an account, the user can register an account with a unique email that have not been registered in this system before.

Firstly, the user can access the room that the user has joined. In the room, if the user is the owner of the user, he or she can upload some assignments and make some announcements. When uploading an assignment, the system will ask the user to provide some task templates. These task templates can be imported by the members of the room as directions for them to do the assignment. If the user is not the owner of the room, the user can only view announcements and view and download the assignment. Based on the requirements of the assignment, the members of the room may form an assignment group or do the assignment individually. If it is a group assignment, group will be required for the members. Thus, if the user is not the owner of the room, the user can form an assignment group manually by sending a group forming request to others. Group will be formed only when the request is accepted. Additionally, before sending the request, the user can view the ratings and reviews of that member. However, if the user is the owner of the room, the user can manage the assignment groups of the members. The user can view and manage the members of the assignment group. The user can also choose to assign an assignment group for the members of the room manually or automatically. In addition, the owner can also view the reported free rider cases of a particular member and decide whether he or she should mark this member as free rider or not. After the user has formed an assignment group, the user will be able to view the group and manage the group. The group module will also provide the user to manage the group activities, manage the members of the group and manage the tasks. The user is always able to report a member as free rider any time. The owner of the room will be able to decide to mark that member as free rider by reading the reported cases. Furthermore, the user is able to create and manage tasks. After the creation of a task, the user will be allowed to assign the task to any member of the group. The assigned task will need to be accepted by that user. After that, every member of the group will be able to view the task status to follow up the progress. However, if the assigned user is a free rider, this user will not be able to update the task status. Leader and moderator of the group only will be able to update the task status for the free rider. The moderator is assigned by the owner of the room and the moderator will have permission to approve a task as a verification of the integrity of the task. The updated task histories will be available for viewing for every member of the group and the owner of the room. Apart from that, this system also provides the user a chatroom to discuss the assignment together. The user can send and view messages in this module. Moreover, the user can also do the assignment together with their groupmate in the real time collaborative text editor. Lastly, after the user has submitted the assignment, the user will be able to write some ratings and reviews for his or her groupmates.

4.4   NoSQL Database Design

As this project is using MongoDB as the primary database, a database model diagram for NoSQL database can be shown as below:
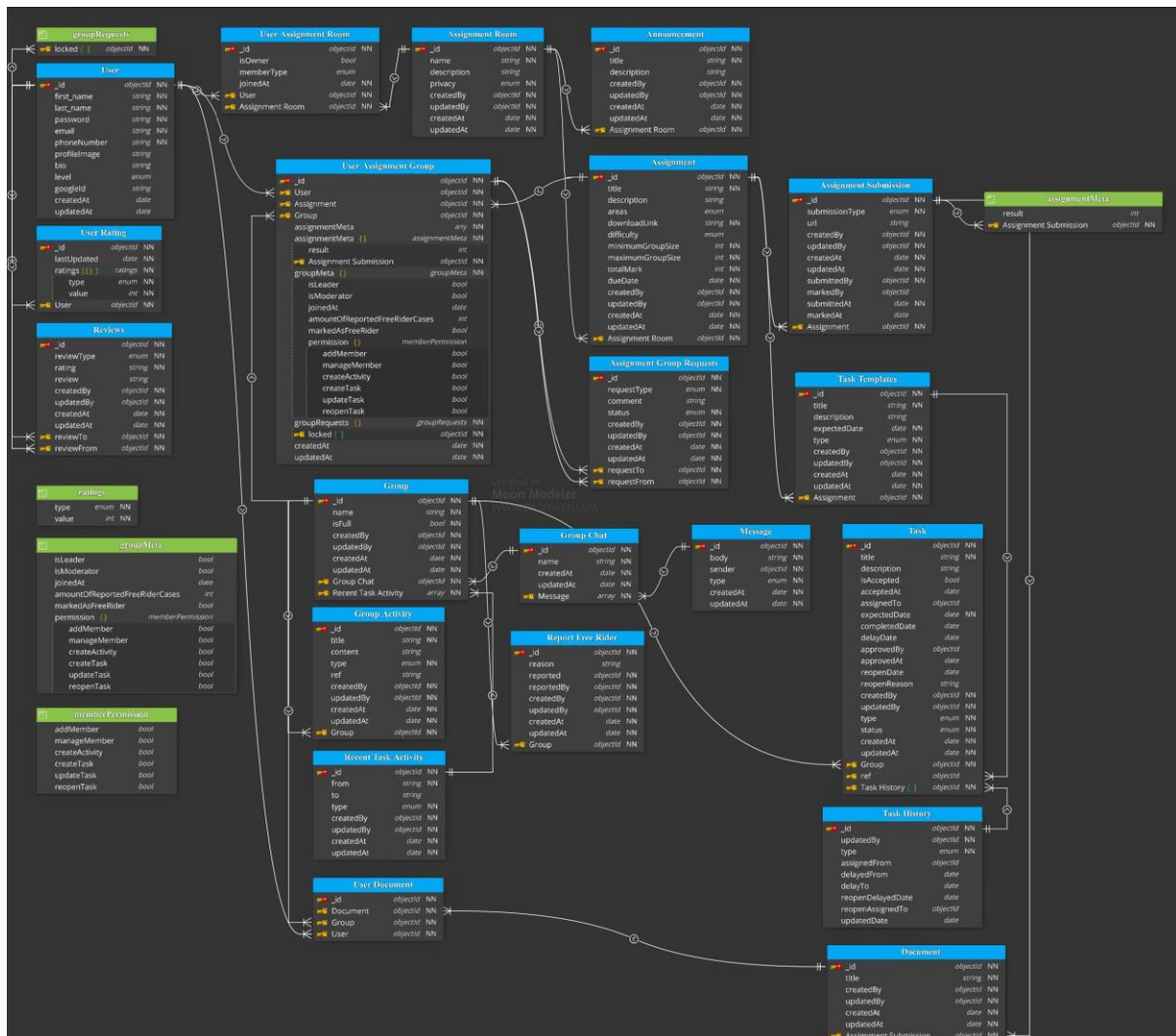

Figure 4.4.1 NoSQL Database Diagram

According to the figure above, it will have 19 tables in the database. These 19 tables will be used for the operation of the system. Firstly, the user table will be used to store the user details. A user data should contain the first name of the user, last name of the user, password of the account, a unique email, phone number, profile image, bio, permission level, id of the google account and the created or updated time of the account. Every user account should have a unique email address. One email address can only be registered once in this system. Additionally, every user account will have its' own ratings called user ratings. This user ratings table will store the sum of each rating such as the user scored 3 points in the communication

skill. The score of each rating is come from the review table. The review table will store the details of the review made by other users. Hence, this table should store the type of the review, the rating score, content of the review and review from whom to whom. The review will have six types which are openness, communication, responsibility, problem solving, knowledges of roles, and management and operation. The meaning of each type can be shown as below:

1. Openness

    The user is eager to get to know one another, especially those with diverse experiences and interests. The user is receptive to fresh perspectives, different points of view, and the variety of people in the group. The user solicits ideas from others by listening to them. The user is aware of how to balance the need for individual expression with the need for collective unity.

2. Communication

    The user can express their own ideas and feelings in a direct but non-aggressive manner. Additionally, the user can listen to others patiently and can infer the emotions of people via their body language. Moreover, if they notice tensions rising, they will start conversations concerning the culture or procedures of the organizations. The user can also encourage others in the group to reflect on their own group's interactions and activities.

3. Responsibility

    The user is responsible for the user own work.

4. Problem Solving

    The user contributes to the development and implementation of crucial strategies for the goals of the group. As a result, the user can contribute to group decision-making and constructively settle conflict. The student is aware of when to consult the professor for additional advice and support in difficult circumstances.

5. Knowledges of the Roles

    The user is knowledgeable about the different roles that can be played within the group, including those of the facilitator, idea generator, summarizer, evaluator, mediator, encourager, and recorder, as well as the one that the user and others are most fit for. The user is also willing to change positions to maximise both their own and others' group learning possibilities.

6. Management and Operation

The user who is skilled in time management, task planning, and meeting facilitation. For instance, the user ensures that the meeting's goals are defined, that an agenda is created and followed, and that everyone has an opportunity to speak. The user can help others focus on the current work by providing support.

Hence, the users can base on the types above to write the reviews and store into the database. The user assignment room will be associative table of the user table and the assignment room table. It will store which assignment room has been joined by the user. The assignment room table will store the details of the assignment room such as name, description and so on. In an assignment room, the owner of the room can make some announcements. Hence, an announcement table will be created to store the announcement details such as title of the announcement, description of the announcement and so on. Additionally, in the assignment room, the owner can upload the assignments while the member can view the assignment. Therefore, an assignment table will be created to store the assignment details such as the title of the assignment, link to download the assignment, assignment minimum and maximum group size and so on. Hence, assignment group is required for the uploaded assignment. Therefore, user assignment group will be built to store the user assignment group details. The user assignment group table will be used to show what user is doing which assignment and have joined which group. Moreover, this table will also be used to store the permissions of the user in the group and also the submission status of the assignment. The "groupRequests" property will be used to store the list of users who have sent forms to this user. Therefore, it is used to prevent a user from sending a form request to a user who has already sent a form request to that user. Hence, an assignment group request table will be built to store the request of the user. A group table will also be created to the group details such as the name of the group and so on. Every group will have a group chat. Thus, a group chat table will also be built to store the chat messages of the group. Hence, a message table will also be built to store the message details such as the body of the message, who is the sender and so on. In addition, the member of the group can create a group activity as an announcement in the group. Therefore, a group activity table will be created to store the details of the activity such as the title of the activity, content of the activity, and so on. On the other hand, the member of the group can also create some tasks to allocate the workload to other members. Hence, a task table will be built to store the details of the task such as the title of the task, who is being assigned to this task, the task is accepted by the assigned user or not, the expected completion date, the actual completion date,

the delayed expected completion date and so on. The user can create the task and assign to other members. That particular assigned member can accept or reject the task. Hence, every updated of the task will also be store into another table called task history table. This table will be used to store the task updated history. The recent task activities table will be used to the global history of the group. Hence, it is different from the task history. The task history table is storing the history of the task while the recent task activities are storing the task creation or update globally. Moreover, the member of the group can also do the assignment in real time. Hence, the user document table will be used to store the document that the user can access from the group. The document table will be the table to store the details of the document such as the title of the document and so on. The content of the document will be stored in the signaling server. Lastly, an assignment submission table will be created to store the assignment submission of the user. It will have two types of submission which are by the document in the system or by a link to download the assignment. In a nutshell, with the design above, the system will be functionally capable to operate without error.

4.5   Algorithm Design

In this section, the design of the algorithm that has been implemented in this project will be discussed. The algorithm of the auto assign assignment group function will be discussed. The owner of the room can assign the assignment group for the members of the room automatically in this project. Therefore, an algorithm to assign the members into a series of groups are required.

4.5.1   Algorithm of Auto Assign Assignment Group

The user can choose to assign the assignment group automatically in this project. Thus, an algorithm that can help the user to assign a heterogenous assignment group is important for education. Each member of the group should excel at a different skill. No group should contain members with the same strongest skills. Therefore, the requirements for the algorithm can be shown below:

1. Every group should contain at least half of the different students with different strongest skills.
2. Heterogenous assignment group is the goal.

Hence, in this project, two methods will be implemented which are General method and Specific method. These two methods will have the same goals but with different logic to assign

the assignment group. Firstly, regarding the General Method, it is simply assigning the users based on the total ratings of the user. The user with high ratings will always form the assignment group with the user with low ratings. Therefore, the concept of this algorithm is grabbing all the ratings of the users and then sum it up. However, there will have a parameter call weight will affect the total result. Before assigning the assignment group for the members of the room, the owner can choose some skills which are important to do the assignment. Therefore, these skills will occupy much more proportion of the total result compared to other skills.

$$Total\ Rating\ of\ a\ user\ = \frac{\left(\sum_{i=0}^{n-1} x_i \cdot weight_i\right)}{n}$$

The system will first grab one user with high ratings and then check the size of the current group is met the maximum group size or not. If not, the system will continue to grab the user with low ratings and then do the checking again. If still not meet the condition, the system will grab the user with high ratings again until the condition is met.

```
//assignment_id: the id of the assignment
//weights: the weights of the skills when calculating the total ratings of the user
async function GeneralAssign(assignment_id, weights){
    Grab the users' ratings.
    if users' ratings exist:
        Loop:
          Calculate the total ratings of every user based on the weights given.

        Get the maximum assignment group size based on the given assignment_id.

        while there exists user without group:
            if the temporary group is still not full yet:
                if last assign is from lowest:
                    Grab the current highest ratings user in the ratings' array and assign it a group.
                else:
                    Grab the current lowest ratings user in the ratings' array and assign it a group.
            else:
                Create a group for the users in the temporary group and store it into a database.
                Clear the temporary group data.

        if the temporary group is not empty:
                Create a group for the users in the temporary group and store it into a database.

    return
}
```

Figure 4.5.1 Pseudocode for General Assign Method

From the figure above, it shows the pseudocode for the general assign method. The function firstly will grab the users' ratings. If the users' ratings exist which means not null, it will open a for loop to calculate the total ratings of every user based on the given weights. The weights refer to the skill set that is chosen by the owner. The skill set will contain at least one skill is important or maximum three skills are important. After calculating the total ratings of the users, the system will find out what is the maximum group size for this assignment and then start to do the auto assign. When there exists users are not having group, it will keep doing the

assignment. It will firstly grab a user who is currently having the highest total rating in the array and assign it into a temporary group and remove it from the array and check whether the group is full or not. If not full, the system continues to grab a user who is currently having the lowest total rating in the array and assign it into a temporary group and then do the checking again. If full, the system will create a group for the user in the temporary group and then clear the temporary group. If not, the system will repeat grabbing the user who is currently having the highest ratings in the array. When all the users have a group, the system will do the final checking to check whether the temporary group is really empty or not. If not, create a group for the rest in the temporary group.

```
//assignment_id: the id of the assignment
//ratings_order: array of ranking of the skills based on importance.
//Ex. [3, 3, 3, 0, 1, 2] 0 - the most important, ..., 3 is the not important skills
//weights: the weights of the skills when calculating the total ratings of the user
async function SpecificAssign(assignment_id, ratings_order, weights){
    Grab the users' ratings.
    if users' ratings exist:
        Loop:
            Calculate the total ratings of every user.

        Get the maximum assignment group size based on the given assignment_id.

        Create a empty populations' array variable.
        Based on the given length of the weights, push the empty array into the populations.

        Create "expected" variable with the value of the expected number of groups after forming.

        Loop based on the length of the weights plus one:
            if the number of loop is not equal to 3
                Find the skills that have been marked as important (0/1/2) in the ratings order
                based on the current number of loop.

                Based on the value of expected, extract the students that is the top ranked of the current skill
                into an array from the users' ratings.

                Push this array into the populations.
            else
                Push the rest of the students into an array and then push the array into the populations

        Sort every elements in the populations from highest to lowest.

        while there exists user without group:
            Loop based on the length of populations:
                if the group is full:
                    Create a group for the users in the temporary group and store it into a database.
                    Clear the temporary group variable.
                Grab one student from the array in the populations based on the number of loop into the temporary group.

        if the temporary group is not empty:
            Create a group for the users in the temporary group and store it into a database.

    return
}
```

Figure 4.5.2 Pseudocode for Specific Assign Method

For the second assign method, the procedure is similar to the General method. However, it is implementing different logic. The figure above shows the pseudocode of the specific assign method. This method is assigning the members of the room based on the skills that the owner has specified. The result of this algorithm will try to ensure that every single group will have at least one student that is good at a skill that is chosen by the owner. After the system obtains the ratings of the users, it will try to assign the users into different array group. When the system

done doing the distribution of the populations, it will contain at least one array in the population is chosen by the owner as important and another one array is the rest of the students that is not having any high ranked skill in the chosen skills. The system will use this population and do the assignment until all of the users have a group.

According to the Figure 4.4.2, it is similar to the General method. The system will firstly get the users' ratings and calculate the total ratings but not based on the given weights. After that, it will get the maximum assignment group size. Later, based on the given skillset length, create an empty population variable. This population variable will store at least two samples or maximum four samples. The sample refers to the top ranked students of the given skillset. For example, the owner chooses three skills in an order which means the first skill will be the most important. The system will base on this given order and allocate the top ranked students into the sample set and then assign into the populations. The rest of the students that are not included in the top ranked students' samples will be store into one sample and store into the populations. After that, the system will sort the samples in the populations before doing the auto assign. The auto assign part will keep repeating grab the students from the first sample until the last sample and then start again from the first sample when the temporary group is not full. If the temporary group is full, it will create a group and clear the temporary group. This part will keep repeating until all students have a group. When all the users have a group, the system will do the final checking to check whether the temporary group is really empty or not. If not, create a group for the rest in the temporary group.

4.6　System Deployment

Heroku will be used as the main deployment platform. It is a Platform as a Service (PaaS). It is providing the service to deploy and manage the application. Hence, in this project, all the frontend and backend applications will be deployed by using Heroku. Therefore, there will be one web application and two backend servers which are the API and the signaling server hosted online after the deployment.
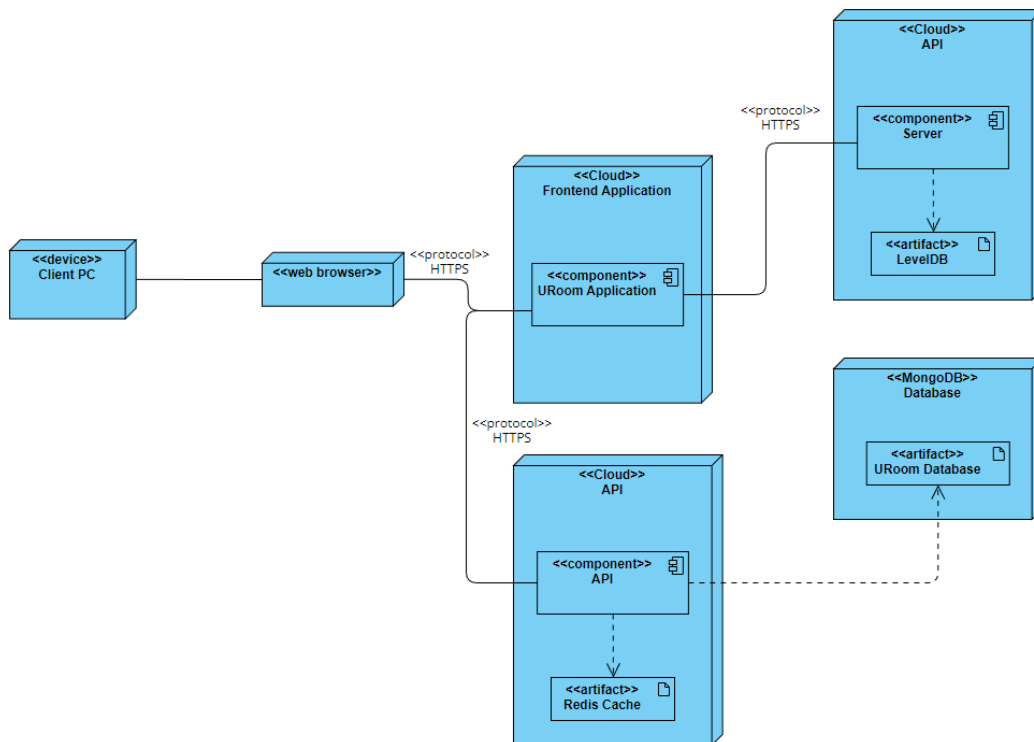
Figure 4.6.1 Deployment Diagram

Chapter 5

System Implementation

In this chapter, the hardware and software setup for the development will be presented. Besides, the result of the operation of the system will also be presented in this chapter.

5.1 Hardware Setup

A laptop is used to develop this project. The specification of the laptop is listed as the following:

Table 5.1 Laptop Specification

Brand	MSI GL63 8SE
OS	Windows 10
Processor	Intel(R) Core (TM) i5-8300H @ 2.30GHz
RAM	16GB DDR4 2400MHz
GPU	NVIDIA GeForce RTX 2060
Hard Drive	128GB KINGSTON SSD RBUSNS8154P3128GJ

5.2 Software Setup

The following list is showing the software that has been used to develop this system:

1. Visual Studio Code
2. Git: 2.31.1. windows.1
3. Node.js: v14.15.0
4. WSL

5.3 System Operation

This system is containing multiple modules which are:

- Assignment Room Module
- Assignment Module
- Assignment Group Module
- Chatroom Module
- Real Time Collaborative Module
- Assignment Submission Module

Hence, the operation of every single module will be discussed separately.

5.3.1 Assignment Room Module

Starting from this sub section, the discussion of the module will be separated into two parts which are view from owner and view from member. View from owner refers to the user who is the owner of the created room while view from member refers to the user who is the member of the room the user joined. Owner of the room will have different functionalities to manage the room while member of the room will only have the functionalities to view the room.

In this module, the user can create an assignment room and become the owner of the room to upload assignment while other users can join the room with the invitation link and become the member of the room.
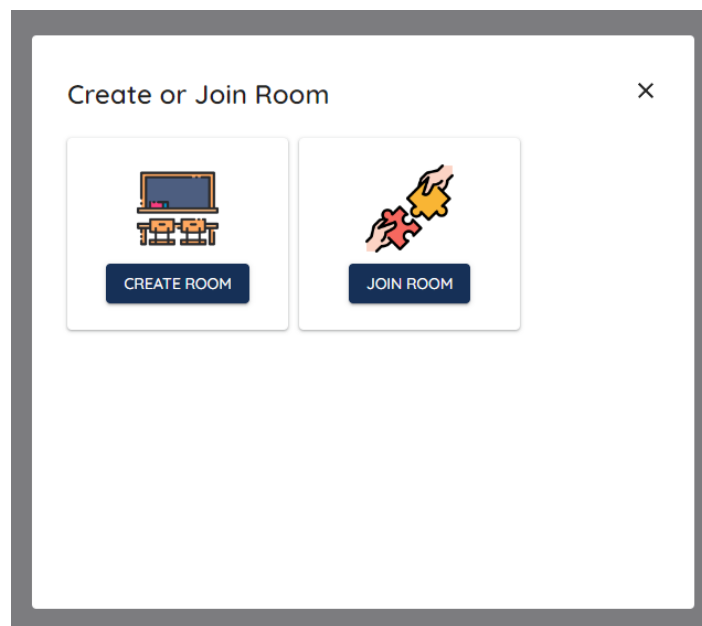
Figure 5.3.1   Create or Join Room

Owner

After the owner of the room has created a room, the owner will see the page below.

Figure 5.3.2   Room – Owner View

The owner can make some announcements, upload assignments, manage the members' assignment groups and invite other users to join the room. The owner just needs to copy the invitation link and send it to other users.
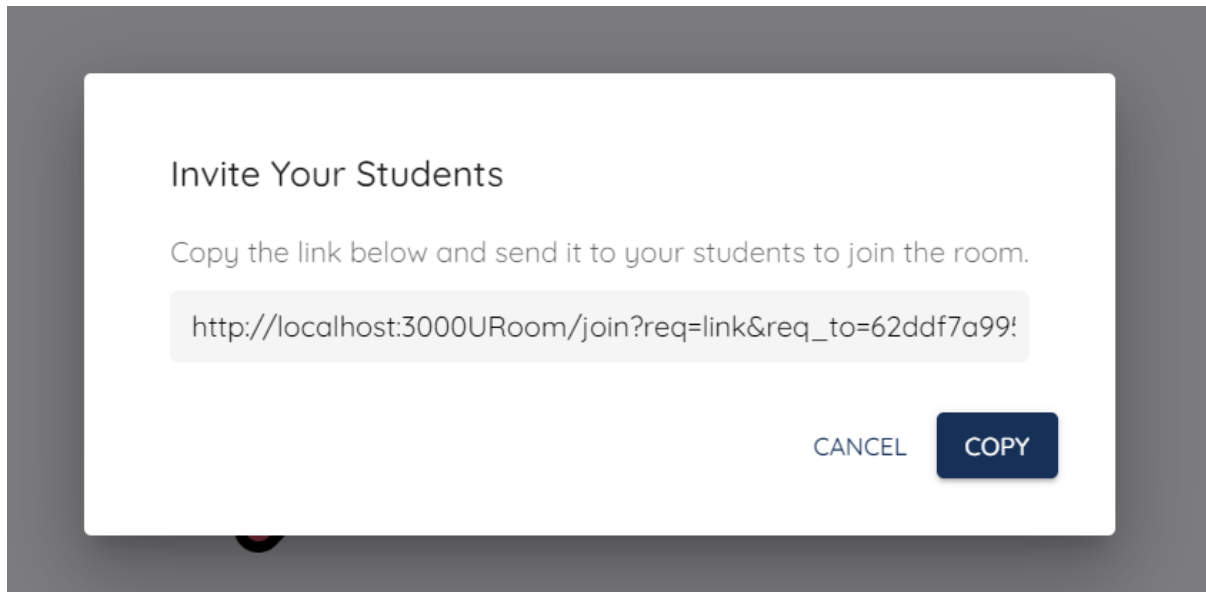
Figure 5.3.3   Invitation Link

In addition, the owner can also make announcements easily by clicking the "CREATE NEW ANNOUNCEMENT" button.
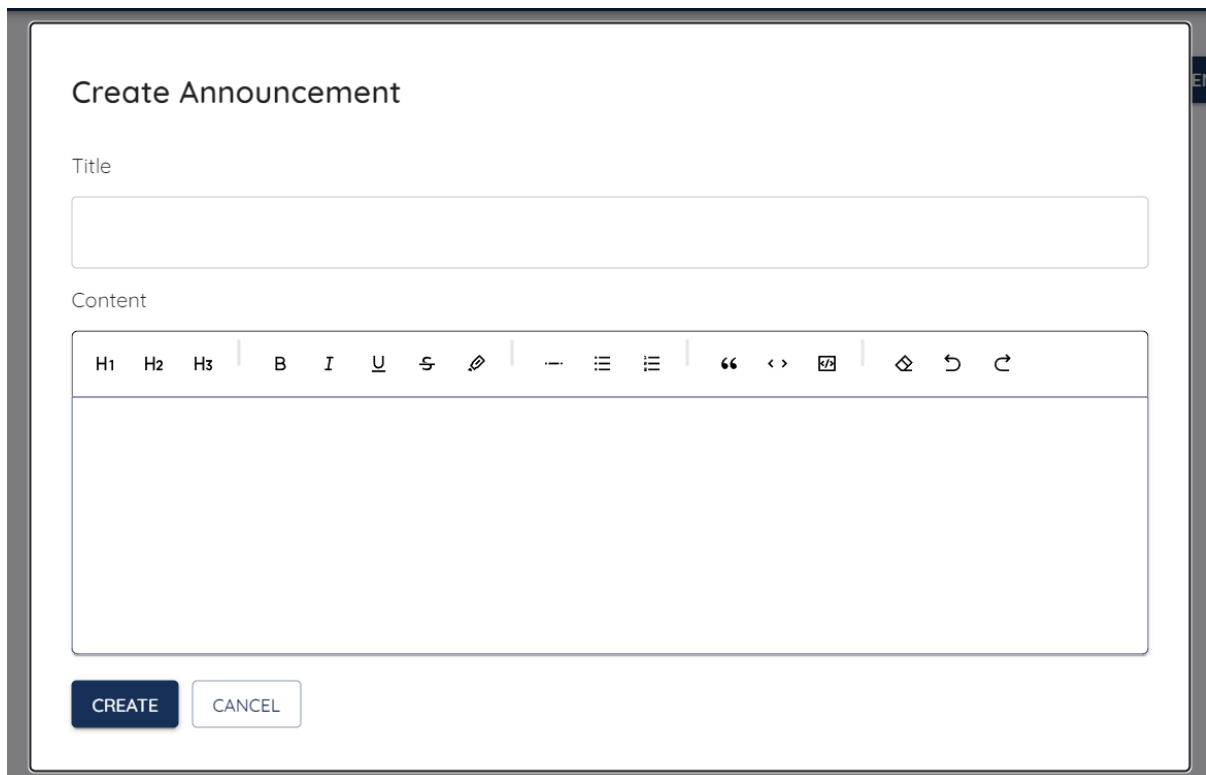
Figure 5.3.4   Create Announcement

Member

The user can join the room with an invitation link and become the member of the room.
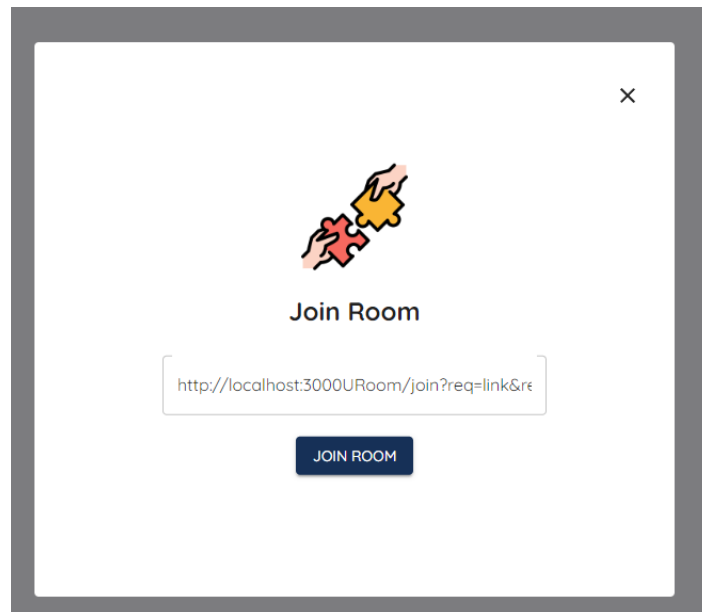
Figure 5.3.5   Join Room

The member of the room can view
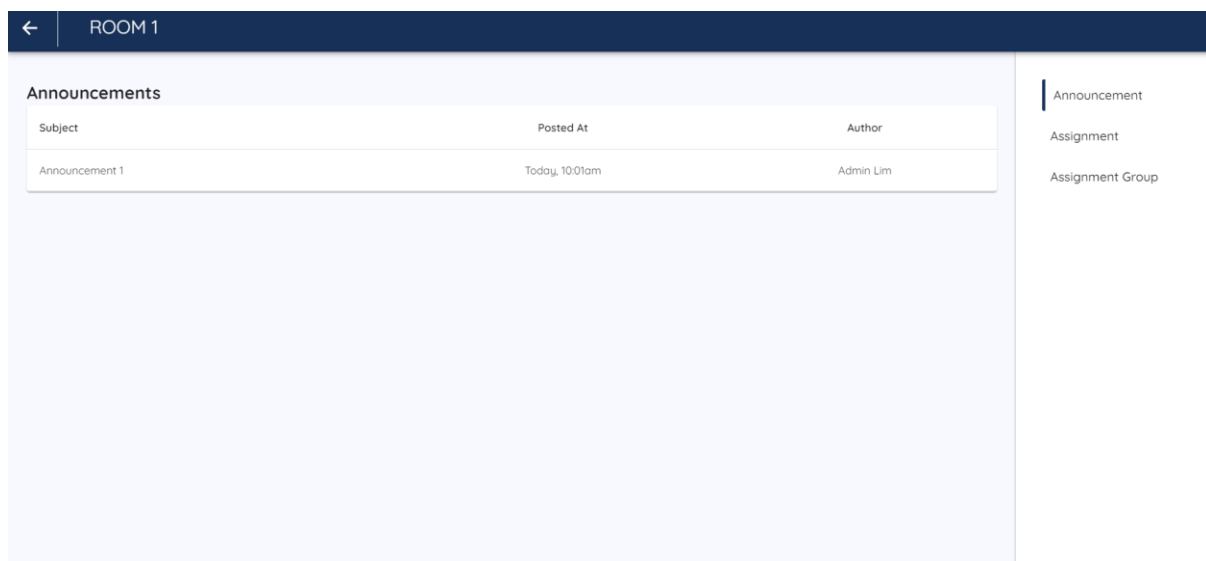
Figure 5.3.6   Room – Member View

The member can view the announcement, view the uploaded assignments, form and manage the assignment group. The member can easily view the announcement which is made by the owner with just a simple click on the title in the subject column. The system will show the content of the announcement. The figure shows an example view of the announcement view page.
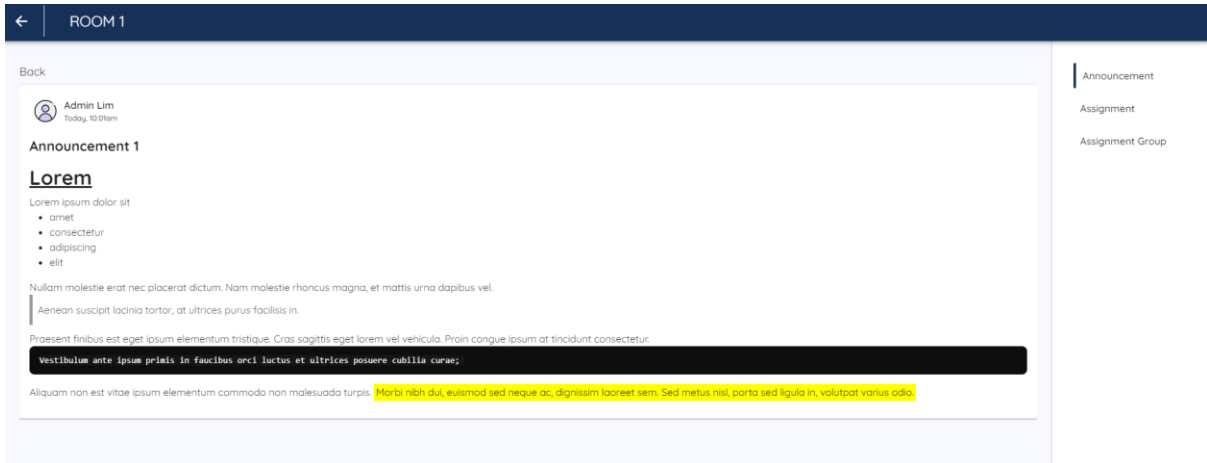
Figure 5.3.7   View Announcement

5.3.2   Assignment Module

In this module, the owner can upload an assignment and create some task templates for the members to distribute their workload. The members of the room can view the assignment and download the assignment.

Owner

Figure 5.3.8   Assignment Upload

The figure above shows that the owner needs to provide the details of the assignment before uploading it. After that, the system will ask the owner whether want to create some task templates or not.
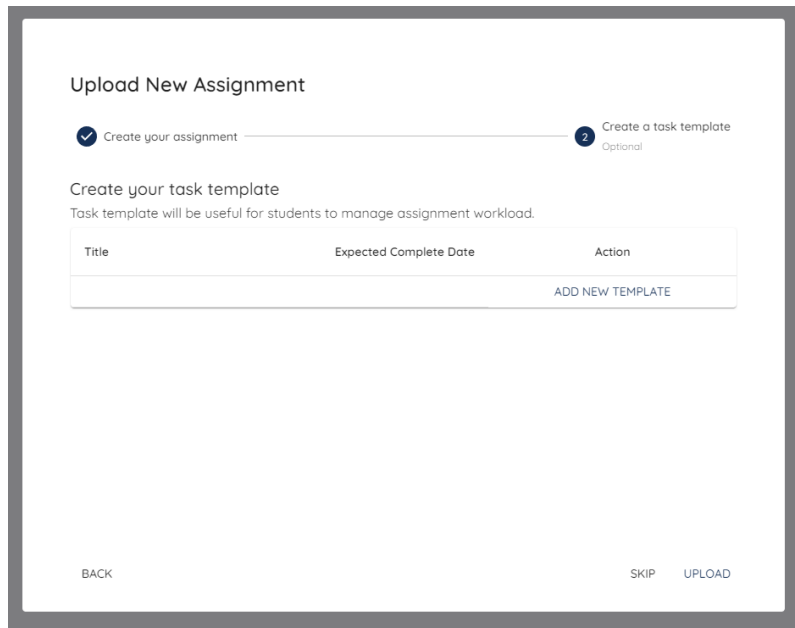
Figure 5.3.9   Task Templates

Member
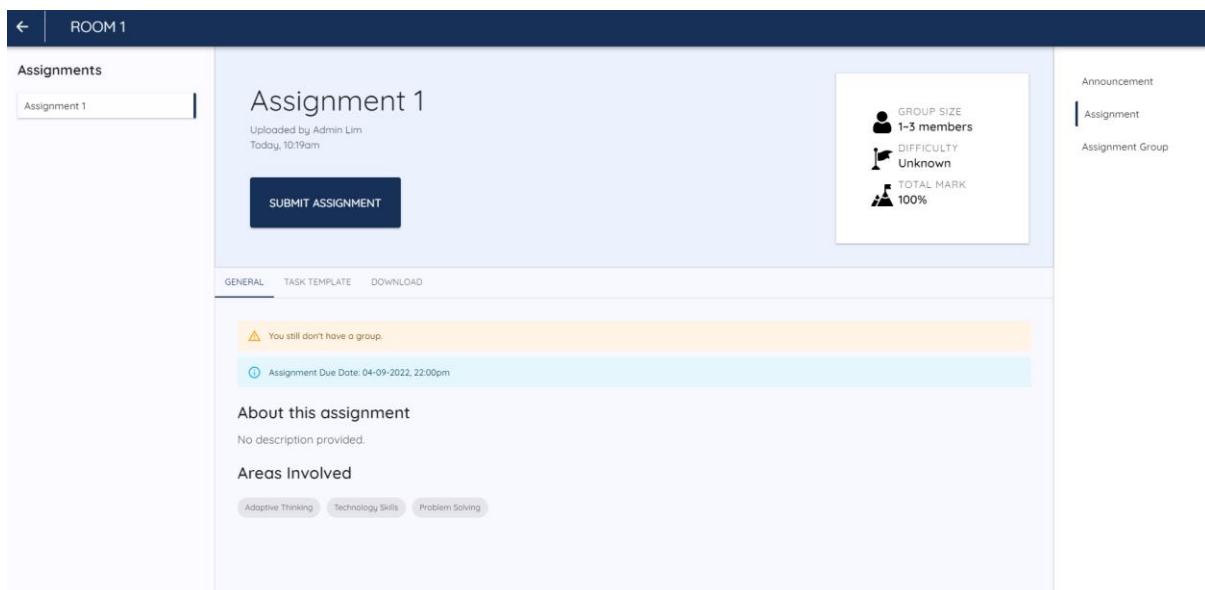
Figure 5.3.10   Assignment View - Member

The member can also view the task templates that have been created by the owner and also download the assignment with the link provided.
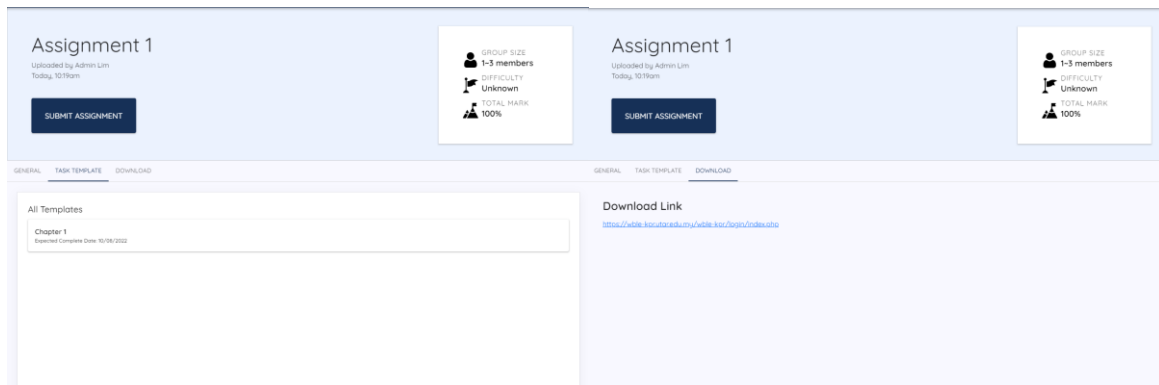
Figure 5.3.11   Task Templates and Download Link – Member

5.3.3   Assignment Group Module

In this module, the owner can manage and assign the assignment group while the members can form and manage their assignment group.

<u>Owner</u>

The figure below shows that the owner can view and manage all the members in the room.
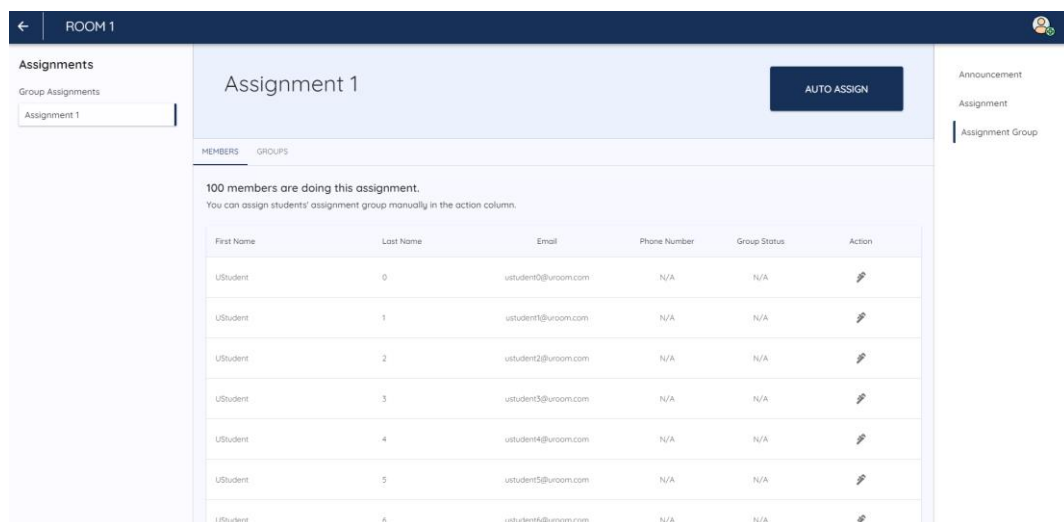
Figure 5.3.12   Assignment Group Management – Owner View

In addition, the owner also can assign an assignment group for the members by using the auto assign function. The owner can choose three skills that the owner thinks that is important for the assignment to do the assignment. The system will base on the chosen skill to assign the group. This is to ensure that every group is heterogenous and having at least one member is strong at one of the chosen skills. Hence, the owner no need to assign the assignment group manually and still can obtain the result of heterogenous group.

Figure 5.3.13   Auto Assign Group

Assume that the owner is using this auto assign function and want to assign the members into few groups and focus on the communication and responsibility skill. After few seconds, the system will show the result.

Figure 5.3.14   Assignment Groups
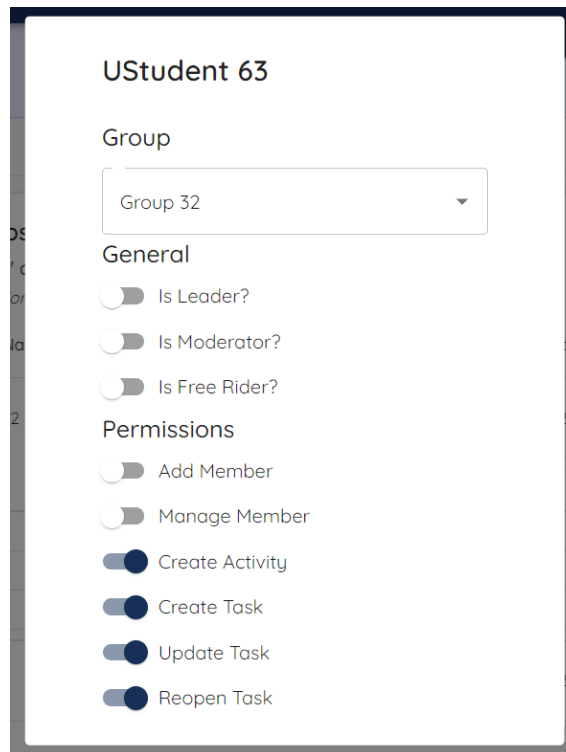
Figure 5.3.15 Group Member Permission Management

The owner can check the "is Free Rider" option to mark this member as free rider. The free rider will lose some permissions in the group. Moreover, when the member is marked as a free rider, it will be recorded in the member's profile.
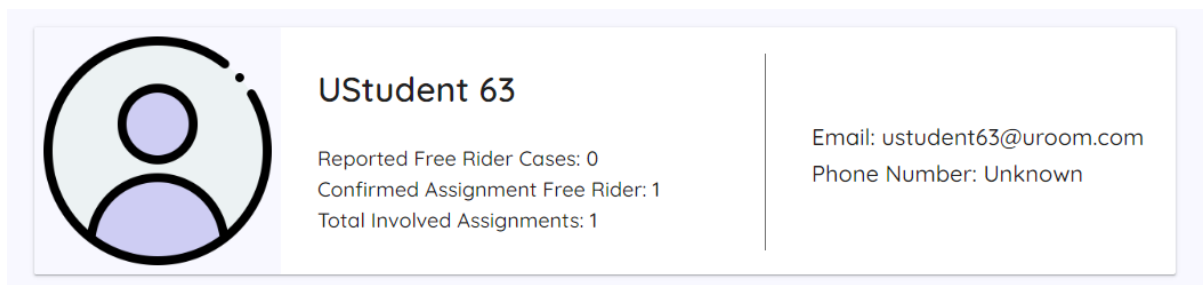
Figure 5.3.16 Member Profile

In addition, the "is Leader?" and "is Moderator?" options are to let the owner to assign the position to the member directly. A leader will have the full power to manage the assignment group. However, the moderator is to let the member to help the owner to do the task approval job. The purpose of this job is to check the integrity of the task. If the task has been approved by the moderator, the owner can be easier to believe that the integrity of the task is promised. Hence, the owner can assign a moderator when the group occurs the free rider problem. The moderator can help the owner to check the task integrity that has been done by the free rider to avoid the free rider updating the task without truly doing it.
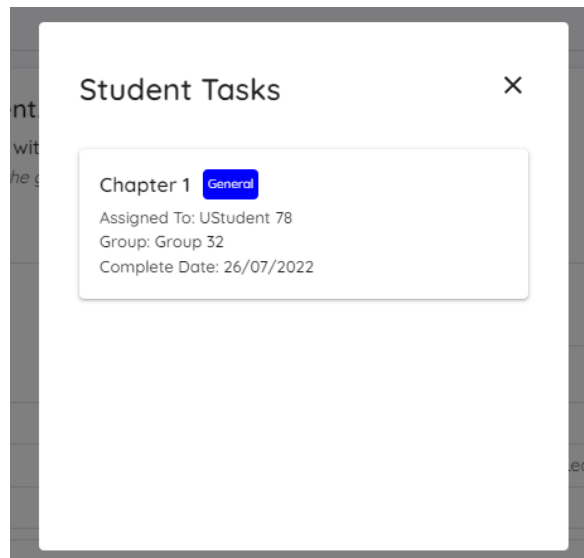
Figure 5.3.17   Student Tasks

The owner can check the task that has been done by the member of the group. The owner can also view the details of the task and read the task history.

Member

As a member of the room, the member can form the assignment group manually by sending a forming request to others. The member can view a list of members whose are not having any group yet.
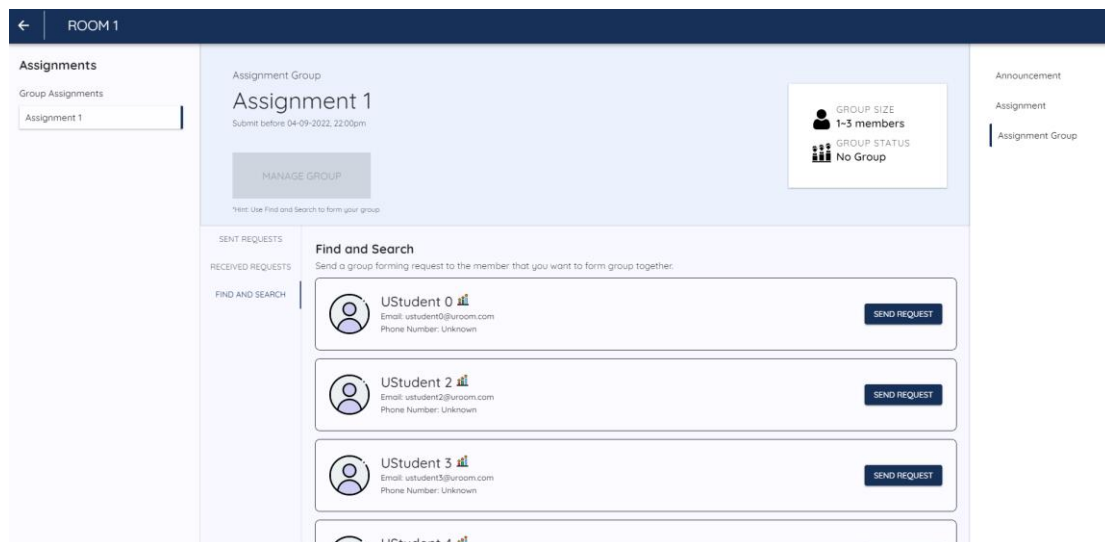
Figure 5.3.18   Assignment Group Find and Search Page

In addition, before sending the request, the member can also view the ratings of the member. The ratings can be used as a reference to decide whether want to do assignment together with this member or not.
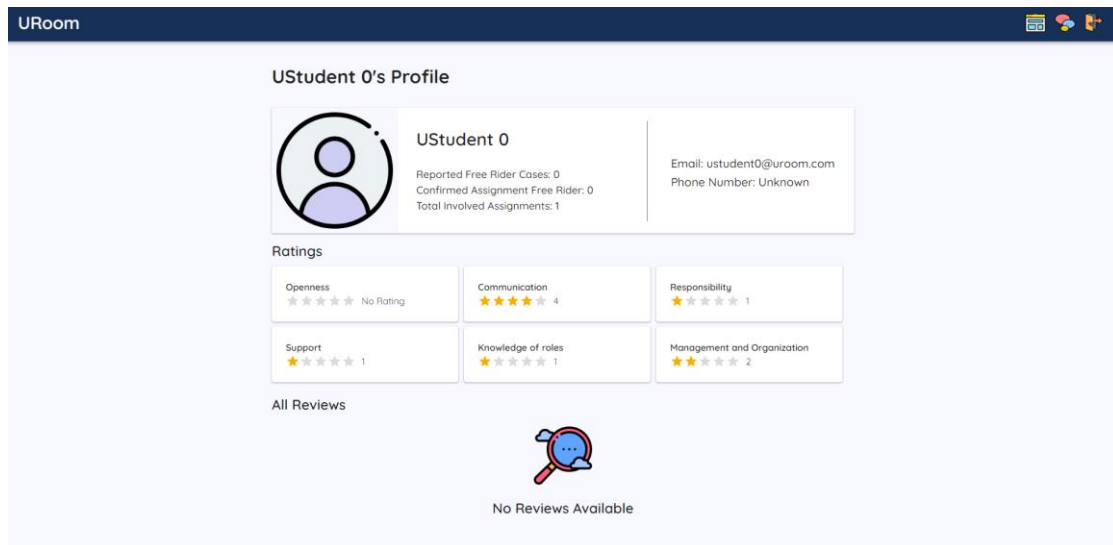
Figure 5.3.19 User Ratings Page

From the figure above, it is clearly showing that this user has not been reported as a free rider and marked as a confirmed free rider by the owner before. Besides, according to the ratings result, it is easy to find that this member is strong at communication but weak at other skills. Hence, the information above is clearly showing that the strength and weakness of this member. The member who is viewing this page can refer to this information to decide whether want to form assignment group with this user or not. If the member is satisfied with the ratings, the member can send a forming request to this user.
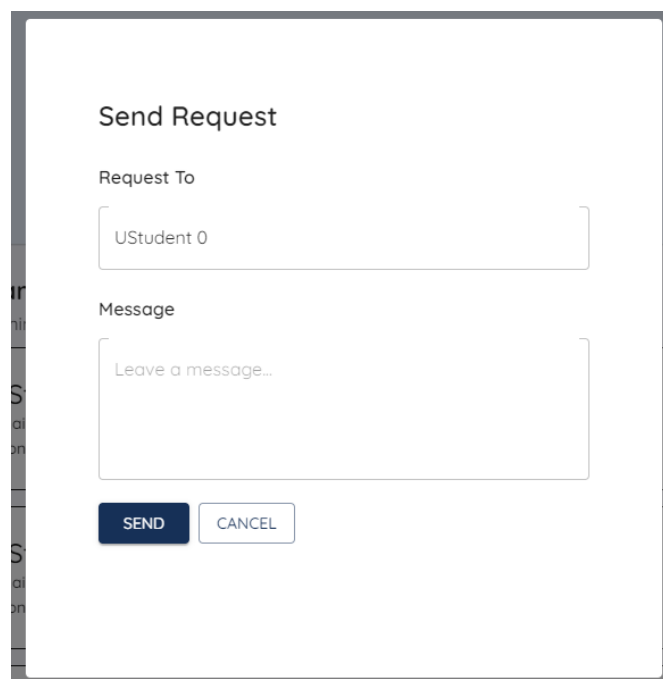
Figure 5.3.20 Send Request

Other member can view the received request and do the decision to accept or reject the request.
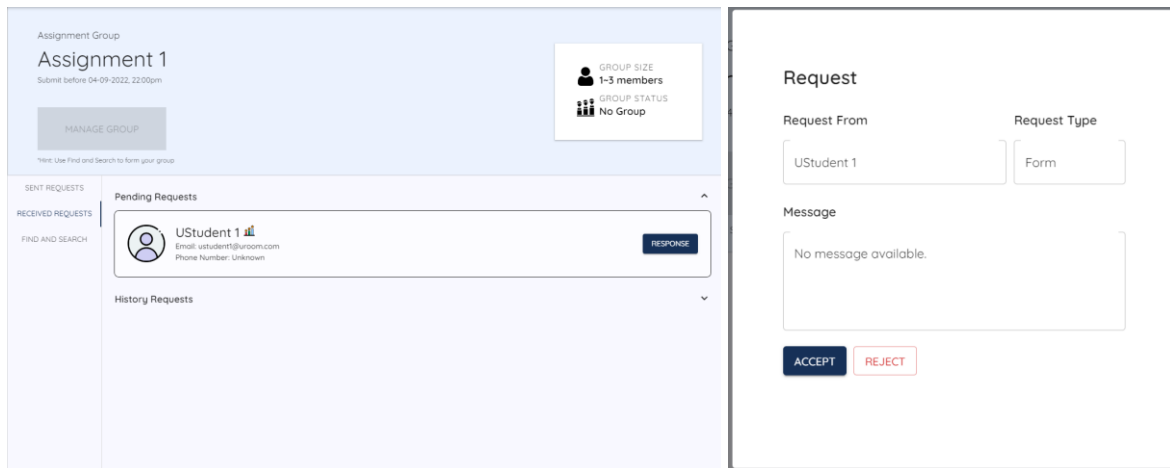
Figure 5.3.21   Accept or Reject Request

Once the request is accepted, the system will redirect to the group management page. However, if the member rejects this request, the request will be updated to "Reject", and nothing will happen.
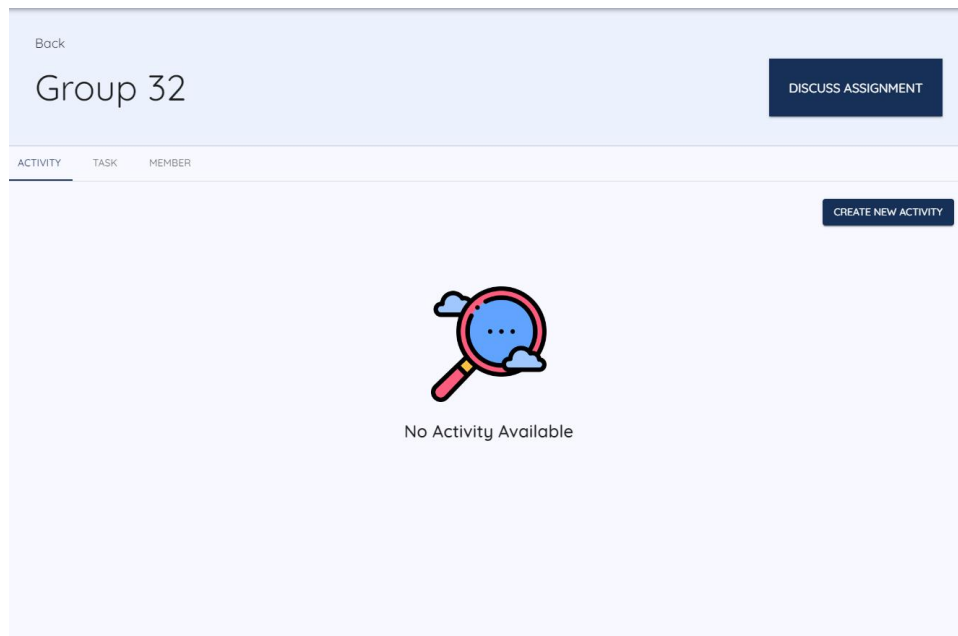
Figure 5.3.22   Assignment Group Management – Member View

The member can create an activity, manage tasks, and manage members at this assignment group page. Firstly, the group activity function is similar to the announcement function. The member can create some activities to do some announcements or notes. Secondly, the member can manage other members by the manage member function. The member can become a leader or report other members as free rider at here. The owner will receive the reported free rider cases that reported by the member.
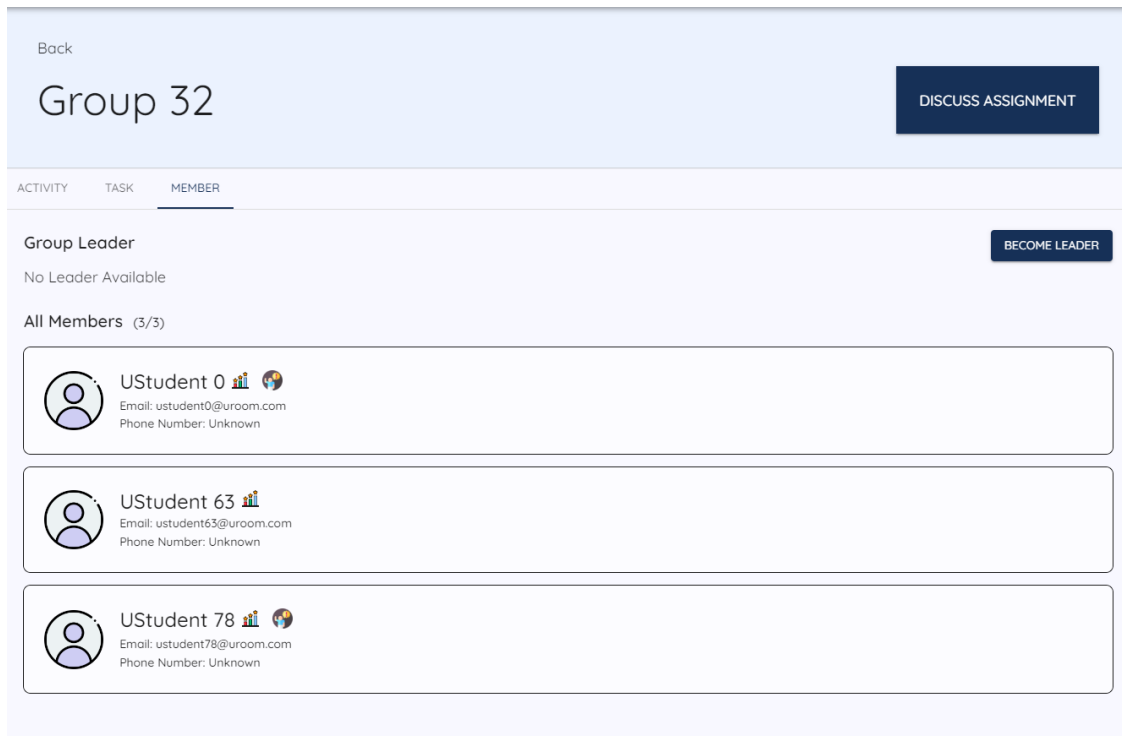
Figure 5.3.23 Member Management

Lastly, the member can also manage the tasks in the group.
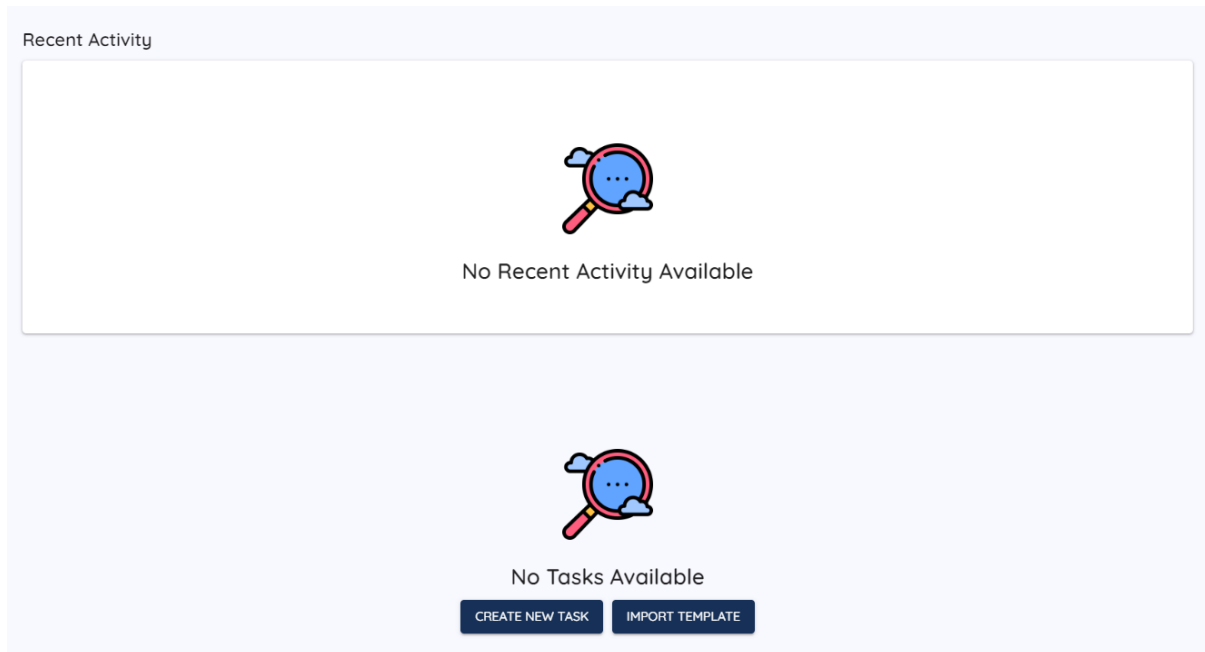
Figure 5.3.24 Task Management

The leader can import the template that has been created by the owner. However, every member in the group always has the permission to create a new task.

Figure 5.3.25 Task Management

The "Recent Activity" section will show the recent update of the tasks while the "All Tasks" section will show all the tasks that are available in this group. Every member in the group will have the permission to update the tasks except the free rider of the group.

Figure 5.3.26 Task Update

The task can be assigned to the member of the group. If the member accepts the task, that member can update the task as completed or reopen the completed task anytime. All the updates will be stored into the database and show in the task history page.
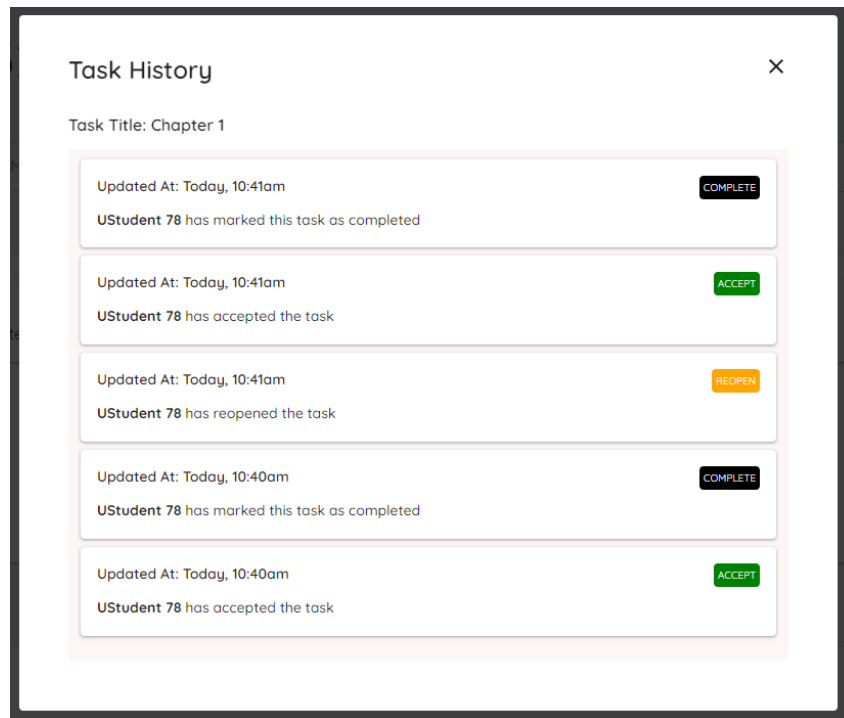
Figure 5.3.27 Task History

5.3.4 Chatroom Module

Chatroom is provided in this system. This is to provide the users a place to discuss their assignment. The chat for the assignment group will be created automatically after the group has been formed.
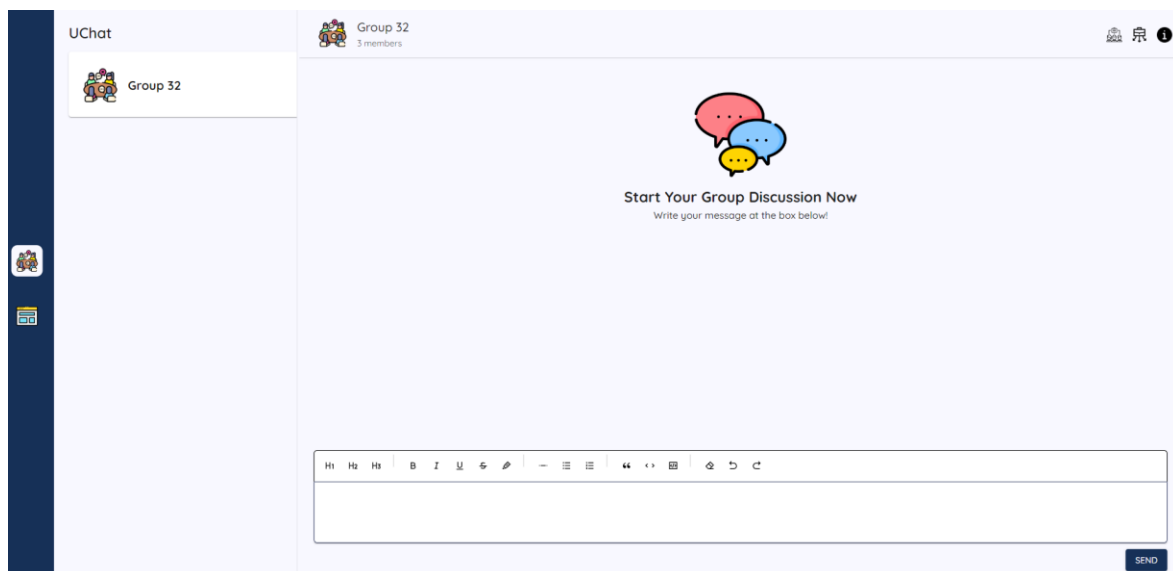
Figure 5.3.28 Chatroom

The users can send a message and view messages at this module. The text editor is also providing the user to write a customizable message with a lot of tools such as bold.
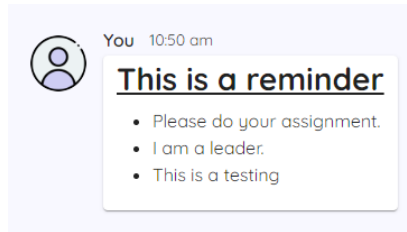
Figure 5.3.29 Message

On the other hand, the user can also check who is online currently and view the tasks of the group.
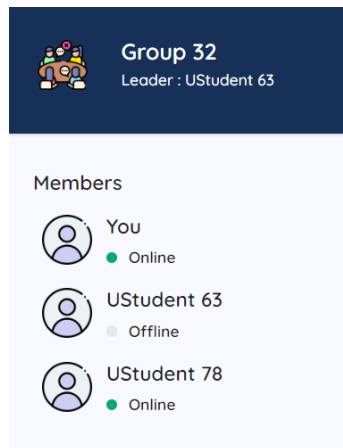
Figure 5.3.30 Chat Information
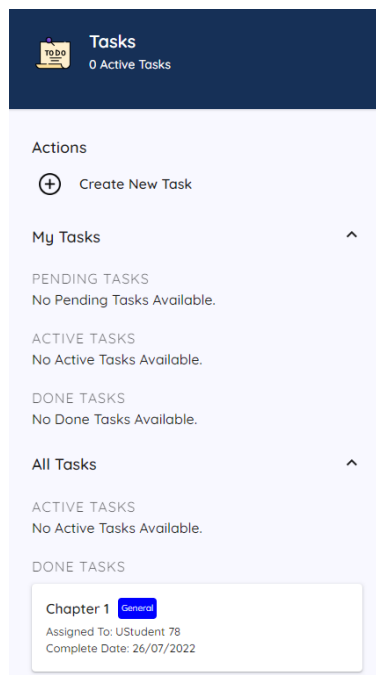
Figure 5.3.31 Group Tasks

5.3.5 Real Time Collaborative Module

This system provides the user a place to do their assignment together. All members of the group can modify the document and others will see the modification immediately in real time.
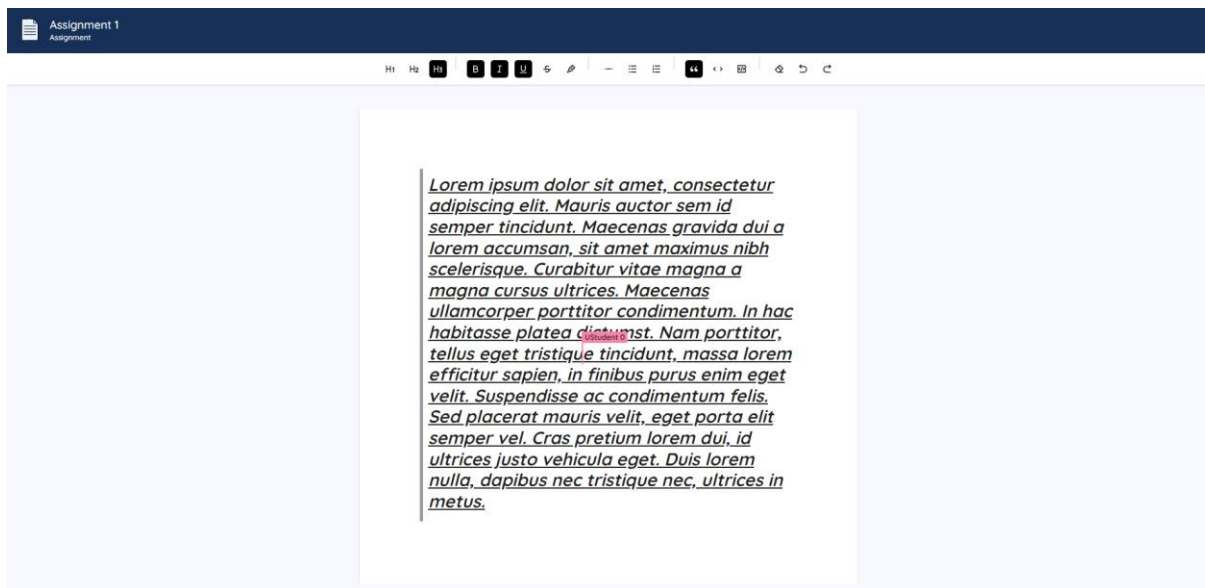
Figure 5.3.32 Real Time Collaborative Text Editor

5.3.6 Assignment Submission Module

In this module, the members of the room can submit their assignments while the owner can mark and upload the result of the assignment.

<u>Owner</u>

The owner can view all the submissions of the assignment and upload the mark.
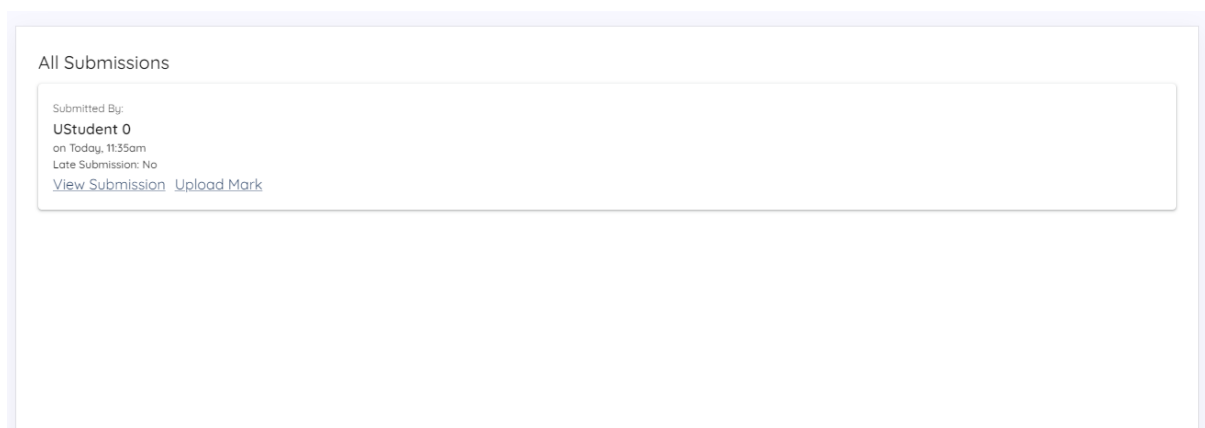
Figure 5.3.33 All Submissions
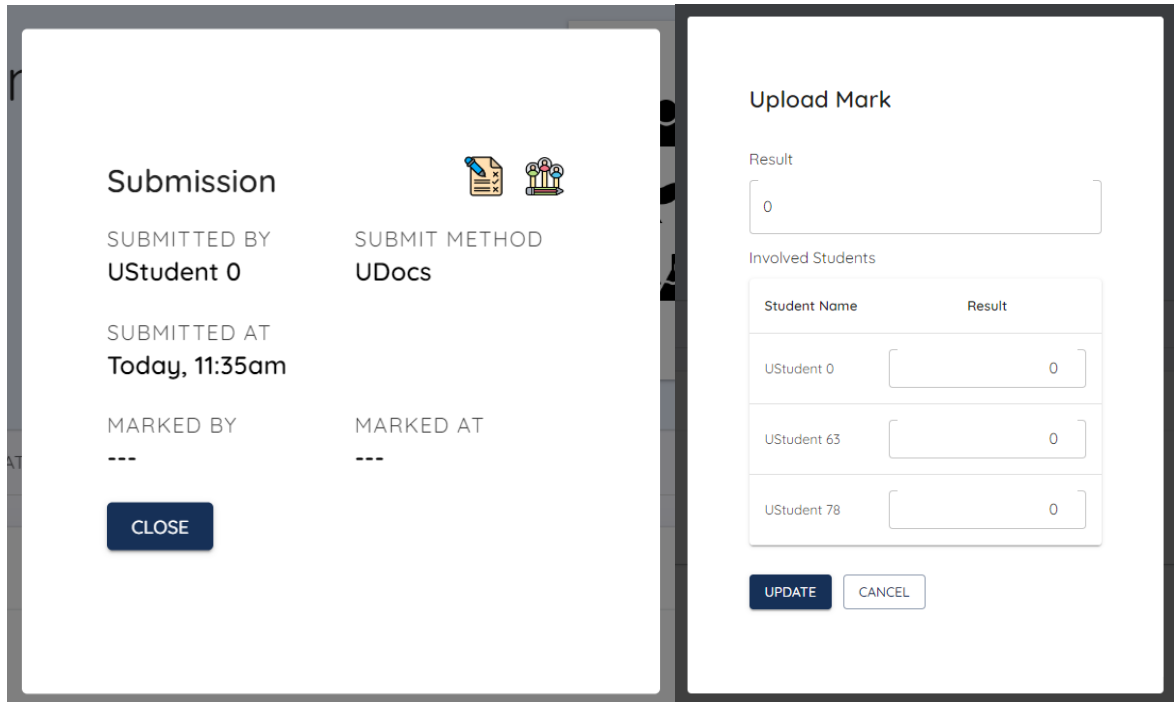
Figure 5.3.34 View Submission and Upload Mark

Member

The member can submit their assignment at here. However, if the assignment is a group assignment, only one member is required to submit the assignment. Others member will be marked as submitted automatically. Only assignment that is not requiring a group will need to submit by every member in the room.
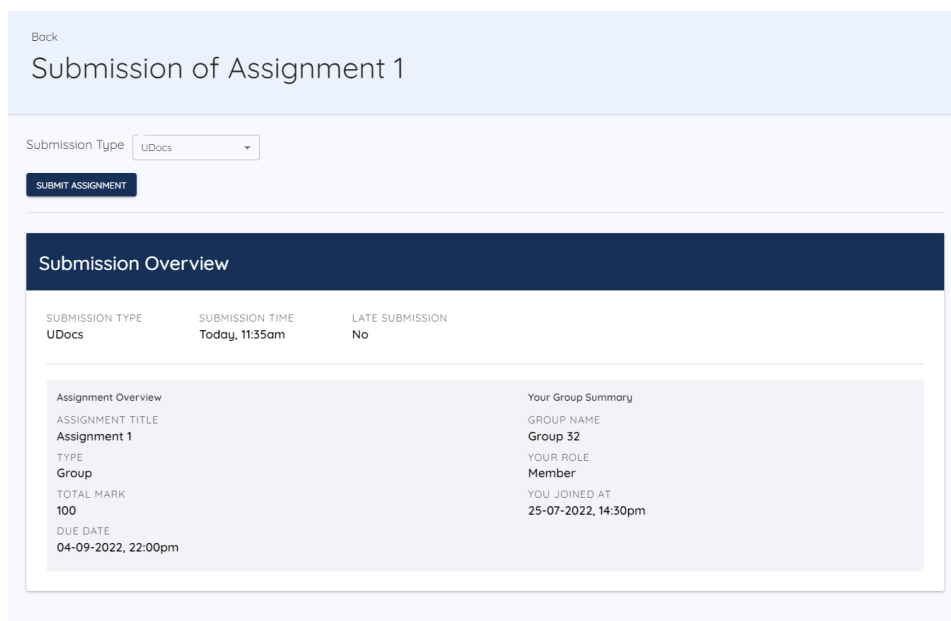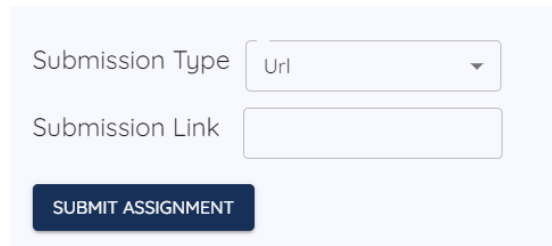
Figure 5.3.35 Assignment Submission
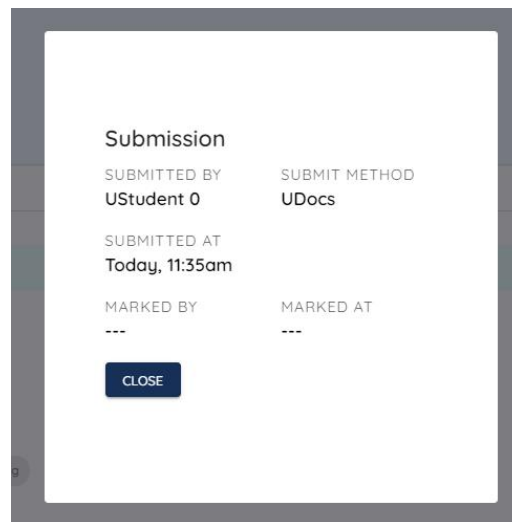
The member can submit the assignment in two ways. One is directly submitting the assignment by the UDocs which is mentioned in the Real Time Collaborative Module. Another way is submitting the assignment by with a URL.
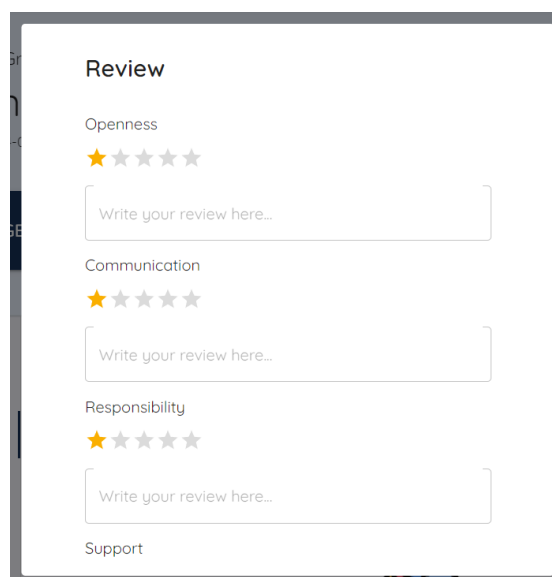
Figure 5.3.36 Assignment Submission by URL

After submitting the assignment, the member can view the submission and wait for the result of the assignment. Moreover, the member can also write the reviews for other groupmates.

Figure 5.3.37 Submission

Figure 5.3.38 Review Writing

Chapter 6

System Evaluation and Discussion

In this chapter, the progress of testing the system and the results of the test will be presented first. After that, the system evaluation and challenges of this project will also be discussed. Lastly, an evaluation of the objectives will also be done.

6.1   System Testing

The testing of this system will be separated into two parts which are Unit Testing and System Integration Testing (SIT). Unit Testing will be done by the developer while SIT will be done by a tester. Therefore, in this section, the performance metrics and the testing result will be presented.

6.1.1   Performance Metrics

According to the Matt Watson's article [18], the performance metrics that can be applied in this project can be shown below.

1.   Average Response Time
2.   Error Rates
3.   Application Availability

Hence, the evaluation of the system's performance will base on the performance metrics above.

6.1.2   Testing Result and Discussion

Unit Testing is used to test every single small testable unit of this system after every single development. Hence, the result of Unit Testing is the functionality of every developed component or module is workable and usable. Every module will pass this testing first before marking the module as completed.

System Integration Testing (SIT) is used to test the overall system behaviour to evaluate the system performance after integrating the hardware and software environment. Hence, a tester will be found to do this testing. An expectation result will be given before doing the testing. The tester will record down the real result of the system. The testing result can be shown below.

General – Overall functionality of the system

Performance – The performance of the system such as response time

Table 6.1 Testing Result

Module	Type	Expectation Result	Real Result
Assignment Room	General	The system should be able to let user create or join a room with an invitation link. The room should be able to let the owner to create announcement and let the member to view the created announcement.	User can create a room or join a room with an invitation link. The system is able to prevent duplicate joining. The owner of the room can create an announcement. The member of the room can view the created announcement.
	Performance	The system should show a list of rooms or announcements to the user within 1 second and create a room or an announcement within 2 seconds. The system should also let the user to join the room within 3 seconds.	In average, the system uses about 2 seconds to show the rooms or announcements and creating the room or announcement within 3 seconds. The system can let the user to join the room within 3 seconds.
Assignment Module	General	The system should be able to let the owner to upload assignment and create the task templates. The members should be able to view the assignment and download the assignment with a link.	The owner can upload the assignment and create the task templates. The members can view the assignment and download the assignment with link provided.
	Performance	The system should be able to upload assignment and create task templates within 3 seconds. The members should be able to view the assignment details within 2 seconds.	The system matches the expectation.

Assignment Group Module	General	The system should be able to le the owner to view a list of members' assignment group, manage the roles and permissions of the member in a group and view the task that has been done by the member in the group. The owner should also be able to assign the assignment group for the members manually or automatically. The system should also let the member to form the assignment group manually by sending a forming request. The member should be able to view the user ratings before sending the request. The request should be able to be accepted or rejected by the receiver. If the member has a group, the member should be able to manage activities, manage tasks, and manage members in the group.	The owner can view a list of members' assignment group and manage the roles and permissions of the member in the group. The owner can also view the tasks that have been done by the member. Besides, the auto assign function is working and can be used to assign the assignment group. The owner can choose up to three skills or at least one skill as the weights of assigning. The member can view the user ratings and send a forming request. Request can be accepted or rejected. Once the member has a group, the member can manage activities (create and view), manage tasks (create, update and view), and manage members (become leader and report free rider).
	Performance	The system should be able to response within 2 seconds for every GET request. The system should be able to response within 3 seconds for every POST request.	All the data that can be viewed in this module can response within 2 seconds. All the data that involved POST request can response within 3 seconds except the

		The system should be able to response within 10 seconds when using the auto assign function.	auto assign function. It needs about 6 seconds in average.
Chatroom Module	General	The system should allow the user to view who is online currently. The user should be able to send and view message.	Users can send and view the message. Users can also view who is online currently.
	Performance	The system should receive and update the message flow within 1 seconds.	The system matches the expectation.
Real Time Collaborative Module	General	The system should allow the users to do the assignment in real time.	Users can write and modify the document in real time.
	Performance	Concurrency should be promised.	Concurrency is promised.
Assignment Submission Module	General	The system should allow the owner to view and upload the mark of the submission. The members should be able to submit and view the assignment submission.	The owner can view and upload the marks while the member can submit the assignment successfully.
	Performance	For all requests regarding submission, the system should response within 2 seconds.	The system matches the expectation.

From the table above, all the modules are well-tested and evaluated. The expected behaviour of the modules is doing well after the integration of all the modules. The assignment room module is able to let the user create and join the room while it is also having the capability to prevent duplicate joining. Hence, this module is doing well. The assignment module is also performing well as no major error occurs while uploading assignment and creating task templates. The assignment group is the biggest module in this project. It is integrated with a lot

of features such as auto assign assignment group function, report free rider function, task management and so on. However, the integration of these features with the module is doing well and no major error occurs. The module can provide the functionality to form and manage the assignment group well. It is matching the expectation. Moreover, this assignment group module is also communicating well with other module like assignment submission module. The assignment submission module is able to retrieve some relevant data from the assignment group module. Hence, it is truly showing that the data of the formed assignment group in the assignment group module can be retrieved and imported without error. The chatroom module is also doing well in this system. The user is able to send and receive message without error. The performance of the chatroom module can also be considered as acceptable. The real time collaborative module is also doing well while the users can do their assignment together. The assignment submission module is also doing well and can communicate well with other modules to retrieve some data. Overall, the functionality and performance of this system is good and can be accepted.

6.2   System Evaluation

According to Table 6.1, this system is well-evaluated and tested in the integration test. Owner view and member view are evaluated in this test to examine the functionality of all the modules together. The tester can access the system with the hosted URL by using a personal laptop.

Table 6.2   Evaluation of Testing Result based on the Functionality Coverage

Module	Functionality Coverage
Assignment Room Module	Well Accepted
Assignment Module	Accepted
Assignment Group Module	Accepted
Chatroom Module	Moderate
Real Time Collaborative Module	Moderate
Assignment Submission Module	Accepted

The table above shows the evaluation of the testing result based on the coverage of the module functionality. Assignment room module is considered as well accepted as this module is doing well and having some checkers to prevent some predictable errors occur. However, assignment module, assignment group module, and assignment submission module are considered as accepted only. This is because although these three modules are doing well and functionally capable to operate, improvements still can be made. The current functionality of these three

modules is fulfilled the project scope and objectives but some improvements still can be done such as adding some instructions function for the assignment module and so on. However, these improvements are not covered in this project. Thus, it can be considered as accepted. However, for the chatroom module and real time collaborative module can only be moderately considered as accepted. This is because a lot of improvements can be made for these two modules such as emoji features for chatroom and comments feature for real time collaborative module. The extra functionalities to enrich the modules are not covered. Hence, it can be considered as moderately accepted.

Table 6.3   Evaluation of Testing Result based on the System Performance

Module	System Performance
Assignment Room Module	Good
Assignment Module	Nice
Assignment Group Module	Moderate
Chatroom Module	Good
Real Time Collaborative Module	Good
Assignment Submission Module	Nice

The table above shows the evaluation of the testing result based on the system performance. According to the performance metrics of this project, the system targeted performance can be shown as below:

1. The average response time should not more than three seconds excluding the auto assign assignment group function.
2. The error rates should be low.
3. High application availability is important.

The performance of the assignment room module is good but do not meet the expectation. This is because the assignment room module needs some extra time to retrieve some extra items like icon to show the whole room page. Thus, it is increasing the burden of the module to show a page. However, the overall performance is good. The response time of this module is in average and low error rates as this module can prevent some predictable errors happen. The availability of this application is promised as users can easily create, join, and view the room. Chatroom module is also considered as good as the response time of chatroom is matching the expectation and low error rates. In addition, the availability of this module is promised as the users can easily find out where to send and view the message or using any other functions. The assignment module, the assignment submission, and the real time collaborative module are

doing well as it is matching the expectation and under the average of response time. Moreover, the error rates are low, and availability of the module is high. However, the assignment group module is having moderate performance. This is because the auto assign assignment group function is in the assignment group module and this function is taking much more time after deployment. The performance of this function is doing well in local environment but not so good in deployed environment. This is because the deployment platform of this application is using the free version of Heroku deployment environment. It is not having many resources for the algorithm of assigning. However, the availability of this module is still good. In a nutshell, the overall performance of this system is best in local environment but doing good in the deployment environment. Nevertheless, the result of the performance is acceptable as it is fulfilled the performance metrics.

Hence, based on the evaluation result, it is clearly showing that all the modules are successfully integrated and be able to communicate with the API without error. In addition, this system is also having an authentication module for user identity authenticating purpose. This module will only allow the user to use unique email address to register an account. The system will communicate with the API to check whether the email is registered or not. Hence, all the modules can perform the task as what the system is expected to operate. Therefore, the scope of this project and objectives can be considered as fulfilled while all the modules are functionally capable to operate.

6.3   Project Challenges

This project is facing a lot of challenges during the development as this project is involving a lot of different modules such as Real Time Collaborative Module. Hence, the development of some modules is different from what was expected at the beginning. Firstly, huge workload is one of the challenges while developing this project. It is hard to develop the project with full of features when times and resources are the limitation of the development. For an example, one of the hardest parts of Real Time Collaborative module is the page break features of the document. It is not easy to implement this feature as it is hard to detect or monitor the user behaviour while doing the assignment. Hence, when to add a page break and go to a new page is a touch task. It is requiring a lot of times and resources to develop this feature, and this will become a huge workload to the developer. Therefore, in order to achieve the objectives, the workload of this project has been minimized by throwing away some of the not important features. Secondly, finding a way to assign the assignment group based on some references is

one of the challenges of this project. Heterogenous is the main of concern of assigning the assignment group. Thus, how to design an algorithm that can promise a good result is the concern. However, in this project, this challenge is solved successfully. Lastly, the last challenge is controlling the behaviour of the application. It is important to design a good behaviour model of the web application. Hence, how to design the behaviour like when should the system transfer to "Done" state while creating a new room is the main challenge. However, in this project, this challenge is solved successfully.

6.4   Objectives Evaluation

According to the verification plan in Chapter 3, this section will run some experiments to evaluate the objectives of free rider problem and group management and imbalanced group problem.

6.4.1   Free Rider Function

As a member of the room, the member can report their groupmate in the assignment group.
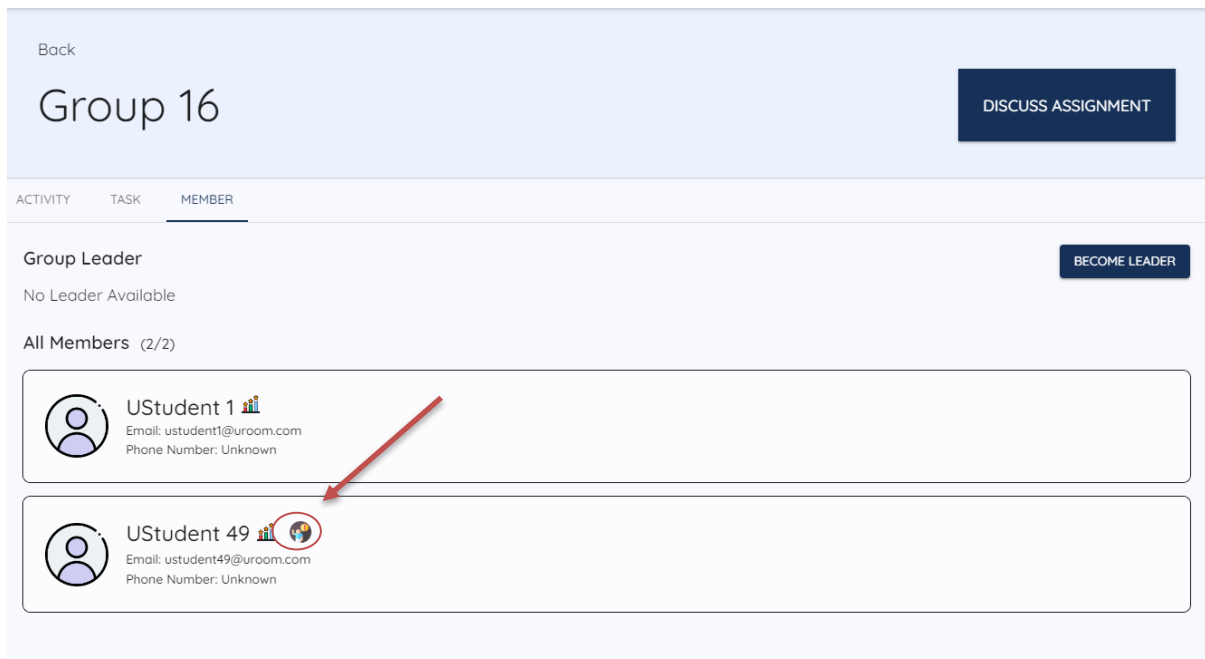
Figure 6.4.1   Report Button

The member can press the button which shown in the figure above when he or she feels that that groupmate is not doing anything and do not want to contribute to any parts of the assignment. The member can use this button to report the free rider which can be shown as below.
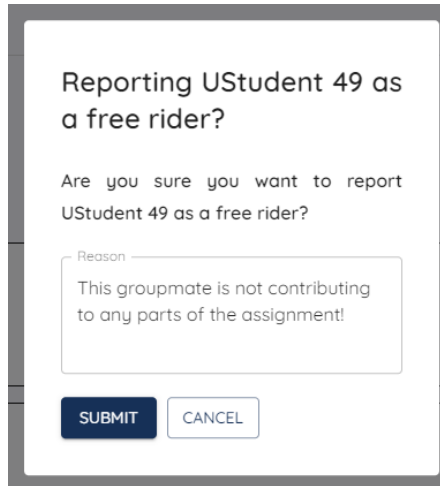
Figure 6.4.2   Report Free Rider

The member can write some reasons to tell the owner why this member is a free rider. After that, the member can press the submit button to submit the report.

In the owner view, the system will display the following to the owner.

∧	Group 16		2	28/07/2022			N/A
Student Name		Reported Free Rider Case	Result				
UStudent 1		0	0		Manage		View Tasks
UStudent 49		1	0		Manage		View Tasks

Figure 6.4.3   Assignment Group Data

At here, the owner can clearly find out who has been reported as a free rider. From the figure above, it is showing that UStudent 49 is reported as free rider. This is because the reported free rider case column has a number of 1 at the UStudent 49 row. By clicking the number 1, the system will show the owner the details of the cases.
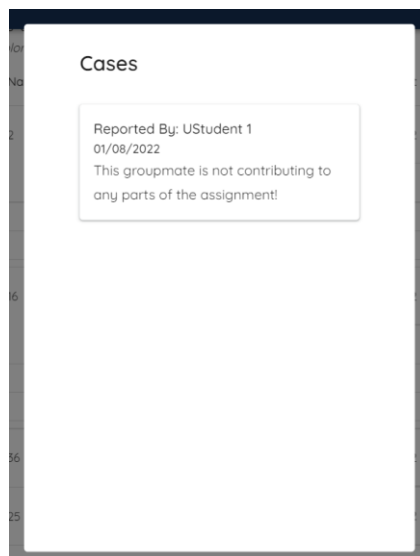
Figure 6.4.4   Free Rider Cases

According to the figure above, it is easy to find that UStudent 49 is a free rider as this member is not contributing to any parts based on the reported case. Hence, the owner can start to investigate by viewing the tasks that has done by UStudent 49 with the "View Tasks" button which is shown in Figure 6.4.3. However, it is showing that UStudent 49 is doing nothing from the figure below.
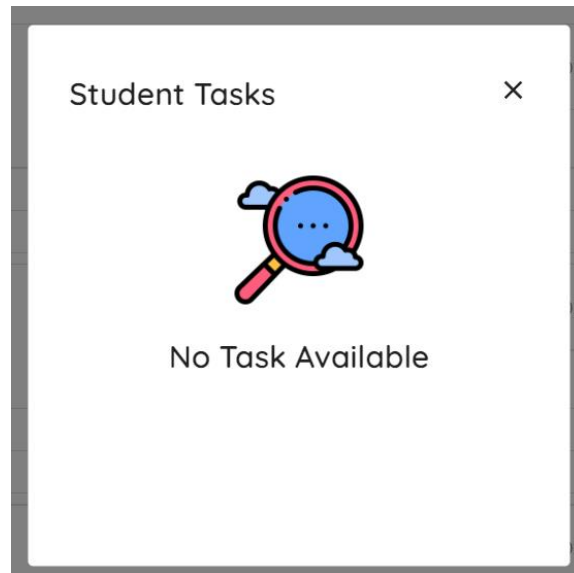
Figure 6.4.5   Student Tasks

The owner still can try to do further investigation by contacting to the member. However, if the owner decides to mark this member as free rider, the owner can press the "Manage" button which is shown in Figure 6.4.3 to mark it. From the figure below, the "Is Free Rider?" should be checked to mark this member as free rider.
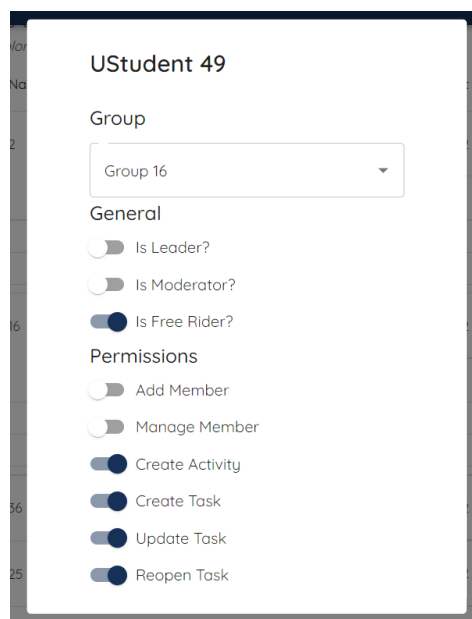
Figure 6.4.6   Student Permission

When the member has been marked as free rider, the name of the free rider will be shown with the colour of red.

	Group 16		2	28/07/2022		N/A
Student Name		Reported Free Rider Case	Result			
UStudent 1		0	0		Manage	View Tasks
UStudent 49		1	0		Manage	View Tasks

Figure 6.4.7   Assignment Group Data with Free Rider

Moreover, the name of the free rider will also be shown with red colour when the owner is uploading the result of the submission.

Figure 6.4.8   Upload Mark with Free Rider

The owner can upload different marks for the free rider.

	Group 16		2	28/07/2022		Submitted
Student Name		Reported Free Rider Case	Result			
UStudent 1		0	80		Manage	View Tasks
UStudent 49		1	60		Manage	View Tasks

Figure 6.4.9   Assignment Group Data with Result

Furthermore, there will have some limitations for the free rider in the group. A free rider can only accept or reject the task assigned to the free rider. The free rider will not have the permission to update the task. This is to prevent the free rider keep updating the task to show that he or she is doing the assignment but without actually doing it.
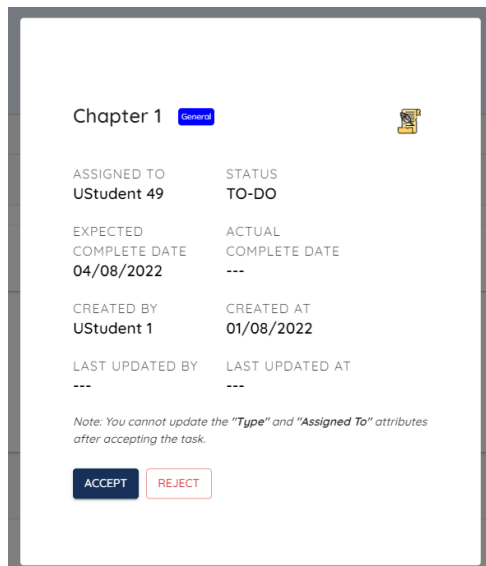
Figure 6.4.10 Task Accept or Reject
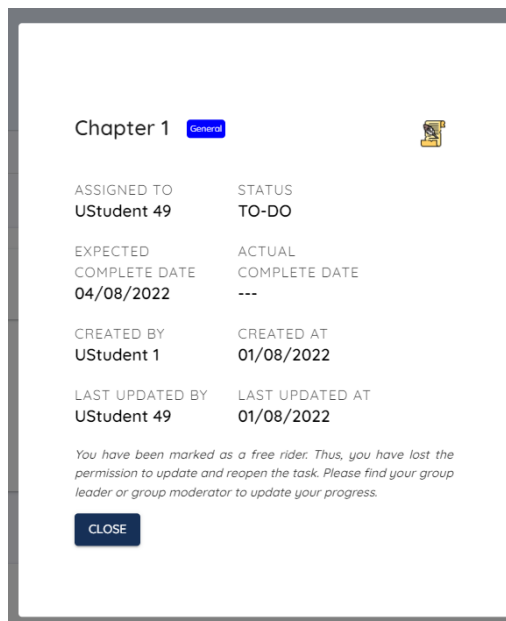
Figure 6.4.11 Free Rider Task Update View

From Figure 6.4.11, the free rider will be told that he or she has been marked as a free rider. Hence, the free rider cannot update the task. The free rider needs to find the leader or moderator to update the task. The owner can assign a moderator for this group by check the "Is Moderator?" which is shown in the Figure 6.4.6. The moderator can help the owner to update and approve the task that has been done by the free rider.
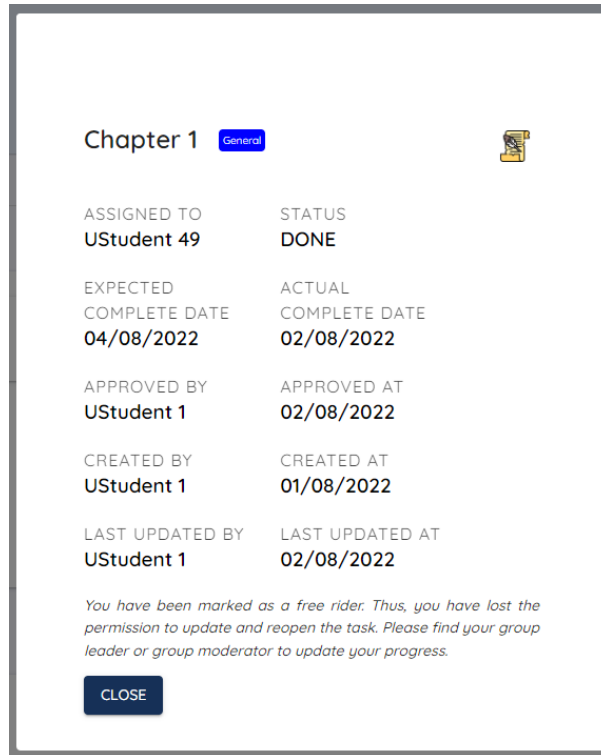
Figure 6.4.12 Task Approved by Moderator

Thus, the integrity of the task that has been done by the free rider can be promised. Furthermore, the reported free rider case will be stored in the system. Hence, every time other users view the profile of the free rider, the system will show how many reported cases have been stored in the system, how many times the owner marks the free rider as a free rider and how many assignments the free rider have done before.
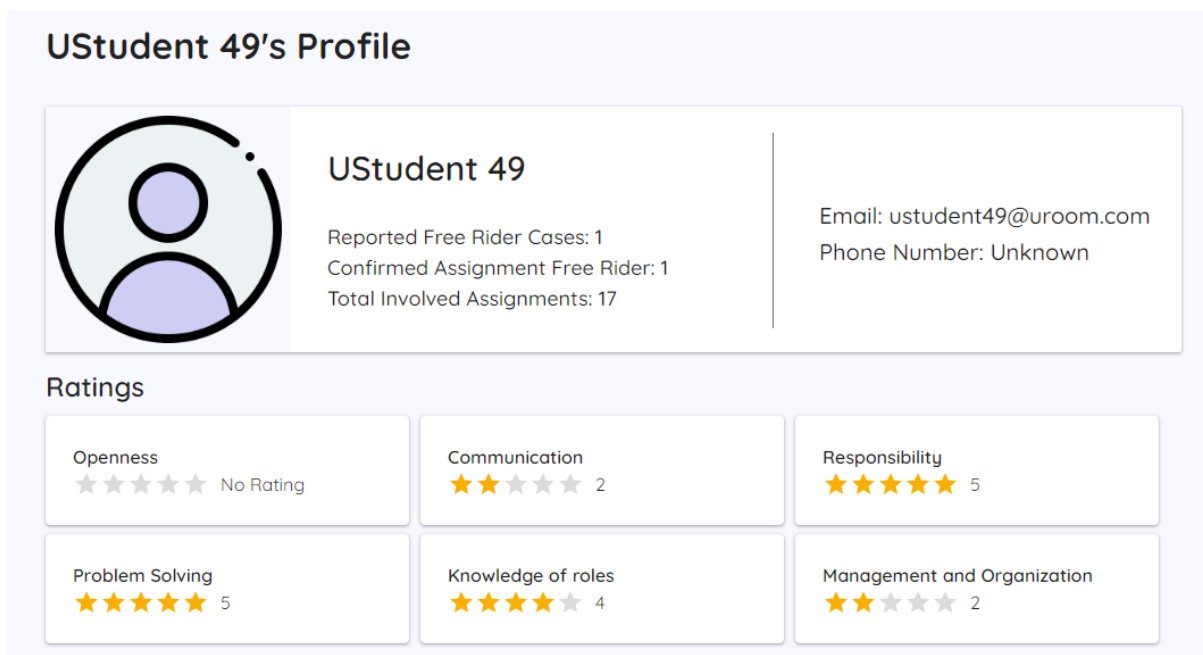
Figure 6.4.13 Free Rider Profile

Hence, with the provided information in the profile, there will be more information for other user to refer before deciding to team up with this person. Therefore, it can prove that the likelihood of free rider problems can be reduced as the users can avoid forming a team with the person that is having high reported free rider cases. Moreover, the user that have the potential becoming a free rider may think more before deciding not to contribute anything as they might have a hard time to form group with others in the future when the reported cases are high. Therefore, the likelihood of the free rider problem can be reduced. Thus, the verification of the objective of reducing the likelihood free rider problem has been done and proved that the objective is achieved.

6.4.2 Group Management and Auto Assign Assignment Group Function

As an owner of the room, the owner always can get the latest details of the members' assignment group data easily. By clicking the Assignment Group button in the room page, the system will display a list of assignment group data.

Figure 6.4.14   Assignment Group Management (1)

According to the Figure 6.4.14, the group status will show the group forming status of the student. If the student has a group, it will show as "Formed" else it will show as "N/A". However, instead of auto assigning, the owner can also choose to assign manually by clicking the icon in the "Action" column. It will display some options for the owner to assign a group for UStudent 50 manually which is shown as below.
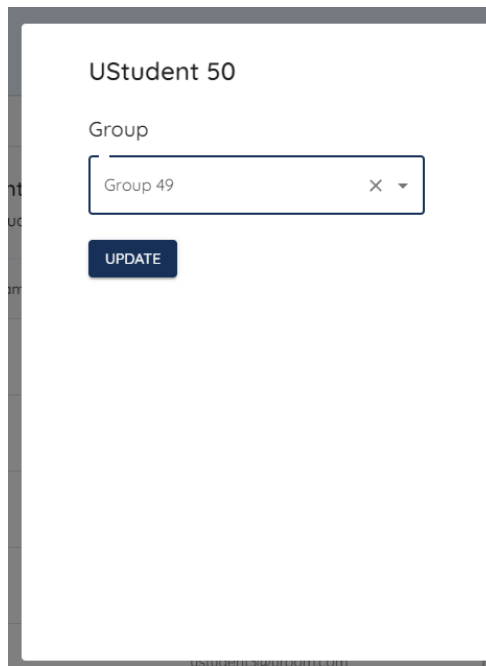
Figure 6.4.15   Assign Group Manually

Furthermore, the owner can also view the students' assignment group data.

Figure 6.4.16   Assignment Group Management (2)

The system will display the assignment groups that has been formed by the student manually in this page. The owner always can easily get the latest data of the students' assignment group without any extra operations. According to the figure below, the owner can view which group has submitted the assignment, size of the group, members of the group, reported free rider cases and result of the assignment. Furthermore, the owner can also manage the permission of the group member in the group and view the tasks that has been done by the group member.

Figure 6.4.17 Assignment Group Management (3)

By clicking the "Manage" button, the owner can manage the students' permission and roles in the group. The provided option in the figure below will enable the owner to control the member permissions and roles in the group.

Figure 6.4.18 Assignment Group Management (4)

The owner can click the "View Tasks" button to view the task that has been done by the student.
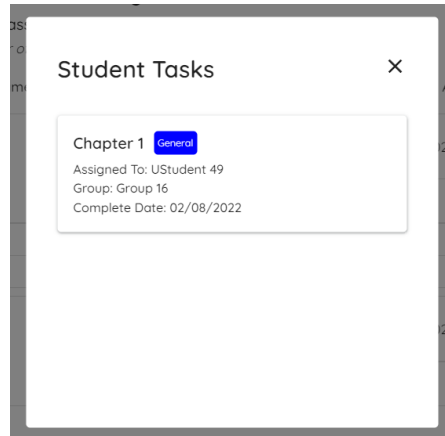
Figure 6.4.19   Student Tasks Done

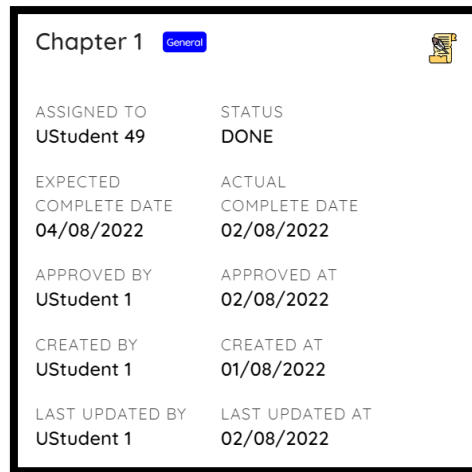The owner can also view the task details and update history of the task by clicking the task.

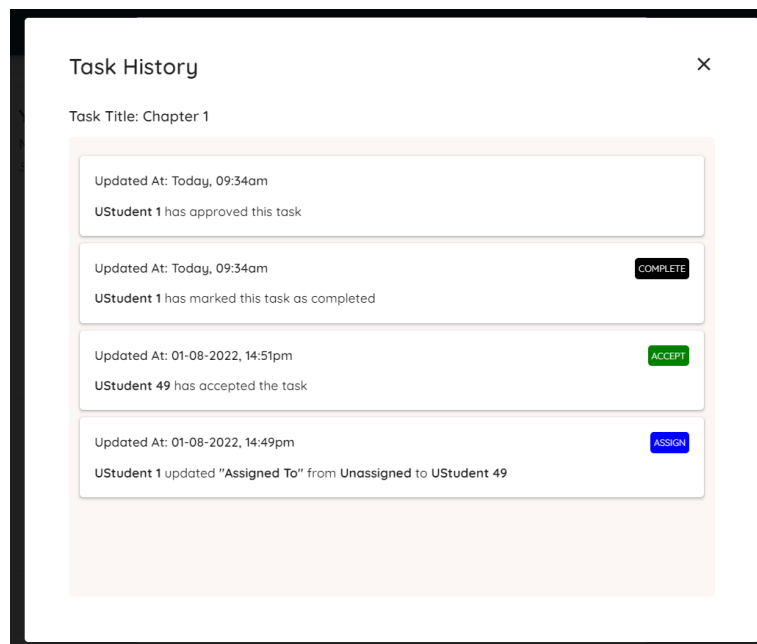Figure 6.4.20   Details of Student Task Done

Figure 6.4.21   History of Student Task Done

Hence, the owner can easily track the task that has been done by the group member. With these features, teachers not only can manage the assignment group of their students and also the permission of the students in the groups. They can also track the students' work done easily. If the teachers are concerned about the task created by the students are not standardized, they can also create some task templates for the student to import. Hence, all tasks that done by students can be standardized and clearly categorized. Thus, the objectives of solving the problem of managing assignment group can be achieved.

Figure 6.4.22 Task Templates

On the other hand, the owner can also choose to assign an assignment group for students automatically. In this system, two assign methods are provided which are General Assign Method and Specific Assign Method. The owner can select up to three skills that the owner considers important which is shown as the figure below. The system will base on the selected skill to assign the group. This is to ensure that the assigned groups are balanced. The design of the algorithm has been discussed in Chapter 4.

Figure 6.4.23 Auto Assign

Assuming the owner is assigning 100 students to a three-person assignment group using the General Assign Method and has chosen "Problem Solving" as the most important skill and "Management and Organization" as the second important skill.

Figure 6.4.24 General Assign Method (1)

The result of the assigning will be shown as below. It will have 34 groups which is correct.

Figure 6.4.25 General Assign Method (2)

Based on the result from Figure 6.4.25, three results will be picked randomly to verify the correctness and functionality of the method.

Table 6.4   Result of General Assign Method

Group	Student	Ratings of Problem Solving	Ratings of Management and Organization	Total Ratings
Group 3	UStudent 0	1	2	23
	UStudent 52	4	4	63
	UStudent 72	0	3	22
Group 21	UStudent 2	3	3	48
	UStudent 94	3	0	35
	UStudent 96	1	0	35
Group 32	UStudent 1	3	4	43
	UStudent 79	3	3	42
	UStudent 90	4	3	42

According to the result above, it is showing that every group will have at least one member is good at one of the important skills. For example, UStudent 0 and UStudent 72 both is weak at the problem-solving skill but UStudent 52 is strong at the problem-solving skill. Hence, at least one of the group members will be good at the skills that have been marked as important. In addition, the average total ratings of the groups above are 36, 35 and 42. Thus, it is easy to find that the average total ratings of the groups are not far off. Assuming the owner is assigning 100 students again with the same important skillsets but with specific method and three results will also be picked randomly to verify the correctness and functionality of the method.

Table 6.6   Result of Specific Assign Method (2)

Group	Student	Ratings of Problem Solving	Ratings of Management and Organization	Total Ratings
Group 3	UStudent 18	2	5	3.17
	UStudent 52	4	4	3.67
	UStudent 62	1	1	1.67
Group 21	UStudent 35	4	0	2.5
	UStudent 55	2	4	2.33
	UStudent 89	1	2	2.67

Group 32	UStudent 8	2	1	3.5
	UStudent 48	4	2	1.67
	UStudent 61	1	4	1.5

According to the result above, every group will have at least one member is strong at one of the skills and the average total ratings of the groups above are 2.84, 2.5 and 2.22. The average total ratings are also similar compared with the result in Table 6.5. From Table 6.5, Group 21 is only having one member is good at both important skills. However, in Table 6.6, Group 21 is having one member is strong at problem solving and another student is strong at management and organization which is more balanced. Furthermore, Group 32 is having the members are having similar ratings in Table 6.5 but having quite different ratings in Table 6.6. However, it is easy to find that in Table 6.5, Group 32 is having quite similar total ratings but in Table 6.6, Group 32 is having quite different total ratings. In Table 6.6, one of the members is bad at both important skills but having quite high of total ratings result. UStudent 48 is strong at problem solving and UStudent 61 is strong at management and organization. Hence, it is clearly showing that the Specific Assign Method is much more balanced. This is because although UStudent 8 is bad at both important skills, but this member is strong at other four skills. Hence, this member can support other members in other related field such as communication as UStudent 48 and UStudent 61 are only having a low result of total ratings. Therefore, the General Assign Method and Specific Assign Method are having the functionality to assign assignment group for students heterogeneously. However, General Assign Method will focus more on the average total ratings of the group is balanced but Specific Assign Method will focus more on the overall ratings of the group is balanced. Hence, the objectives of avoiding the imbalanced group problem can be achieved with the implementation above.

In conclusion, all the objectives of this project are achieved successfully.

Chapter 7

Conclusion and Recommendation

In this chapter, the conclusion of this project will be presented. However, some recommendations for the potential researcher in future will also be given in this chapter.

7.1 Conclusion

URoom is a web application that focus on the assignment and group management. Teachers can manage the assignments and students' assignment group easily while students can form and manage the assignment group in a more convenient way. URoom has also proposed some solutions for the problems mentioned in Chapter one such as free rider problem. Students can report the free rider and teachers will have the power to mark the students as free rider. This mark will be stored into the database and show to others in future as a reference for them to form the assignment group. Hence, URoom has built with a lot of features and modules to achieve the objectives.

This system is built with Assignment Room module, Assignment module, Assignment Group module, Chatroom module, Real Time Collaborative module, and Assignment Submission module. These modules will be used to help the teachers and students to do the assignment. Assignment Room module will enable the teachers to create room and invite students to the room. Assignment module will enable the teachers to upload the assignment. The Assignment Group module will enable the teachers to manage the assignment group and assign assignment group for students manually or automatically and members while the students can form and manage the assignment group. Students can also create the tasks and assign to others in a group. Teachers will be able to track the workload of a students with the task management features. Hence, it is having another way to find out who is the free rider in the group. Moreover, Chatroom module enables the students to discuss their assignment without the needs of creating a group chat in another application. Additionally, students can do their assignment in Real Time Collaborative module together. Lastly, the Assignment Submission module enables the students to submit assignment and view the submission while teachers can view and upload the result of the submission.

In a nutshell, with the modules and features discussed above, the project objectives can be achieved. URoom will be a new choice for the teachers and students to do their assignment.

7.2   Recommendation

There are some recommendations for the future researchers or developers that are going to do the similar project and can be list as below:

1. Real Time Collaborative module is not easy to build when times and resources are the limitations. Hence, it is a good decision to integrate some other applications like Google Docs into the application instead of building it.

2. Solving the free rider problem completely is not possible. Hence, trying to reduce the likelihood of the problem occurs is more sensible. This is because human behaviour is difficult to control.

3. The skillset of the students can be changed based on the requirement and environment. The skillset of the students mentioned in the previous chapter is just a recommendation and fit the developer cultural and environment.

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FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Y3S3	**Study week no.:** 2
Student Name & ID: Lim Jing Xiang, 1906862	
Supervisor: Ts Wong Chee Siang	
Project Title: UROOM: CONNECTING TEACHERS AND STUDENTS FOR CLASS ASSIGNMENT	

1. WORK DONE

- Added manage permission function for the owner in the assignment group module.
- Created Auto Assign web page.

2. WORK TO BE DONE

- Implementation of the auto assign function.
- Auto Assign function testing.
- Report free rider function.
- Add moderator feature for the owner to assign when free rider occurs.

3. PROBLEMS ENCOUNTERED

- Algorithm Design. The current algorithm cannot meet the expectation.

4. SELF EVALUATION OF THE PROGRESS

Current progress of this project is good. Most of the modules are completed and waiting for deployment. However, the auto assign function still requires some time to develop. SIT should be conducted soon.

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Supervisor's signature

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Student's signature

FINAL YEAR PROJECT WEEKLY REPORT
(Project II)

Trimester, Year: Y3S3	**Study week no.:** 4
Student Name & ID: Lim Jing Xiang, 1906862	
Supervisor: Ts Wong Chee Siang	
Project Title: UROOM: CONNECTING TEACHERS AND STUDENTS FOR CLASS ASSIGNMENT	

1. WORK DONE

- Completed the implementation of the general auto assign function with the auto assign algorithm.
- Created a function to report free rider by the members of the group.
- Added assign moderator features for the owner in the assignment group module.

2. WORK TO BE DONE

- Show the reported free rider cases to others to view in the user profile.
- Create another method called Specific assign method as another new method to assign students in auto assign function.
- Add features to let teacher to mark who is the free rider in the group.
- Limit the free rider permission.

3. PROBLEMS ENCOUNTERED

- It is hard to design another method called Specific assign method based on the given skill set as it may occur some groups are having all members with high ratings.

4. SELF EVALUATION OF THE PROGRESS

The progress of this project is good. Currently, a general method for the auto assign function has completed and implemented. Although the Specific assign method still in progress. However, the current progress still remains in line with the project schedule.

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Supervisor's signature

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Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Y3S3	**Study week no.:** 6
Student Name & ID: Lim Jing Xiang, 1906862	
Supervisor: Ts Wong Chee Siang	
Project Title: UROOM: CONNECTING TEACHERS AND STUDENTS FOR CLASS ASSIGNMENT	

---

1. WORK DONE

- Limited the free rider permission.

- Added features to let teacher to mark who is the free rider in the group.

- Others now can view the reported free rider cases in the user profile.

2. WORK TO BE DONE

- Create another method called Specific assign method as another new method to assign students in auto assign function.

3. PROBLEMS ENCOUNTERED

- It is having some problems on designing the Specific assign method with Genetic Algorithm.

4. SELF EVALUATION OF THE PROGRESS

The current progress of this project is still good. However, other algorithms will be studied as the current implemented algorithm to develop the Specific assign method cannot meet the expectation.

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FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Y3S3	**Study week no.: 8**
Student Name & ID: Lim Jing Xiang, 1906862	
Supervisor: Ts Wong Chee Siang	
Project Title: UROOM: CONNECTING TEACHERS AND STUDENTS FOR CLASS ASSIGNMENT	

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1. WORK DONE

- Created another method called Specific assign method as another new method to assign students in auto assign function.

2. WORK TO BE DONE

- SIT
- Deployment

3. PROBLEMS ENCOUNTERED

- Need to find a way to deploy the application.

4. SELF EVALUATION OF THE PROGRESS

Current progress is good as the problem of implementing the Specific assign method is able to be solved on time by self-designing the algorithm. Hence, deployment should be done to do the SIT.

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Supervisor's signature   Student's signature

FINAL YEAR PROJECT WEEKLY REPORT

(Project II)

Trimester, Year: Y3S3	Study week no.: 10
Student Name & ID: Lim Jing Xiang, 1906862	
Supervisor: Ts Wong Chee Siang	
Project Title: UROOM: CONNECTING TEACHERS AND STUDENTS FOR CLASS ASSIGNMENT	

1. WORK DONE   • Deployment
2. WORK TO BE DONE   • SIT   • Report Writing
3. PROBLEMS ENCOUNTERED   • Need a tester to test the system
4. SELF EVALUATION OF THE PROGRESS   Deployment has been done successfully by using Heroku. Hence, system testing should be conducted soon and should start to write the report.

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Supervisor's signature

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Student's signature

FINAL YEAR PROJECT WEEKLY REPORT
(Project II)

Trimester, Year: Y3S3	**Study week no.:** 12
Student Name & ID: Lim Jing Xiang, 1906862	
Supervisor: Ts Wong Chee Siang	
Project Title: UROOM: CONNECTING TEACHERS AND STUDENTS FOR CLASS ASSIGNMENT	

1. WORK DONE

- SIT

- Bug Fixing

2. WORK TO BE DONE

- Report Writing

3. PROBLEMS ENCOUNTERED

- A lot of bugs have been found after tested by the tester. However, some of the bugs are difficult to fix.

4. SELF EVALUATION OF THE PROGRESS

The progress of this project is healthy and be able to deliver on time. System Integration Testing has been done and all the bugs have been fixed. Hence, the system can be delivered as final version by the end of this week.

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Supervisor's signature

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PLAGIARISM CHECK RESULT

Bachelor of Computer Science (Honours)
Faculty of Information and Communication Technology (Kampar Campus), UTAR

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY

Full Name(s) of Candidate(s)	Lim Jing Xiang
ID Number(s)	19ACB06862
Programme / Course	Computer Science
Title of Final Year Project	UROOM: CONNECTING TEACHERS AND STUDENTS FOR CLASS ASSIGNMENT

Similarity	**Supervisor's Comments** **(Compulsory if parameters of originality exceed the limits approved by UTAR)**
Overall similarity index: ___2___ **%** **Similarity by source** Internet Sources: ____1_____% Publications: ____1_____ % Student Papers: ____1_____ %	
Number of individual sources listed of more than 3% similarity: _0_____	

Parameters of originality required and limits approved by UTAR are as Follows:
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  (ii) **Matching of individual sources listed must be less than 3% each, and**
  (iii) **Matching texts in continuous block must not exceed 8 words**
Note: Parameters (i) – (ii) shall exclude quotes, bibliography and text matches which are less than 8 words.	

Note: Supervisor/Candidate(s) is/are required to provide softcopy of full set of the originality report to Faculty/Institute

Based on the above results, I hereby declare that I am satisfied with the originality of the Final Year Project Report submitted by my student(s) as named above.

_____   _____
Signature of Supervisor   Signature of Co-Supervisor

Name: __Ts. Wong Chee Siang_____   Name: _____

Date: ___02/09/2022_____   Date: _____

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Faculty of Information and Communication Technology (Kampar Campus), UTAR

CHECKLIST FOR FYP2 THESIS SUBMISSION

Student Id	19ACB06862
Student Name	Lim Jing Xiang
Supervisor Name	Ts. Wong Chee Siang

TICK (√)	DOCUMENT ITEMS Your report must include all the items below. Put a tick on the left column after you have checked your report with respect to the corresponding item.
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√	List of Abbreviations (if applicable)
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Date: 27/07/2022