CMS – COURSE MANAGEMENT SYSTEM

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ABSTRACT

Currently, the Covid-19 epidemic is devastating and causes many serious consequences. Along with the development of technology 4.0, online learning methods are currently the best and most effective solution.

The primary purpose of a course management system is to manage courses and classes easily, providing students with the means to learn effectively and without consuming many resources.

This report will identify and build a course management system with the right technologies: ReactJS, Django and PostgreSQL.

This report will include sections such as introduction to CMS, technologies to build the system, comparison of similar products and presentation of the project construction process.

ACKNOWLEDGEMENTS

I would like to express my gratitude to Mr Do Minh Quan for helping me a lot during the implementation of the project. Thanks to his helpful advice, I completed the project.

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1. Introduction

In the context of the growing and unpredictable COVID-19 epidemic, online learning is becoming a more transformative street training solution than ever before. However, to manage the process of organizing online lessons and providing facilities and materials for classes, a specific system for control is required. The course management system was created and built to be able to solve the problem quickly. In this project, a course management system will be designed, built and applied to a practical education centre.

2. Literature Review

Currently, there is a lot of technology to design, build and develop a web system. However, before building, we need to learn the generality of the purpose and objectives of the website. Then, evaluate the selection of the right technologies for project construction and development. In this section, I will give an overview of the course management system, assessing the strengths and weaknesses of each technology, platform and development method to be able to choose the most suitable options for the project.

2.1. Course management system

2.1.1. Overview of CMS:

Today, along with the development of technology and internet revolutions applied in all fields, people have been looking for and developing solutions to manage large data works and information in education more efficiently and effectively. There have been slow changes in the use and application of the web to improve management, teaching and learning. These changes gradually led to the introduction and development of a course management system (CMS) tool.

2.1.2. Definition of CMS:

The course management system is defined as a web application and is a cornerstone of educational software. It allows faculty and educational institutions to manage courses along with a lot of students and a large number of lectures and accompanying materials. The course management system also provides tools to make management

easier such as sharing materials, holding presentations or discussions, uploading courses and assignments for students. (Vanderbilt University, 2021)

2.1.3. Feature of CMS:

According to (Cole & Foster, 2008), the system has useful features to make course management easy and effective as follows:

- Uploading and sharing materials:

Most course management systems have tools to store and publish documents and content easily. Teachers can upload symies, share materials, take notes on lessons, create assignments for their students anytime, anywhere just need an Internet connection.

- Forums and chats:

The system provides the means to create forums and chat online easily. This gives faculty and their students plenty of time and places to discuss and communicate quickly and easily.

- Quizzes:

Online puzzles can easily be created by faculty and students can interact and respond quickly. At the same time, these puzzles can score instantly and students will quickly receive assessments of their abilities. What's more, the course management system can store online quizzes into a question bank, so faculty can be easily compiled and used.

- Gathering and reviewing assignments:

The introduction of assignments, assignments on the online system, the lecturers will easily monitor and check. Furthermore, students will be encouraged to work and increase performance when using the online environment for assessment.

- Recording grades:

Provide the ability to monitor and check information about developments and scores in the course. This also helps students keep their grades private, allowing only students to see their own grades.

2.1.4. History of CMS:

In order to achieve the current broad development and allocation, the course management system has been built on previous management tools and platforms.

According to (Athmika, 2020), from the 1920s to 1929, scientists Sidney L. Pressey and Milton Ezra LeZerte invented tools to provide students with materials and questions without their faculty's guidance. More importantly, the tool has been designed and built to check students' answers; This saves much time for the instructor during the examination and grading.

In the 1950s and 1960s, there were significant changes in the application of technical institutions to teach. In particular, the University of Houston, USA, has broadcast credit courses on television for the first time. Accordingly, everyone can learn from home without having to go to school.

In 2000, the first open-source CMS system, Moodle, was developed and built. With Moodle, users can take courses and read related documents when installing the app (Athmika, 2020).

2.1.5. Growth of CMS:

According (Kats, 2010)to, 75% of universities and colleges in the United States adopted CMS in 2002 and were promoted to 90% in 2006. In North America, the course management system market ended in 2006 with a 26% growth rate, reaching $480 million in revenue.

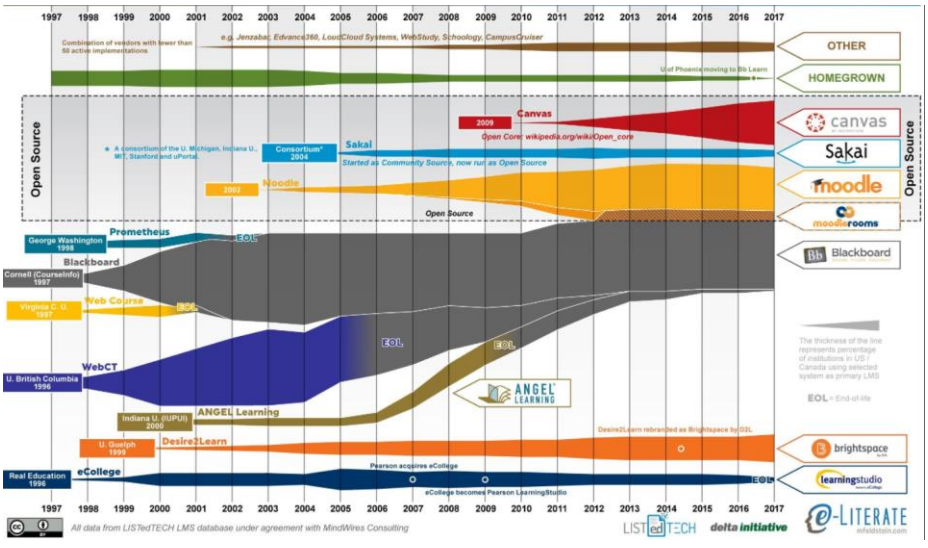

Figure 1. CMS Market Share for the US (Duin & Tham, 2020)

The market share of companies providing CMS systems has changed markedly. In the first five years, Desire2Learn grew to 2,117%. Angel Learning has thrived and become the fastest system with a market share increase of 10% in 2008. BlackBoard, Inc. became a major force in the CMS market when it acquired AngelLearning in 2009. (Duin & Tham, 2020)

2.1.6. Current Status of CMS:

According to (MarketsandMarkets, 2020), the global course management system market size is estimated to increase from $13.4 billion in 2020 to $25.7 billion in 2025, with a growth rate of 14.0%. However, according to (FortuneBusinessInsights, 2021), the CMS market size is estimated to reach $10.84 billion in 2020. The growth rate is 23.8% in 2020 compared to the average annual growth from 2017 to 2019. Moreover, the system's market is projected to grow by $13.38 billion in 2021 to $44.49 billion in 2028.

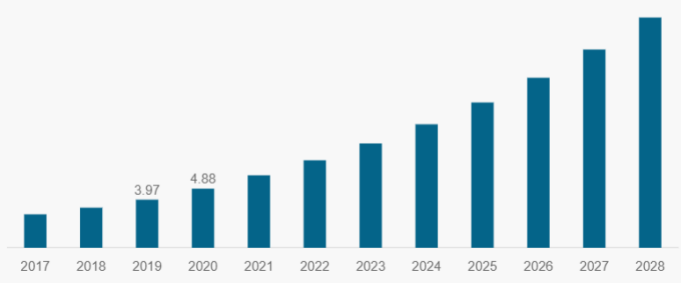

Figure 2. North America CMS Market Size (FortuneBusinessInsights, 2021)

Effects of COVID-19

As an effect of COVID-19, the global education system has changed its teaching practices, temporarily shutting down educational institutions such as schools, colleges, and universities to organize teaching on online platforms. According to (Reports, 2021) more than 1.2 billion students in 186 countries have been struck by the COVID-19 pandemic. The difficult circumstances caused by the epidemic have put pressure on educational institutions to develop and apply online teaching systems to teaching.

According to the heavy influence of the(MarketsandMarkets, 2020) pandemic, the economy and society in the world have changed markedly. Educational and manufacturing facilities must be closed; Major sporting and cultural events are

delayed. Businesses have to bear the consequences of the shortage of human resources and apply technologies to overcome this period. In education, educational institutions seek and apply online learning solutions; Teaching tools are also being focused on development and support.

2.2. Technologies

For designing and building a website, it is essential to compare and evaluate the technologies involved in choosing the right one. In the Technologies section, the report will evaluate the technologies in detail and compare them. The web application is divided into two parts: Front-end and Back-end.

2.2.1. Front-end technologies:

In terms of technologies for designing and building interfaces, many frameworks support and make design more accessible. In particular, two frameworks are quite famous and trusted and used by the development community: React and Angular.

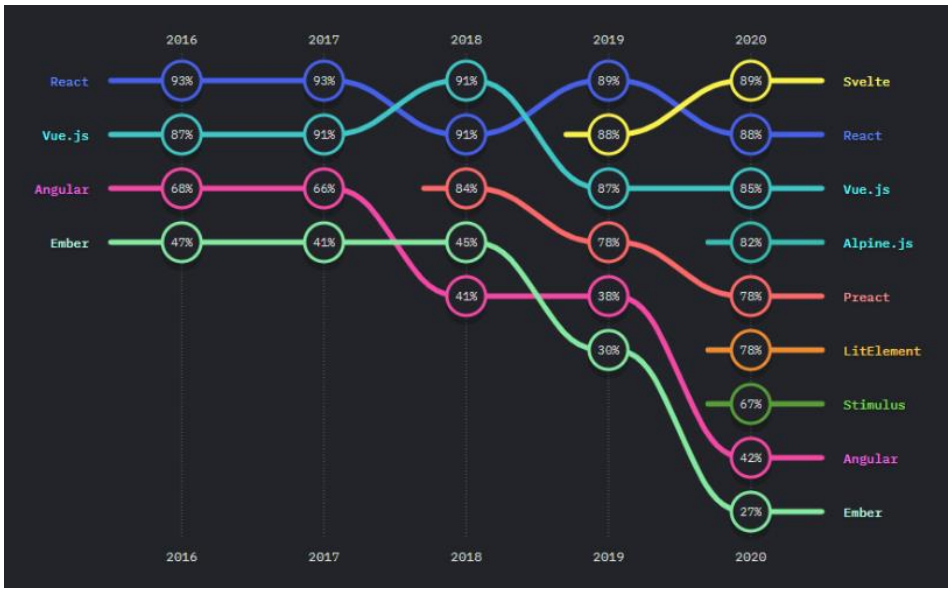

Figure 3. Front-end Technologies

2.2.1.1. React framework:

(Roy, 2019)React is an open-source framework designed and developed by Facebook. React is considered the best framework currently and is trusted by the majority of front-end developers.

React stands out due to the virtual Document Object Model (DOM), its unique functions. Therefore, the project can use React to work with high traffic and stabilize

its management. Moreover, this framework is user-friendly, and a large user community can support it at any time. (Roy, 2019)

According to (Grabski, 2020), React has the following pros and cons:

Strengths:

- Reusable components: React supports project construction based on small components. These small components are responsible for a small portion of the entire application, so they can be reused at any time. Break down a complex application into constructive and straightforward components.
- Easy to expand: thanks to the reusability of components, just manage small components and use them to build a more significant application.
- Virtual DOM: Enhances the design and development process of app developers.
- Large growing community: the React community has been overgrowing. This is an excellent opportunity to be able to learn, as well as ask for help to solve the difficulties of problems during the project implementation.

Weakness:

- High growth rate: Currently, React is still a relatively new and rapidly evolving technology. When React updates, developers need to update the project along with their skills to ensure the quality of the project.
- Lack of proper documentation: Along with high-speed development, technology is constantly updating and innovating. However, documents and information cannot keep up with that pace of development. Even so, with large communities, this problem can be solved.

2.2.1.2. Angular framework:

Angular is a framework for designing and developing web applications and is the foundation for efficiently and quickly creating applications. Angular was designed and developed by Google, officially released in 2016. Except for its first version, AngularJS, Angular was designed and built on the TypeScript language. Unlike React, Angular has two-way data flow tracking characteristics; real-time synchronization between view and modelling (Kumar, 2018).

According to (AltexSoft, 2020), Angular has the following pros and cons:

Strengths:

- Component-based architecture: Provides easier code reuse, readability, and code maintenance capabilities for project and product developers.
- Use typescript language: TypeScript language is an upgraded version of JavaScript. It helps developers search, detect, and eliminate common errors when making code. In other words, it provides a better tool, code that will be easier to read, easy to understand, and more scalable.
- Google releases angular, and now, Google plans to develop and work long-term with Angular.

Weakness:

- The community isn't huge: The front-end developer community no longer prioritizes Angular among front-end development technologies.
- Difficult to learn: When developers get used to JavaScript and start learning Angular, they will have to face many difficulties related to models and packages related to... In addition, TypeScript also takes much time to get acquainted and master.

2.2.2. Back-end technologies:

Besides building the look of the website, building servers and setting up databases is also critical. Currently, there are many technologies or frameworks to support design and construction easily, including Django, Flask, Express, Laravel... In this report, on server building technology, Django and NodeJs will be the two technologies evaluated and compared; As for database building, MongoDB and PostgreSQL will be mentioned.

2.2.2.1. Django framework:

Django is an open-source framework built on the Python language. This framework is considered suitable for designing, constructing, and developing websites with massive databases and many features. Moreover, Django facilitates the possibilities of optimizing code lines, reducing encryption, along with the ability to reuse and expand projects quickly (Sachdeva, 2020).

According to (Benchmark, 2021), Django has the following pros and cons:

Strengths:

- Taking advantage of python's capabilities: Because it is designed and built on the Python language, Django can take advantage of python's utilities and capabilities. Based on that, developers can quickly develop, maintain and improve the project. Moreover, many Python support libraries will make the project easier to develop.
- High-security system: Django is rated as a secure framework due to its accompanying number of integrated systems, preventing security issues. In addition, Django provides a system that requires users to work with the database securely.
- High Scalability: Django offers the possibility to expand the project with ease. In addition, this framework provides better performance and facilitates the implementation of a necessary task quickly and efficiently.

Weakness:

- Not suitable for small projects: Django comes with multiple codes, thus increasing processing and making servers take longer to respond. In other words, servers running on low bandwidth will encounter many problems and can be severely damaged.
- Monolithic nature: Django, when initiated, will have particular and pre-defined file sets. Therefore, to be able to build effectively, the programmer needs to understand its nature and follow the pre-defined rules.
- There is no possibility of multiple requests at once: Unlike other frameworks, Django does not have this ability. This causes much discomfort for developers to learn and come up with alternative ways to solve this problem.

2.2.2.2. Express framework:

Express is an open-source framework running on the JavaScript language and is one of NodeJs' most popular frameworks. Express is designed and built primarily in response to API construction and related Web applications. This framework was officially announced in 2010 and achieved the standard under the MIT (Alberto, 2019)license.

According to (AlterSoft, 2019), Express has the following pros and cons:

Strengths:

- Powerful technology stacks: help developers design and build servers more efficiently and productively. It also offers free tools and the ability to reuse code to support the implementation of code.
- Rich support library: With a wide range of tools, free, supported libraries accessible and usable, developers can quickly develop and build projects.
- Dynamic community: Large community with highly experienced users, easy to support and answer questions related to the project.
- Easy to learn and use: Built on the JavaScript language, a widely used and popular programming language. Most front-end developers use JavaScript, so it will not take long to learn and master this framework.

Weakness:

- Poor security: Do not provide security systems and are easily hacked, data theft. Besides, the framework requires manual operations to control and solve security-related issues.
- Resource-heavy: When performing file conversion, video encryption, and... Express will consume a lot of CPUs, which will take a long time to reason.

2.2.2.3. MongoDB:

The MongoDB database is also known as the NoSQL database. Instead of saving data in data tables with interconnected relationships, MongoDB will save data in BSON. BSON is defined as the encryption of JSON format documents, including keys and values (K, 2019).

According to (K, 2019), MongoDB has the following pros and cons:

Strengths:

- Easy to design and use: MongoDB is a NoSQL facility, so developers do not need to design, define schemas and relationships between tables and data in databases.
- Easy to store and query: Because the data is in JSON format, storing and querying them is extremely easy. Just the key and value can quickly get the data.
- MongoDB is easy to scale (horizontally).

Weakness:

- Prone to data errors: Due to the lack of data constraints, developers can store flawed information.
- Use multiple memory: Due to being stored as JSON, including pairs of keys and values. MongoDB collections will vary in value, but the lock is repeated, resulting in much memory.

2.2.2.4. PostgreSQL:

PostgreSQL is an open-source database system. Unlike MongoDB, PostgreSQL uses SQL language combined with many features to process and store information securely. This system is supported with many features to help developers design, build applications, provide measures to protect data integrity, and support data control and (PostgreSQL, 2021)management.

According to (Aalpha, 2021), PostgreSQL has the following pros and cons:

Strengths:

- Security: Postgres has many international recipients of data security capabilities. It provides tools and features to ensure the security of parameters and application security in the database.
- Scalability: If developers need to add features to the database, they can add it themselves. This is considered difficult for some other databases.

Weakness:

- Slower performance: There are many performance and efficiency issues that people when using Postgres need to face. Due to the relational database structure, when making queries, the system needs to go through the entire data table to find the information with relevant data. When the database has a large amount of data, and there are many fields saved in the table, it will take quite a long time to implement.
- Database structure: Before designing and building a database, developers need to identify objects and relationships so that they can draw on the structures of the database. Besides, once a table is built, developers cannot add a collection to a separate field. To solve this problem, that table needs to be changed, and additional fields are needed.

2.3. Development Methodologies

In order to manage, control and understand the progress of the software development project, development methods need to be explored and applied to the project. In this section, several development methods will be outlined and compared to choose the most suitable option.

2.3.1. Waterfall:

According to (Dennis, et al., 2005), the methodology designed and applied first is waterfall development. When applying this method, the project will be divided into many different stages and will have to be done in turn, similar to the waterfall. The stages are divided into Planning, Analysis, Design, Implement. The waterfall model is often applied to small projects with little change in the implementation process.

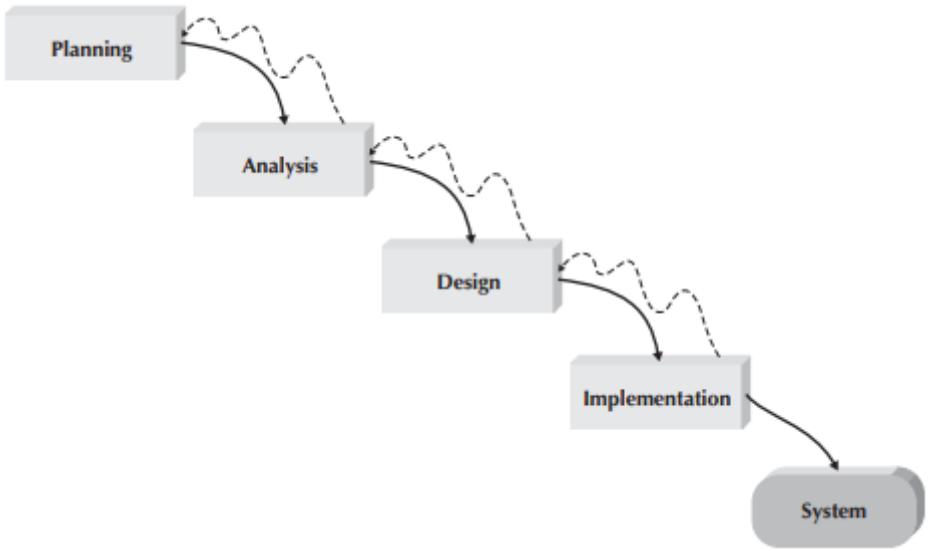

Figure 4. Waterfall model (Dennis, et al., 2005)

According to (Dennis, et al., 2005)waterfall model has the following pros and cons:

Strength:

- Easy to implement, easy to manage: Because the waterfall model performs sequence steps in different stages. Therefore, it will be easy to manage the project progress according to the set steps.
- Clearly define the requirements of customers: Before implementing the design and construction of the project, developers need to carefully research and analyze customers' requirements, minimizing the risk of changes to the requirements when implementing the project.

- Disciplinary model: When implementing the waterfall model, the stages need to be completed. Once one stage has been completed, the next one begins. Therefore, the whole project will focus on a particular stage, minimizing the risks of implementing the project.

Weakness:

- Difficulty changing designs: Designs must be completed before starting the project. Therefore, when the project is underway, changes in customer requirements or designs will cause many difficulties for the development team.
- Time-consuming: Transfers between stages often take much time. In order to conduct a new stage, it is necessary to check and analyze the previous stage's results and conduct the system transfer.

2.3.2. Agile/Scrum:

Agile is a flexible software development technique and a way for managing software projects. It incorporates an integrated and interactive workflow to expedite getting the product into the hands of the consumer (Stellman & Greene, 2014).

According to (Stellman & Greene, 2014), Agile/Scrum has the following pros and cons:

Strength:

- By involving consumers, the Scrum approach ensures the most substantial outcomes.
- Facilitates success in enterprises when paperwork is an issue.
- Rapid findings and an uncomplicated testing technique result in greater productivity and quality of work.
- This is a straightforward method that entails periodic progress reports. Regular meetings are held to ensure that the information is up to date.

Weakness:

- Does not have a fixed time or cost estimate, which permits it to be divided into many sprints.
- Requires a great degree of commitment on the part of all team members. Serious problems might arise if certain members are not up to the task.
- Ideal for small teams with a strong sense of togetherness and understanding.
- A group of skilled workers must fulfill the assigned tasks.

2.4. Conclusion

Here is a selection of technologies and development options that are suitable for my project.

Front-end: The react and Angular frameworks mentioned above are both frameworks for building popular web applications. I decided to choose to React as the framework to implement and develop the project instead of Angular. Although both frameworks use component-based structures, reusable and expanded efficiently, React uses JavaScript and Angular uses TypeScript; I've mastered javascript. Besides, React tends to be more interested than Angular; Moreover, React's community is more significant, and I can quickly solve questions and problems that I only encounter when implementing the project. Another factor in evaluating is the flexibility in using libraries, packages and related tools to build projects. React frameworks can provide these tools flexibly, but with Angular, there are many limitations.

Back-end: I decided to choose Django to build the web service API for the project and select PostgreSQL to build the database for my project. The reason I chose Django for my project instead of Express, the first is in terms of python and JavaScrip languages, with python, I can easily apply the giant utilities it brings; The second is about security, to implement this project I need to prioritize more secure and secure capabilities. Besides, Django is built and designed according to a common framework to control and maintain the code easily. Although this is only a tiny project complete project, I will still look forward to future improvements to build a complete system.

The reason for choosing PostgreSQL instead of MongoDB for my project is that my project will have to store the data with complex fields and efficiently manage the changes in the data. I decided to use the SQL data model for the project. Besides, PostgreSQL is recognized as having only international in terms of security, so I will not have to worry too much about security issues. Similar to the last reason I chose the technology for server construction, I look forward to marked improvements in the future to build a complete system. My database will have to store much information at that time, and MongoDB has no advantage in optimizing information storage.

Development methodology: I choose the waterfall model to apply to my project for the project development method. Since I did not have much experience implementing the scrum development method, I would choose the waterfall model, which I've done

quite a lot during my studies at the school. Therefore, in the implementation process, I will have to carefully carry out the necessary stages of the waterfall model and apply it to the project so as not to spend much time implementing it.

3. Requirement Analysis

There are currently many web applications related to the course management system. Here are the related applications that have given me ideas and information to design and build for my project. This section will provide an overview of the information to analyze and identify the requirements for my web application.

3.1. Similar Application

3.1.1. CMS FGW Greenwich Vietnam:

This is the website of the course management system of the University of Greenwich, Vietnam. This is also one of the websites that gave me the idea to do this project.

Below is a home image; users can search for courses and search for information about classes and related materials.

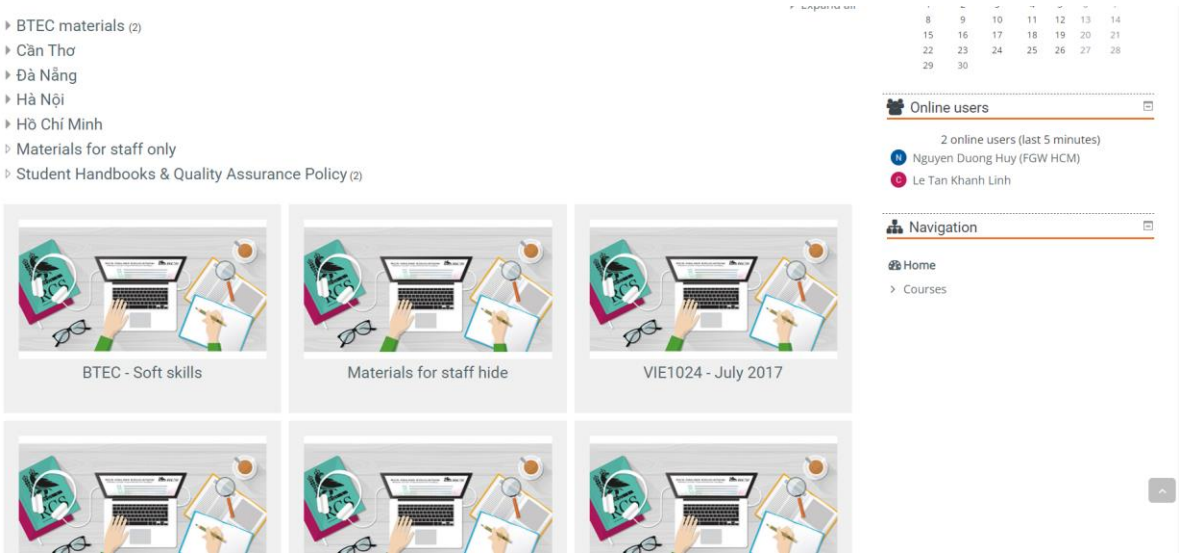

Figure 5. Homepage of CMS

When entering a certain class, information about activities in the class as well as exercises will be shown. These activities are carefully divided by week.

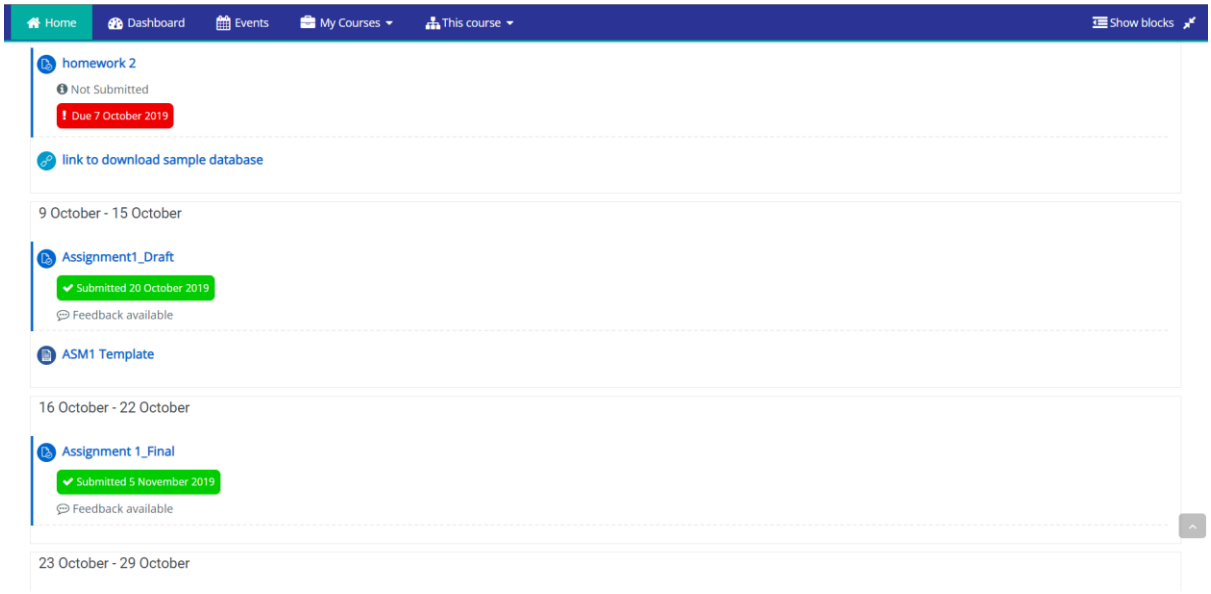

Figure 6. Class in CMS

To see the details of the activity, the assignment, the student can press on it, and the detailed screen is displayed.

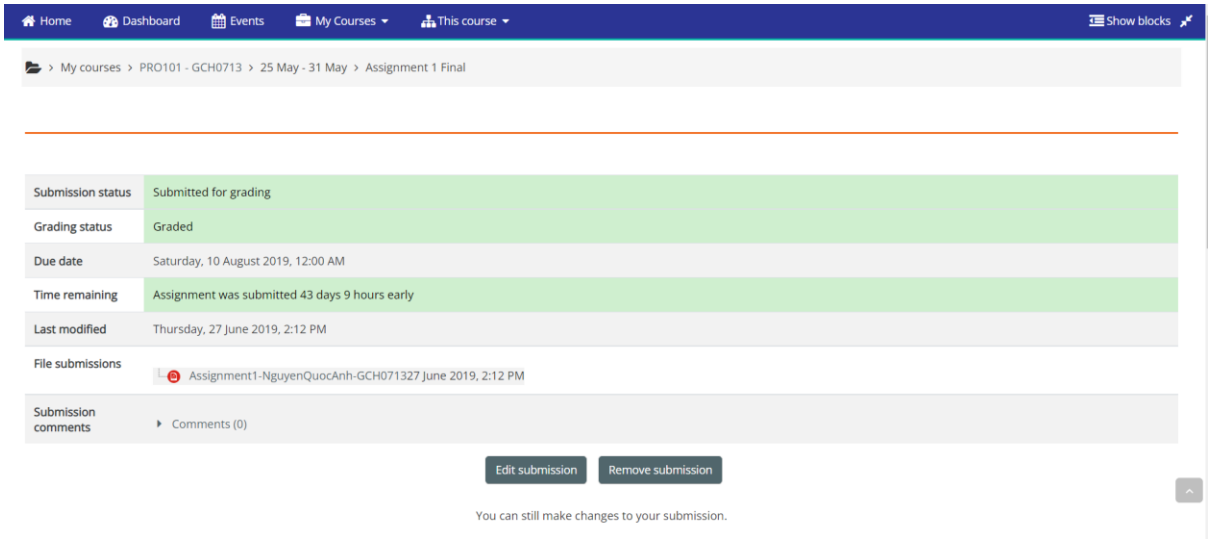

Figure 7. Submission Page

Information such as Submission status, Grading, Due date, ... will be presented, and students can rely on that to perform and complete the activities.

What's more, CMS also offers a Calendar feature so that students can check out the upcoming activities of a particular class. Based on this, students can rest assured that they are not being overlooked for any activity or assignment.

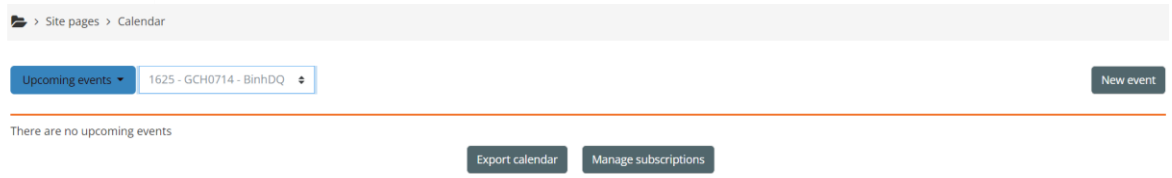

Figure 8. Calendar feature in CMS.

3.1.2. Google Classroom:

Technically, Google Classroom is not considered a course management system. However, the features it brings have the appearance of a course management system.

Below is the home page of the Google Classroom system. Classes participated are shown on the screen; Information such as class name, the teacher is shown in detail.

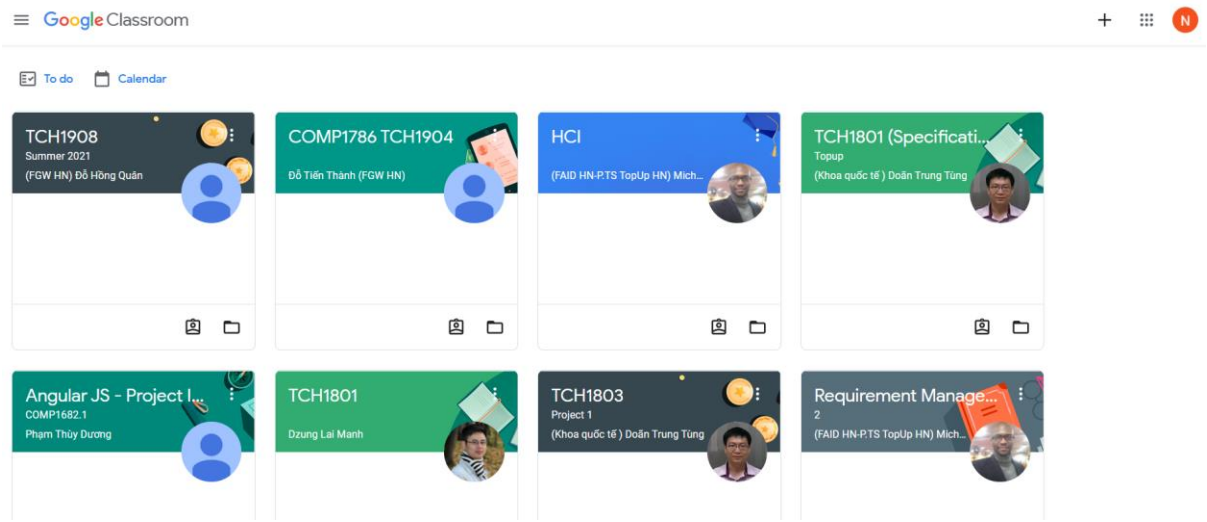

Figure 9. Homepage of Google Classroom

Once the user has started entering a class, they will see the details of the activities of that class. Information about the poster, activity name, and posting time is also detailed on each activity.

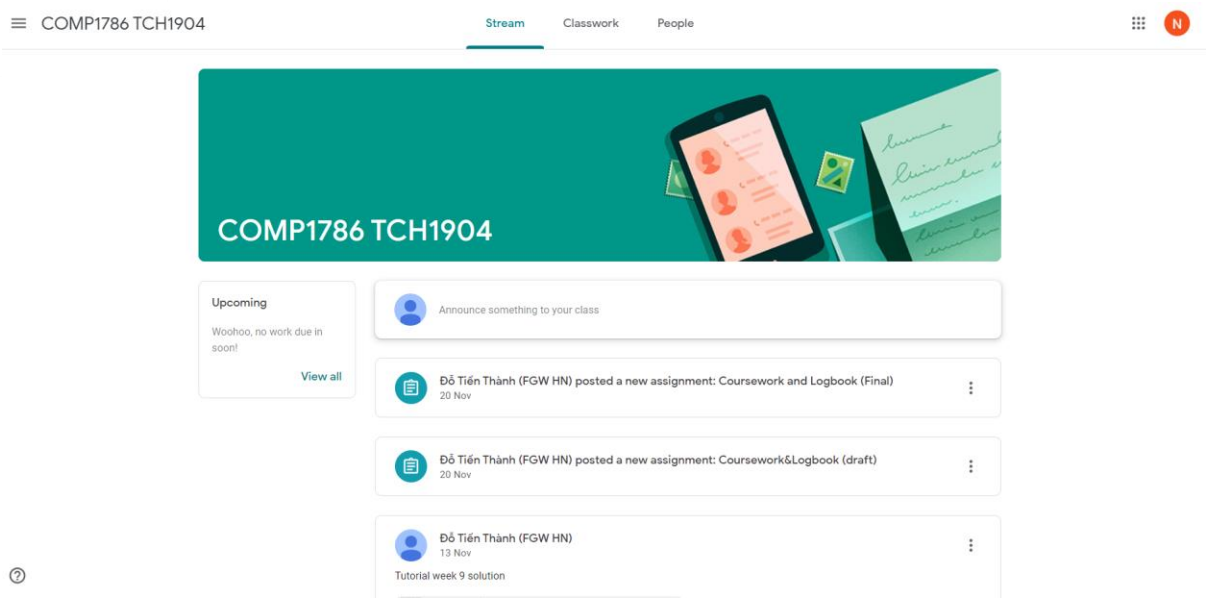

Figure 10. View Class in Google Classroom

Next is the classwork page of the class, students will see the assignments assigned and the deadline to complete them.

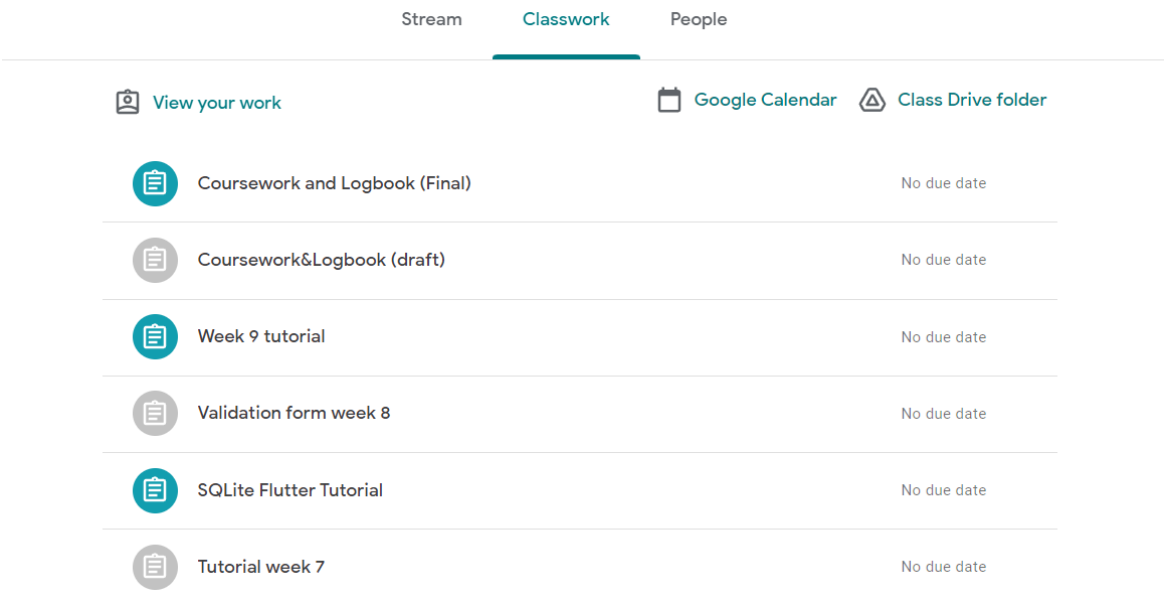

Figure 11. View Classwork

When students want to see more details of these assignments, they click and the screen switches to detail the assignment's requirements.

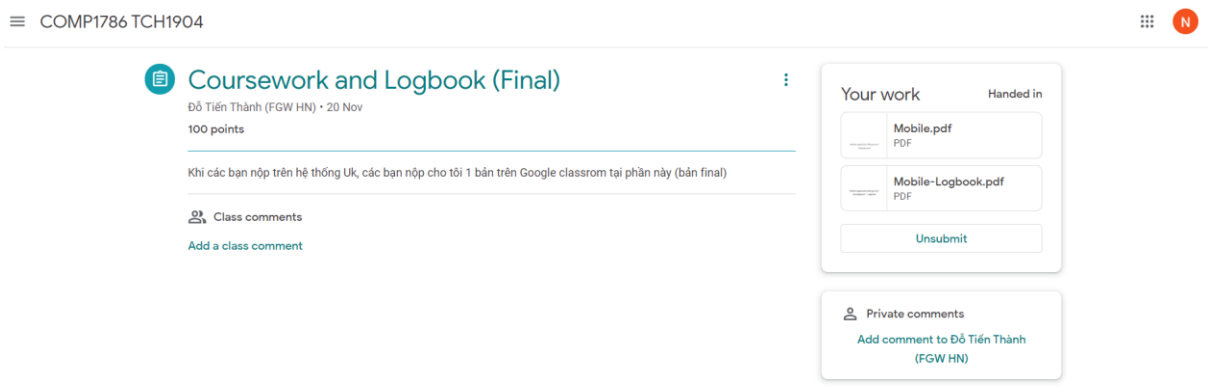

Figure 12. Submission page.

Moreover, they will submit the exercises in the left frame of the screen.

Google Classroom also offers a view calendar feature that allows users to control upcoming activities or future assignment deadlines.

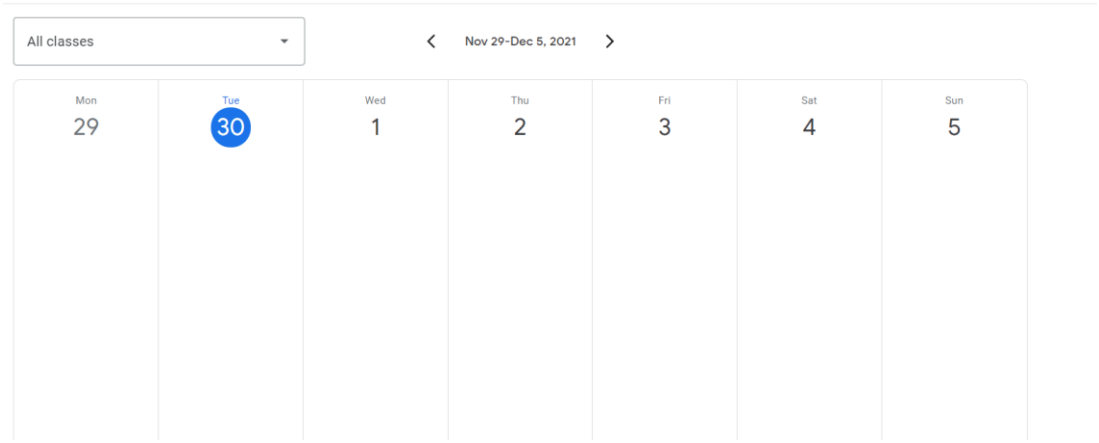

Figure 13. Calendar feature in Google Classroom

More specifically, when comparing and evaluating the Google Classroom system, I can play as a lecturer to take a close look at the features of Google Classroom that help track and check students' assignments. For my university's CMS page, I can hardly judge when I'm just a student.

Below is a screen of the student's submitted assignments. Here, instructors can easily control the students' assignments in their classrooms and comment and grade for their students.

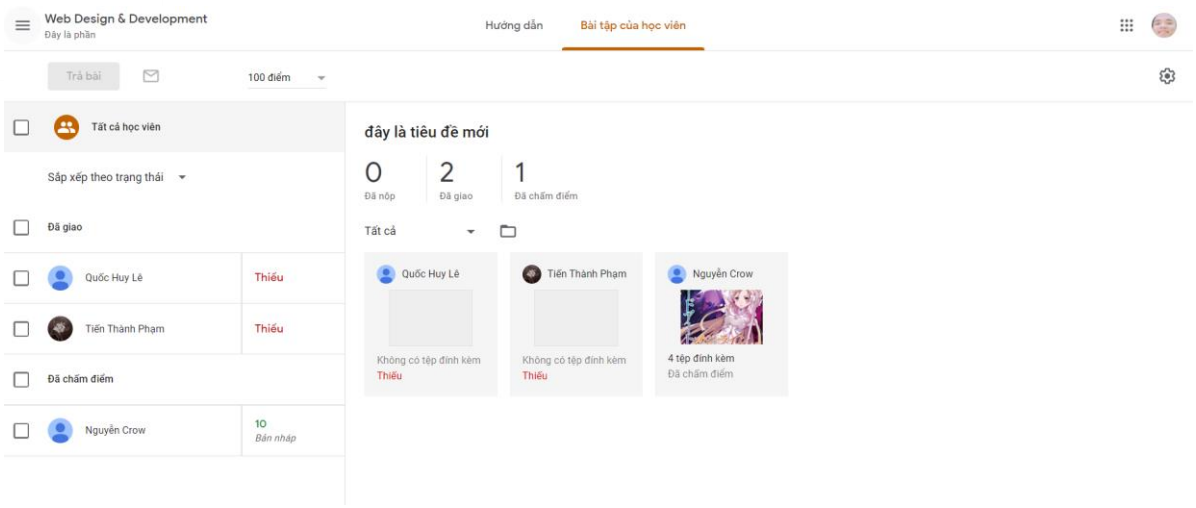

Figure 14. View submissions

Below is a grading screen for students' assignments. At the same time, tutor can make detailed comments about the assignments that students have submitted.

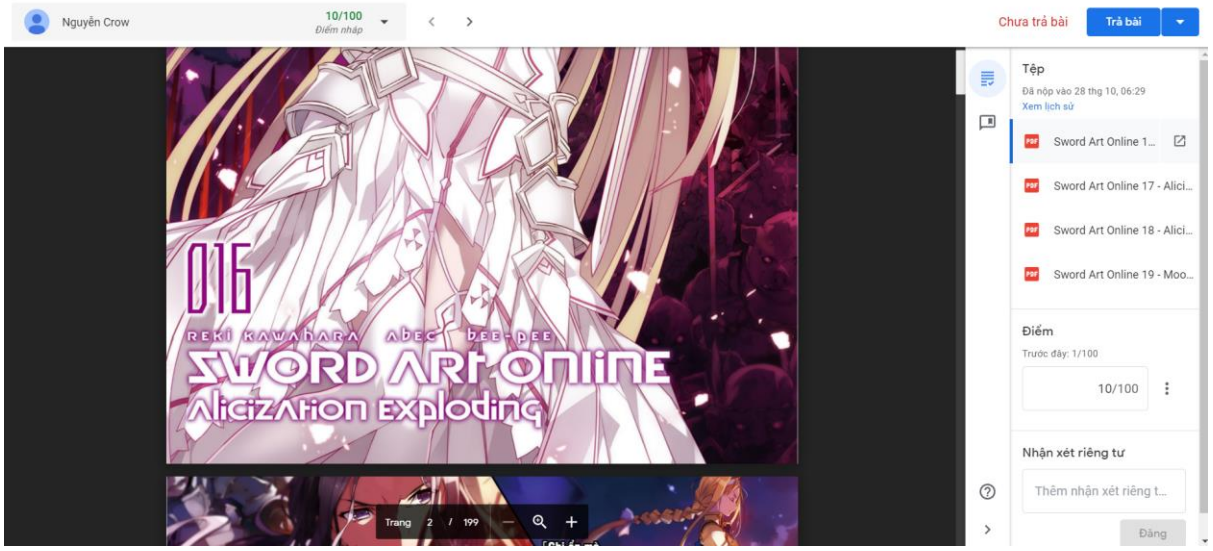

Figure 15. Check and grade submission

3.2. Requirements

3.2.1. Define functional requirements

Based on similar products, along with the information learned about the course management system, I have identified the requirements of my project.

I will determine and evaluate their first levels of love with a scale of 1-4 (1: must-have, 2: should have, 3: could have, 4: would have)

Table 1. Requirements

No.	Requirement	Priority
1	As a user, I want to sign in	1
2	As a manager, I want to manage users.	1
3	As a manager, I want to manage courses.	1
4	As a manager, I want to manage classes.	1
5	As a tutor, I want to create activities for the classroom.	1
6	As a tutor, I want to check my students' assignments.	1
7	As a tutor, I want to grade student assignments.	1
8	As a tutor, upload learning materials for the class	1
9	As a student, I want to take the class.	1
10	As a student, I want to see the materials shared.	1
11	As a student, I want to be able to submit my homework.	1
12	As a student, I wanted to find information about the course.	1
13	As a user, I want to manage my profile.	2
14	As a user, I want to change my password.	2
15	As a student, I want to download documents.	2
16	As a student, I wanted to check my homework schedule.	3
17	As a user, I want to talk to other members.	3

3.2.2. Non-functional requirements:

Besides functional requirements, I will also identify non-functional requirements.

- Security: It is necessary to ensure information security and user authentication to avoid severe errors in the system. At the same time, do not let out the phenomenon of data theft, cyber attacks on the system.
- Integrity: It is necessary to take safeguards, backup databases to avoid incidents causing loss and damage to data.

4. Design

4.1. Use Case Diagram

Based on the identified requirements, my project will be divided into three main roles: Staff, Faculty, and Students. Based on the highest priority requirements, I've identified functions that each role can use.

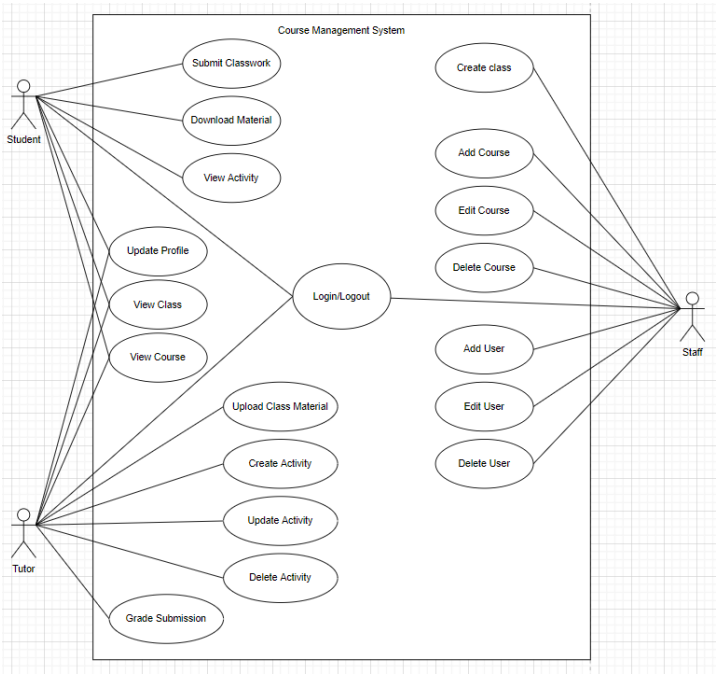

Figure 16. Use case diagram

Staff will manage courses including adding, editing and deleting; managing users including adding, editing and deleting users; and creating classes.

Teachers and students can update profiles, view classes, view courses. However, the faculty can also upload class material, add, edit and delete activities and eventually grade student submissions. As for students, they can view activities, submit assignments and download documents.

4.2. Entity Relationship Diagram

To create a database for the project, I will identify realities and connections between entities to create an ERD diagram. Below is a detailed picture of the diagram.

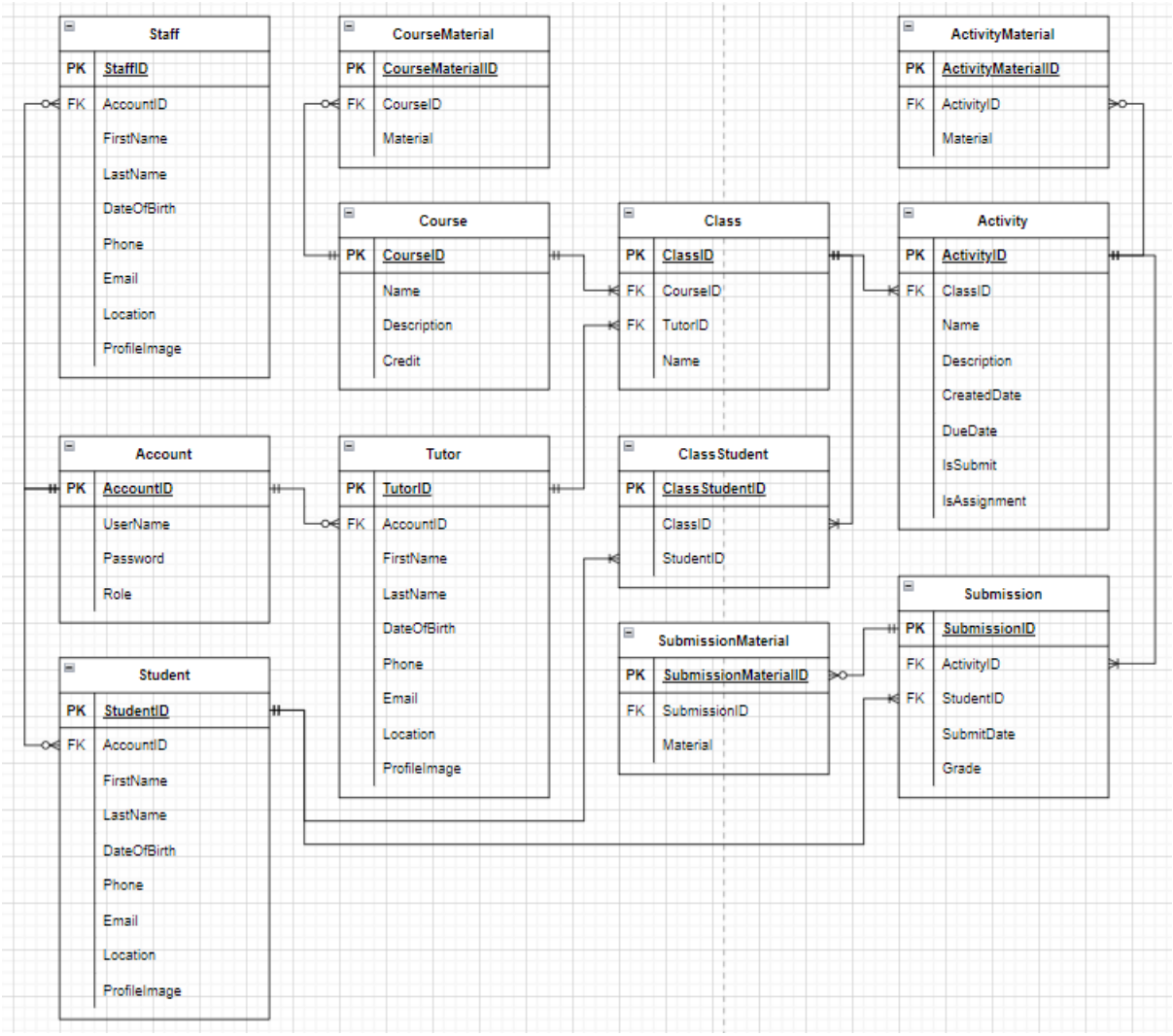

Figure 17. Entity Relationship Diagram

To build the functionality and store the information needed for the project, I will need 12 tables: Account, Staff, Student, Tutor, Course, Class, ClassStudent, Activity, Submission, CourseMaterial, SubmissionMaterial, ActivityMaterial.

The account table will be a table to store information about the user's account, username, password, role.

Staff, Student, Tutor tables will store personal information such as name, date of birth, phone number, email, address.

The Course table will store information about the course.

The Class table will store information about the class, including faculty and course.

The Activity table will store activities in a classroom. The submission table will store student assignments based on student and activity.

Finally, three tables, CourseMaterial, ActivityMaterial and SubmissionMaterial will store links to documents, related files.

4.3. Wireframe

In this section, I will evaluate the wireframe of my project. Based on these designs, I will apply to the interface of the project.

First, when the user accesses the app, the user will be led to the system's sign-in request screen. On the interface, there will be a form to enter username and password for users to perform.

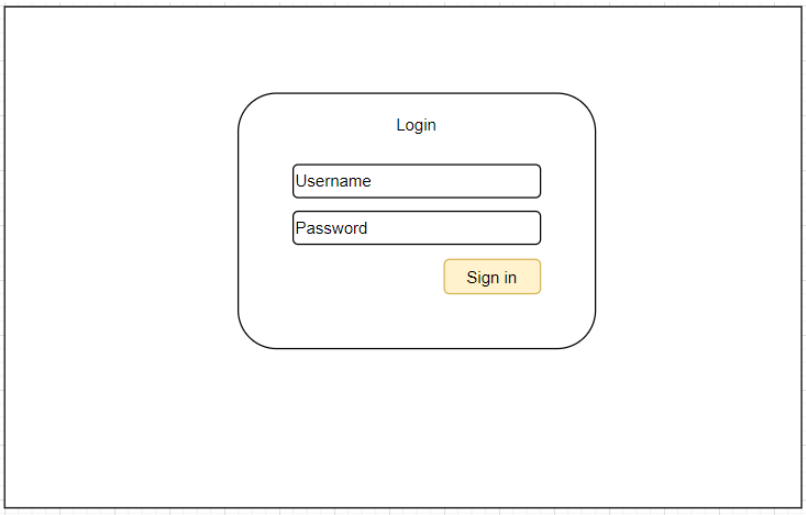

Figure 18. Login wireframe

When the user successfully logs into the system, the home screen is displayed. Class lists will be displayed on the screen. This design, I rely on GoogleClassroom to simplify features.

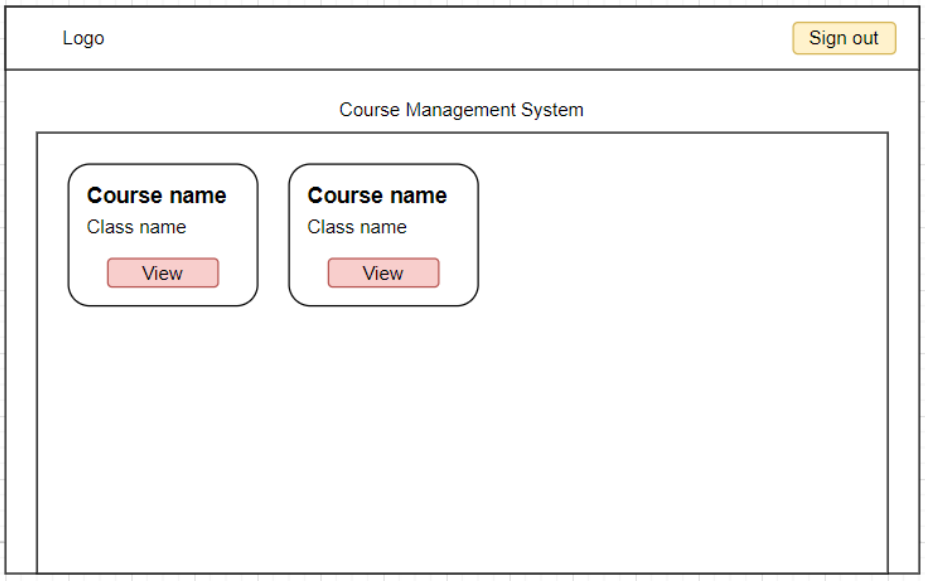

Figure 19. Homepage wireframe

Next is the information screen of activities in the classroom. Here, users will see information related to the course and the activities mentioned in it.

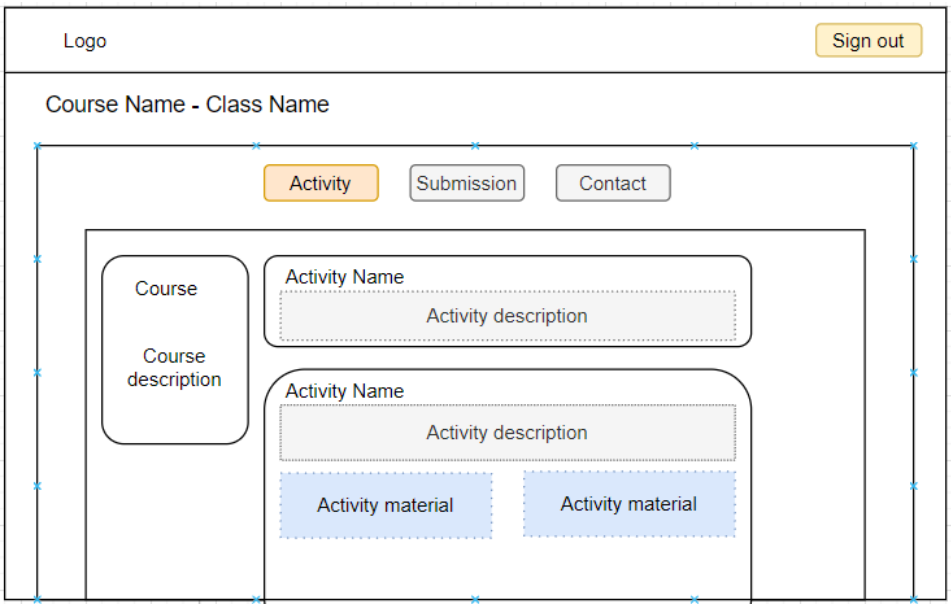

Figure 20. Class page wireframe

Next is the Contact screen, which shows the list of faculty and students in the classroom.

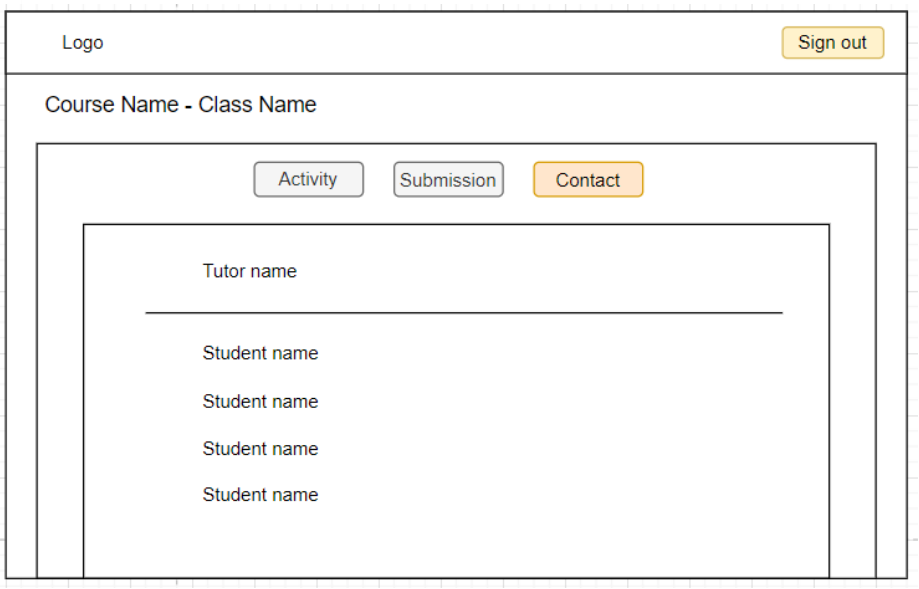

Figure 21. Contact page wireframe

Next is the student's assignment submission screen, which students will send up their assignment files and submit to the system. Besides, here, students can see details about the content as well as the materials related to the assignment.

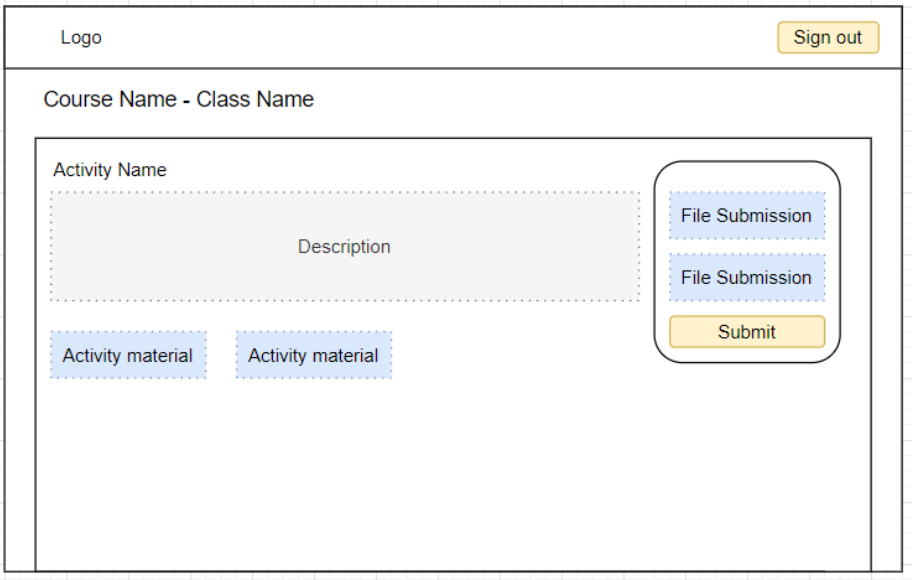

Figure 22. Submit file submission wireframe

Next is the teacher's grading screen, which will see the files that the student sends and grade the assignment.

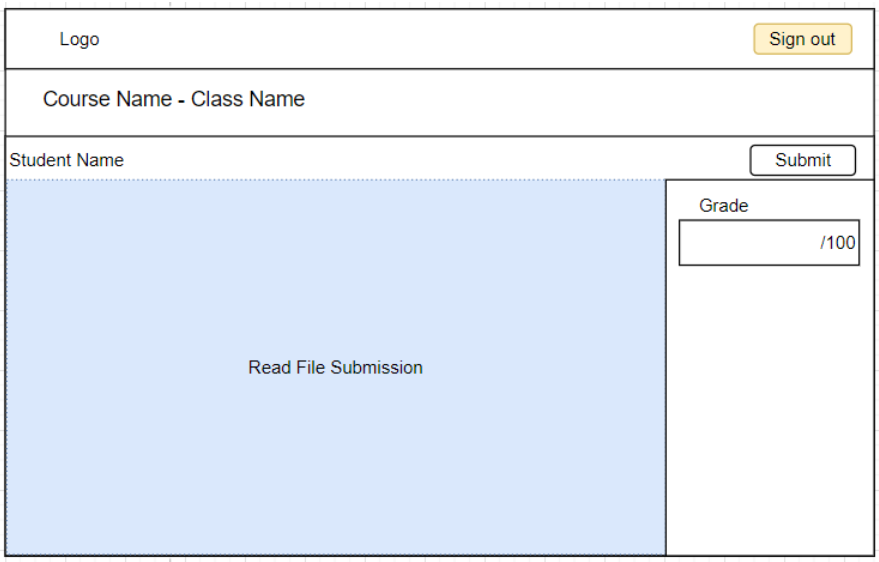

Figure 23. Grade submission

Finally, after successfully logging into the system, this screen will be the main working screen of staff. In addition, the work tasks will be shown to the left of the screen, and managers efficiently manage the information in table form.

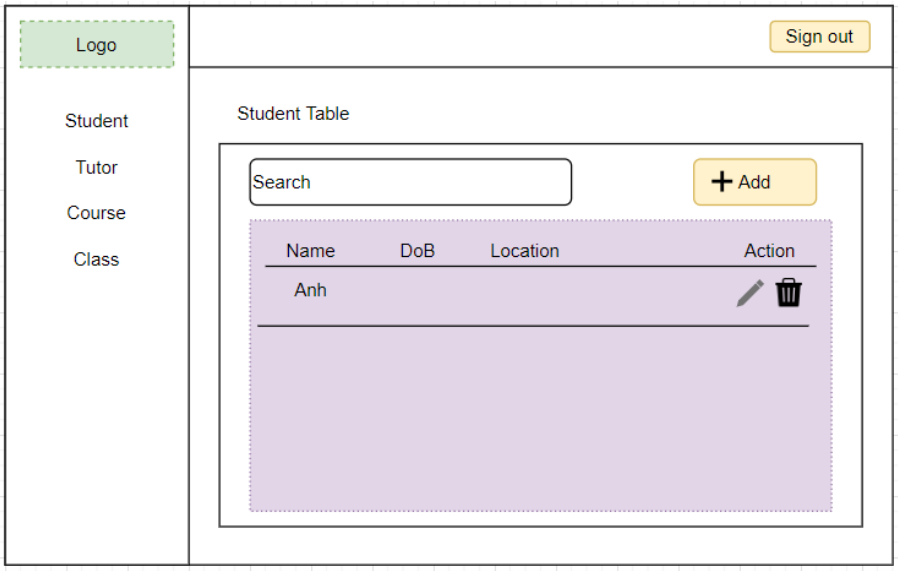

Figure 24. Staff page

This will be designed for popup forms to manage the information in my project. When the user wants to perform tasks related to adding, editing the information, a dialogue box will appear along with the necessary input form. As such, users will not have to lose focus when having to switch the screen continuously.

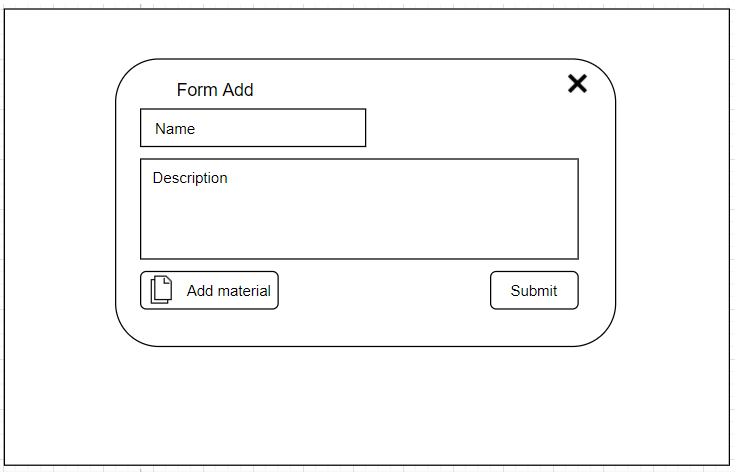

Figure 25. Dialogue form input

5. Implementation

In this section, the project's implementation and construction stages will be presented and explained in detail.

5.1. Development Environment:

5.1.1. Front-end:

As discussed in the literature review, I use the React framework to design and build the interface for the project. Below are the libraries, the necessary environment that was used to complete the construction of the interface.

5.1.1.1. Working with Material-UI:

Material-UI was built and developed to become one of the most popular React Component libraries. This library brings components with a pre-designed interface and supports custom features for users. With this library, developers can build react systems quickly and (MUI, 2021)efficiently.

Install:

With just a simple statement, the project was able to easily use this librarian to be ready to design and build.

```
pnpm install @material-ui/core
```

Figure 26. Install MUI

Use:

Based on the components you want to work on and design, you'll have to call them out from the library.

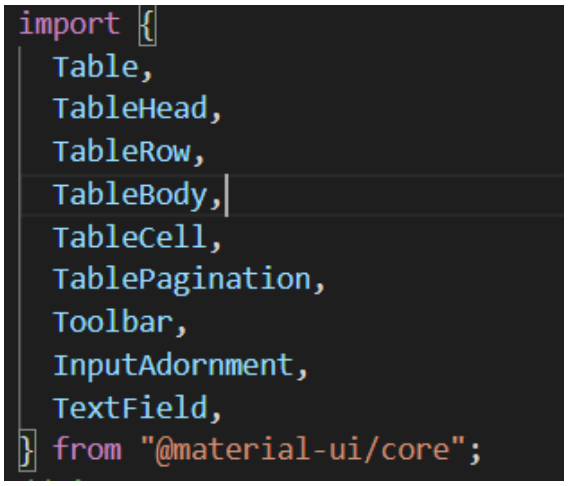

Figure 27. How to use MUI

5.1.1.2. Structure of Front-end application:

Using React to design and build the interface, the structure and location of files need to be done carefully. This work will make it easier and more time-consuming to control and maintain the project. In my project, the work environment is carefully arranged, files with their own functions are stored in their own folders.

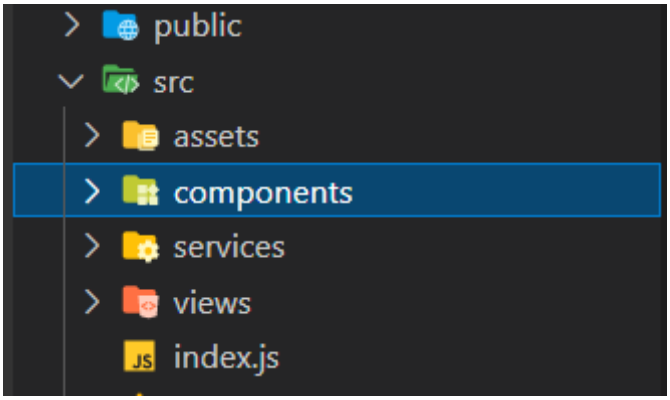

Figure 28. Structure of Front-end application

SRC ink message is a folder that stores all the components of my project. Next is the assets folder that will store files related to images, CSS files, ... The components folder will store files related to small, reusable components for most of the project. The

services folder will store files that handle communication with the server. Finally, the views folder is where files are stored to build out the system's interface.

5.1.2. Back-end:

5.1.2.1. Working with Django REST framework

Django REST framework is considered a powerful and highly flexible set of supplies for building a web API.

Install:

With simple syntax, my project can be easily applied and designed for the back-end.

```
pip install djangorestframework
pip install markdown       # Markdown support for the browsable API.
pip install django-filter  # Filtering support
```

Figure 29. Install djangorestframework

In addition, edit the installation file and add the 'rest_framework' syntax to the INSTALLED_APPS so that the system can recognize which applications are being used.

```
INSTALLED_APPS = [

    "rest_framework",

]
```

Figure 30. Setting for rest_framework

5.1.2.2. Structure of Back-end application:

In my project will have to work with many different objects (which have been identified in the Entity Relationship Diagram), so I will create my own folders to manage them.

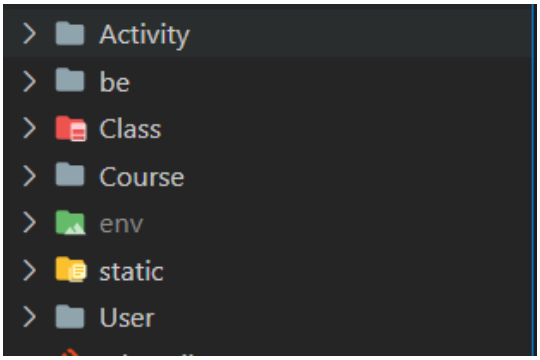

Figure 31. Structure of Back-end application

Because the framework has been established before, the folders will consist of the same files.

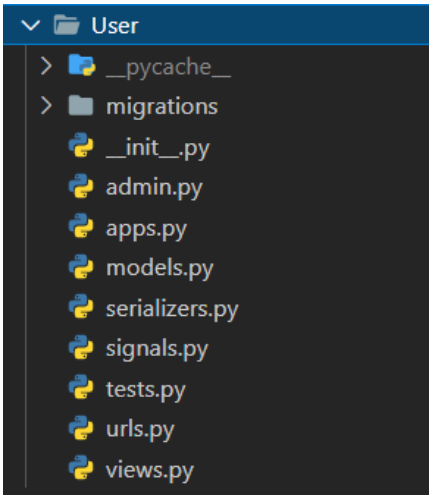

Figure 32. Structure in folder User.

In particular, models.py to build objects, views.py to write API syntax and urls.py will define paths for the Front-end side to call.

5.2. Significant problems and solutions:

5.2.1. Handling multiple input forms:

Problem: The application will have many forms to send information to the server and then store information into the database. To have an ideal source of information and not encounter any errors in processing and storing information, processing the user's inputs is extremely necessary. However, when there are multiple inputs simultaneously, encryption will have many problems when it is difficult to control and check each input, which will take quite a long time.

Solution: Thanks to the support of a huge library, my React system can easily control and check the user's inputs. Moreover, I can also give error messages to users. Use the Formik library to control events that change the value of inputs in the form, validate values and error messages, and handle the user's submission. Besides, the Yup library will make it easy for me to build the conditions for evaluating values according to each input.

For example, I'll handle the user's sign-in process. With username and password input, users will need to enter enough information for these two input fields. In addition, the value in the entered fields must be in the allowed range.

```
const validationSchema = yup.object({
  username: yup
    .string()
    .min(5, "Too Short!")
    .max(50, "Too Long!")
    .required("Username is required"),
  password: yup
    .string()
    .min(6, "Too Short!")
    .max(50, "Too Long!")
    .required("Password is requried"),
});
```

Figure 33. Yup object

Next, Formik will be called and do its job.

```
const formik = useFormik({
  initialValues: myInitialValues,
  validationSchema: validationSchema,
  onSubmit: async (values) => {
    const isLoginSuccess = await loginService(values);
    isLoginSuccess == false
      ? setNotify({
          isOpen: true,
          message: "Login false. Wrong username or password...",
          type: "error",
        })
      : null;
  },
});
```

Figure 34. Setting Formik

Formik controls values inside and outside the state form.

```
<CustomInput
  id="username"
  name="username"
  error={
    formik.touched.username &&
    Boolean(formik.errors.username)
  }
  onChange={formik.handleChange}
  value={formik.values.username}
  helperText={
    formik.touched.username && formik.errors.username
  }
/>
```

Figure 35. Input field with formik

5.2.2. Sending multiple files:

Problem: The user sends multiple pdf files simultaneously and expects the server to receive and store their paths in the database. However, in doing this work, I had a lot of difficulties and took much time do this work. I initially used encrypting files as strings to save to an array and save them to a database. However, for large files, this for me was impossible, and I started looking for other options. Below I will present my plan.

Solution: After thoroughly researching the methods of operation and data processing of both front-end and back-end, I have a solution to solve the following.

First, at the front-end application, since I have applied the formik library to the event management change the value of input fields and formik only receives the first values of the array of file values that the file field (with an index is zero), it is necessary to customize the event to change the input file field. Therefore, I handled the following:

```
React.useEffect(() => {
  formik.setFieldValue("file", getFilesFromMyCustomList(files), false);
  return null;
}, [files]);
```

Figure 36. Custom handle change

Use useEffect to make changes to the value of the file field whenever the file value changes.

Next, process the data and send it to the server. Check the value of the file field and perform the creation of a FormData structure() to send to the server.

```
if (values["file"].length != 0) {
  let formData2 = new FormData();
  formData2.append("course", course.data["id"]);
  for (const file in values["file"]) {
    formData2.append("file", values["file"][file]);
  }
```

Figure 37. set FormDate to server

When the server receives the data, it checks and performs the process of storing the path of the file into the database. The files will be stored on the server and will be called with the path saved in the database.

```
data = request.data
serializer = CourseMaterialSerializers(data=data)
if not serializer.is_valid():
    return Response(serializer.errors, status=status.HTTP_400_BAD_REQUEST)
my_file = data.pop("file")
my_course = data.pop("course")
for file in my_file:
    CourseMaterial.objects.create(
        file=file, course=Course.objects.get(id=my_course[0])
    )
```

Figure 38. Handle in server

The server will create collections with the authenticated information field in the data.

5.2.3. Identify and Authenticate:

Problem: User identification and authentication are essential so that the system can give accurate feedback to users.

Solution: With the help of the djangorestframework-simplejwt library, I used tokens to authenticate and identify users when accessing the system. Besides, I also carry out custom processes so that the token can respond to the necessary information.

```python
class MyTokenObtainPairSerializer(TokenObtainPairSerializer):
    def get_token(cls, user):
        token = super().get_token(user)
        if len(UserSerializers(user, many=False).data.get("groups")) > 0:
            groups = UserSerializers(user, many=False).data.get("groups")[0]
        else:
            groups = 0

        if groups == 1:
            token["account_id"] = str(get_staff(pk=user.id).id)
            token["role"] = "staff"
        elif groups == 2:
            token["account_id"] = str(get_tutor(pk=user.id).id)
            token["role"] = "tutor"
        elif groups == 3:
            token["account_id"] = str(get_student(pk=user.id).id)
            token["role"] = "student"
        else:
            token["role"] = "admin"

        return token
```

Figure 39. Custom token

5.3. Results:

Here, I will evaluate the critical functions in the system that I have completed.

5.3.1. Create/Edit Activity or Classwork:

In general, the activity or classwork function is going quite smoothly, and no errors occur. After checking and validating the required fields, the user, here as a lecturer, will successfully add activities in the class. Everyone in the class can see these new activities on the home page of that class. As for editing activities, operational details will be retrieved from the database and filled out in the fields on the editing form. Users will not have to re-enter all the data but just edit on the field they want to change.

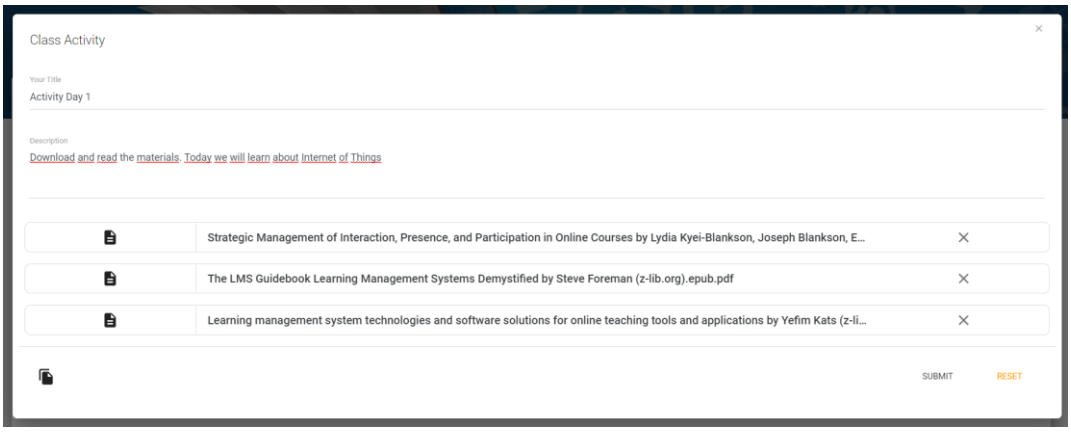

Figure 40. Form for activity

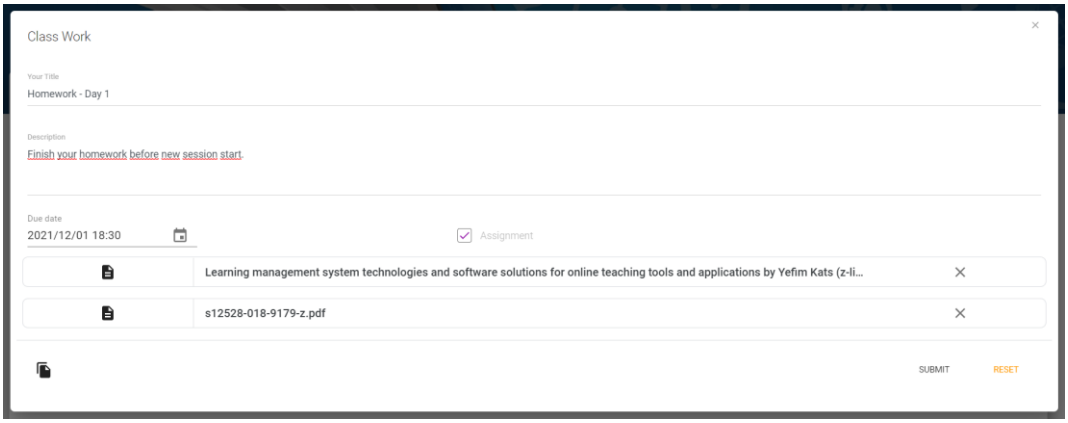

Figure 41. Form for classwork

5.3.2. Submit files for submission:

This is also an essential feature in my system. After clicking the upload button, students will select the files in their machine, and all those files will be shown on the screen. If students want to upload new files, they can still retain the submitted files and select the other files they want to add. This is a feature I have tried to implement to facilitate the submission of papers to students.

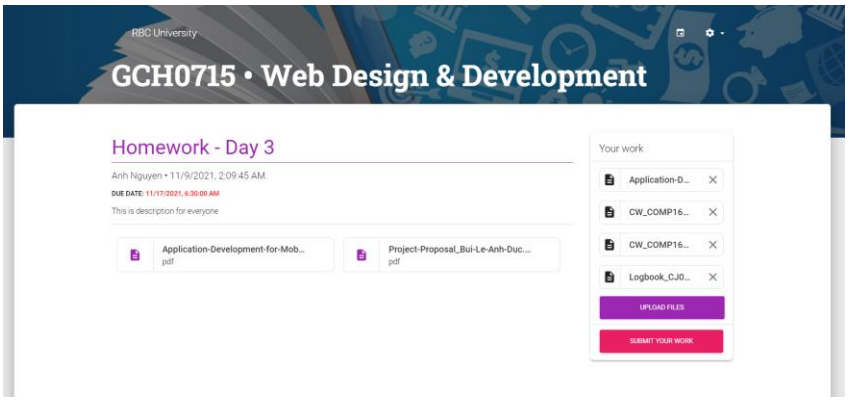

Figure 42. Select files to submit

5.3.3. View and grade submission:

Besides submitting students' papers, checking and monitoring students' submissions is also an important feature. The teacher can select other files that students attach with the wing to tap the files to the right of the screen.

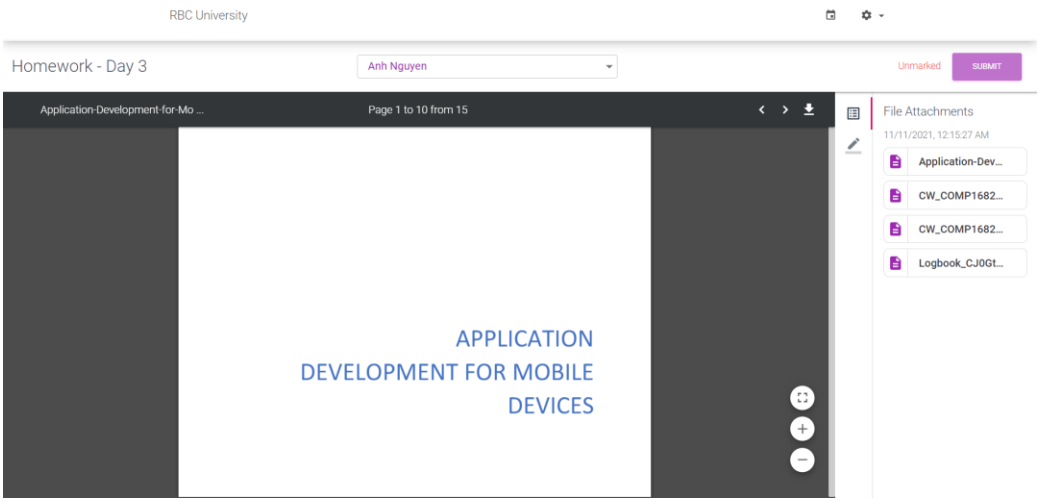

Figure 43. View submisisons

Furthermore, for grading, the instructor can click on the tab with the pencil icon and grading.

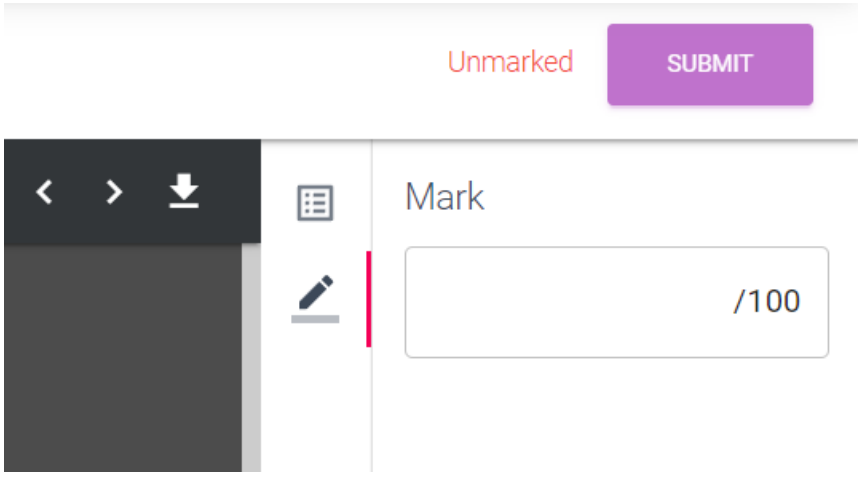

Figure 44. Grading tab

5.3.4. Create/ Edit user:

Managing users in a course management system are always something to be done. After the manager fills in all the necessary information and presses the submit button, that data is sent to the server. After receiving the data, the server creates an account for that person based on the email that the manager has entered and uses other information in the data from the request to store it in the appropriate table.

The email field is unchangeable for user editing, and other fields can still change as normal as other editing functions.

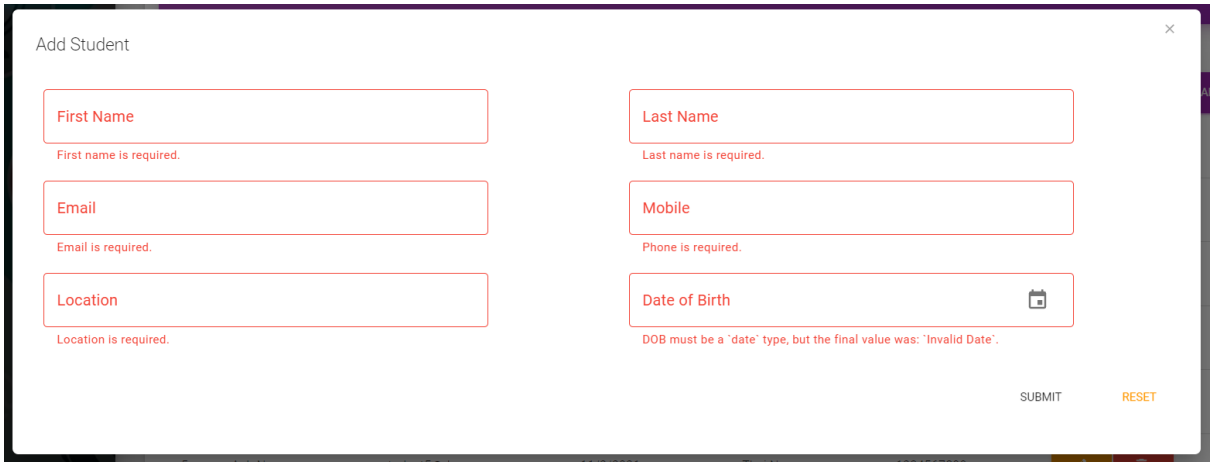

Figure 45. Validate form User

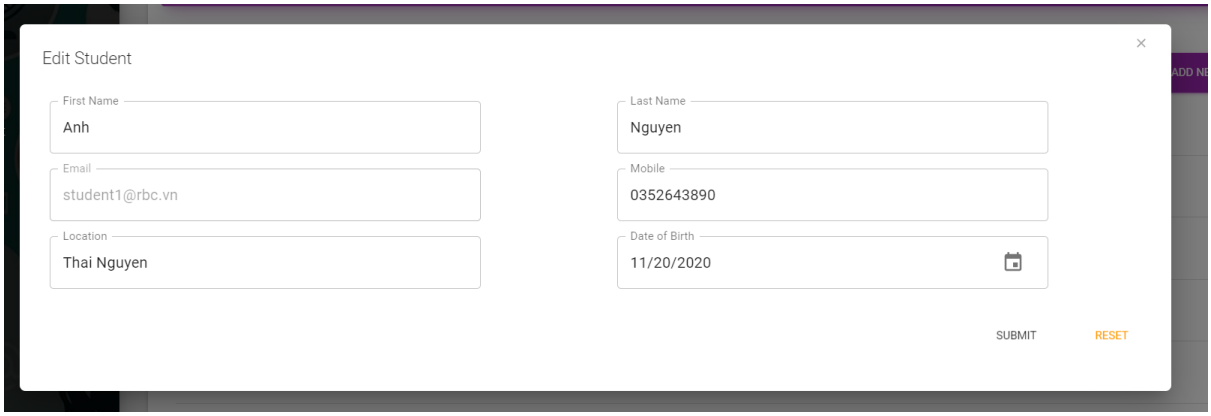

Figure 46. Edit form User

5.3.5. Create/Edit Course:

Similar to user management, course management is also essential. After entering all the necessary information, the course will be added new. Besides, the editing function is similar to other editing functions.

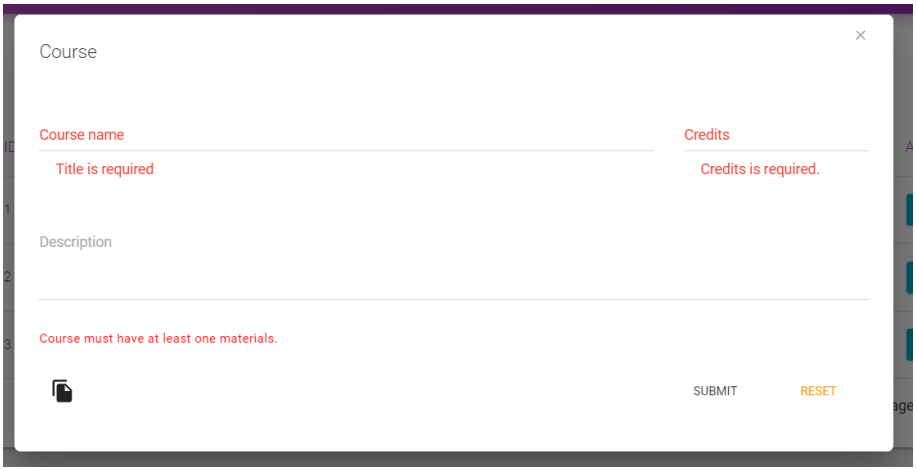

Figure 47. Validate form Course

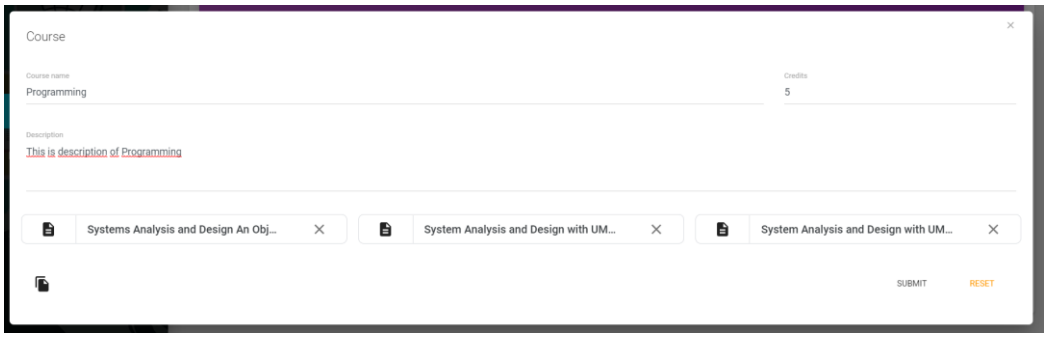

Figure 48. Edit form Course

5.4. Testing

5.4.1. Test case:

I present all Test cases in Appendix.

5.4.2. Evaluate:

Most of my test cases passed smoothly. This proves that I have strictly implemented the control procedures and forced the user to fill in the necessary information before sending it to the server.

As for the test cases being false, although the information is still sent to the server, the application needs to be refreshed to change the elements. I think the reason for this is that React hasn't noticed which components have been changed, so it doesn't update automatically. I think I'll have to use the useEffect functions to log the change to get around this. From there, React will recognize the changes and automatically update the elements.

6. Evaluate:

6.1. Self-assessment of implementation

Advantage:

- Most of the main functions have been designed and built as per my expectations. Moreover, meet most high-priority requests.
- The user interface is relatively simple and easy for users to use. Besides, my application had specific interactions with the user—attempts to notify and respond to user interactions with the system.

Disadvantage:

- Interface designs are not my strong point. Therefore, I try to use templates and build interfaces based on web pages similar to my system.
- Some features have not been implemented to meet the defined requirements. Therefore, I need to improve my skills to solve these problems.

6.2. Difficulties and lessons learned

When working on the project, I had many difficulties learning the technologies and documents involved to implement the project. Moreover, due to mechanical problems, the progress of my project was limited and I had many difficulties in implementing the project. When I encountered severe errors in the system, I had to look for solutions on scientific forums, and luckily I did not spend too much time solving them. Through this project, I have learned many lessons on time management and how to learn and find information. Reading comprehension is also a lesson that I was enhanced upon completing this report.

6.3. Future jobs

Shortly, I want to improve my project. Add the functionality I am missing, improve the interface, and provide the necessary information for a course management system. In the long-term plan, I want my project to be a usable system applicable in some country educational institutions.

7. Conclusion

Through this project, I have learned many lessons and experiences and improved a lot of skills and knowledge related to technology. Besides improving the quality of my expertise, I have also improved my project management and time management skills. These skills are essential when I start working in the future and joining company projects.

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8. Appendix

8.1. Project Proposal

8.1.1. Overview

In the context of the growing and unpredictable COVID-19 epidemic, online learning is becoming a more transformative street training solution than ever before. However, to manage the process of organizing online lessons and providing facilities and materials for classes, a specific system for control is required. The course management system was created and built to be able to solve the problem quickly. In this project, a course management system will be designed, built and applied to a practical education centre.

8.1.2. Aim

Learn how to design a course management system with selected framework (React, Angular, Django, Express).

8.1.3. Objectives

8.1.3.1. Research about mobile app development technologies

Activities:

- Research about React
- Rêsearch about Angular
- Research about Django
- Research about Express
- Research about PostgreSQL
- Research about MongoDB
- Select front-end technology
- Select back-end technology

Deliverables:

- A report about advantages and disadvantages of technologies
- Conclusion of technologies used in the project

8.1.3.2. Research about methodology development

Activities:

- Research about Agile/Scrum methodology
- Research about Waterfall methodology
- Select methodology

Deliverables:

- A report about advantages and disadvantages of development technologies
- Conclusion of the methodology used in the project

8.1.3.3. Create application requirements

Activities:

- Research about a similar application
- Analyze the activities in this app
- Create the project requirements

Deliverables:

- A report of an evaluation of the similar app (functions, appearance, usability)
- A table of application requirements

8.1.3.4. Design the app

Activities:

- Create use-case diagram
- Create database diagram
- Create wireframe

Deliverables:

- Use-case diagram
- Database diagram
- Wireframe

8.1.3.5. Implement the app

Activities:

- Implement layout

- Implement functions

Deliverables:

- Application source code

8.1.3.6. Test the app

Activities:

- Create test plan
- Implement test cases

Deliverables:

- Test plan result table

8.1.3.7. Write report

Activities:

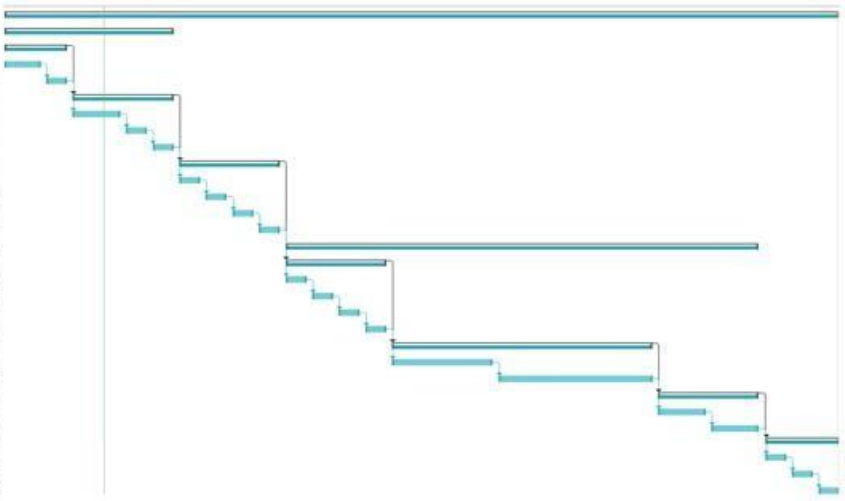
- Write report draft
- Get advice
- Complete the report

Deliverables:

- Final report

8.1.4. Plan

My project	**157 days?**	**Thu 4/1/21**	**Fri 11/5/21**	
Initialize Project	**32 days?**	**Thu 4/1/21**	**Fri 5/14/21**	
Investigation, gathering prerequisites	**12 days**	**Thu 4/1/21**	**Fri 4/16/21**	
Select IDE	7 days	Thu 4/1/21	Fri 4/9/21	
Select Database	5 days	Mon 4/12/21	Fri 4/16/21	4
Plan Project	**20 days**	**Mon 4/19/21**	**Fri 5/14/21**	**3**
Analysis requirement	10 days	Mon 4/19/21	Fri 4/30/21	5
Create WBS	5 days	Mon 5/3/21	Fri 5/7/21	7
Create Gantt Chart	5 days	Mon 5/10/21	Fri 5/14/21	8
Write a literature review	**20 days**	**Mon 5/17/21**	**Fri 6/11/21**	**6**
Find matteria about IDE, framework	5 days	Mon 5/17/21	Fri 5/21/21	9
Find matteria about methodologies	5 days	Mon 5/24/21	Fri 5/28/21	11
Evaluate among IDE, Frameworks	5 days	Mon 5/31/21	Fri 6/4/21	12
Evaluate among methodologies	5 days	Mon 6/7/21	Fri 6/11/21	13
Build the system	**90 days?**	**Mon 6/14/21**	**Fri 10/15/21**	
Design	**20 days?**	**Mon 6/14/21**	**Fri 7/9/21**	**10**
Design use case diagram	5 days	Mon 6/14/21	Fri 6/18/21	14
Design activity diagram	5 days	Mon 6/21/21	Fri 6/25/21	17
Design database - ERD	5 days	Mon 6/28/21	Fri 7/2/21	18
Design interface wireframe	5 days	Mon 7/5/21	Fri 7/9/21	19
Code the product	**50 days?**	**Mon 7/12/21**	**Fri 9/17/21**	**16**
Code Front-end	20 days	Mon 7/12/21	Fri 8/6/21	20
Code Back-end	30 days	Mon 8/9/21	Fri 9/17/21	22
Test the product	**20 days?**	**Mon 9/20/21**	**Fri 10/15/21**	**21**
Set a test case	10 days?	Mon 9/20/21	Fri 10/1/21	23
Execuate the test case and evaluate	10 days?	Mon 10/4/21	Fri 10/15/21	25
Write a summary	**15 days?**	**Mon 10/18/2**	**Fri 11/5/21**	**24**
Evaluate the project	5 days	Mon 10/18/21	Fri 10/22/21	26
Evaluate the system	5 days	Mon 10/25/21	Fri 10/29/21	28
Evaluate lesson learnt	5 days	Mon 11/1/21	Fri 11/5/21	29



8.1.5. Legal, Social, Ethical and Professional problems

8.1.5.1. Legal

The system includes a register and login function for students and teachers. Therefore, the system will have to store the personal and essential information of users in the system. Theprotection of data, preservation of the integrity and uniqueness of user information will need to be done.

8.1.5.2. Social

My system will create an educational community of the highest caliber for pupils. Provide high-quality classes and subjects to disadvantaged kids and invest in their educational chances. Additionally, our system will collaborate with other education systems to enhance the system's quality and size.

8.1.5.3. Ethical

Our system must be dedicated to the quality of subjects and instruction.

8.1.5.4. Professional

Commitment to work professionally and on time. Additionally, pertinent matters will be resolved quickly and accurately.

8.2. Test plan

Table 2. Test case

No	Description	Steps	Expected result	Actual result	Status
Create/Edit activity					
1	Check validation	Submit blank input	The errors message exist	The errors message exist	Pass
2	Check validation	1. Enter only description 2. Submit	The errors message exist	The errors message exist	Pass
3	Check validation	1. Enter title, description 2. Submit	The form popup will close, and successful notification will exist	Form popup close and notification exist	Pass

4	Check validation	1. Enter title, description 2. Select pdf file 3. Submit	The form popup will close, and successful notification will exist	Form popup close and notification exist	Pass
5	Check validation	1. Select pdf file 2. Submit	The errors message exist	The errors message exist	Pass
6	Add activity	1. Enter all fields 2. Submit	The form popup will close, and a successful notification will exist. A new activity is added.	Form popup close and notification exist. However, I need to reload to new activity exist	False
7	Edit activity	1. Change all fields 2. Submit	The form popup will close, and a successful notification will exist. The activity is changed.	Form popup close and notification exist. However, I need to reload to activity change	False
Create/Edit classwork					
8	Check validation	Submit blank input	The errors message exist	The errors message exist	Pass
9	Check validation	1. Enter only description 2. Submit	The errors message exist	The errors message exist	Pass
10	Check validation	1. Enter title, description 2. Submit	The form popup will close, and successful notification will exist	Form popup close and notification exist	Pass
11	Check validation	1. Enter title, description 2. Select pdf file 3. Submit	The form popup will close, and successful notification will exist	Form popup close and notification exist	Pass
12	Check validation	1. Select pdf file 2. Submit	The errors message exist	The errors message exist	Pass

13	Check validation	1. Enter title, description 2. Checkbox Assignment 3. Submit	The errors message exist	The errors message exist	Pass
14	Check validation	1. Enter title, description 2. Checkbox Assignment 3. Select DueDate in the past 4. Submit	The errors message exist	The errors message exist	Pass
15	Check validation	1. Enter title, description 2. Checkbox Assignment 3. Select DueDate in the future 4. Select materials 5. Submit	The form popup will close, and successful notification will exist	Form popup close and notification exist	Pass
16	Add classwork	1. Enter all fields 2. Submit	The form popup will close, and a successful notification will exist. New classwork is added.	Form popup close and notification exist. However, I need to reload to new classwork exist	False
17	Edit classwork	1. Change all fields 2. Submit	The form popup will close, and a successful notification will exist. The classwork is changed.	Form popup close and notification exist. However, I need to reload to classwork change	False
Grade submission					
18	Check validation	Enter invalid grade	The errors message exist	The errors message exist	Pass
Login					
19	Check validation	Enter blank field	The errors message exist	The errors message exist	Pass

20	Check login	1. Enter right username 2. Enter wrong password 3. Press Login	Error Notification will exist	Error Notification exists	Pass
21	Check login	1. Enter wrong username 2. Enter right password 3. Press Login	Error Notification will exist	Error Notification exists	Pass
22	Check login	1. Enter right username 2. Enter right password 3. Press Login	Turn into the homepage, and hello notification will exist	Turn into the homepage, and hello notification exists	Pass
Create/Edit User					
23	Check validation	Submit blank input	The errors message exist	The errors message exist	Pass
24	Check validation	1. Enter Name 2. Submit	The errors message exist	The errors message exist	Pass
25	Check validation	1. Enter invalid email 2. Submit	The errors message exist	The errors message exist	Pass
26	Check validation	1. Enter invalid phone 2. Submit	The errors message exist	The errors message exist	Pass
27	Check validation	1. Enter all fields with valid information 2. Submit	The popup will close, and a new user added.Success notification exists.	The popup closes, and a new user is added. Success notification exists.	Pass
28	Check a new account	1. Enter the username of the new account created on test 23. 2. Enter password “gch18120” 3. Enter	Turn into the homepage, and hello notification will exist	Turn into the homepage, and hello notification exists	Pass
Create/Edit Course					
29	Check validation	Submit blank input	The errors message exist	The errors message exist	Pass

30	Check validation	1. Enter Name 2. Submit	The errors message exist	The errors message exist	Pass
31	Check validation	1. Enter Name 2. Enter Credit 3. Submit	The errors message exist	The errors message exist	Pass
32	Check validation	1. Enter Name 2. Enter Credit 3. Select files 4. Submit	The popup will close, and a new course added. Success notification exists.	The popup closes, and a new course is added. Success notification exists.	Pass
Logout					
33	Check automatic logout	1. Login 2. Wait to token run out of time	The application turns into the login page	The application turns into the login page	Pass
34	Check logout function	1. Login 2. Press logout	The application turns into the login page	The application turns into the login page	Pass

8.2.3. Screenshot

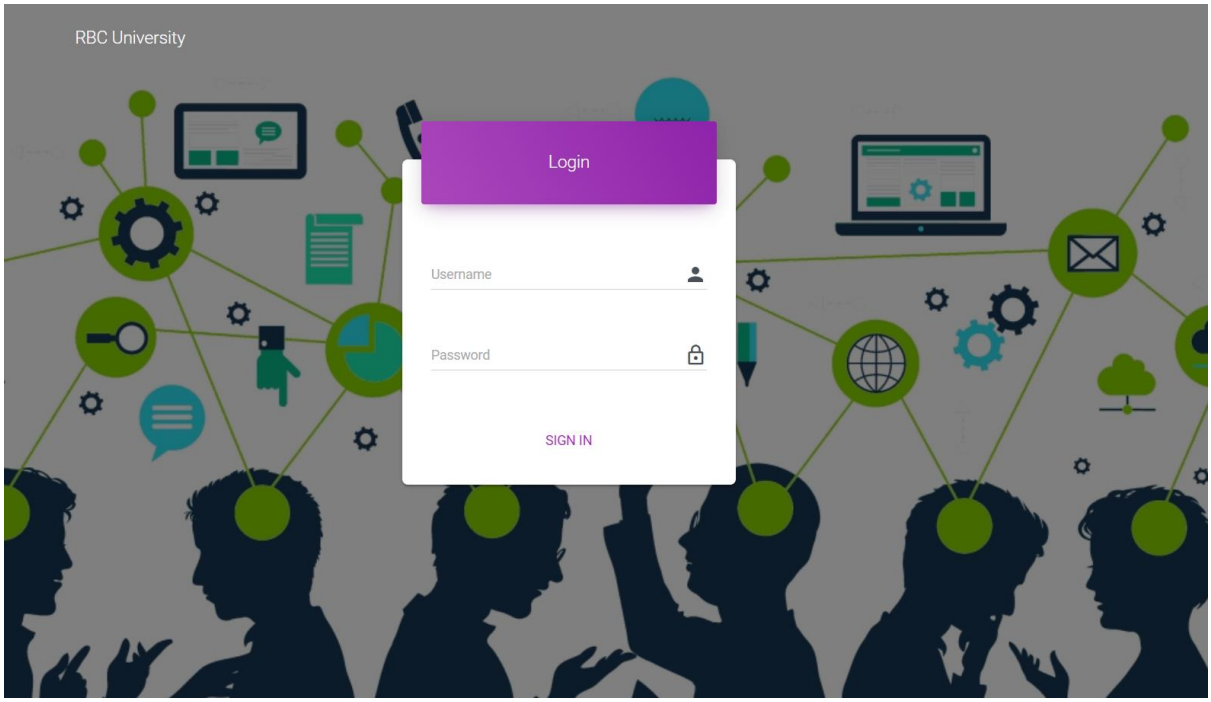


Figure 49. Login page

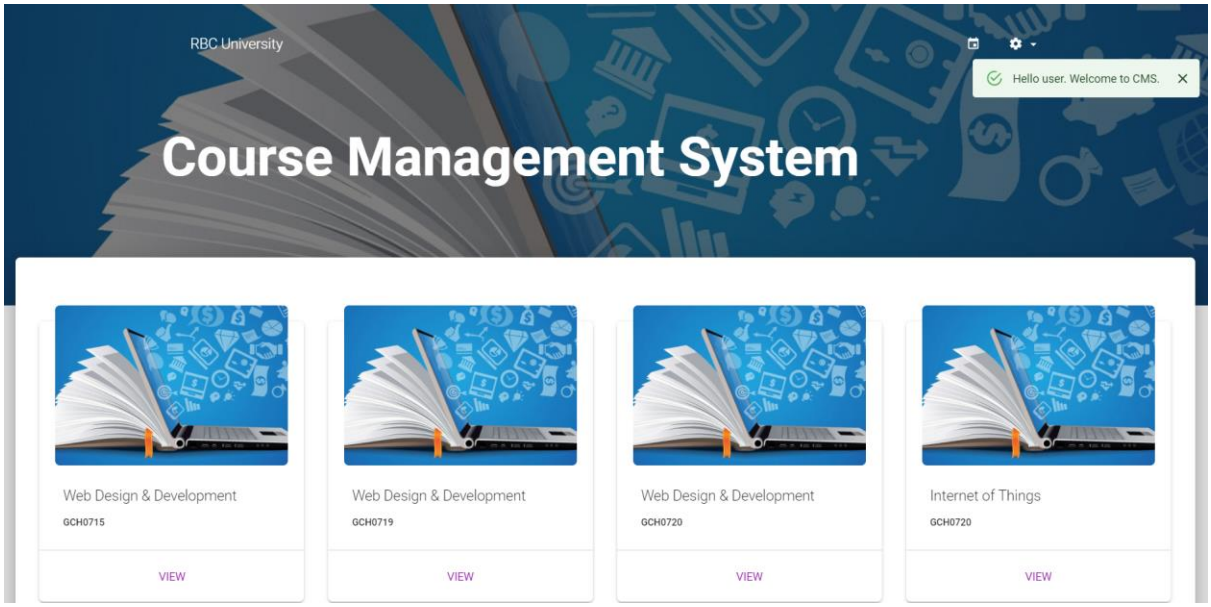


Figure 50. Homepage

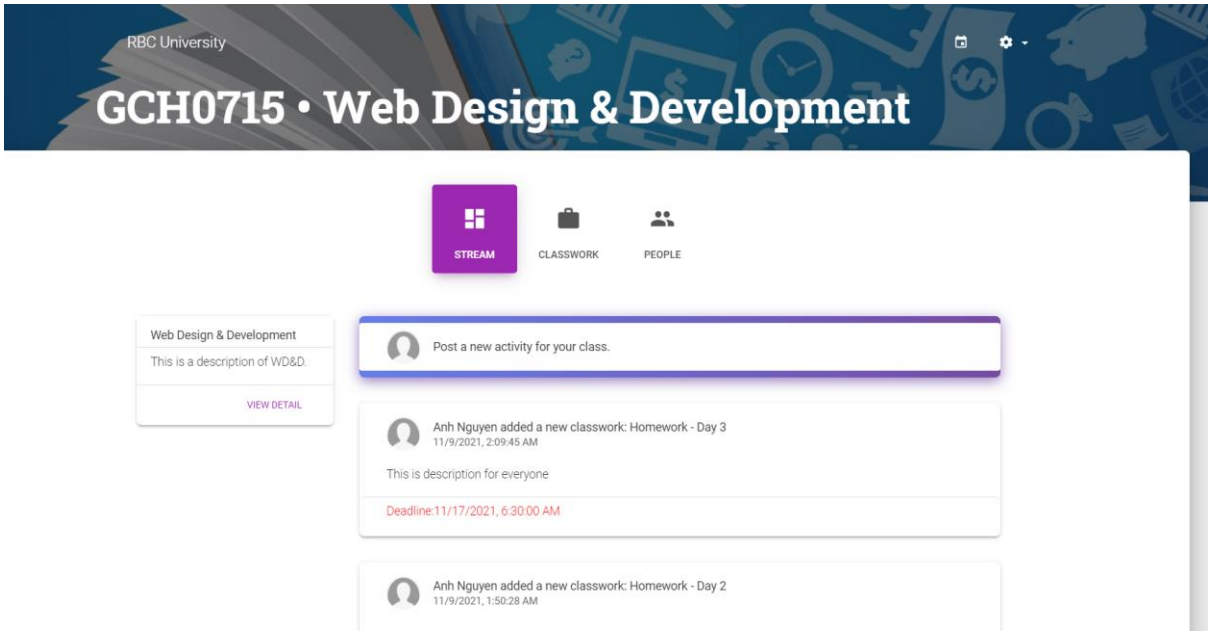


Figure 51. Stream on class page

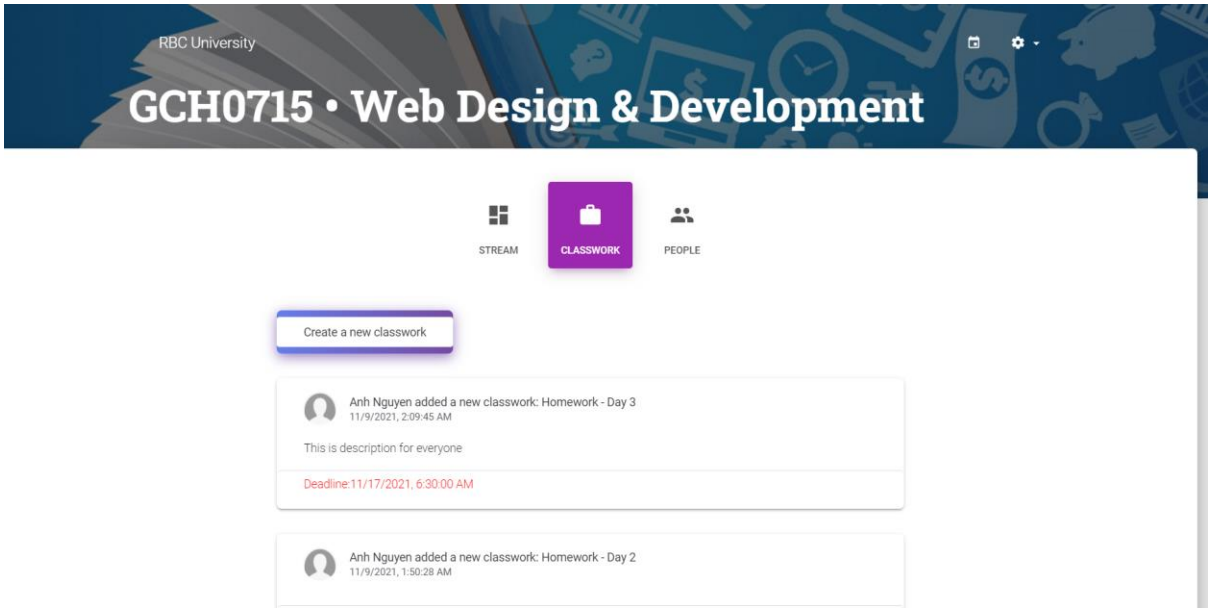


Figure 52. classwork on class page

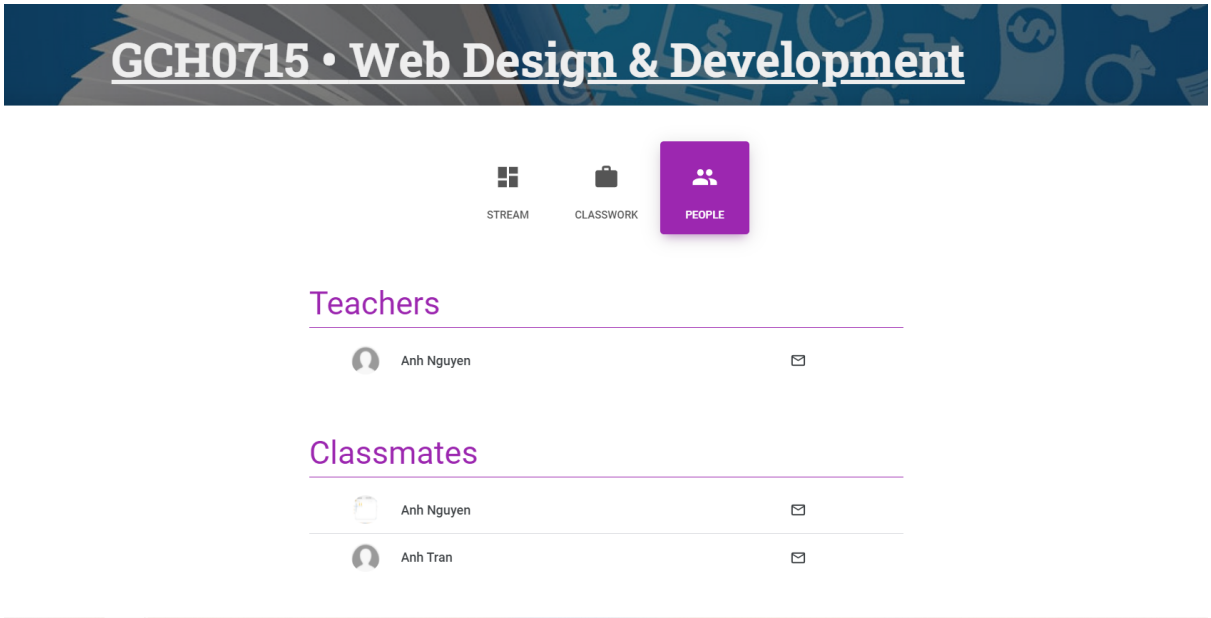


Figure 53. People on class page

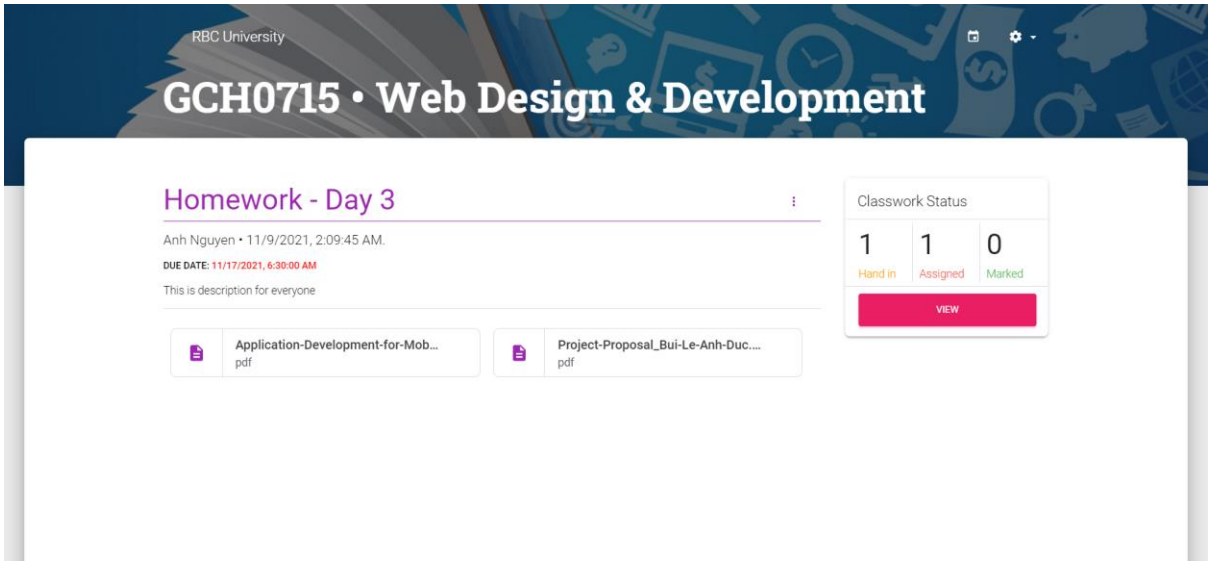


Figure 54. Submission page as tutor

Figure 55. Check Submissions

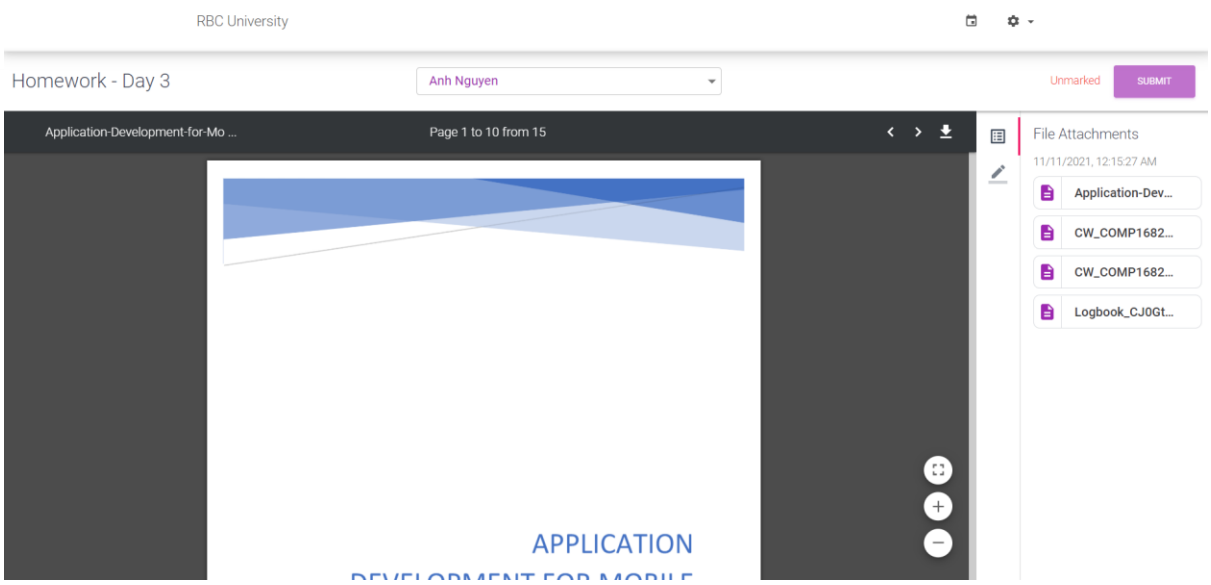


Figure 56. View and grade submission

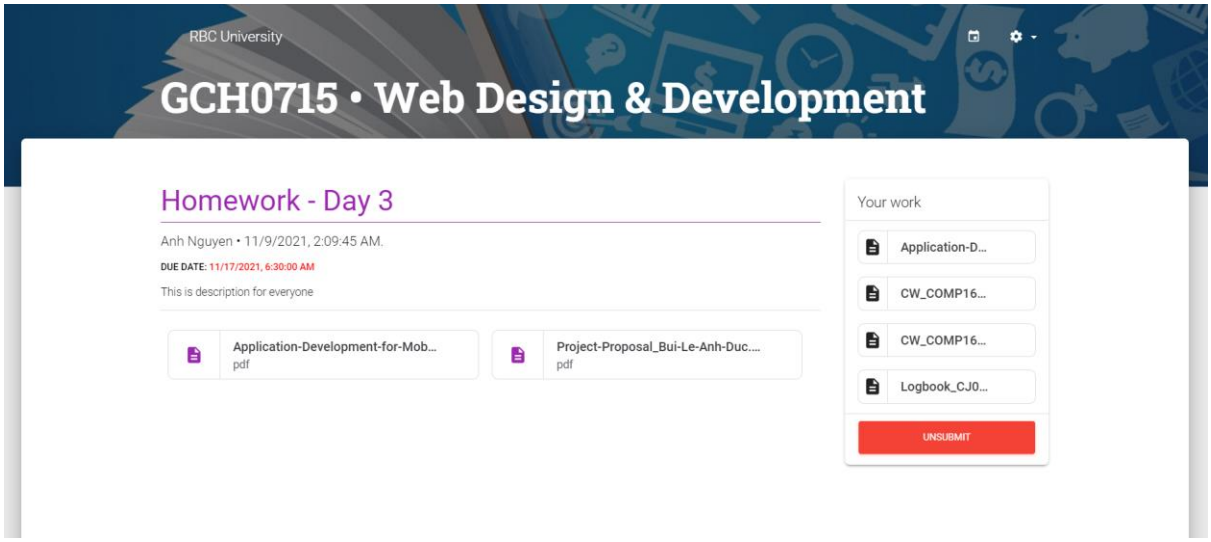


Figure 57. Submission page as Student

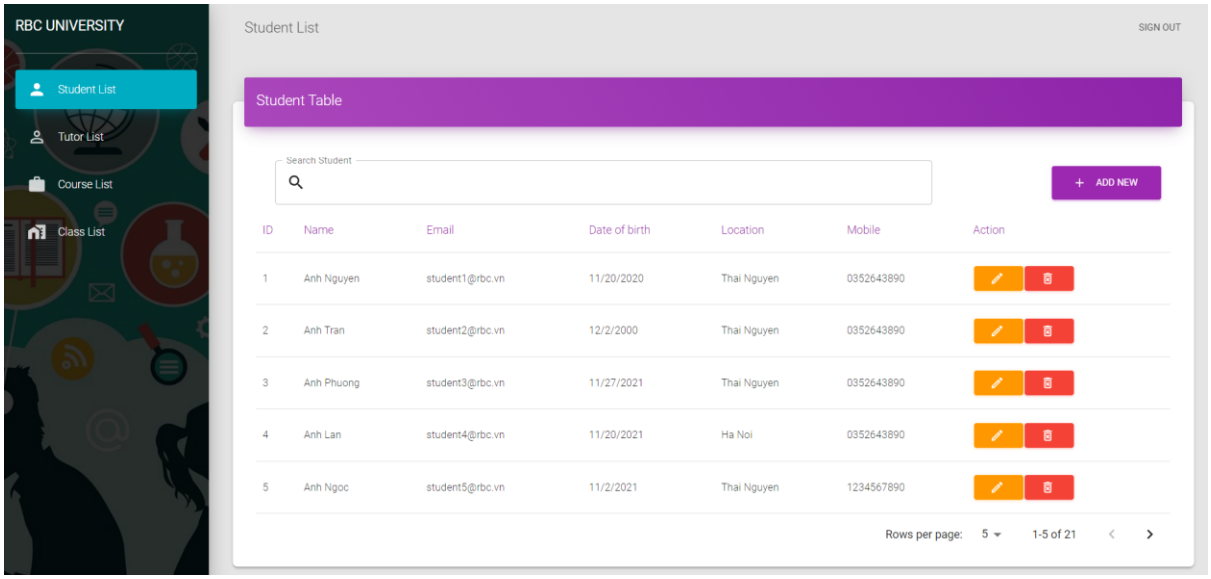


Figure 58. Manage Student

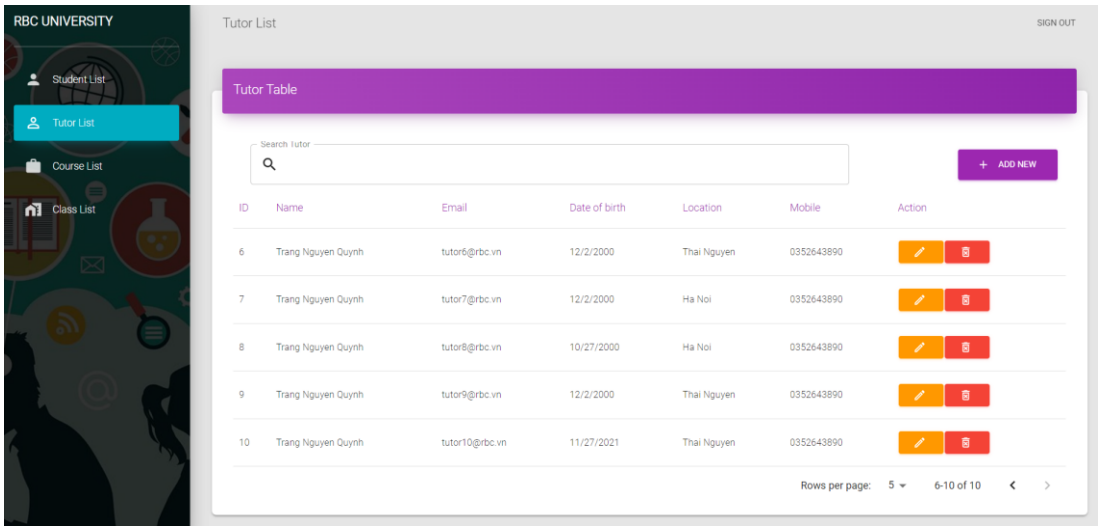


Figure 59. Manage Tutor

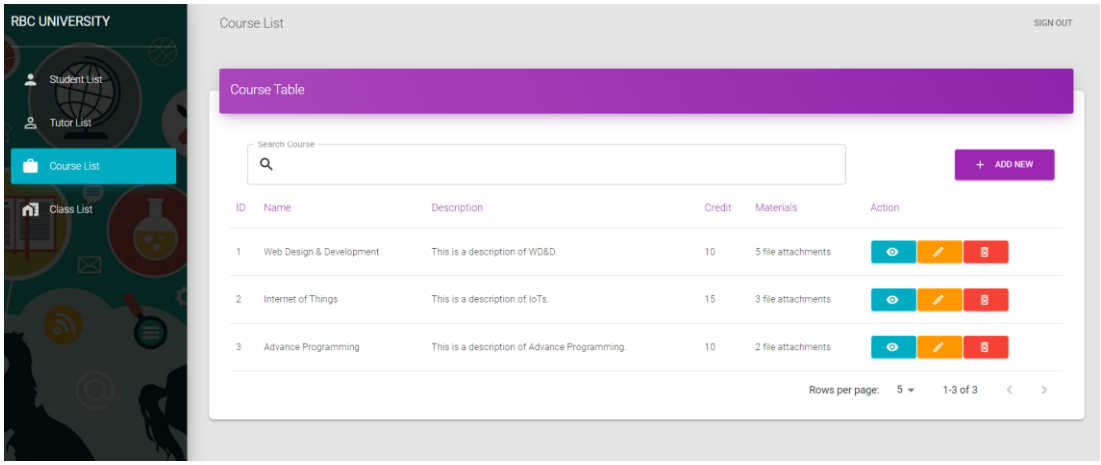


Figure 60. Manage Course

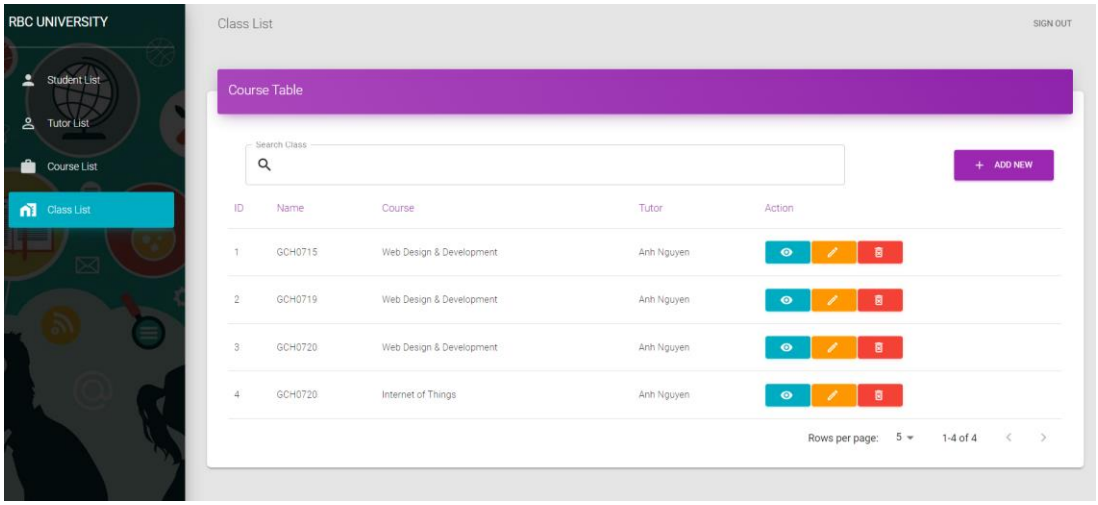


Figure 61. Manage Class

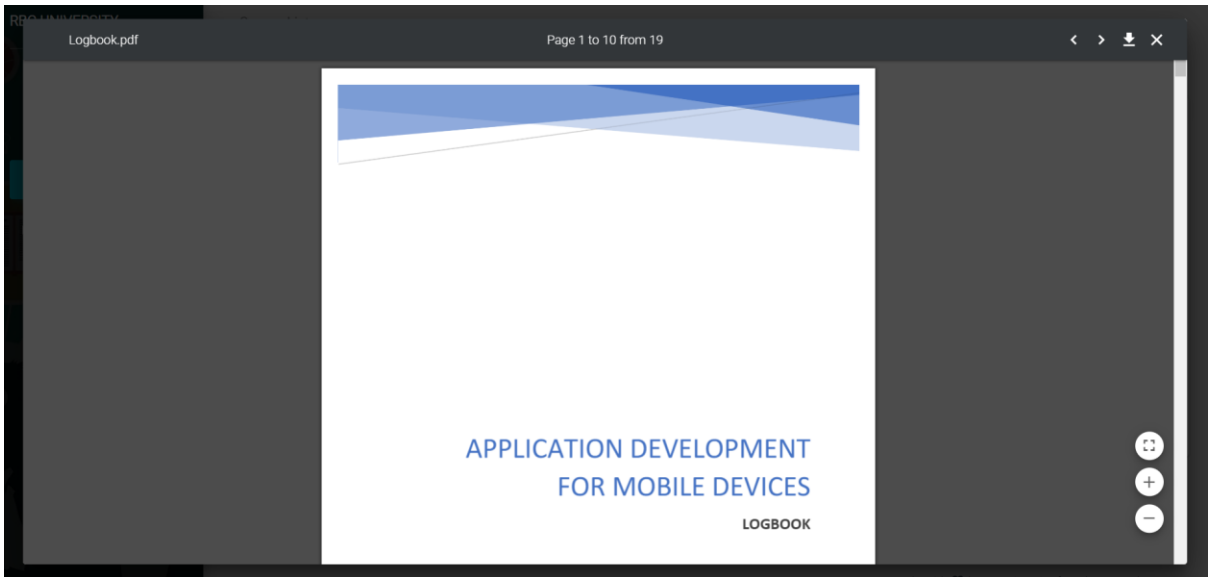


Figure 62. View material