VIRTUAL CLASSROOM PLATFORM WITH REAL-TIME COLLABORATION FEATURES

BY

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ABSTRACT

This project situated in the field of educational technology, develops a web-based Virtual Classroom Platform to enhance online learning through real-time collaboration. Current virtual learning environments often suffer from inadequate real-time interaction, poor accessibility for users with limited technological resources, and ineffective peer-to-peer engagement, collectively diminishing the learning experience. To address these, the platform employs frontend technologies (HTML, CSS, JavaScript) for a responsive and device-agnostic interface, backend technologies (PHP, MySQL) for robust data management, and Node.js server using Socket.IO for real-time communication. It integrates open-source collaboration tools such as Jitsi Meet for video conferencing, Etherpad for collaborative text editing, and WBO for shared whiteboards to enable synchronous learning and foster student-instructor peer interactions. The development process uses the Agile methodology, which emphasizes flexibility and iterative progress. Design and functionality were informed by user requirements gathered through a questionnaire, guaranteeing that the platform satisfies a range of needs. The resulting platform provides a dynamic, inclusive, and interactive environment that reduces the distinction between online and in-person education. It overcomes existing limitations by ensuring accessibility across devices and technological capabilities, with successful integration of collaboration tools enhancing user experience. This project excludes the development of mobile applications, automated grading, intelligent tutoring, or personalized learning paths, and VR/AR technologies, focusing on traditional web-based tools for real-time communication and collaboration. This work advances online education by providing a scalable, equitable solution that supports real-time interaction and collaboration, contributing to a more effective learning ecosystem.

Area of Study: Web Development, Education Technology

Keywords: Virtual Classroom, Real-Time Collaboration Features, Interactive Tools, PHP, MySQL, HTML, CSS, JavaScript, Node.js, Socket.IO

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LIST OF SYMBOLS

/	OR
( )	PARENTHESE
-	DASH
“ “	QUATATION MARKS
&	AND

LIST OF ABBREVIATIONS

COVID-19	Coronavirus Disease 2019
iOS	iPhone Operating System
AI	Artificial Intelligence
VR	Virtual Reality
AR	Augmented Reality
3D	Three-Dimensional
PHP	Hypertext Preprocessor
WAMP	Windows, Apache, MySQL, and PHP
MySQL	My Structured Query Language
HTML	Hypertext Markup Language
CSS	Cascading Style Sheets
API	Application Programming Interface
SMS	Short Message Service
C#	C-Sharp
OOP	Object-Oriented Programming
WebRTC	Web Real-Time Communication
MVP	Minimum Viable Product
XAMPP	Cross-platform, Apache, MariaDB, PHP, and Perl
AJAX	Asynchronous JavaScript and XML
HP	Hewlett-Packard
UI	User Interface
GB	Gigabyte
RAM	Random-Access Memory
ERD	Entity Relationship Diagram
FYP	Final Year Project
CRUD	Create, Read, Update, Delete
MD5	Message-Digest Algorithm 5
Bcrypt	Blowfish crypt
GD Library	Graphics Draw Library
WBO	Whiteboard Online

SMTP	Simple Mail Transfer Protocol
HTTP	Hypertext Transfer Protocol
JaaS	Jitsi as a Service
LTS	Long Term Support
NPM	Node Package Manager
SDK	Software Development Kit

CHAPTER 1

Introduction

This chapter introduces the overview and incentive behind the development of a virtual classroom platform with real-time collaboration features, the contributions within domain, and the overview of the project.

1.1 Background Information

Over the past few decades, technology has advanced so quickly that it has fundamentally altered the way that education is provided and received [1]. Traditionally, education was bound to the physical classroom, where students and teachers interacted directly when learning took place. Geographical constraints, the availability of resources, and rigid scheduling were inherent limitations of this educational model, despite its effectiveness in fostering interpersonal relationships and hands-on learning. With the advent of digital technology and the ubiquity of the internet, a new era of online education emerged, offering learners the flexibility and accessibility that traditional classrooms could not always provide.

Global occurrences like the COVID-19 pandemic, which drove educational institutions worldwide to swiftly implement remote learning strategies, substantially expedited this shift. The sudden shift highlighted not only the need for scalable and flexible educational environments but also the limitations of conventional classroom settings [2]. Online education has shown to be an effective substitute in this case because it allows students to access the course material at any moment, from anywhere, and frequently at their own convenience. However, this rapid transition also exposed gaps in digital delivery systems, particularly in ensuring that online learning could match the engagement and interactivity of traditional education.

Key terms related to online education, such as "virtual classrooms" and "real-time collaboration tools," have become central in understanding this shift. A virtual classroom is an online setting that simulates a traditional classroom setting by enabling students and instructors/lecturers to engage in real time. Usually, this is done through chat, video conferencing, and other collaborative tools. These platforms aim to provide a space for live communication, discussion, and learning, regardless of physical location. Features like interactive whiteboards, which let users write and draw in real time, and real-time document editing, which lets several people edit a shared document at once, are examples of real-time collaboration tools. Another crucial tool that allows for face-to-face communication between instructors and students is video conferencing, which replicates the dynamics of an in-person classroom.

To address the challenges of online education, virtual classrooms were developed as a means to replicate the classroom experience in a digital environment. They typically incorporate tools such as video conferencing, messaging, and basic collaboration features. However, while these platforms mark a significant step forward, many of them still fall short in delivering an engaging, interactive, and truly collaborative learning experience. Essential features like online document collaboration, interactive whiteboards, and video conferencing are often underdeveloped or exist as isolated functionalities rather than a cohesive whole [3]. The overall learning process may be hampered by this lack of integration, which makes it more difficult for instructors and students to work together effectively.

This project seeks to close these gaps by setting up an unified virtual classroom platform that assimilates all necessary real-time collaboration tools into a single, seamless interface. The platform is made to get over the fundamental drawbacks of both the current digital learning tools and conventional classroom environments by bringing together features like chat modules, interactive whiteboard, live document collaboration, file sharing, video conferencing, and quiz assessment. Such an integrated approach promises to enhance both the students' and instructors'/lecturers' experience, making online education more engaging, interactive, and accessible for a diverse range of learners.

In summary, as education continues to transform in response to technology breakthroughs and global challenges, there is a pressing need to rethink and redesign digital learning environments. This project not only builds on the historical progression from physical classrooms to online learning but also addresses the critical shortcomings of existing virtual classroom platforms. It is a significant step toward creating a more dynamic, interactive, and inclusive educational future.

1.2 Problem Statement and Motivation

Traditional classroom environments often struggle with limitations such as geographic constraints, limited resources, and rigid scheduling, which can prevent many students, especially those in rural or underprivileged areas from accessing quality education. For example, students in remote regions may face long commutes or even need to relocate to attend schools with adequate facilities, and schools in economically disadvantaged areas often lack modern technology or sufficient funding. In addition, rigid class schedules may not accommodate students who must balance education with work or family responsibilities, leading to further inequities [4]. These factors collectively contribute to an educational divide, where many students are denied the same opportunities as their counterparts in urban or well-funded districts. While online education emerged as a flexible alternative, existing virtual classroom platforms often fail to replicate the collaborative dynamics of in-person learning. Many lack integrated real-time collaboration tools, leading to fragmented workflows, reduced student engagement, and diminished instructional effectiveness [5]. Meaningful peer-to-peer and instructor-student interactions are impeded by this gap, which ultimately lowers the standard of online learning [6].

This project addresses the critical need for a unified virtual classroom platform that combines the flexibility of online learning with the interactivity of traditional classrooms. The motivation stems from the growing demand for hybrid and remote education solutions, particularly in a post-pandemic landscape where accessibility and engagement remain paramount. Current platforms often leave students feeling isolated due to limited real-time collaboration, hindering their ability to participate in group activities or receive immediate feedback [7]. With the use of technologies like interactive whiteboard, video conferencing, and real-time document collaboration, this initiative aims to establish a vibrant, community-driven learning environment. Such a platform will not only unify the experiences of virtual and in-person education but also empower educators to deliver more impactful instruction, guaranteeing that all students across the world have fair access to high-quality educational opportunities.

1.3 Research Scope

The intended outcome of the project is to build a virtual classroom platform with real-time collaboration features that will provide an engaging and interactive learning experience for students and instructors/lecturers at all educational levels (e.g., elementary, secondary, higher education, etc.). This main deliverable will be in the form of a web platform hosting different collaboration and interactive tools like videoconferencing, real-time document editing, interactive whiteboards, chat functionality, file sharing features, and quiz assessments supporting both synchronous and asynchronous modes of learning to cater for different user needs.

The proposed solution will resolve some key limitations in existing virtual classroom platforms, such as the lack of immediate instructor/lecturer feedback, poor accessibility for students in remote locations or with limited technological resources, and the absence of informal peer-to-peer interaction. The platform will enhance online learning environments' interactivity and engagement by integrating smooth real-time collaboration and instant feedback. By the end of this project, the result will be a fully functional virtual classroom platform capable of supporting dynamic and interactive online learning environments with an emphasis on real-time collaboration and accessibility.

1.4 Project Objectives

To attain the primary objective of enhancing the virtual learning experience, this project will have several goals that address some of the existing shortcomings of online learning. These objectives are based on having a platform that provides essential tools, fosters real-time interaction, and encourages peer collaboration. The following are objectives that define the approach to be adopted in creating an end-to-end solution that addresses the diverse needs of both students and teachers at varying levels of learning.

1.4.1 To Develop a Comprehensive Virtual Classroom Platform

The main intent of this project aims at establish a comprehensive virtual classroom platform designed to optimise both synchronous and asynchronous learning experiences. This platform will focus on creating an interactive, engaging, and effective learning environment for students and instructors/lecturers across various educational levels. The goal is to bridge the gaps in current virtual learning environments by integrating a robust, user-friendly interface with essential collaboration and interactive tools. These tools will facilitate immediate communication, collaborative problem-solving, and shared content creation, simulating the dynamics of a physical classroom. By focusing on accessibility and fostering student engagement, this platform will cater to diverse learning needs, supporting users from remote or underserved areas.

1.4.2 To Integrate the Real-Time Collaboration Features

A key focus of this project is the seamless integration of real-time collaboration tools that empower both instructors and students to interact dynamically. Features like videoconferencing, real-time document editing, and interactive whiteboards will be incorporated to enable immediate communication, collaborative problem-solving, and shared content creation. These features will foster an engaging learning environment where students can actively engage in live discussions, collaborate on shared documents, and visualize concepts in real-time. This integration will help unify the experiences of online and in-person learning, creating an immersive and responsive educational experience.

1.4.3 To Facilitate Peer Interaction through Interactive Tools

In addition to the collaborative features, this project will focus on fostering a peer interaction and social learning environment. Tools like group chats, file sharing, and quiz assessments will be integrated to promote informal interactions among students, allowing them to collaborate on projects, share resources, and support each other's learning outside of formal instructional settings. By establishing channels for peer-to-peer communication and teamwork, the platform will strengthen the sense of community, a key factor in effective learning. These features will also facilitate asynchronous learning, enabling students to continue their interactions and discussions beyond scheduled class times, making learning more flexible and continuous.

The platform will be web-based to ensure accessibility for users with limited technological resources. It will be optimized for use on laptops and desktops, eliminating the need for specialized hardware or software, and catering to students in remote locations or those without high-end computers. This project excludes the development of mobile applications (iOS/Android), as the platform will be primarily web-based. Furthermore, advanced AI-driven functions, such as automated grading, intelligent tutoring, or personalized learning paths, will not be part of the current phase of development. Similarly, the integration of VR or AR technologies is outside the purview of this project, as the platform will focus on traditional web-based tools that facilitate real-time communication and collaboration rather than immersive 3D environments.

1.5 Impact, Significance and Contribution

This project holds transformative potential for the future of education by addressing critical gaps in online learning such as long-standing issues of fragmented digital learning tools and delayed feedback. By unifying real-time collaboration tools such as video conferencing, interactive whiteboards, and shared document editing into a single seamless platform, the solution bridges the divide between the flexibility of virtual classrooms and the engagement of in-person learning. Geographical and socioeconomic barriers are broken down as students, especially those in underserved or remote areas, have equitable access to dynamic, interactive education. Instructors/lecturers benefit from tools that enable live feedback, collaborative problem-solving, and real-time monitoring, empowering them to deliver more impactful instruction. Educational institutions can adopt this platform to foster inclusivity, reduce dropout rates, and elevate the quality of online education globally.

The significance of this project stems from its capacity to redefine virtual learning as a collaborative, community-driven experience rather than an isolating one. The platform's integrated design tackles the fragmentation of current tools, which frequently impede engagement and productivity in a post-pandemic era where hybrid education is the norm. By prioritizing simplicity and accessibility, the solution ensures that even users with limited technical proficiency can participate fully. Beyond immediate educational benefits, this project contributes to broader societal goals such as democratizing access to quality education, reducing disparities between urban and rural communities, and preparing a digitally fluent workforce for the future.

1.6 Report Organization

The ensuing chapters present the details of this research. Chapter 2 presents the literature review regarding existing virtual classroom platforms. Then, the proposed methodology, system specifications, requirement analysis, and timeline will be presented in Chapter 3. Chapter 4 will continue by describing the system design such as system architecture, block diagram, use case diagram, activity diagram, ERD diagram, flowchart, wireframe, and storyboard. Chapter 5 will give a brief on system implementation such as hardware and software setup, system executions, and implementation barriers. Chapter 6 brings a talk on system analysis and discussion which includes system testing, test result, objectives assessment, and concluding remark. At last, Chapter 7 will be reporting the findings for this project and give some future recommendations.

CHAPTER 2

Literature Review

2.1 Previous Works on Virtual Classroom Platform with Real-Time Collaboration Features

2.1.1 Design and Implementation of a Web-Based Virtual Classroom System - (A. O. Charles and I. G. Babatunde, 2014)

In this work, A. O. Charles and I. G. Babatunde [8] emphasize the development and implementation of a web-based online classroom system that integrates various interactive learning features to facilitate remote education. Their system incorporates key components such as shared whiteboards, real-time chat, and audio/video communication, all aimed at fostering an interactive and engaging environment for students and instructors alike. By utilizing platforms like Moodle and Elluminate in combination with the WAMP server and programming languages such as PHP, JavaScript, and MySQL, the system creates a robust infrastructure for synchronous and asynchronous learning experiences. The inclusion of both real-time and delayed learning options provides greater flexibility, enabling users to access course materials and interact with instructors in different time zones. The use of these technologies supports the dynamic nature of online education, allowing educators to teach and engage students effectively, regardless of physical location. The system also supports a comprehensive, multifaceted learning environment, where students can collaborate actively, replicate traditional classroom dynamics remotely, and receive timely feedback, ultimately enhancing the online learning experience.

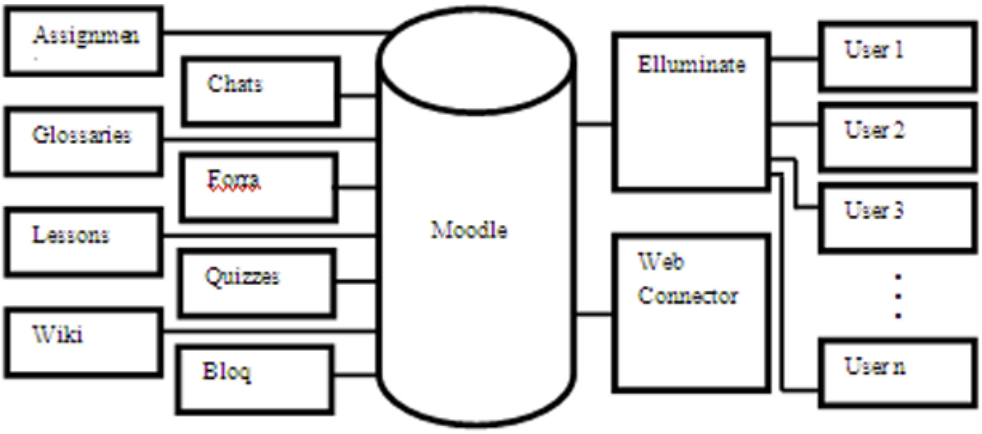


Figure 2.1.1 - The Interrelationship among Application Modules

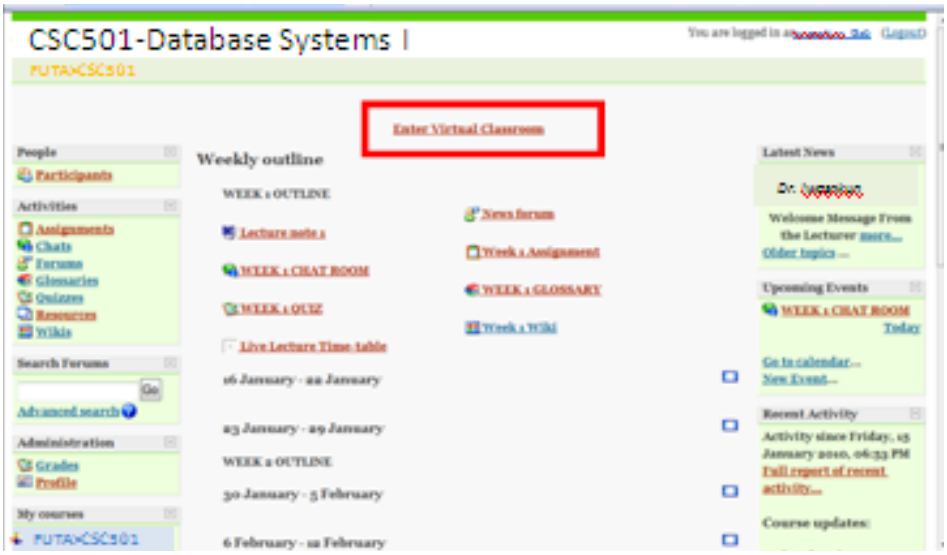


Figure 2.1.2 – Interface of Virtual Classroom

2.1.2 Virtual Classroom - (T. Sharma et al., 2023)

T. Sharma et al. [9] developed an advanced virtual classroom platform designed to enhance remote learning by incorporating real-time collaboration tools such as video calls, shared screens, and interactive quizzes. The system uses modern web development technologies, including jQuery, HTML, CSS, API, JavaScript, C#, React, and Object-Oriented Programming (OOP), to generate an interface that is engaging and handy. This platform allows teachers to manage classrooms efficiently and engage students through a variety of tools, making the experience of learning more dynamic. The integration of interactive quizzes provides immediate feedback, reinforcing students' understanding of the material. This study is significant because it addresses the need for a comprehensive online classroom environment where multiple forms of interaction such as video, screen sharing, and quizzes which are seamlessly incorporated into a unified system, allowing instructors and students to collaborate in real-time, thus overcoming the limitations of isolated tools in traditional virtual classrooms.

2.1.3 Virtual Classroom System - (H. Koyande et al., 2023)

H. Koyande et al. [10] propose a push-type virtual learning system that aims to automate assignment distribution and enable real-time communication through video conferencing, utilizing WebRTC technology. The system also provides access to live and recorded lectures, which significantly enhances the accessibility and flexibility of learning for students. One of the strengths of this platform is its ability to optimize resource management and reduce administrative overhead by automating repetitive activities like content distribution and assignment submission. The integration of WebRTC allows for seamless peer-to-peer video conferencing, which enhances interaction between students and instructors, promoting an immersive, interactive learning environment. This system also focuses on improving the overall experience for both students and teachers by minimizing the complexity associated with system management and offering real-time communication tools for better engagement.

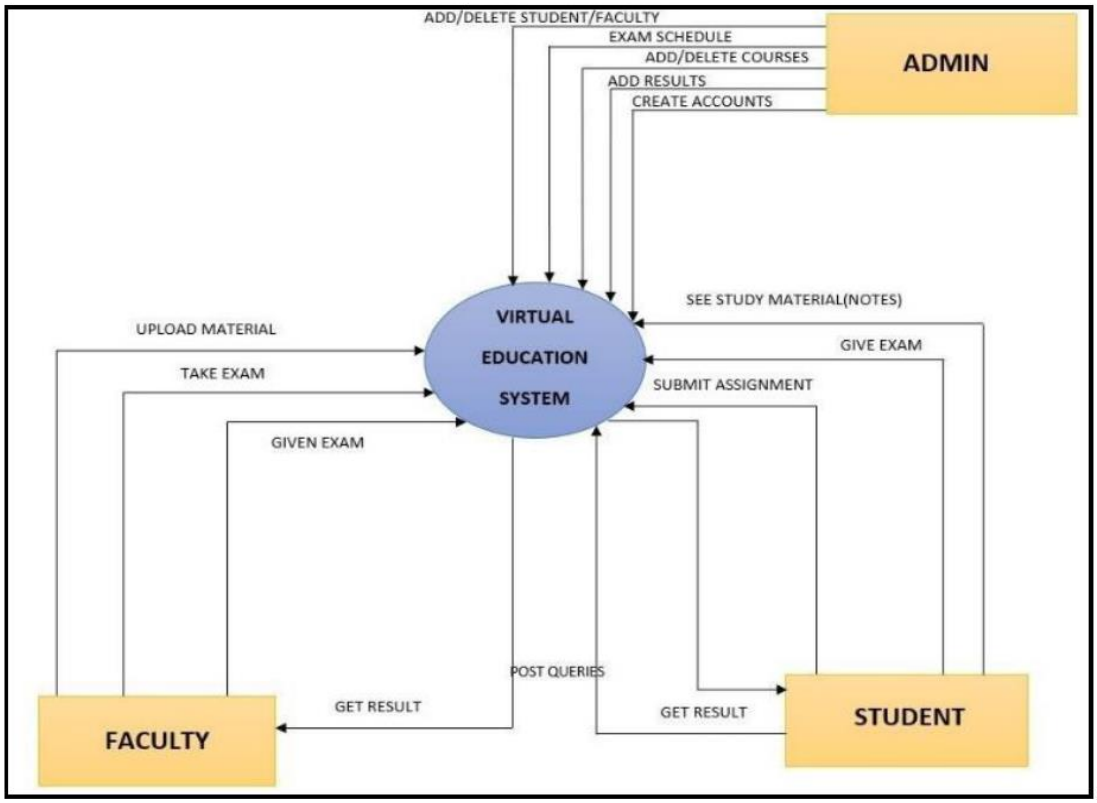


Figure 2.1.3 - Block Diagram for Virtual Classroom System

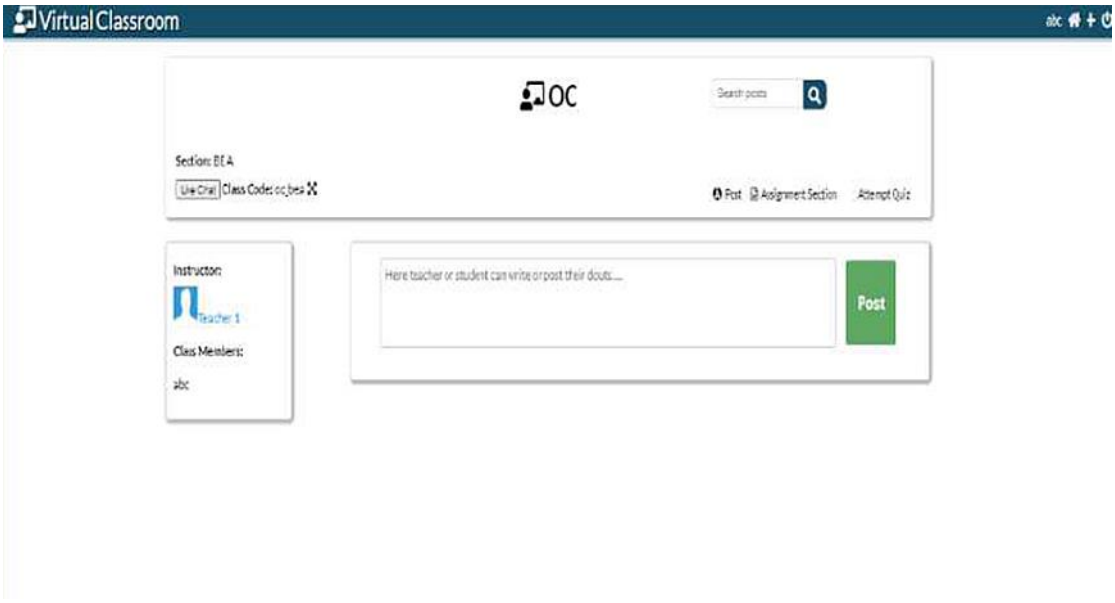


Figure 2.1.4 - Interface of Virtual Classroom Home Page

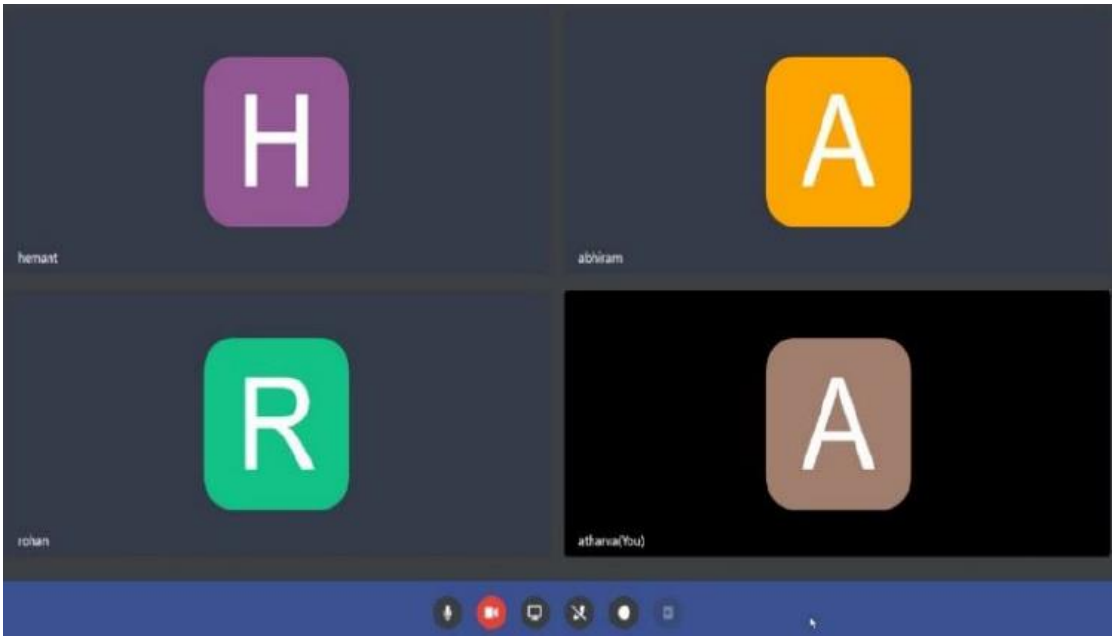


Figure 2.1.5 - Interface of Video Conference

2.1.4 Virtual Classroom System - (A. Nair et al., 2021)

A. Nair et al. [11] propose a virtual classroom system that emphasizes flexibility and interactivity, providing an environment where students can access recorded lectures, participate in live polls, and engage in forum discussions. The system also includes features such as quizzes and assignment management, which further enhance the learning process by giving students multiple ways to interact with the content. The technologies used in this platform are MySQL, JavaScript, and PHP which help build a reliable and efficient system. This study is important because it addresses the need for a versatile platform that accommodates various learning styles, providing both asynchronous and synchronous learning experiences. The inclusion of live polls and forum discussions allows for real-time student feedback and interaction, increasing engagement and fostering a more connected learning community. By enabling students to access lessons on their own time while still engaging in interactive activities, the system provides an accessible, flexible learning environment that caters to diverse needs.

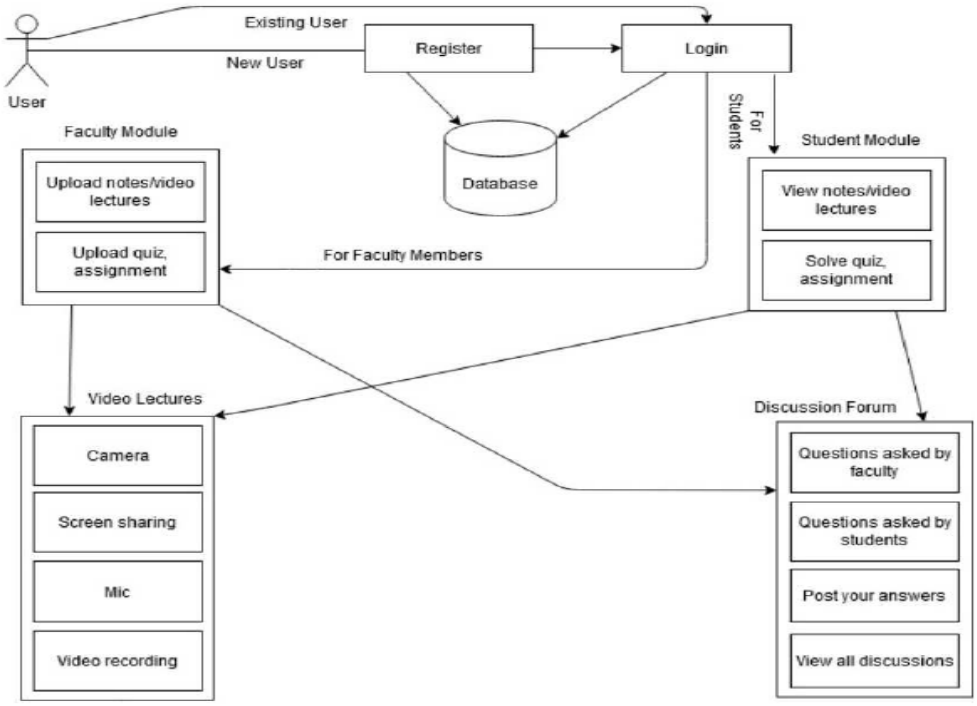


Figure 2.1.6 - Architecture of Virtual Classroom System

2.1.5 Digi-Class - (Z. Alpholicy X et al., 2021)

Z. Alpholicy X et al. [12] developed Digi-Class, a mobile-optimized virtual classroom platform designed to address the limitations of rigid schedules and geographical constraints. The system integrates mobile accessibility, video conferencing, real-time data syncing, and paperless assignment management using modern technologies such as Flutter, Dart, and Firebase. By enabling live lectures, quizzes, attendance tracking, and communication tools, Digi-Class offers a streamlined, flexible learning experience for both instructors and students. Its mobile-first approach ensures that students, especially those in remote locations or without access to traditional desktop computers, can engage with course materials and participate in live sessions. The use of Firebase for real-time data synchronization ensures that interactions, assignments, and other learning activities are updated instantly, creating a seamless and dynamic learning environment. The platform's user-friendly interface and mobile capabilities allow students to engage with content more effectively, reducing barriers to participation and fostering a more inclusive educational experience.

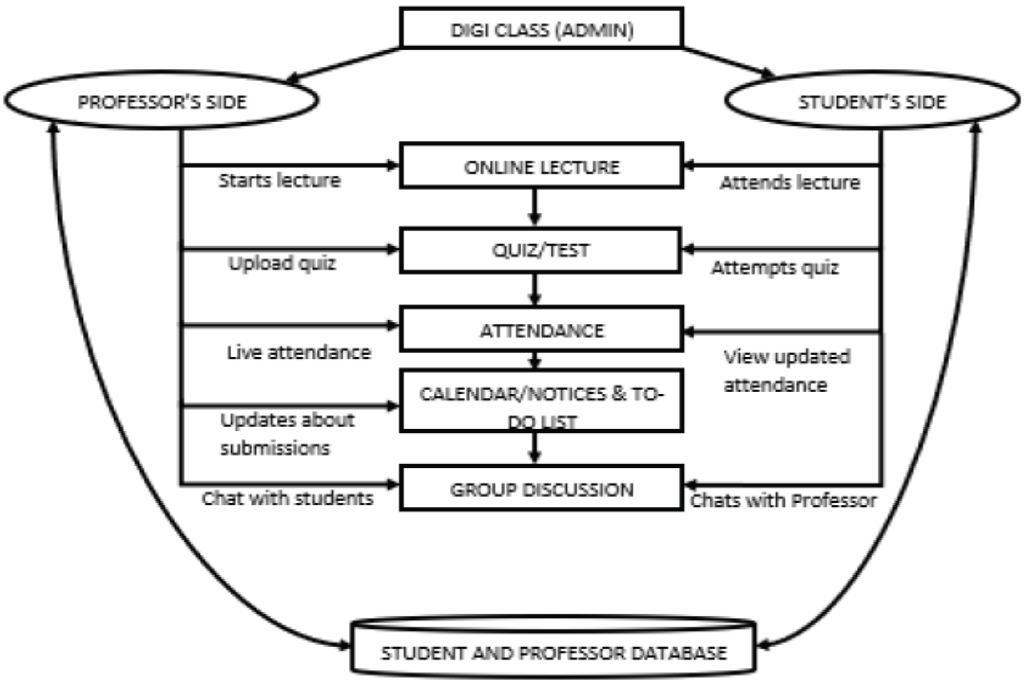


Figure 2.1.7 - Architecture of Digi-Class

Figure 2.1.8 – Teacher Interface of Virtual Classroom

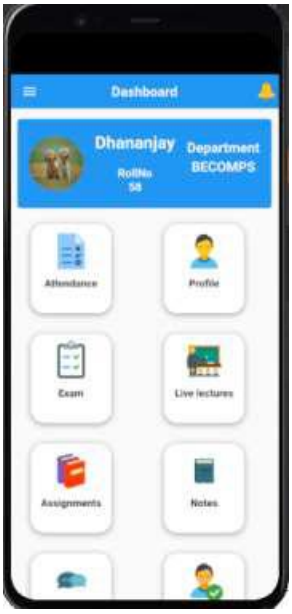


Figure 2.1.9 - Student Interface of Virtual Classroom

2.1.6 Virtual Classroom - (A. Shaikh, 2015)

A. Shaikh [13] developed a virtual classroom system that facilitates synchronous distance learning by offering features like live sessions, chat, polls, and document sharing. The platform is built using Java EE, Servlets, and Java Server Pages, enabling real-time interaction between instructors and students. One of the significant benefits of this system is its ability to foster a sense of immediacy and engagement through live chat, polls, and document sharing, which allow students to ask questions, provide feedback, and collaborate in real-time. The integration of organizational tools such as session registration and timetable management further enhance the platform's ability to support structured learning experiences. This system is particularly valuable because it combines both the content delivery and the administrative aspects of a virtual classroom, streamlining the management of online courses while enhancing interaction between students and instructors. By facilitating real-time communication and providing tools for collaborative learning, Shaikh's virtual classroom system addresses the need for interactive, flexible, and well-organized online learning environments.

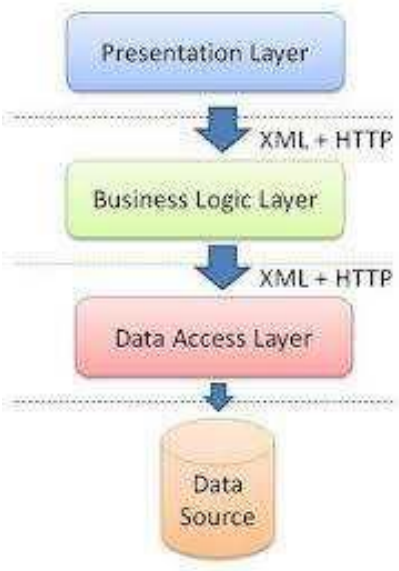


Figure 2.1.10 – 3 Tier Architecture of the Virtual Classroom

Figure 2.1.11 – Homepage of the Virtual Classroom

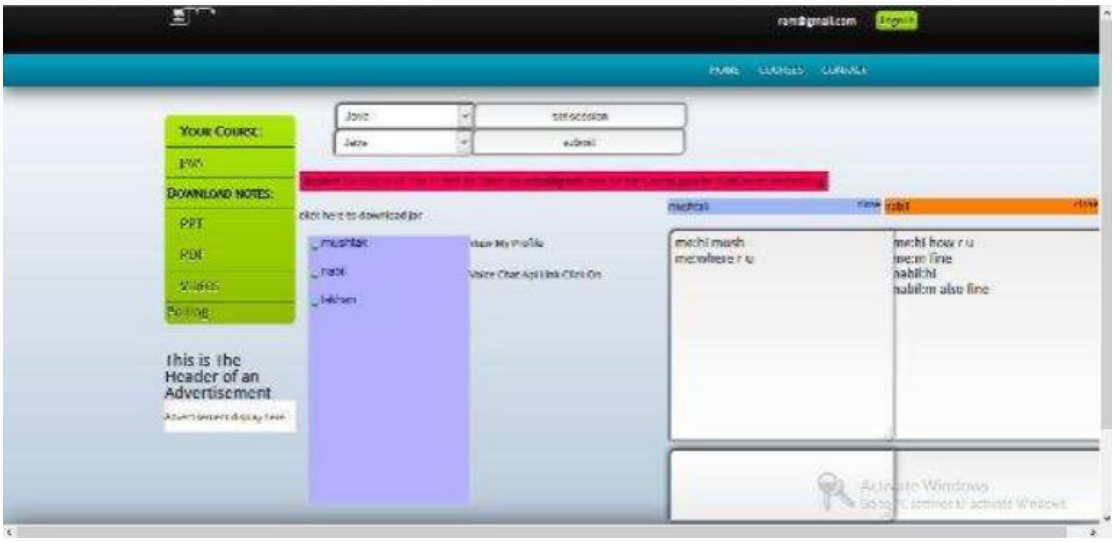


Figure 2.1.12 – Chat Application of the Virtual Classroom

2.2 Critical Remarks of Previous Works

2.2.1 Strengths of Previous Works

A.O. Charles and I.G. Babatunde [8] provide a significant strength in their integration of both real-time and delayed learning experiences. This flexibility supports students across different time zones and those who might need to revisit course material, ensuring broader accessibility and accommodating diverse student schedules and needs. The system fosters inclusivity by offering both synchronous and asynchronous modes of learning, enhancing the overall learning experience.

Secondly, T. Sharma et al. [9] excel in their focus on providing immediate feedback through interactive quizzes that reinforce understanding during live sessions. This approach ensures that students receive instant evaluations of their grasp on the content, allowing them to correct mistakes early in the learning process. This real-time feedback capability strengthens the learning cycle, motivating students and enabling instructors to monitor progress efficiently.

Additionally, H. Koyande et al. [10] bring forward a key strength in their platform's focus on automating administrative tasks. This reduces the burden on instructors by streamlining the distribution of assignments and other learning materials. The push-type distribution of assignments allows for more efficient management of learning resources, ensuring students receive timely updates and assignments without requiring manual intervention from instructors, which is particularly helpful in large-scale learning environments.

In addition, A. Nair et al. [11] make a notable contribution by emphasizing peer-to-peer interactions through live polls and forum discussions. These tools help promote a sense of community, allowing learners to collaborate outside of structured activities. This creates a space for informal exchanges, which is crucial for building relationships and enhancing the learning process, something that traditional classroom environments naturally provide.

Furthermore, Z. Alpholicy X et al. [12] offer a groundbreaking innovation in making the virtual classroom mobile-first, optimizing the system for students who have limited access to desktops. This design ensures that students, particularly in rural or underserved areas, can engage in live learning, attend lectures, and complete assignments directly from their mobile devices. The platform's ability to deliver real-time updates and sync data across devices also bridges the gap for students in geographically isolated regions.

At last, A. Shaikh's [13] platform prioritizes simplicity and ease of use, making it especially beneficial for students and instructors who may not be very familiar with technology. The clear user interface ensures that both instructors and learners can focus on content delivery and interaction without being bogged down by complicated systems or technical issues, helping to ensure that the platform is accessible to a broader user base.

2.2.2 Weaknesses of Previous Works

While substantial progress has been made in the development of virtual classroom platforms with real-time collaboration features, several critical limitations still hinder their effectiveness in fully replicating the collaborative, interactive experience of traditional classrooms.

A recurring limitation in previous studies, such as the one developed by A.O. Charles and I.G. Babatunde [8], is the insufficient provision of real-time instructor feedback. Although their system includes features like real-time chat and video communication, the platform still lacks the immediacy and responsiveness that are characteristic of face-to-face interaction in a physical classroom. In an online environment, real-time feedback is crucial to maintain student engagement and correct misunderstandings promptly [14]. Without this direct interaction, students may feel disconnected, which can hinder their learning progress and motivation. The lack of quick feedback during collaborative activities such as group work or interactive conversations lowers the richness of the learning experience, forcing students to work alone rather than communicate dynamically with instructors and classmates.

Another limitation, emphasized by researchers like T. Sharma et al. [9] and A. Shaikh [13], is the heavy reliance on technology, which can exacerbate the digital divide. For many students, particularly those in rural or underdeveloped areas, access to reliable devices and stable internet connections remains a major barrier to participating in online learning [15]. Even though some systems aim to offer comprehensive features like video conferencing and document sharing, if students cannot reliably access these tools due to technological constraints, the platform becomes ineffective. This unequal access creates disparities, especially in global settings where educational resources are not evenly distributed. While some platforms attempt to bridge this gap by providing mobile accessibility or offline functions, they frequently fail to give a consistent experience across devices, resulting in issues such as slowness, low-quality video, or difficulty accessing assignments.

Furthermore, the social aspect of learning, particularly peer-to-peer interaction, is often neglected in previous virtual classroom systems, as seen in the works of H. Koyande et al. [10]. While technical features such as video conferencing and real-time document editing support structured interactions, they cannot fully replicate the informal social dynamics of a traditional classroom. In-person classrooms naturally foster casual discussions, group study sessions, and collaborative activities that help build a sense of community among students. The feeling of isolation in online platforms due to a lack of group chats, brainstorming capability, and collaboration outside structured activities decreases a sense of belonging and eventually leads to course engagement problems. In such a context, the full virtual classroom potential is not used, and without these informal opportunities for interaction, students struggle to from relationships with peers that are one of the very strong reasons and motivators for deep learning.

At last, a critical limitation, particularly highlighted by A. Nair et al. [11] and Z. Alpholicy X et al. [12], is the technical complexity of many virtual classroom systems. These platforms often require a certain level of technical proficiency from both students and instructors. Complicated user interfaces, integration issues, and inconsistent system performance can alienate users who are not technologically savvy [16]. For instance, navigating through multiple features like video, chat, document sharing, and polls simultaneously can be overwhelming for those unfamiliar with online learning tools. These complexities become a significant use barrier, notably for older adults, students with limited experience in using digital technologies, and instructors who may receive little to no training in its use. A system that is either hard to navigate or does not function well can greatly detract from the learning experience, causing frustration and disengagement.

2.2.3 Comparison Between Previous Works and Proposed Solutions

In response to the limitations identified in previous studies, this project proposes a comprehensive virtual classroom platform that integrates a wide array of real-time collaboration features designed to address the issues of interactivity, accessibility, and user engagement.

One of the central solutions proposed is the integration of real-time document editing, interactive whiteboards, and seamless video conferencing tools that allow instructors to engage with students instantly. This way, instructors can immediately provide feedback on assignments, documents, and other learning materials that students are working on in real time, just like the dynamic exchange that happens within a face-to-face classroom. Features like the interactive whiteboard enable the instructor to explain concepts, solve problems together, and show ideas in real-time, further enhancing learning. The solution addresses the critical need for continuous feedback which keeps students engaged and ensures misunderstandings are corrected swiftly.

In order to cope with the challenge of digital access, the platform will be working seamlessly with a wide range of devices, from laptops to desktops. This compatibility guarantees that students, regardless of their technological resources, can access the platform and participate in the learning process. This means that the system will be barrier-free and more inclusive and efficiently including features that work on high-end and lower-spec devices. This will ensure the bridging of the digital divide and a much more equitable online learning experience.

Besides, to build a stronger rapport among the users and encourage a more peer-to-peer learning environment, the platform should have a range of different interactive tools. It could include group chat, a file-sharing module and quiz assessments to help informal interaction and collaborative learning among its students. Such features can help replicate the social dynamics of physical classrooms, where so many students form study groups, ask questions informally, and exchange ideas outside the formal sessions. The platform will create a more connected and engaged learning community by fostering casual interactions and group collaboration.

Features	A. O. Charles and I. G. Babatunde, 2014	T. Sharma et al., 2023	H. Koyande et al., 2023	A. Nair et al., 2021	Z. Alpholicy X et al., 2021	A. Shaikh, 2015	Proposed Solution
Real-time audio/video communication	✓	✓	✓	✓	✓		✓
Interactive whiteboards	✓	✓				✓	✓
Real-time chat	✓	✓	✓			✓	✓
Shared document editing							✓
Real-time quizzes	✓	✓	✓	✓	✓		✓
Discussion boards and forums	✓			✓	✓		✓
File sharing	✓	✓		✓	✓	✓	✓
Recorded lectures			✓	✓	✓		
Assignment submission and management	✓		✓	✓	✓		✓
Mobile device compatibility					✓		

Table 2.2.1 - Features of the Previous Platforms and Proposed Solutions

CHAPTER 3

System Method/Approach

To build the Virtual Classroom Platform with real-time collaboration features, several key methods and technologies will be utilized. These technologies are selected to ensure that the system is robust, scalable, interactive, and accessible, meeting the objectives of providing a seamless learning environment for both students and instructors.

3.1 Design Specifications

3.1.1 Methodologies and General Work Procedures

3.1.1.1 Proposed Methodologies

When developing a system such as a Virtual Classroom Platform with real-time collaboration features, the choice of methodology is key to guaranteeing successful development, adaptability, and user satisfaction. Three primary methodologies were considered for this project, which are Waterfall Model, Spiral Model, and Agile Methodology. These methodologies vary in terms of structure, adaptability, and development speed. A thorough analysis of each was carried out to deduce the most appropriate approach for a system requiring continuous feedback integration, and flexibility in feature enhancement.

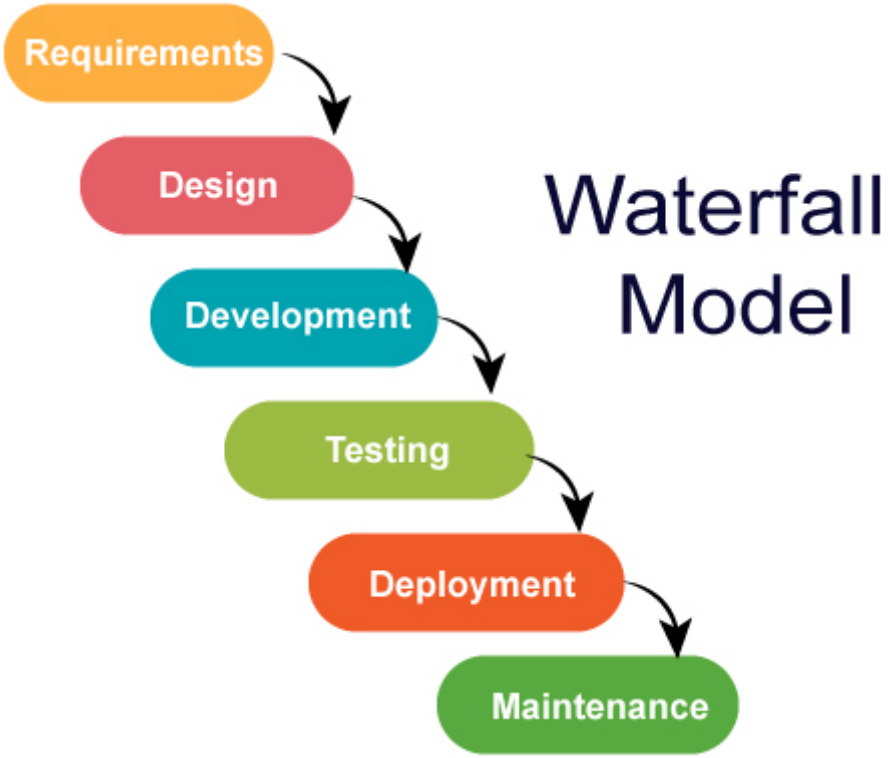


Figure 3.1.1 – Waterfall Methodology

The Waterfall model is characterized by its traditional and successive approach to software development. The process is segmented into distinct stages, which are requirement assessment, solution design, development, testing, deployment, and maintenance. No stage can commence until the previous one is fully completed, and revisiting previous phases is generally discouraged. This structure provides a clear roadmap, streamlining the organization of schedules and documentation. However, one of its major limitations is the inflexibility. Any changes in requirements or unexpected challenges discovered late in the process can be difficult to address. For a dynamic and user-centric system like a virtual classroom, where real-time feedback and adaptability are critical, the Waterfall model may prove too rigid and slow to respond to evolving needs.

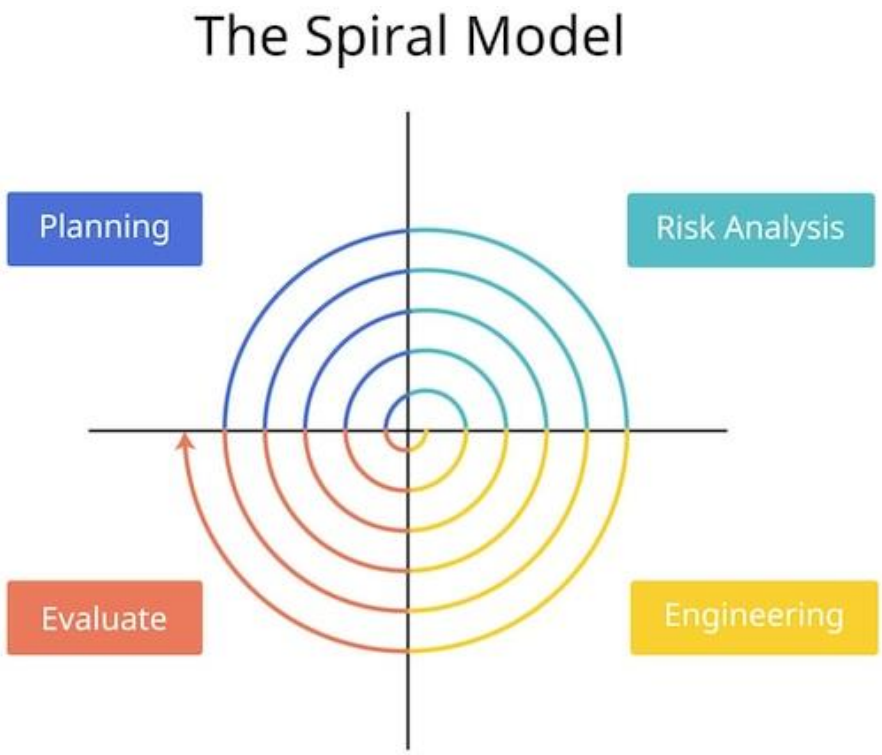


Figure 3.1.2 – Spiral Methodology

The Spiral Model blends repetitive development with rigorous risk analysis, making it particularly suitable for large, complicated, and hazardous projects with evolving or uncertain requirements. It emphasizes repeated refinement through successive cycles, which each of them involves planning, risk evaluation, engineering, and appraisal, allowing for the progressive development of increasingly complete system prototypes. This iterative nature provides greater flexibility than traditional models like Waterfall by accommodating changes and new insights as the project unfolds. Furthermore, the emphasize on early detection and resolution of risks helps prevent issues later in the development cycle. However, this strength can also be a drawback in smaller-scale projects, where time is limited. The continuous analysis required at each cycle can cause significant overhead, potentially slowing development and diverting focus from implementation. While the Spiral Model offers robust tools for managing uncertainty and complexity, its practical application may be excessive for projects with constrained scope and limited duration.

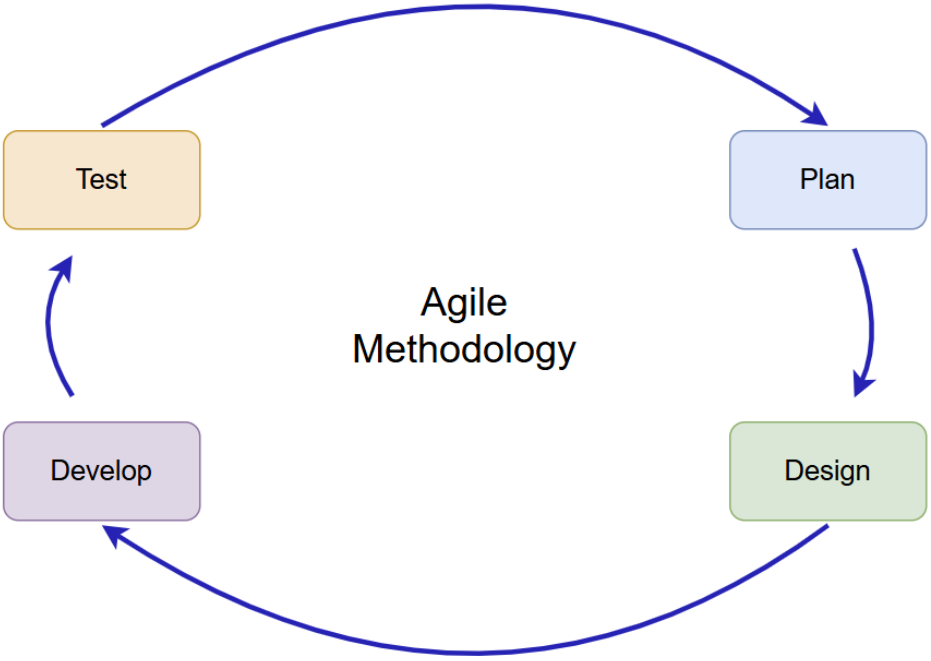


Figure 3.1.3 – Agile Methodology

On the other hand, the Agile methodology is an iterative and incremental approach that promotes flexibility, collaboration, and responsiveness to change. Unlike Waterfall, Agile allows continuous integration of user feedback, and unlike the Spiral Model, it reduces excessive focus on risk documentation and prioritizes working features delivered in short iterations instead. This makes Agile particularly suitable for the Virtual Classroom Platform, where user requirements may evolve, and regular feedback is essential to ensure usability and effectiveness. Its iterative process ensures that features can be tested, refined, and improved incrementally, aligning with the project's timeline. Furthermore, Agile supports the division of the development process into manageable sprints, which ensures that the platform consistently moves closer to meeting its intended objectives. This incremental delivery also minimized the risks associated with late discovery of system flaws, since potential issues were identified and resolved early in the development cycle. By maintaining this balance between structured planning and adaptive change, Agile not only streamlined development but also ensured that the platform remained aligned with users throughout its lifecycle.

Given these considerations, Agile methodology is selected as the most appropriate approach for this project. Its adaptability, iterative nature, and strong emphasis on user feedback make it particularly well-suited to the dynamic requirements of a virtual classroom environment. The platform's development demands continuous integration of new features, responsive adjustments based on educational needs, and a scalable structure that can accommodate future growth. Agile ensures these goals are met through a flexible and structured process that evolves along with the system's users and their expectations.

3.1.1.2 Selected Methodology

For the setup of the virtual classroom platform, the Agile methodology will be adopted due to its flexibility, iterative process, and focus on continuous improvement. The project will be organized into various crucial phases. First, the Planning phase will define the overall flow and features of the platform, setting the direction for the project. In the Design and Development phase, the platform will be created, incorporating the features outlined in the planning phase. Following this, the Test phase will involve trial and error for each feature, with feedback collected from users to refine and adjust the platform's functionalities. These four phases will be repeated for each feature until the system reaches its final form.

During the first semester, the output will focus on developing a Minimum Viable Product (MVP) or prototype, which includes the basic functionalities of the virtual classroom platform. This prototype will be tested and refined through regular feedback. In the second semester, the focus will shift to the full development of the platform, where new features will be added, the user interface will be enhanced, and any issues discovered during the MVP phase will be addressed. The iterative process ensures continuous improvement, with each phase building upon the previous one, guaranteeing that the platform evolves into a fully functional, user-centered system by the end of the project. The methodology’s adaptability allows for incremental progress while meeting deadlines and milestones effectively.

3.1.2 System Requirement

3.1.2.1 Software / Tools

The build-out of the Virtual Classroom Platform relies on a comprehensive set of software tools to ensure a seamless, scalable, and interactive learning environment. The project's frontend and backend code are written, debugged, and managed using Visual Studio Code, a lightweight yet advanced source-code editor with broad extension compatibility, making development more efficient and customizable.

XAMPP is used as the local development server, as it includes Apache, MySQL, and PHP in a single package, permitting developers to test within a locally simulated server environment. This is essential for testing server-side functionality before deployment.

To support modern JavaScript-based integrations and manage front-end packages and libraries, Node.js is utilized. Node.js enables the installation and configuration of tools such as Socket.IO, FilePond, WBO, and Etherpad, ensuring real-time collaboration and interactive features work seamlessly across the platform.

For real-time video conferencing, Jitsi Meet is implemented using Jitsi as a Service (JaaS). This cloud-based solution simplifies the integration of video and audio communication features into the platform while ensuring high availability, scalability, and encryption for user privacy.

To support collaboration, the platform includes Etherpad, a self-hosted, web-based document editor that allows multiple users to edit text documents in real time.

Similarly, WBO (Whiteboard Online) provides an interactive whiteboarding space, enabling students and teachers to draw, sketch, or brainstorm together.

Access to the platform is made cross-compatible and user-friendly by ensuring it runs smoothly on modern web browsers, including Google Chrome, Microsoft Edge, Apple Safari, and more. This helps deliver consistent performance and accessibility across different operating systems and devices.

3.1.2.2 Programming Languages

The backend of the platform is built using PHP, a commonly adopted server-side scripting language valued for its ease of integration with web technologies and databases. PHP handles user authentication, session handling, and server-side processing, making it essential for the platform's dynamic features.

For data storage and retrieval, the system uses MySQL, a robust and scalable relational database management system. It efficiently manages student information, class schedules, assignments, and other essential data, ensuring fast and reliable database operations.

On the frontend, HTML (HyperText Markup Language) defines the framework and arrangement of each page. CSS (Cascading Style Sheets) is used to style and visually design the platform's user interface, including layout, colors, typography, and responsiveness. JavaScript brings interactive functionality and dynamic elements to the platform, such as form validation, interactive menus, and real-time content updates.

3.1.2.3 Libraries

To enhance the functionality of the platform, several libraries are integrated. Socket.IO is used to implement real-time, two-way connectivity between the client and server. This allows features such as instant messaging, live status updates, and dynamic classroom interactions without the need to reload the page, greatly improving the user experience.

For handling email-related tasks, such as password recovery and user notifications, the platform utilizes PHPMailer, a popular and secure PHP library that simplifies transmitting emails with advanced features like SMTP authentication, attachments, and HTML formatting. Composer, a dependency manager for PHP, is used to acquire and maintain PHPMailer, ensuring consistent and maintainable library usage across the project.

File upload functionality is powered by FilePond, a modern JavaScript library designed to handle file uploads smoothly. It offers features like drag-and-drop support, file preview, progress indicators, and client-side validation, providing a user-friendly and visually appealing file upload interface.

Technology	Description
Visual Studio Code	Source-code editor for writing, debugging, and managing frontend and backend code.
PHP	Language used for scripting on the server in web projects.
MySQL	Database management solution for platform data storage and retrieval.
XAMPP	Web server for local development and hosting.
HTML	Markup language for structuring web pages.
CSS	Stylesheet language for designing web pages.
JavaScript	Language used to introduce interactivity and dynamic content.
Socket.IO	JavaScript library that allows real-time, event-based interaction between web clients and servers.
PHPMailer	A PHP library for delivering emails from web applications.
FilePond	A PHP library for delivering emails from web applications.
Jitsi Meet	Video conferencing software for live class sessions.
WBO	Collaborative whiteboard for drawing and note-taking.
Etherpad	Real-time document editing tool for group collaboration.
Node.js	A backend JavaScript runtime using Chrome's engine that supports server-side scripting.
Composer	A dependency manager for PHP that automates the setup and updating of libraries and packages.
Web Browser	For accessing the platform across various devices.

Table 3.1.1 - Specifications of technology stack

3.1.2.4 Hardware

The development and testing of the Virtual Classroom Platform are carried out on a high-performance HP Spectre x360 Convertible 13-aw2xxx laptop. The device's 11th Gen Intel® Core™ i5-1135G7 CPU provides the processing capability and effective multitasking required to create a feature-rich application. It runs on Windows 11, ensuring compatibility with the latest software and tools. The laptop features Intel® Iris® Xe Graphics, offering optimised visual quality during the development of UI elements and integration of real-time collaborative tools. With 8GB RAM, the system ensures smooth operation of multiple applications simultaneously, while 476GB of storage offers ample space for project files, databases, and testing environments. These specifications make the device a good call for building and refining the platform.

Description	Specifications
Model	HP Spectre x360 Convertible 13-aw2xxx
Processor	11th Gen Intel® Core™ i5-1135G7
Operating System	Windows 11
Graphic	Intel® Iris® Xe Graphics
Memory	8GB RAM
Storage	476GB

Table 3.1.2 - Specifications of Laptop

3.2 Users' Requirements Analysis

A questionnaire regarding the users' functional and non-functional requirements of the Virtual Classroom Platform has been created and utilized to collect relevant data in order to justify the problems of current platforms and the need for proposed solutions.

3.2.1 Questionnaire Analysis

3.2.1.1 Section 1 - General Information

Age Distribution (Question 1):

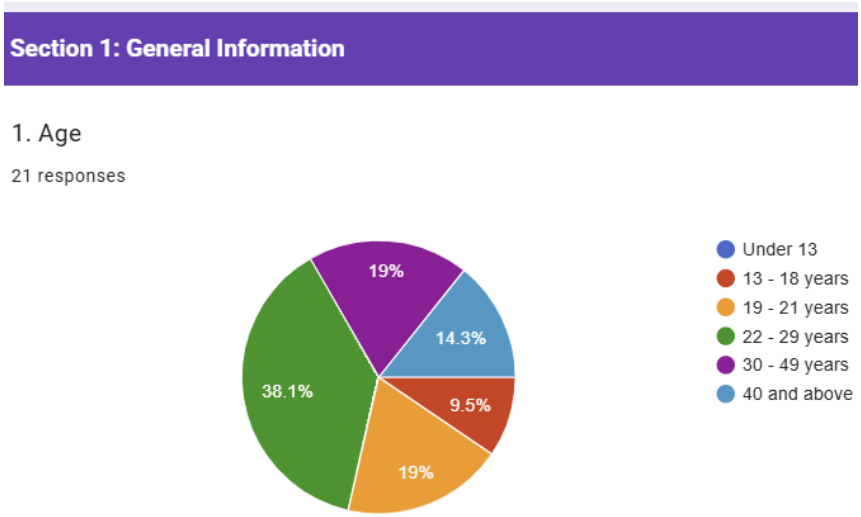


Figure 3.2.1 - Pie Chart of Age Distribution

The respondents that took part in this survey include 13-18 years (9.5%), 19-21 years (19%), 22-29 years (38.1%), 30-49 years (19%), and 40 and above (14.3%). This indicates that the platform would cater to a diverse age group from different levels of the education system. The wide age range suggests the need for a flexible and adaptable platform that meets the varying needs of users across different educational and professional stages.

Role in the Educational Process (Question 3):

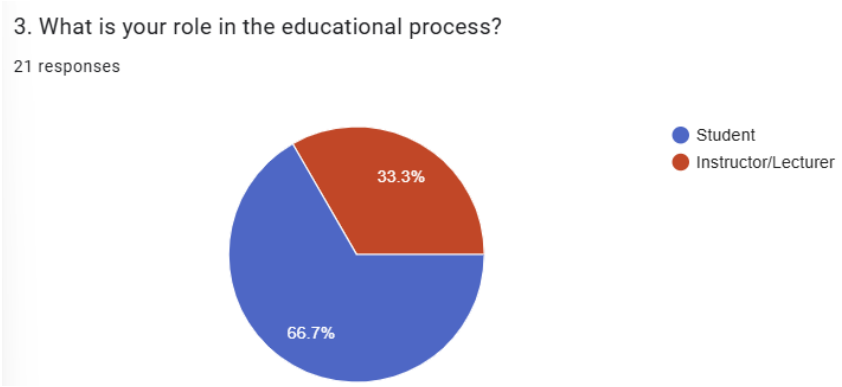


Figure 3.2.2 - Pie Chart of Role in the Educational Process

66.7% of respondents are students, while 33.3% are instructors/lecturers. This highlights the requirement for a platform that balances the demands of both learners and educators, ensuring ease of use for students while providing robust tools for instructors to deliver effective teaching.

Type of Educational Institution (Question 4):

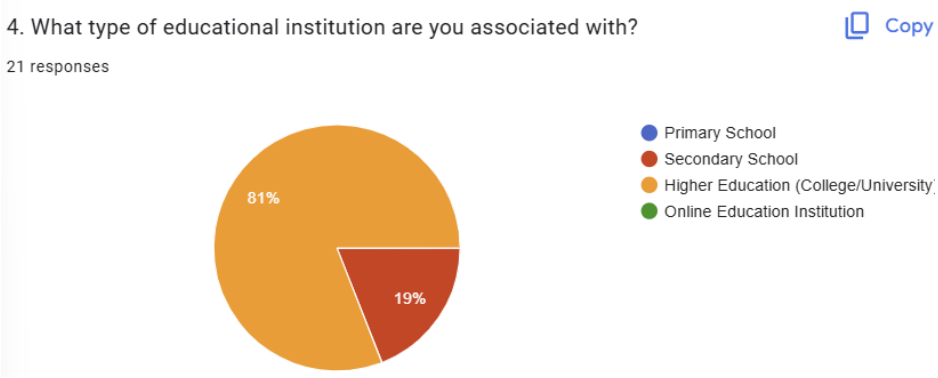


Figure 3.2.3 - Pie Chart of Educational Institution Type

81% of respondents are associated with higher education (college/university), while 19% are from secondary schools. This aligns with the project scope as the platform would primarily focus on students and instructors/lecturers at all education levels (e.g., elementary, secondary, higher education, etc.).

Frequency of Using Online Learning Platforms (Question 5):

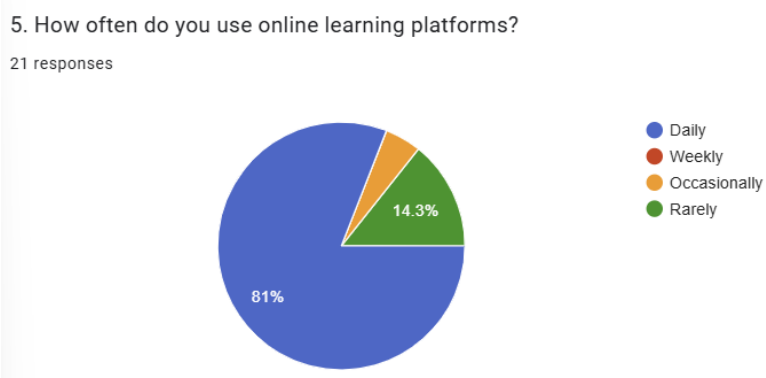


Figure 3.2.4 - Pie Chart Regarding the Frequency of Using Online Learning Platforms

81% of respondents use online learning platforms daily, indicating a high reliance on these tools. This justifies the need for a reliable, user-friendly platform that can handle frequent use without performance issues.

Platforms Used (Question 6):

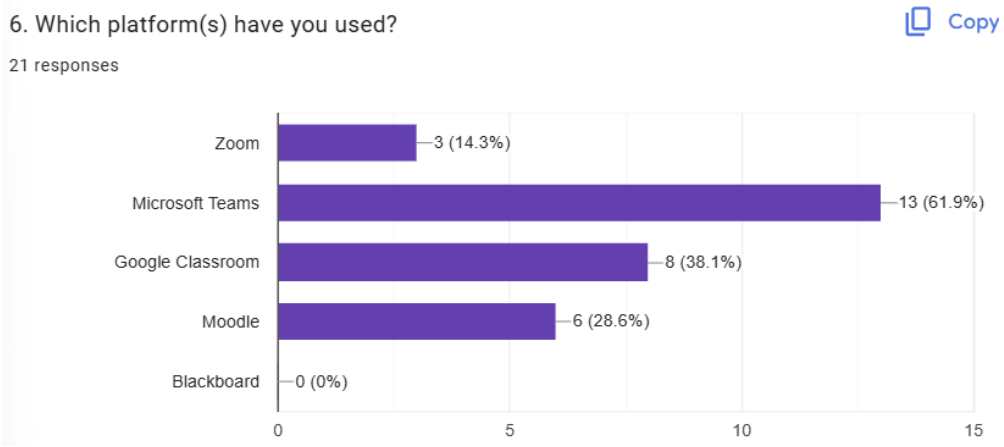


Figure 3.2.5 - Bar Graph of Platforms Used

Microsoft Teams (61.9%) and Google Classroom (38.1%) are the most commonly used platforms, followed by Moodle (28.6%) and Zoom (14.3%). This suggests that users are familiar with mainstream platforms but may be seeking more specialized features, such as enhanced real-time collaboration, which current platforms lack.

Devices Used for Online Learning (Question 7):

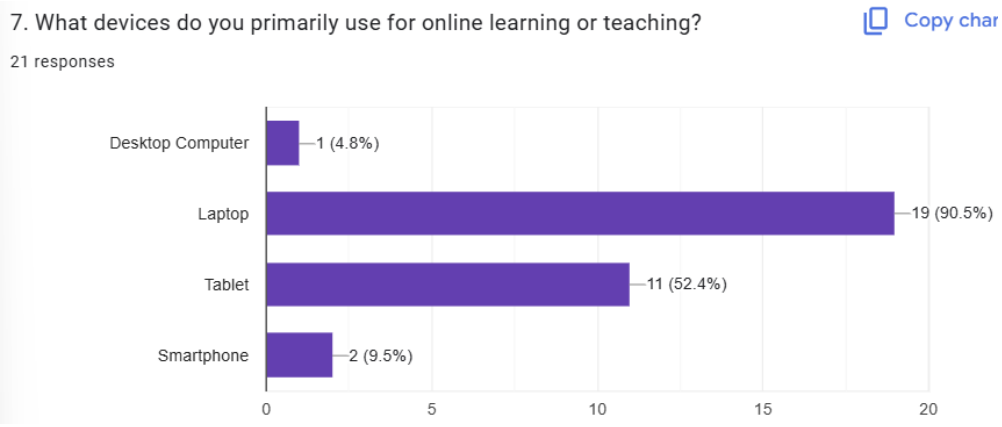


Figure 3.2.6 – Bar Graph of Devices Used for Online Education

90.5% of respondents primarily use laptops, followed by tablets (52.4%) and smartphones (9.5%). This indicates that the platform should be optimized for laptops but also ensure compatibility with tablets and smartphones for a seamless cross-device experience.

3.2.1.2 Section 2 - Overall Feedback on Current Virtual Classroom Platforms

Satisfaction with Real-Time Collaboration Features (Question 8):

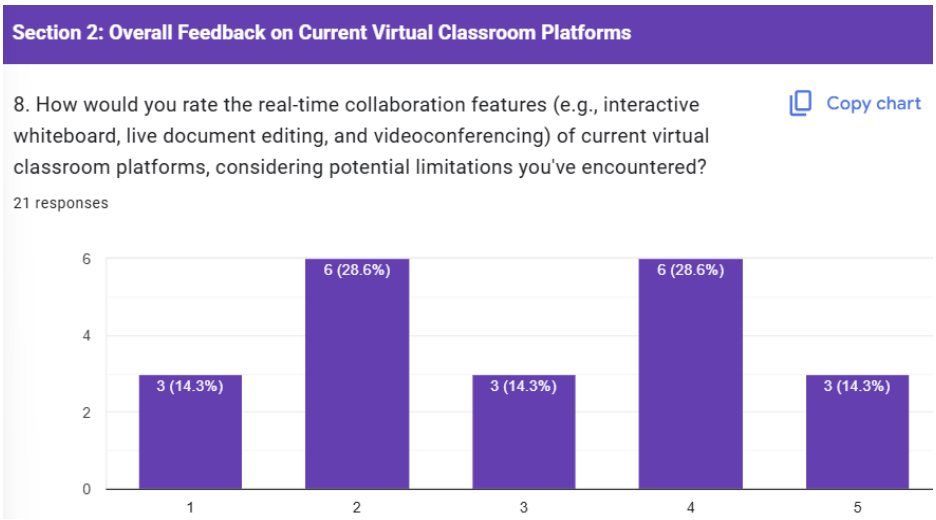


Figure 3.2.7 – Bar Graph of Satisfaction with Real-Time Collaboration Features

While total of 42.9% (28.6% + 14.3%) of respondents rate the real-time collaboration features highly, another 42.9% (28.6% + 14.3%) rate them poorly, indicating mixed satisfaction. This justifies the need for improved real-time collaboration tools (e.g., interactive whiteboard, live document editing, and videoconferencing) in the proposed platform to address the dissatisfaction of a significant portion of users.

Support for Student Engagement and Participation (Question 9):

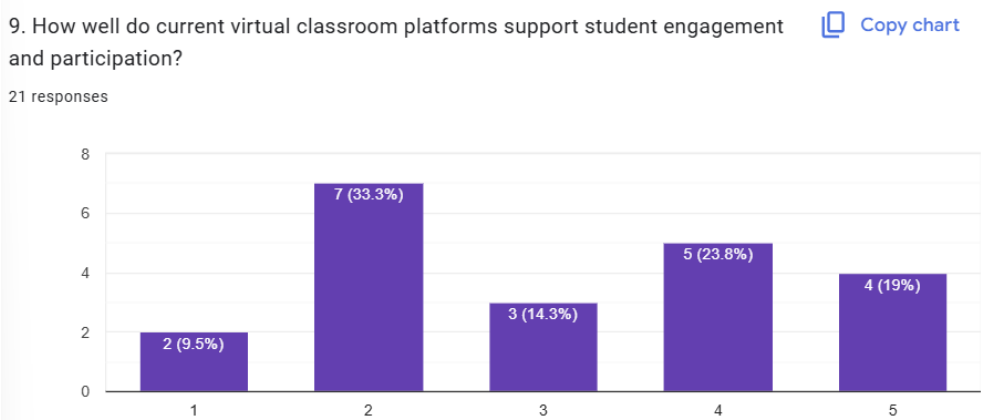


Figure 3.2.8 – Bar Graph of Student Engagement and Participation

42.8% (23.8% + 19%) of respondents rate the student engagement support as high, but also 42.8% (33.3% + 9.5%) rate it poorly. This suggests that current platforms struggle to maintain consistent engagement, highlighting the need for more interactive and engaging features in the proposed solution.

Desired Improvements in Online Learning Platforms (Question 10):

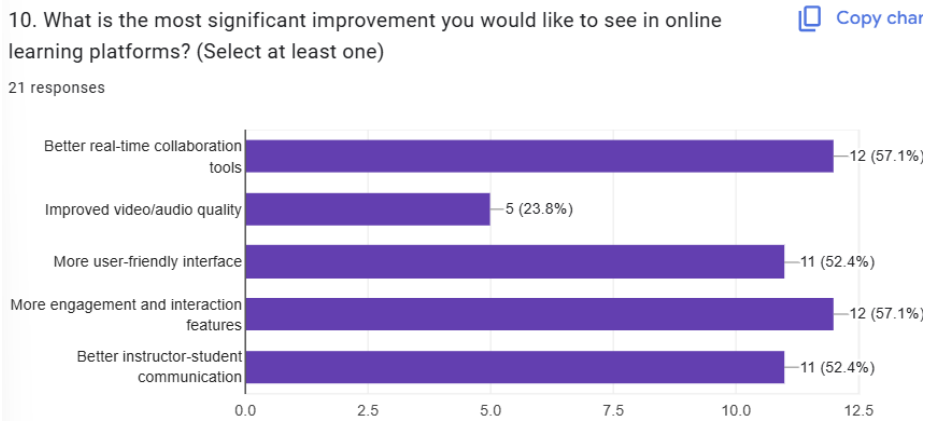


Figure 3.2.9 – Bar Graph of Desired Improvements in Online Learning Platforms

The most requested improvements are better real-time collaboration tools and more engagement and interaction features (57.1%), user-friendly interface and better instructor-student communication (52.4%). These responses align with the project's objectives to enhance interactivity and collaboration.

Likelihood to Adopt a Platform with Strong Real-Time Collaboration Features (Question 11):

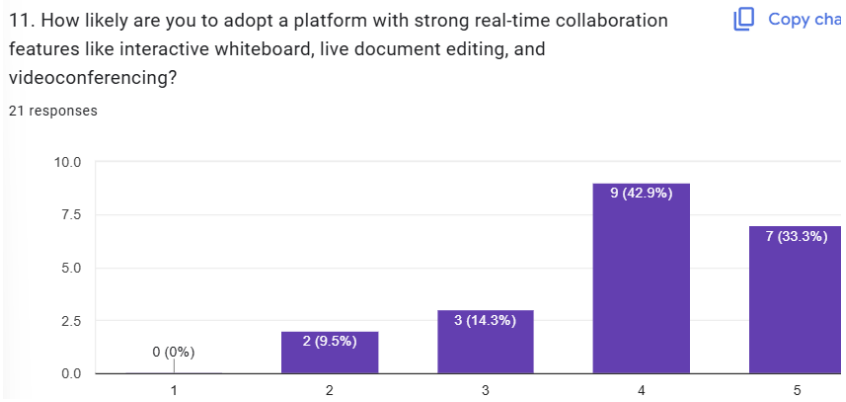


Figure 3.2.10 – Bar Graph of Likelihood to Adopt a Platform with Strong Real-Time Collaboration Features

76.2% (42.9% + 33.3%) of respondents are very likely to adopt a platform with strong real-time collaboration features, indicating a strong demand for such tools. This supports the integration of features like interactive whiteboards, live document editing and videoconferencing.

Importance of an Intuitive Interface (Question 12):

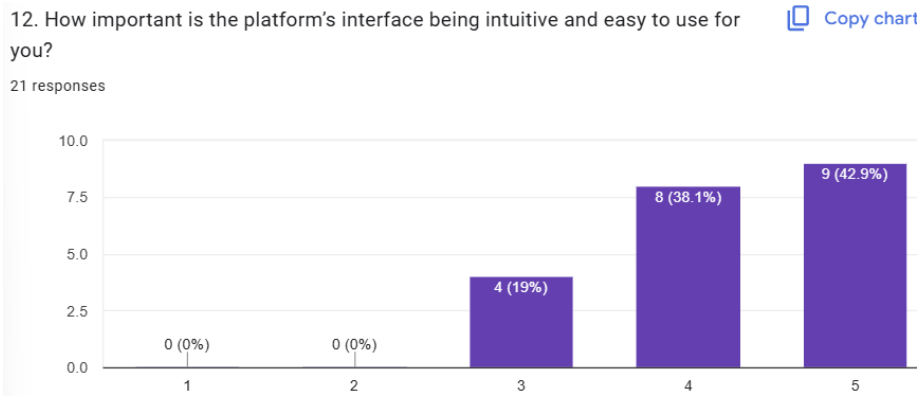


Figure 3.2.11 – Bar Graph Regarding the Importance of Intuitive Interface

81% (42.9% + 38.1%) of respondents consider an intuitive interface very important, emphasizing the need for a user-friendly design that caters to users with varying levels of technical expertise.

Satisfaction with Platform Performance (Question 13):

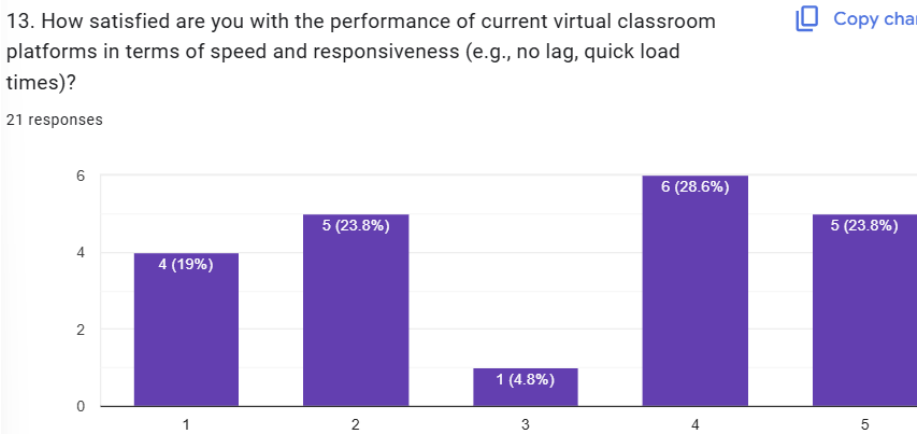


Figure 3.2.12 – Bar Graph of Satisfaction with Platform Performance

While 52.64% (28.6% + 23.8%) of respondents are satisfied with platform performance, another 42.8% (23.8% + 19%) are not, indicating room for improvement in speed and responsiveness. This justifies the need for a platform that minimizes lag and ensures quick load times.

Platform Stability During Live Sessions (Question 14):

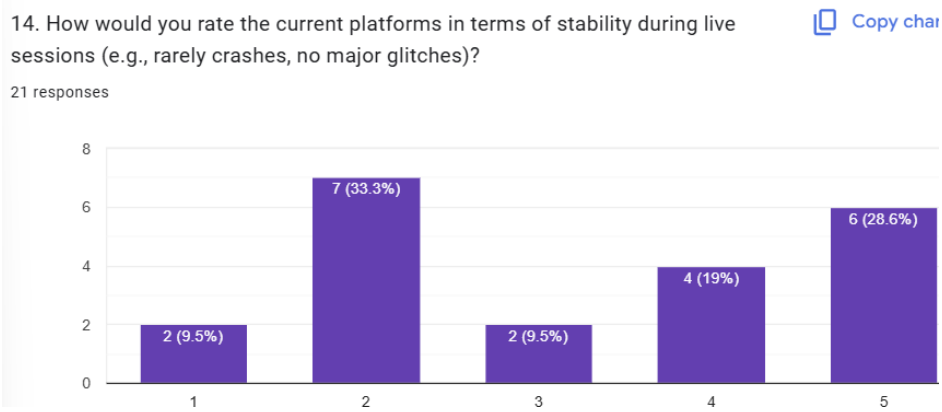


Figure 3.2.13 – Bar Graph of Platform Stability During Live Sessions

47.6% (19% + 28.6%) of respondents rate the platform stability as high, but 42.8% (9.5% + 33.3%) report issues, highlighting the need for a more reliable platform that minimizes crashes and glitches during live sessions.

3.2.1.3 Section 3 - Current Challenges in Online Learning and Teaching

Biggest Challenges with Current Platforms (Question 15):

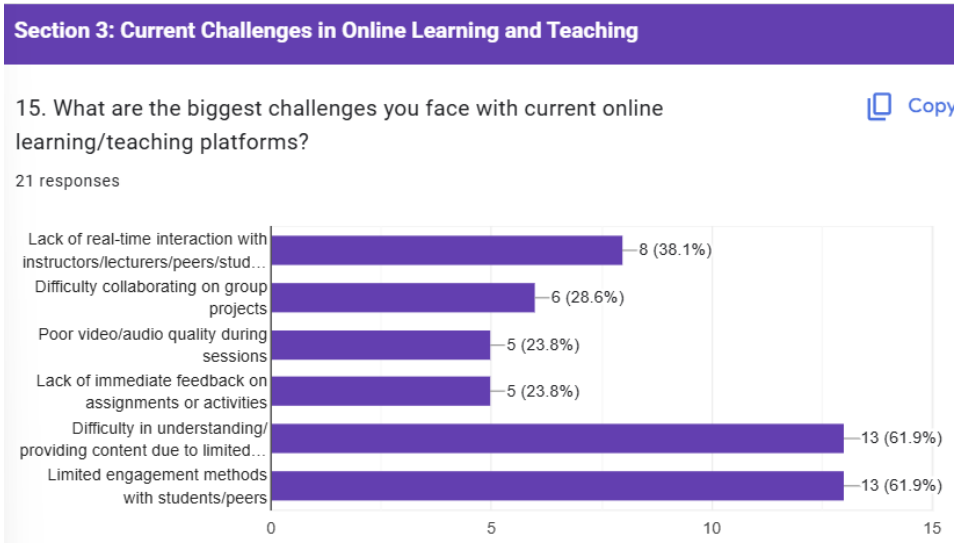


Figure 3.2.14 – Bar Graph of Biggest Challenges with Current Platforms

High rated key challenges are lack of real-time interaction (38.1%), limited interactive tools (61.9%), and limited engagement methods with others (61.9%). These issues justify the need for a platform that addresses these pain points through better collaboration tools and technical reliability.

Challenges in Real-Time Collaboration (Question 16):

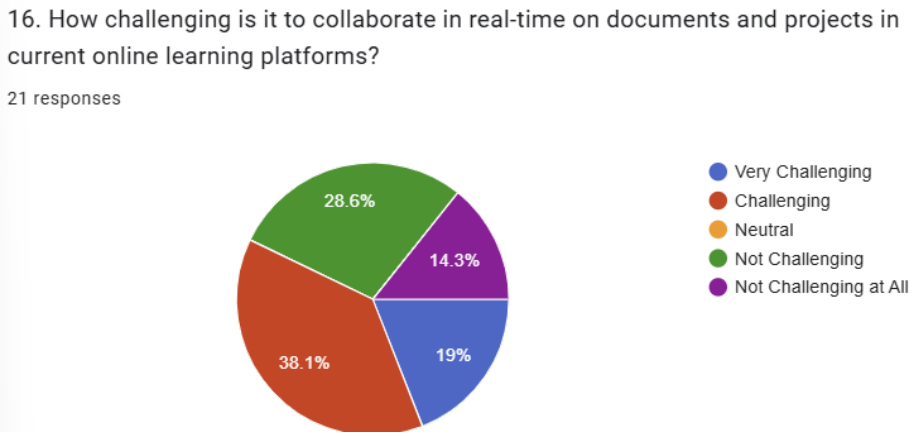


Figure 3.2.15 – Pie Chart of Challenges in Real-Time Collaboration

While 42.9% (28.6% + 14.3%) of respondents find real-time collaboration not challenging, 57.1% (19% + 38.1%) find it challenging. This indicates that while many users are comfortable with current tools, there is still a significant portion who struggle, justifying the need for more intuitive collaboration features.

Challenges with Interactive Tools (Question 17):

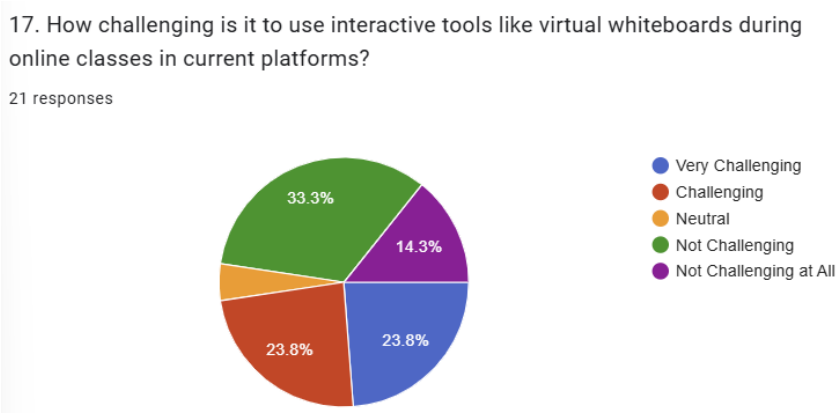


Figure 3.2.16 – Pie Chart of Challenges with Interactive Tools

47.6% (23.8% + 23.8%) of respondents find interactive tools very challenging, but also 47.6% (33.3% + 14.3%) find them not challenging. This mixed feedback suggests the need for more easy to use and efficient interactive tools in the proposed platform.

Feedback Challenges (Question 18):

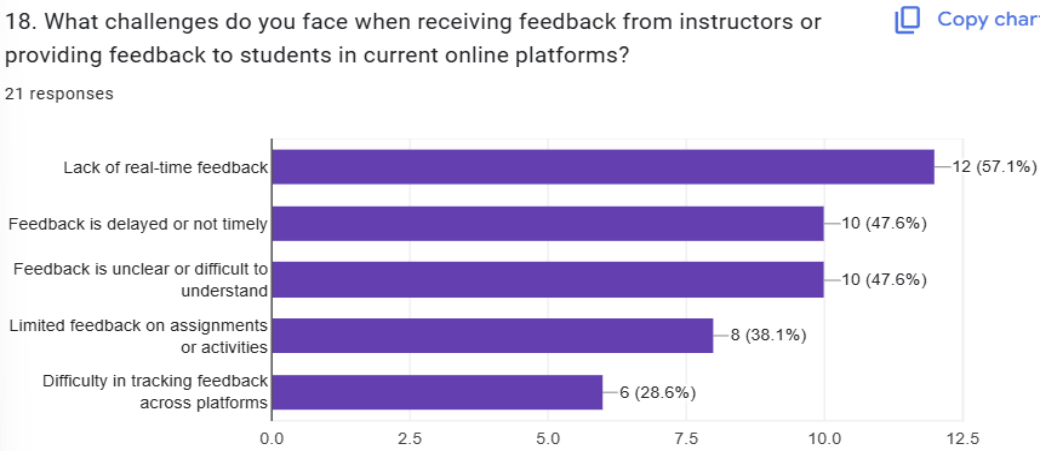


Figure 3.2.17 – Bar Graph of Feedback Challenges

57.1% of respondents face challenges with lack of real-time feedback, highlighting the need for real-time feedback mechanisms in the proposed platform to enhance the learning experience.

Interaction Challenges Outside Scheduled Classes (Question 19):

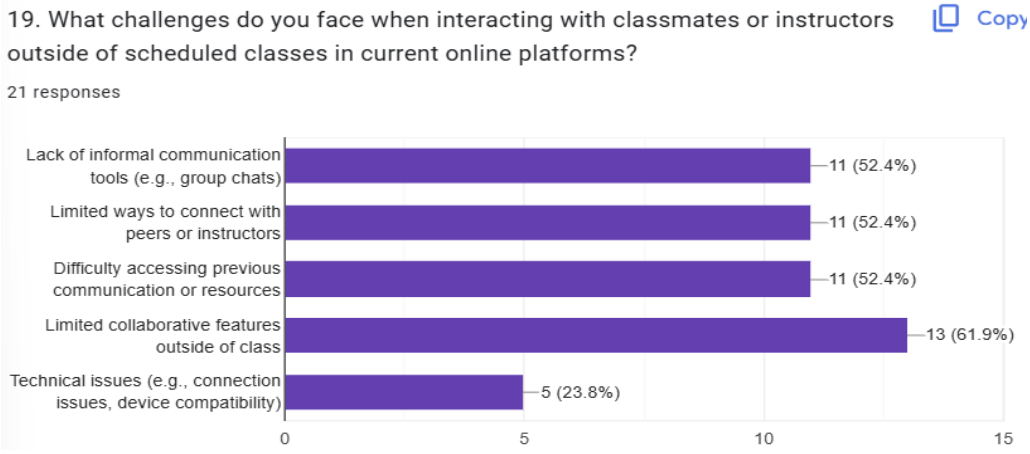


Figure 3.2.18 – Bar Graph of Interaction Challenges Outside Scheduled Classes

More than half of respondents face challenges with limited collaborative features outside of class, lack/limited ways of informal communication tools, and difficulty in accessing previous communication or resources. This justifies the inclusion of group chats and file-sharing tools to foster peer interaction beyond formal sessions.

Frequency of Technical Issues (Question 20):

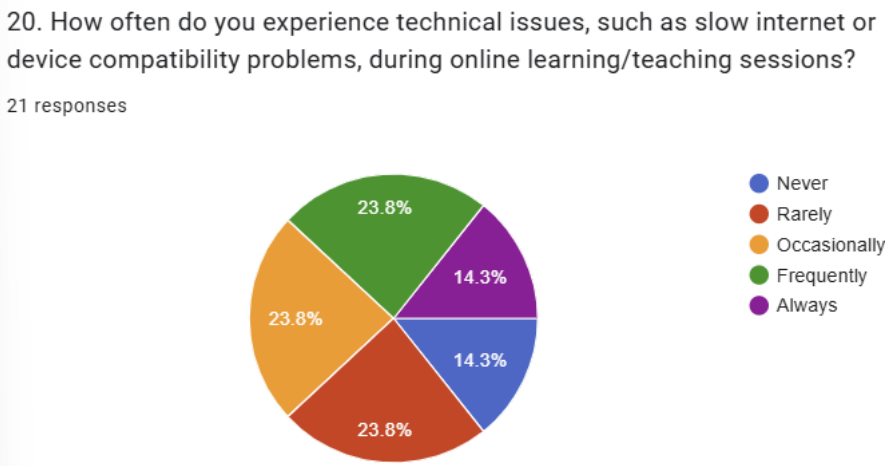


Figure 3.2.19 – Pie Chart Regarding the Frequency of Technical Issues

There are 14.3% of respondents always experience technical issues, and 23.8% frequently. This indicates the need for a more stable and reliable platform to minimize disruptions during online learning.

3.2.1.4 Section 4 - Desired Features for a Virtual Classroom Platform

Desired Features (Question 21):

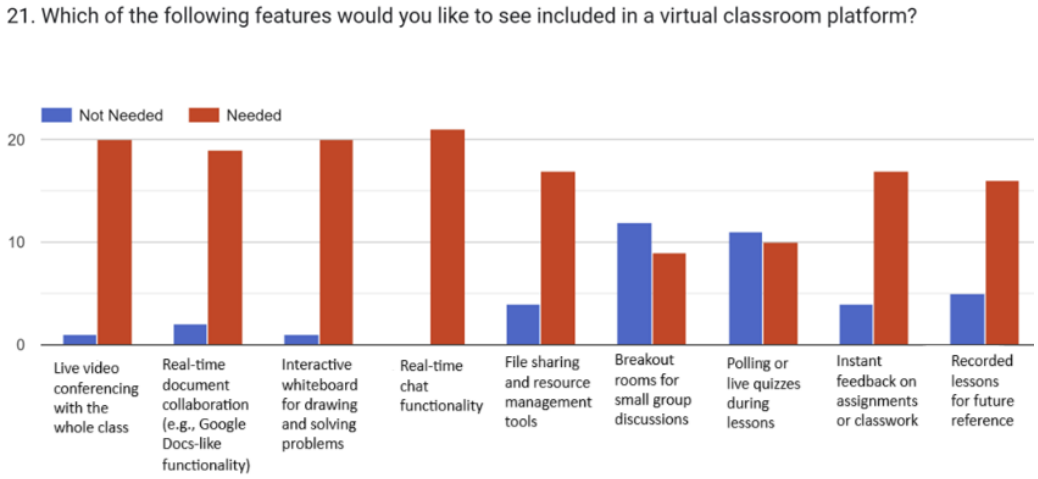


Figure 3.2.20 – Bar Graph Regarding the Desired Features for Proposed Solution

Features like videoconferencing, interactive whiteboards, real-time document collaborating, real-time group chat, file sharing, instant feedback, and recorded lessons are highly desired, aligning with the project's focus on integrating these tools to enhance the learning experience.

Importance of Synchronous and Asynchronous Learning Options (Question 22):

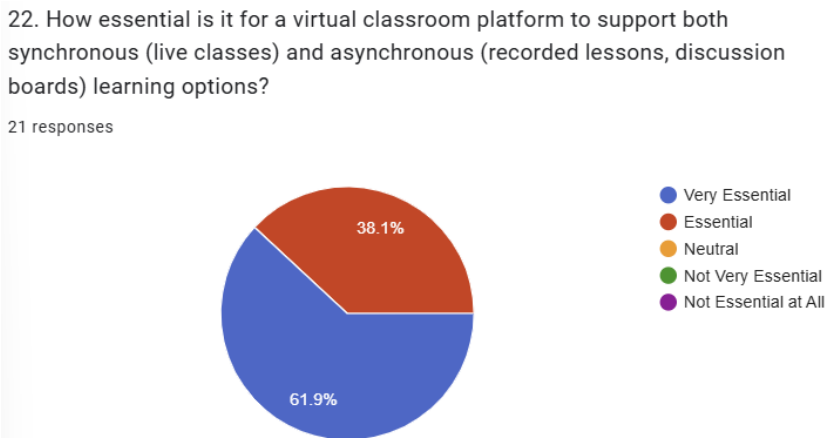


Figure 3.2.21 – Pie Chart Regarding the Importance of Synchronous and Asynchronous Learning Options

All of the respondents find it essential to support both synchronous and asynchronous learning, justifying the inclusion of both live classes and recorded lessons in the proposed platform.

Importance of High-Quality Video/Audio in Low-Bandwidth Conditions (Question 23):

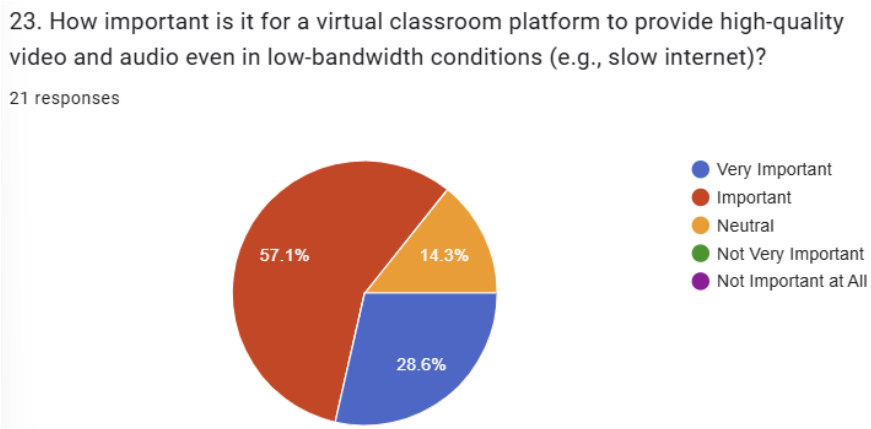


Figure 3.2.22 – Pie Chart Regarding the Importance of High-Quality Video/Audio in Low-Bandwidth Conditions

85.7% (57.1% + 28.6%) of respondents consider high-quality video/audio in low-bandwidth conditions very important, supporting the objective of ensuring the platform is accessible even with limited internet resources.

Importance of User Authentication Features (Question 24):

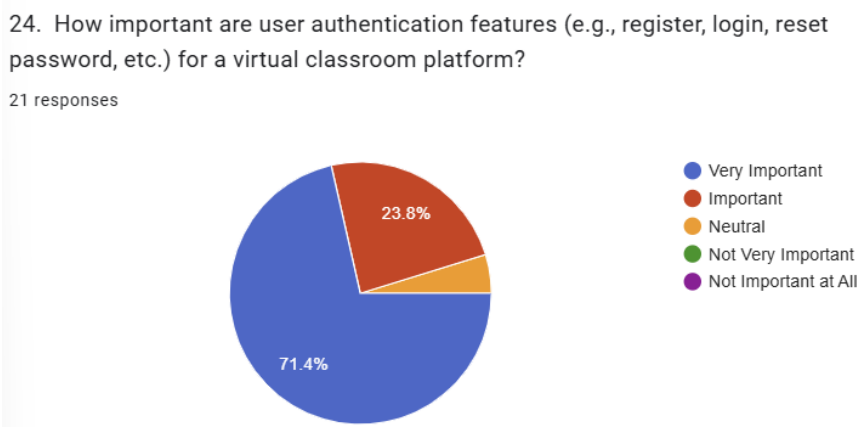


Figure 3.2.23 – Pie Chart Regarding the Importance of User Authentication Features

Almost all of the respondents find user authentication features e.g., register, login, reset password, etc.) are critical part of the virtual classroom platform, supporting the implementation to secure their information.

Use of Interactive Whiteboard (Question 25):

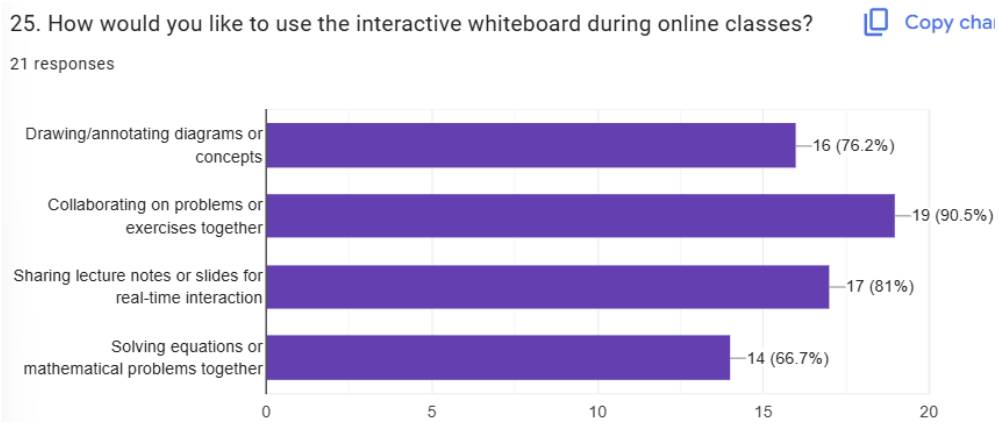


Figure 3.2.24 – Bar Graph Regarding the Use of Interactive Whiteboard

This bar chart indicates that majority of respondents want to use the interactive whiteboard for several purposes. This supports the integration of interactive whiteboard with multiple functions to meet the users' needs.

Use of Videoconferencing (Question 26):

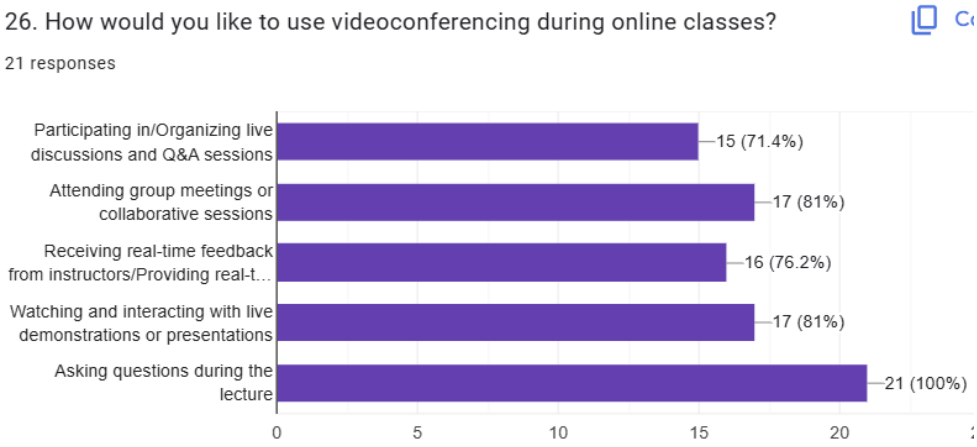


Figure 3.2.25 – Bar Graph Regarding the Use of Videoconferencing

This bar chart indicates that majority of respondents want to use the videoconferencing feature for several purposes. This supports the integration of videoconferencing feature with multiple functions to meet the users' needs.

Use of Real-Time Document Collaboration (Question 27):

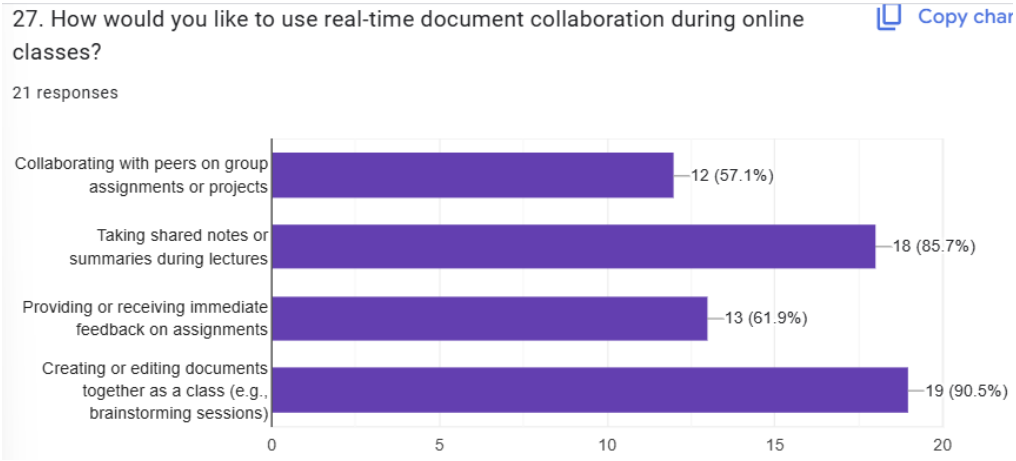


Figure 3.2.26 – Bar Graph Regarding the Use of Real-Time Document Collaboration

This bar chart indicates that majority of respondents want to use the online document collaboration feature for several purposes. This supports the integration of online document collaboration feature with multiple functions to meet the users' needs.

Importance of Accessibility on Various Devices (Question 28):

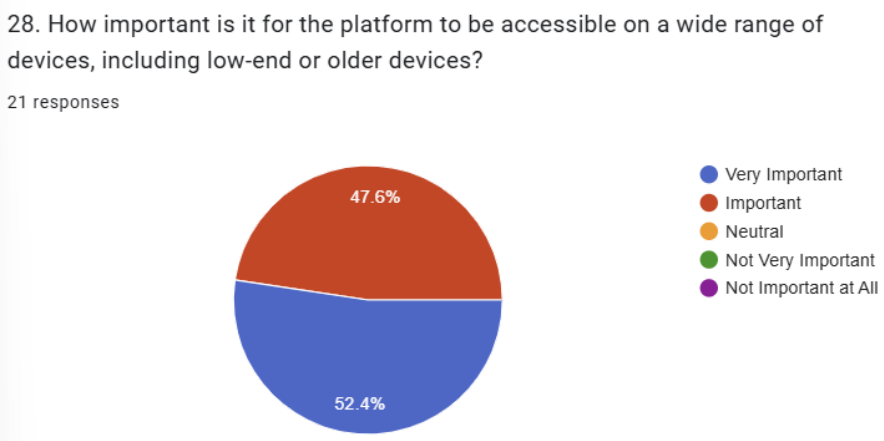


Figure 3.2.27 – Pie Chart Regarding the Importance of Accessibility on Various Devices

All of the respondents consider it very important for the platform to be accessible on a wide range of devices, aligning with the objective of ensuring the platform is inclusive and accessible to users with varying technological resources.

3.2.1.5 Section 5 - Collaboration and Peer Interaction

Importance of Peer-to-Peer Interaction (Question 29):

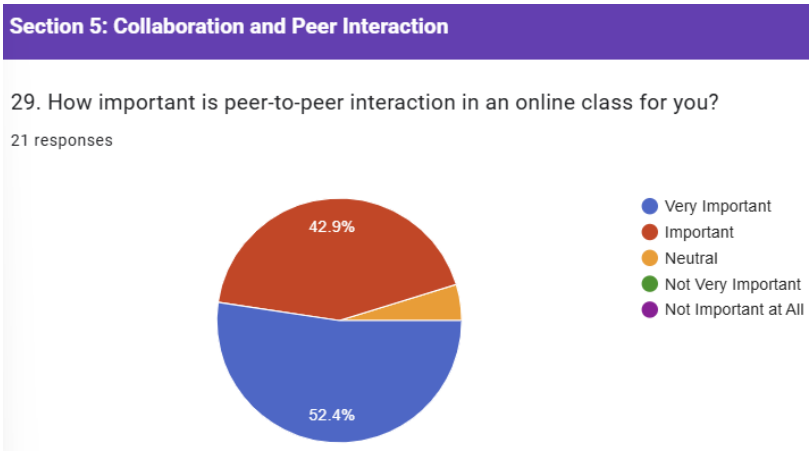


Figure 3.2.28 – Pie Chart Regarding the Importance of Peer-to-Peer Interaction

Majority of respondents consider peer-to-peer interaction very important, supporting the inclusion of features that facilitate peer interaction, such as group chats and other collaborative tools.

Frequency of Group Activities (Question 30):

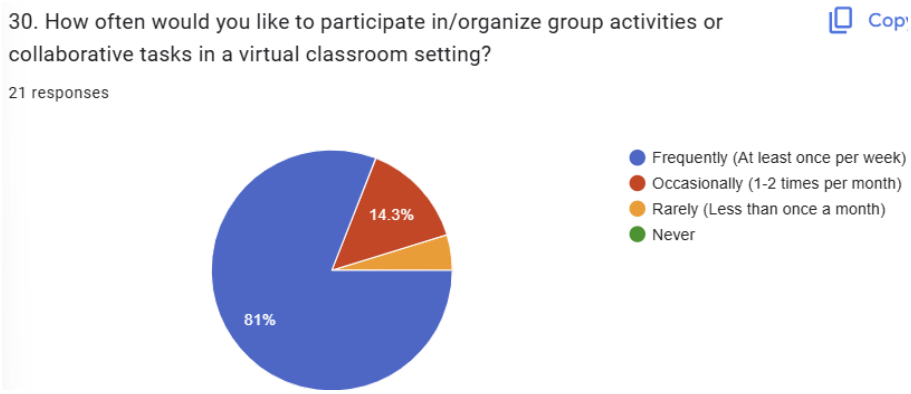


Figure 3.2.29 – Pie Chart Regarding the Frequency of Group Activities

81% of respondents would like to participate in group activities frequently, highlighting the need for robust collaboration features to support regular group work and interaction.

Platform Scalability for Collaboration (Question 31):

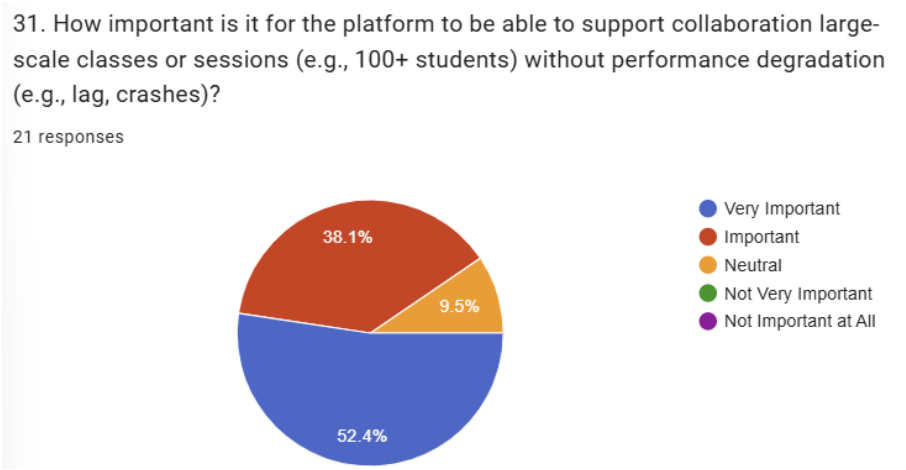


Figure 3.2.30 – Pie Chart Regarding the Platform Scalability for Collaboration

90.5% (38.1% + 52.4%) of the respondents think that platform with high scalability without any performance degradation is important. This indicates the development of the platform to support collaboration for large-scale classes.

Features Encouraging Peer Engagement (Question 32):

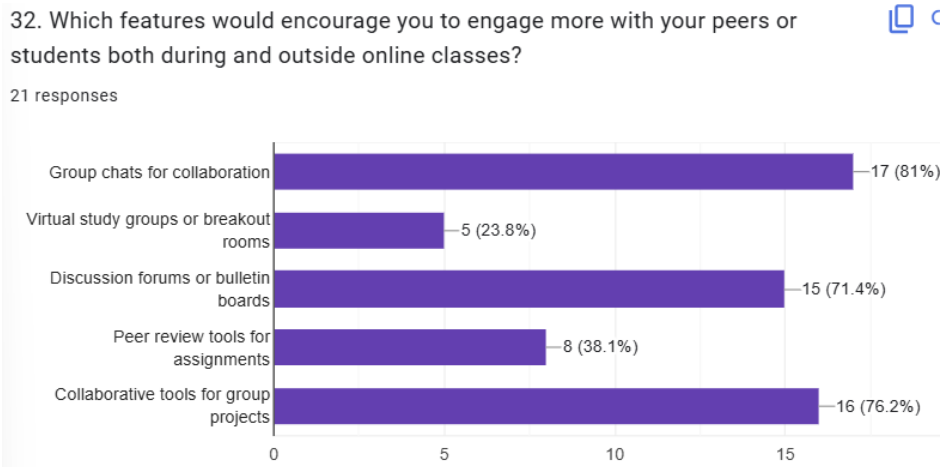


Figure 3.2.31 – Bar Graph Regarding the Features that Encourage Peer Engagement

Group chats (81%), collaborative tools for group projects (76.2%) and discussion forums (71.4%) are highly desired, justifying the inclusion of these features to foster a collaborative learning environment.

Expected Feedback in Online Learning (Question 33):

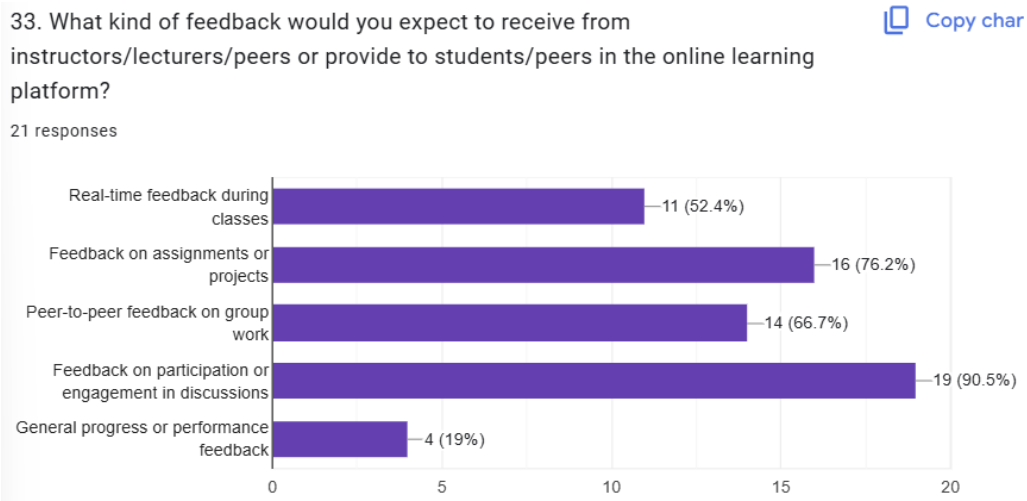


Figure 3.2.32 – Bar Graph Regarding the Expected Feedback in Online Learning

More than half of the respondents expect feedback on participation, assignments, group works, and during classes. These highlighting the need for real-time and comprehensive feedback mechanisms in the proposed platform.

3.2.2 Conclusion of the Users' Requirements Analysis

The insights from the user requirement questionnaire clearly justify the need for a virtual classroom platform that addresses the limitations of current solutions.

3.2.2.1 Functional Requirements

The platform must provide real-time collaboration tools that include an interactive whiteboard, allowing users to engage in live, collaborative activities during lessons. Additionally, real-time document collaboration should be supported, enabling students and instructors to work together on shared documents simultaneously. Videoconferencing is another essential feature, with capabilities for high-quality video/audio, and screen sharing.

For peer interaction and collaboration, the platform needs to include real-time group chat and instant feedback features, allowing students to interact with each other and instructors. The system must also support file sharing capabilities, ensuring that users can easily upload and exchange resources, such as presentations, documents, and assignments. Additionally, the platform should incorporate a quiz feature that enables instructors to create and assign quizzes for students to complete, facilitating knowledge checks, reinforcing learning, and promoting engagement.

Finally, the platform must support both synchronous and asynchronous learning. This includes live sessions for real-time interaction and recorded lessons for students to access at their own pace, ensuring flexibility and meeting the diverse needs of learners.

3.2.2.2 Non-Functional Requirements

The proposed Virtual Classroom Platform needs to be designed to accommodate the diverse requirements of both students and instructors, as identified in the questionnaire. The platform must ensure usability by providing an intuitive interface that is simple to operate for users of varying technical expertise. In terms of performance, the platform should have low latency and high responsiveness, especially during live sessions, to avoid delays or disruptions. Additionally, the platform must be capable of scaling to handle large numbers of concurrent users without experiencing performance issues.

For reliability and stability, the platform needs to be robust, with high stability during live interactions. It should also minimize technical issues, ensuring consistent and smooth operation across different devices and conditions. The platform must meet security requirements by implementing strong user authentication features, such as secure login, registration, and password recovery processes.

In terms of accessibility, the platform should maintain the same quality of video and audio even in low-bandwidth conditions, making it accessible to users in varied network environments. At last, the platform should also facilitate effective feedback mechanisms, providing instructors and students with real-time feedback and evaluation tools during and after sessions. This will enable more interactive and responsive learning experiences.

3.3 Timeline

The Final Year Project (FYP), titled Virtual Classroom Platform with Real-time Collaboration Features, follows a structured timeline across two semesters. In the first semester (shown in Figure 3.4.1), the project begins with Planning phase (Week 1 – Week 3), covering project scope, objectives, literature review, and proposed solutions. This is followed by Designing phase (Week 3 – Week 5), where system specifications and design are developed. The Developing phase (Week 5 – Week 9) focuses on front-end and back-end development, leading to the creation of a Minimum Viable Product (MVP). Testing phase (Week 9 – Week 12) involves MVP review, updates, and final testing, concluding with Closing phase (Week 12), where the system is submitted and delivered. In the second semester (shown in Figure 3.4.2), the project undergoes refinement, starting with Planning (For Refinement) phase (Week 1 – Week 2), followed by Designing (For Refinement) phase (Week 2 – Week 3). The Implementing phase (Week 3 – Week 11) focuses on system implementation which leads to a comprehensive platform, while Evaluating phase (Week 11 – Week 13) includes testing, updates, and final results of the overall system. The project concludes with Closing (Week 13), where the final version of the system is submitted and delivered.

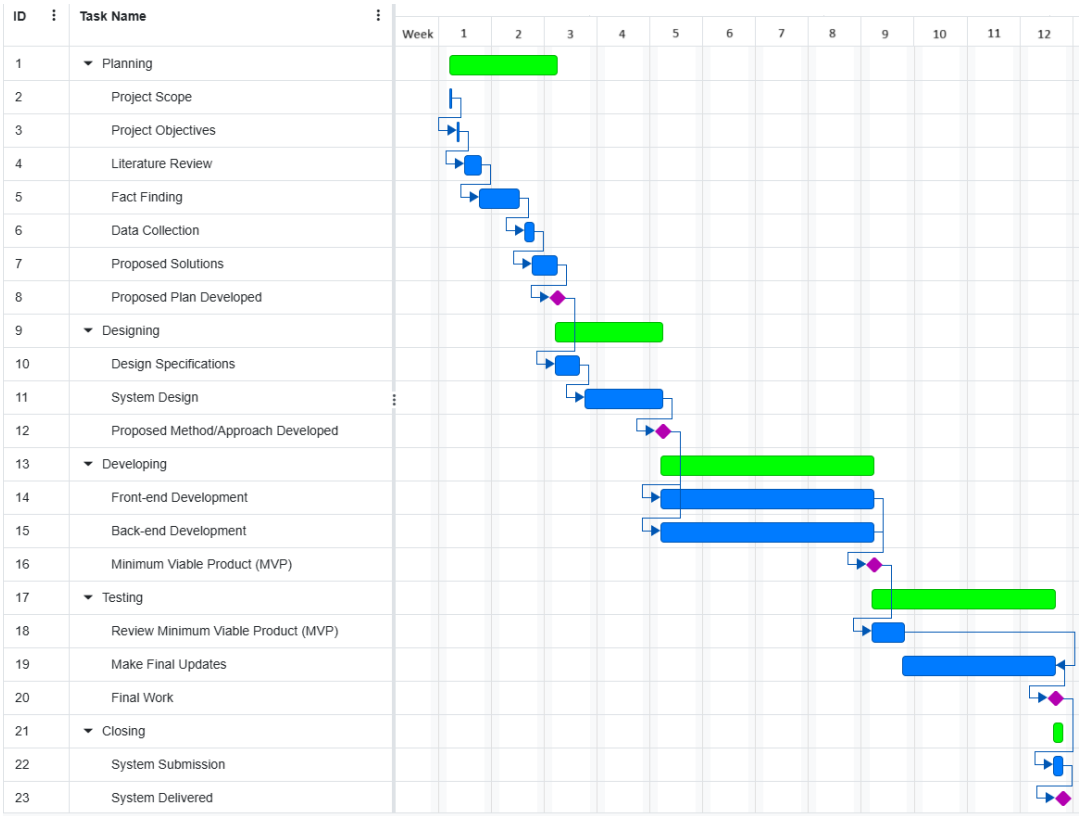


Figure 3.3.1 – Gantt Chart of Final Year Project 1 (FYP 1) Timeline

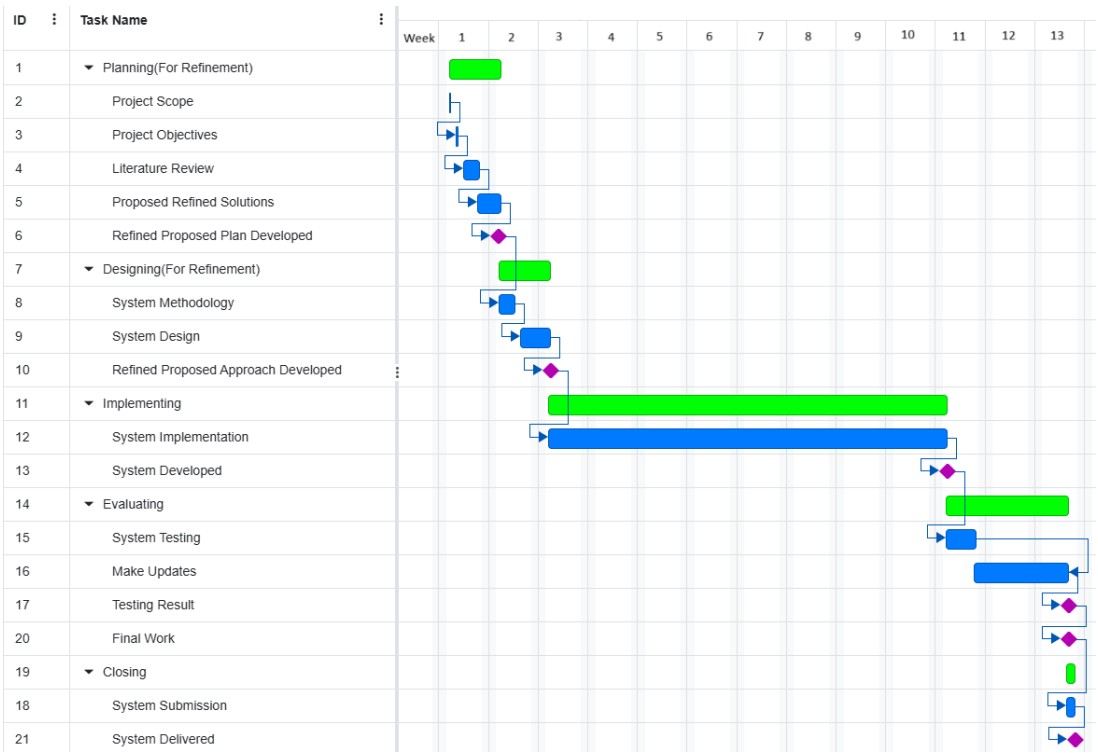


Figure 3.3.2 – Gantt Chart of Final Year Project 2 (FYP 2) Timeline

CHAPTER 4

System Design

4.1 System Architecture Diagram and Description

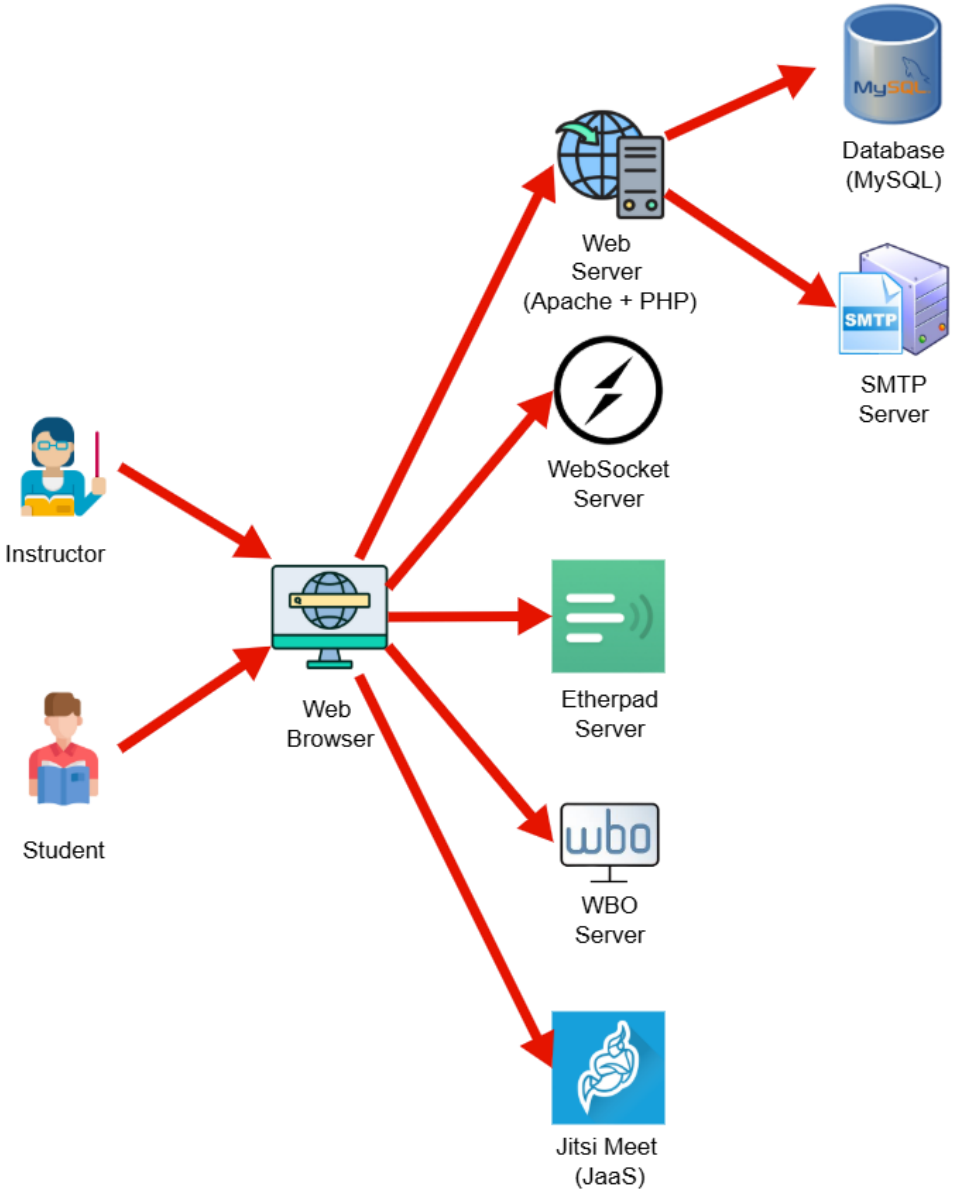


Figure 4.1.1 – System Architecture Diagram

The Virtual Classroom Platform's system architecture is designed to provide a scalable, interactive, and user-friendly online learning environment. The frontend, accessible through modern web browsers such as Chrome, Edge, Firefox, and Safari, is built with HTML, CSS, and JavaScript, delivering an engaging user interface. It communicates with backend services via HTTP and Socket.IO-based real-time connections, and embeds external collaboration tools directly into the classroom interface. The core backend, powered by an Apache web server with PHP, handles user authentication, class management, profile updates, and other server-side logic, serving static frontend files and processing dynamic requests. A MySQL relational database efficiently stores and manages user profiles, class details, posts, comments, and collaboration content. Real-time features, including group chat and live updates, are enabled by a Node.js server using Socket.IO for bi-directional communication. Collaboration tools include a self-hosted Etherpad server for real-time document editing, a WBO server for interactive whiteboarding, and Jitsi Meet (JaaS) for cloud-based video conferencing, all embedded in the frontend via iframes and APIs. Email functionalities, such as notifications and password recovery, are managed by the PHP application using PHPMailer, which connects to an external SMTP server. This modular architecture ensures cross-browser compatibility, efficient data management, and a cohesive virtual learning experience across devices.

4.2 Block Diagrams and Description

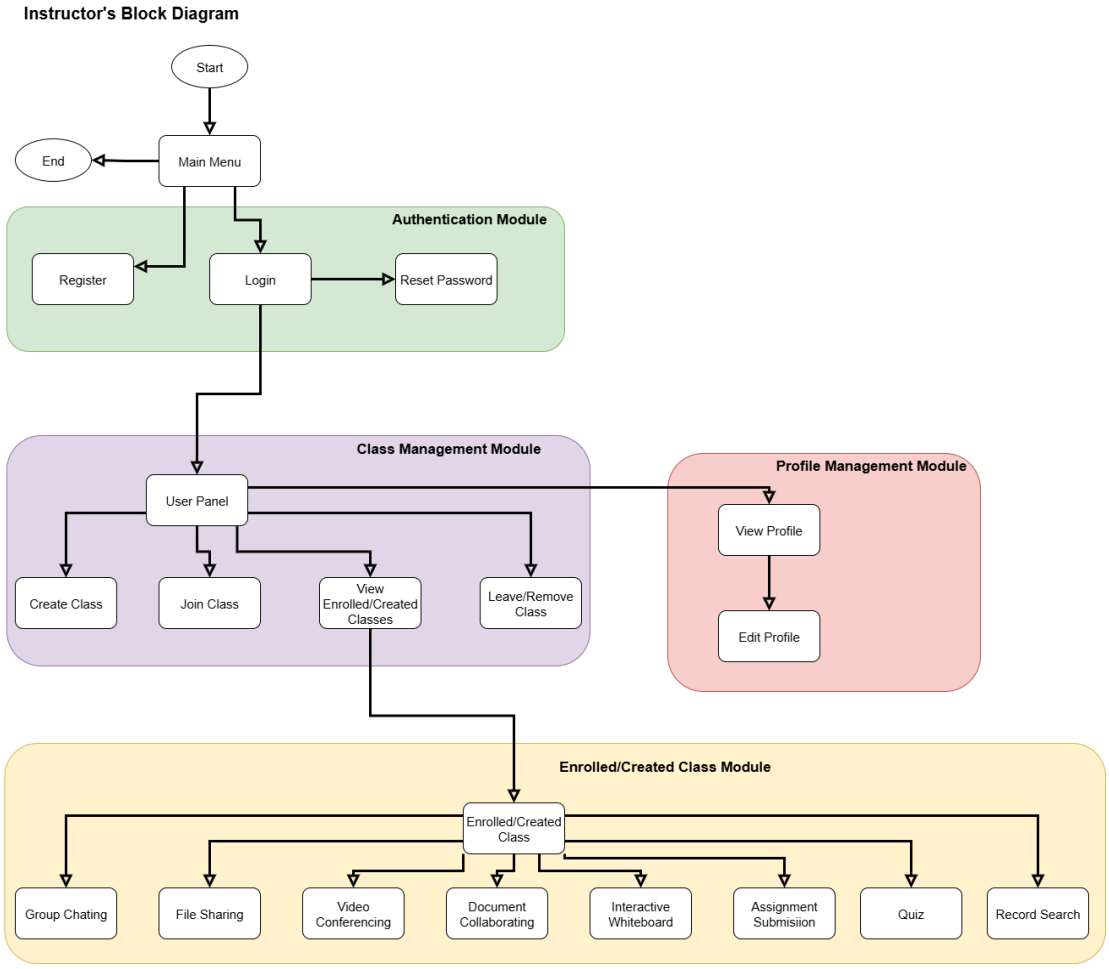


Figure 4.2.1 – Block Diagram for Instructor

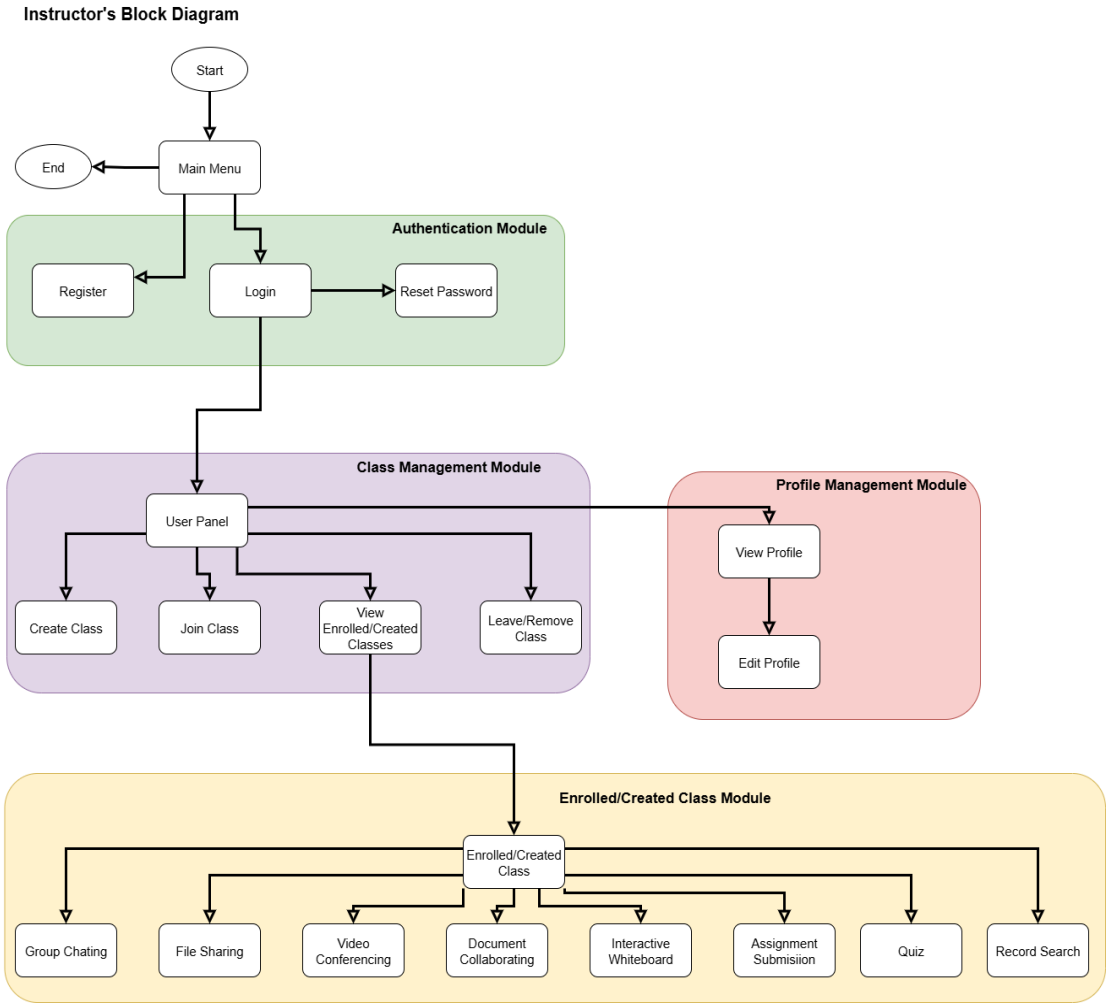


Figure 4.2.2 – Block Diagram for Student

These block diagrams outline the architecture of a virtual classroom platform, structured around four core modules, which are Authentication, Class Management, Profile Management, and Enrolled/Created Classroom. The system begins at the Main Menu, where users can Register, Login, or Quit. Once authenticated, users are taken to the User Panel, which acts as the central hub for accessing the platform's features. In the Class Management module, instructors (Figure 4.2.1) have the ability to create, join, remove/leave, or view enrolled/created classes, while students (Figure 4.2.2) can do the same except create and remove classes, reflecting their distinct roles. The Profile Management module allows users to view or edit their personal details, supporting profile customization and maintenance. The Enrolled/Created Classroom module offers a suite of interactive features accessible to both students and instructors, including live video conferencing, real-time document collaboration, interactive whiteboarding, group chat, file sharing, assignment submission, quiz, and record search, fostering seamless communication and teamwork. These block diagrams effectively capture the platform's modular design and logical flow, providing a clear and comprehensive overview of its functionality and structure.

4.3 Use Case Diagram and Description

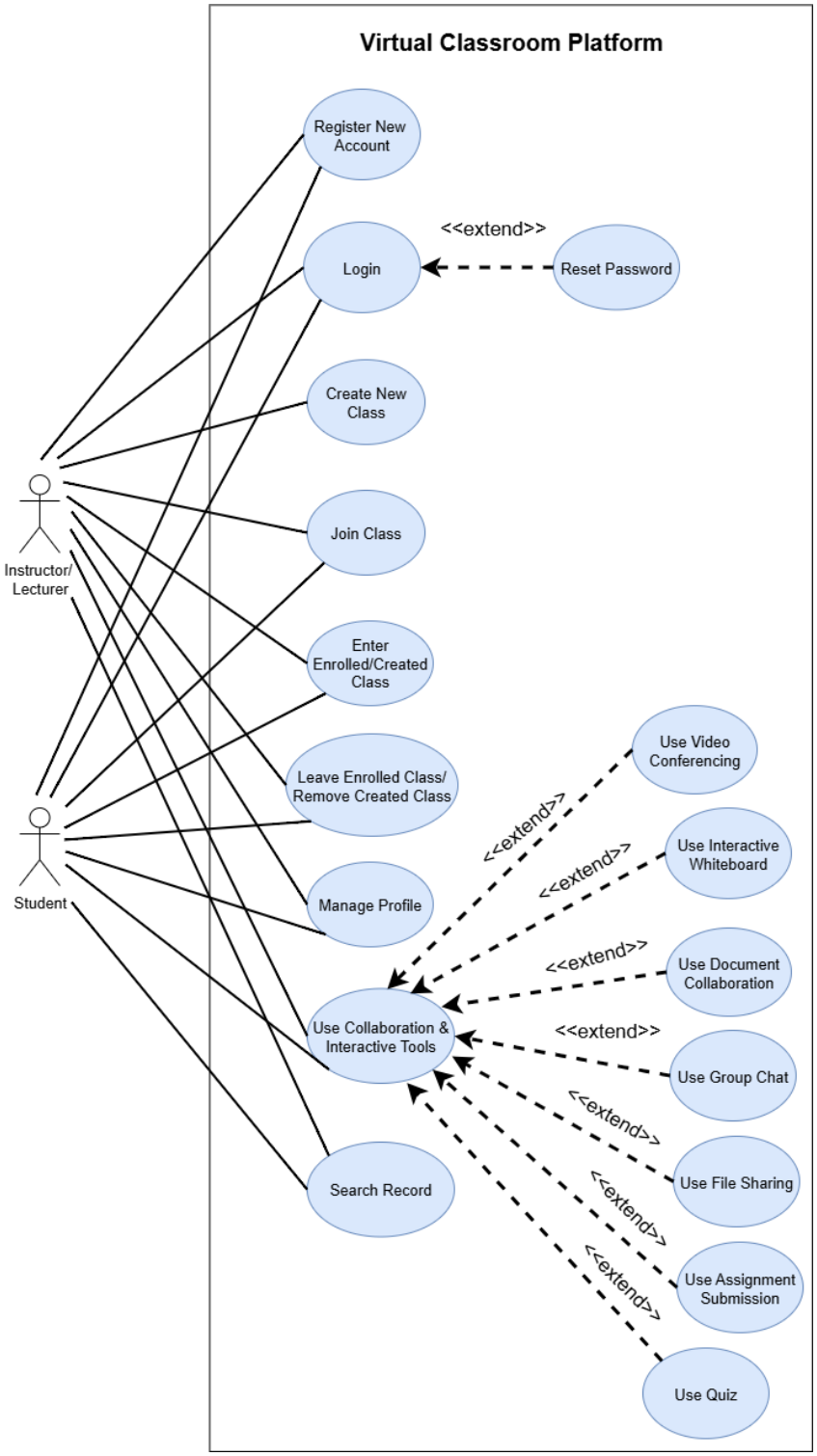


Figure 4.3.1 – Use Case Diagram

Use Case Name	**Actors Involved**	**Description**	**Preconditions**	**Main Flow**	**Alternate Flows**	**Relationships**
Register	Student, Instructor	Allows users to create a new account.	User is not registered.	User provides the required information and submits the form.	If there are any invalid inputs, the user must correct and resubmit.	-
Login	Student, Instructor	Verify users into the system.	User is registered.	User enters credentials and accesses the user panel.	If there are any invalid credentials, the system will prompt retry.	Extends: Reset Password
Reset Password	Student, Instructor	Helps users reset forgotten credentials.	User has forgotten password.	The system sends the user a link to alter their password once they insert their email.	If the email not found, the user will be required to retry.	Extended in: Login
Create Class	Instructor	User creates a new class for others to join.	The user has entered the user panel after logging in.	User provides class details and confirms creation.	If there are invalid details, the user will be required to retry.	-
Join Class	Student, Instructor	User can join existing classes using a class code.	User is logged in and has the class code.	User enters class code and joins class.	If it is an invalid code, the user will be required to retry.	-

Enter Enrolled/ Created Classes	Student, Instructor	Users access classes they have enrolled in or have created.	User is logged in and enrolled in classes.	User selects class from user panel to enter.	If there are no class appearing in the user panel, the system will inform user to either create or join one.	-
Leave Enrolled Class/ Remove Created Class	Student, Instructor	Allows members to leave classes or instructors to delete classes they created.	The user has logged in and is a member of the selected class.	User selects a class to leave or the instructor selects a class to remove, then the system will updates records.	-	-
Manage Profile	Student, Instructor	Allows editing and viewing of personal profile data.	The user has access to the profile section and is logged in.	User views and modifies personal info (e.g., name, email, password, and more).	If there are any invalid inputs, the user will be required to retry.	-
Use Collaboration & Interactive Tools	Student, Instructor	Access collaborative learning tools within an enrolled/created class.	User is on the enrolled/created class page.	User selects and uses desired tools during the session.	-	Includes: Use Video Conferencing, Use Interactive Whiteboard, Use Document Collaboration, Use Group

						Chat, Use File Sharing
Use Video Conferencing	Student, Instructor	Live virtual meetings for class sessions.	User has mic/cam access and is in a live session.	User joins video meeting.	-	Included in: Use Collaboration & Interactive Tools
Use Interactive Whiteboard	Student, Instructor	Visual teaching aid for real-time collaboration .	User is in a live session and the whiteboard is shared.	User opens and interacts with the whiteboard.	-	Included in: Use Collaboration & Interactive Tools
Use Document Collaboration	Student, Instructor	Co-edit documents and learning materials in real-time.	User is in a live session and the document is shared.	User opens shared doc and edits together.	-	Included in: Use Collaboration & Interactive Tools
Use Group Chat	Student, Instructor	In-session messaging between users.	User is on the enrolled /created class page.	User sends and receives messages.	-	Included in: Use Collaboration & Interactive Tools
Use File Sharing	Student, Instructor	Share class materials like PDFs, images, or slides.	User is on the enrolled/ created class page and has file(s) to upload.	User selects and uploads file(s) to the file sharing section.	If user uploads an Unsupported file type, the user will be required to retry.	Included in: Use Collaboration & Interactive Tools
Use Assignment Submission	Student, Instructor	Submit or Receive assignments like PDFs, images, or slides to the related	User is on the enrolled/ created class page and has assignment(s) to	Student selects and uploads assignment(s) to the assignment submission	If user uploads an Unsupported file type, the user will be required to retry.	Included in: Use Collaboration & Interactive Tools

		assignment post.	submit/receive .	section while Instructor opens a submission post.		
Use Quiz	Student, Instructor	Create or Answer to Quiz from the quiz post.	User is on the enrolled/ created class page.	Instructor creates and publishes quiz, while student answers to quiz.	-	Included in: Use Collaboration & Interactive Tools
Search Record	Student, Instructor	Search for any previous records from the classroom.	The user is on the enrolled/ created class page and has something to search for.	User type the search term into the search bar.	If there are no matches for the user's search term, the system will display 'No Record'.	-

Table 4.3.1 – Use Case Description Table

The use case diagram for the Virtual Classroom Platform illustrates the interactions between the users such as students, instructors and the system. A wide array of capabilities are built in to facilitate online learning and collaboration. Users can register to create an account, login to authenticate and access the platform, and utilize a reset password subprocess of "Login" if they forget their credentials. Once logged in, instructors will have the ability to create or join new classes, while students will only be allowed to join new classes. Students can access their enrolled classes and leave them, while instructors can access both their created and enrolled classes, leave joined classes, and remove classes they've created. Additionally, the platform allows users to manage their profile, giving them the option to view and edit personal information. A key feature, use collaboration & interactive tools, enhances the learning experience by offering access to a range of optional tools, including using video conferencing for live interactions, using an interactive whiteboard for dynamic teaching, using document collaboration for shared editing, using group chat for communication, uploading files for resource sharing, submitting/receiving assignments for evaluation, creating/answering quizzes for knowledge assessment, and searching records for resource tracking. All these use cases are contained within the system boundary, clearly defining the scope of the Virtual Classroom Platform and ensuring a comprehensive virtual learning environment.

4.4 Activity Diagrams and Description

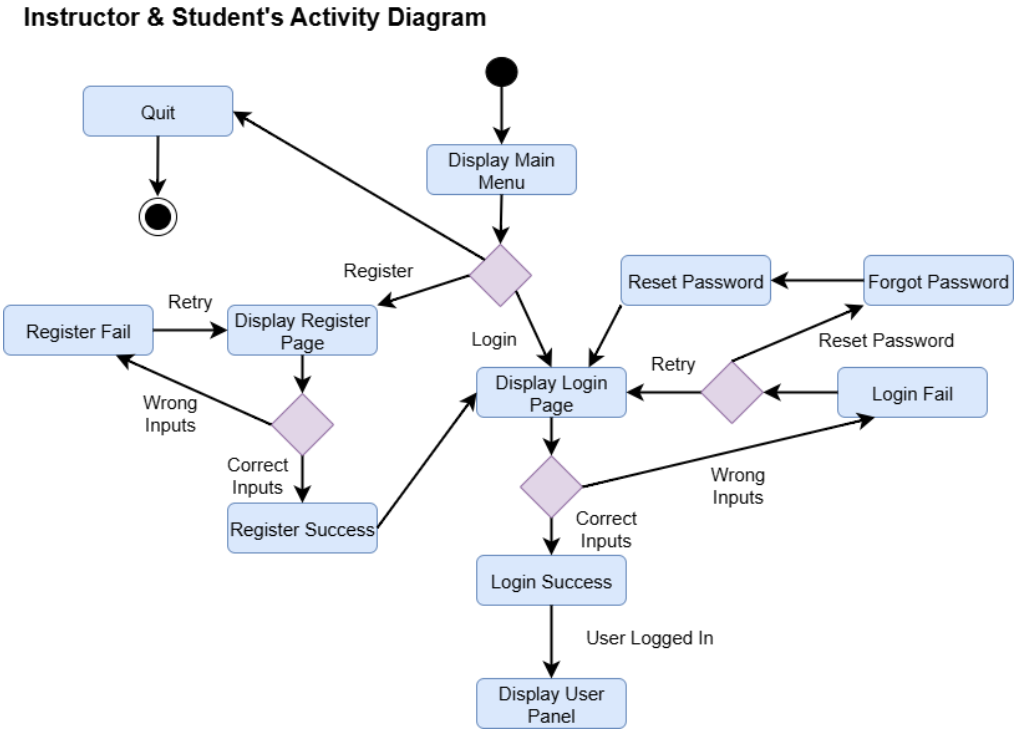


Figure 4.4.1 – Activity Diagram of the Authentication Module for Instructor & Student

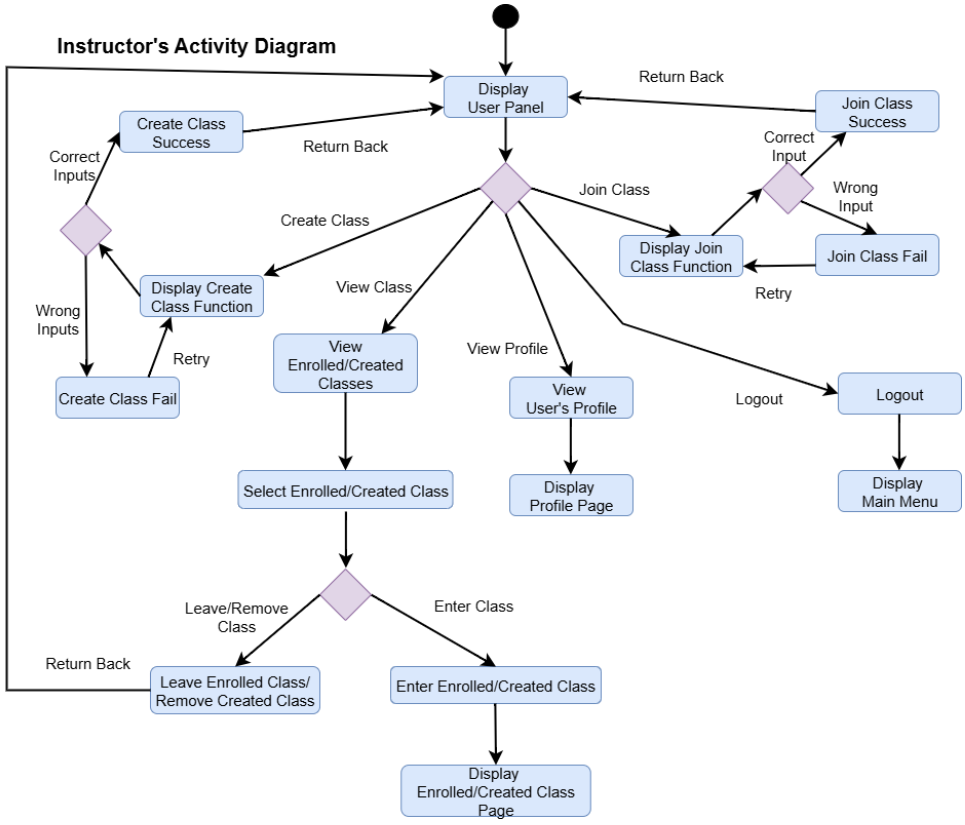


Figure 4.4.2 – Activity Diagram of the Class Management Module for Instructor

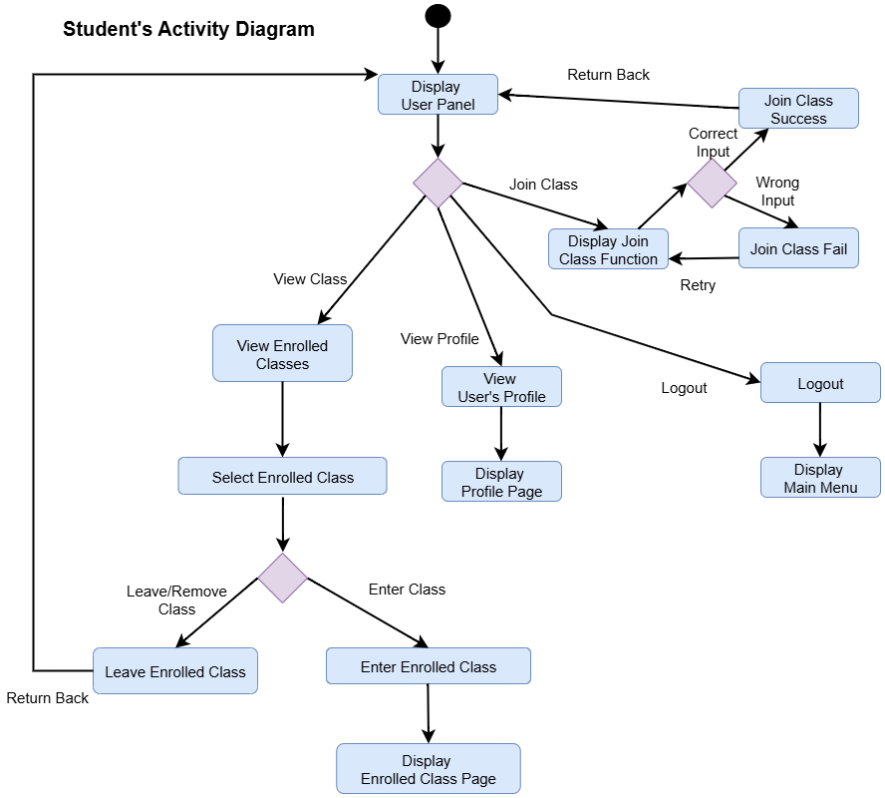


Figure 4.4.3 – Activity Diagram of the Class Management Module for Student

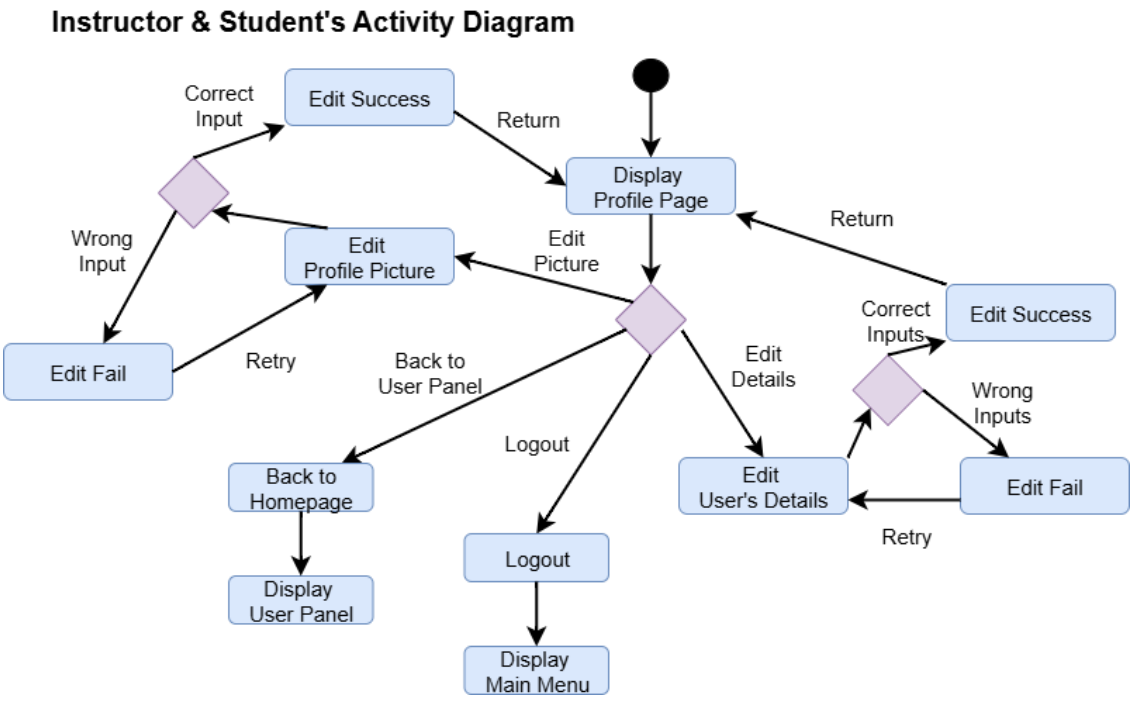


Figure 4.4.4 – Activity Diagram of the Profile Management Module for Instructor & Student

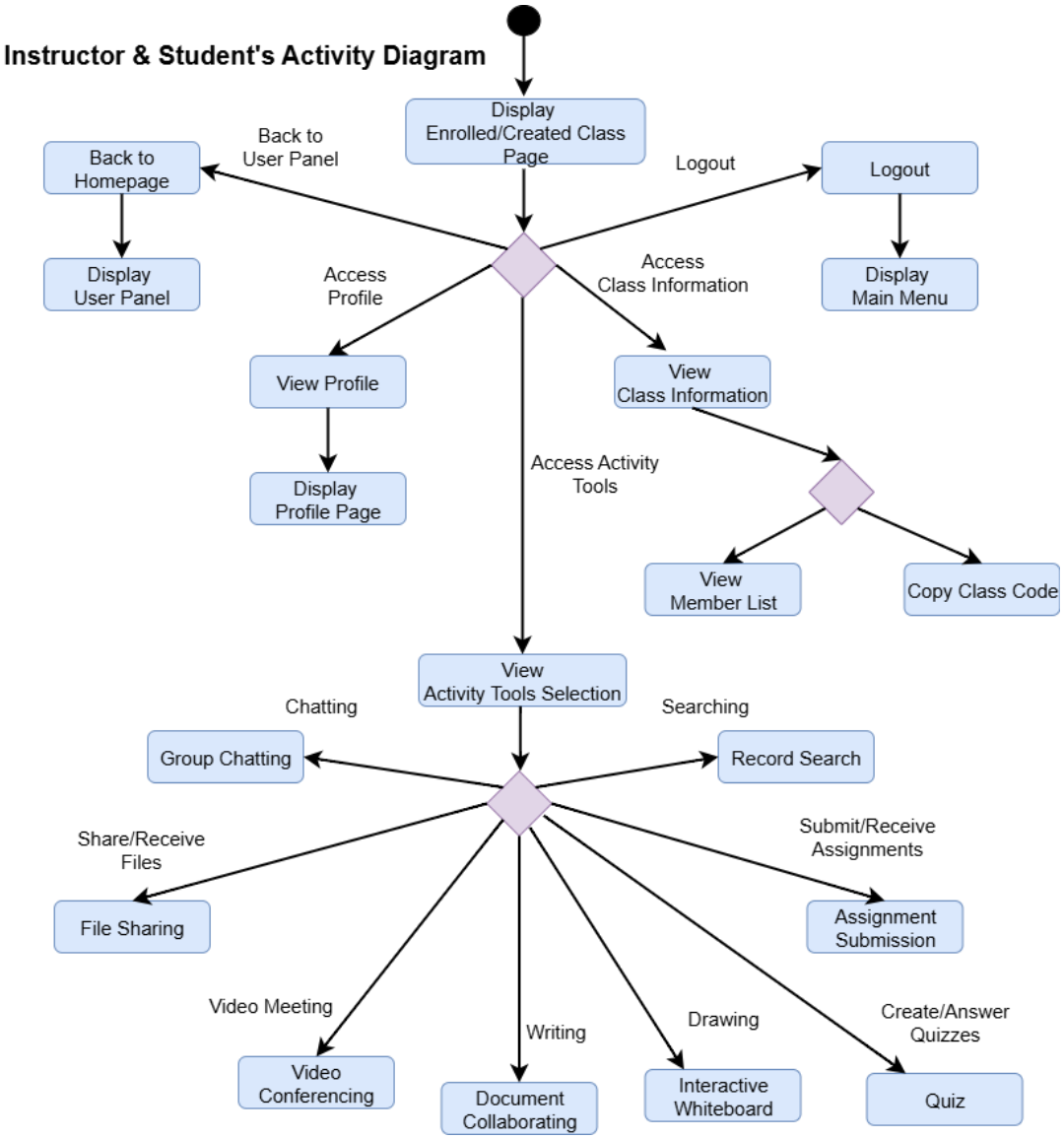


Figure 4.4.5 – Activity Diagram of the Enrolled/Created Class Module for Instructor & Student

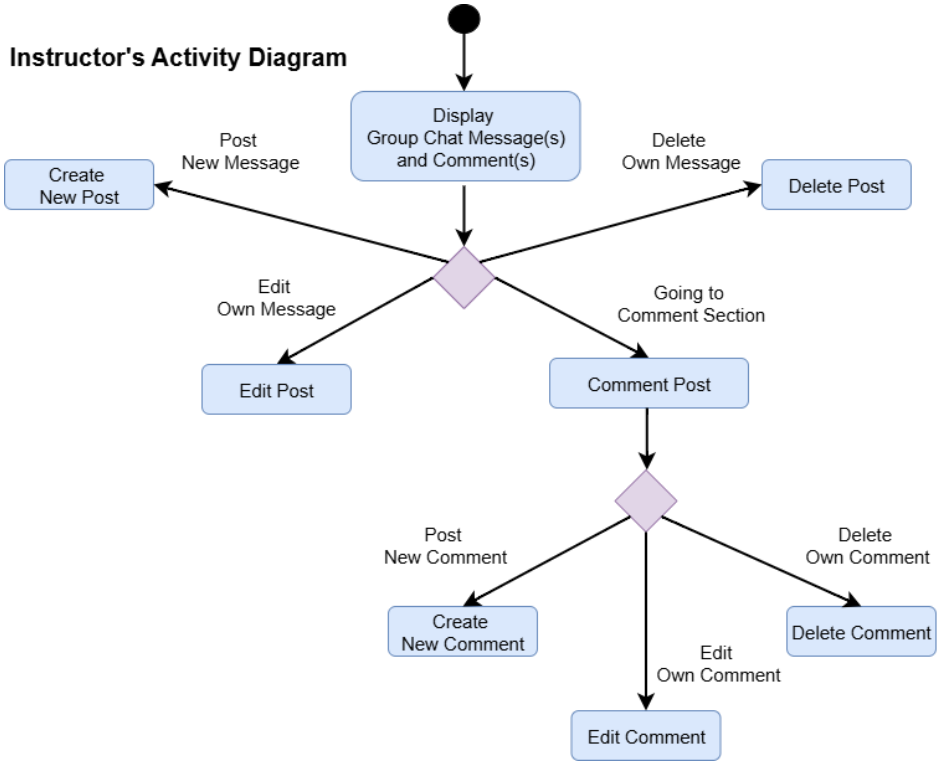


Figure 4.4.6 – Activity Diagram of the Group Chat Section from Enrolled/Created Class Module for Instructor

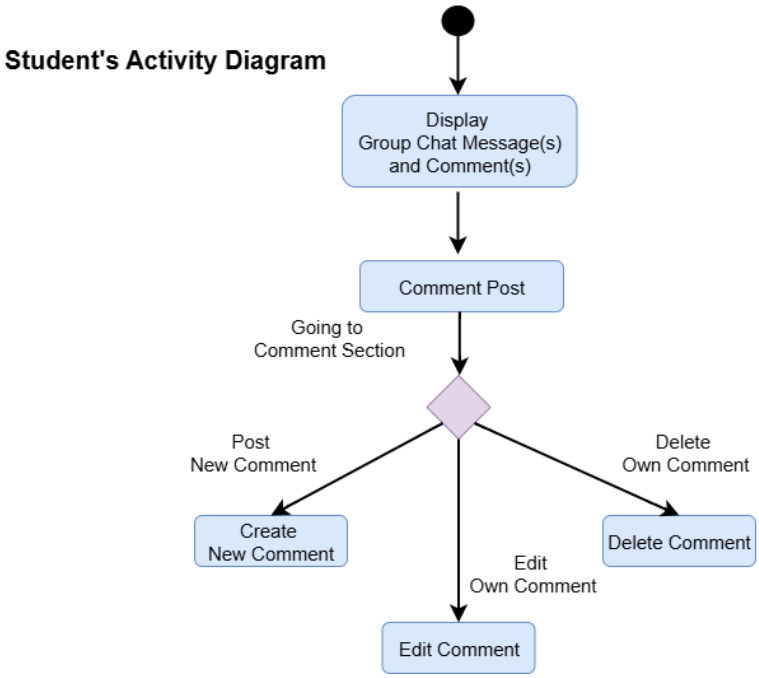


Figure 4.4.7 – Activity Diagram of the Group Chat Section from Enrolled/Created Class Module for Student

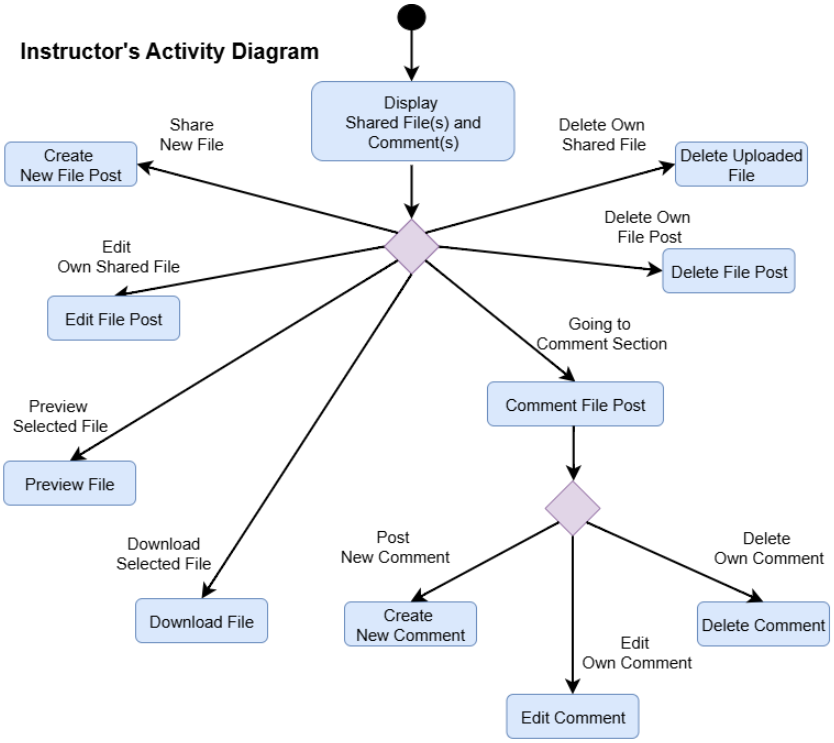


Figure 4.4.8 – Activity Diagram of the File Sharing Section from Enrolled/Created Class Module for Instructor

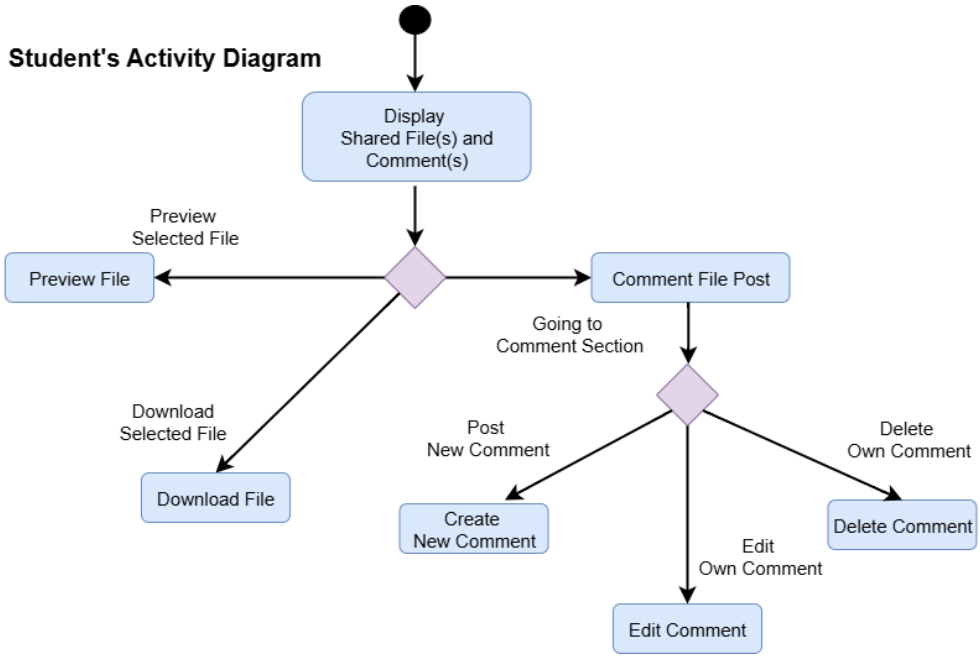


Figure 4.4.9 – Activity Diagram of the File Sharing Section from Enrolled/Created Class Module for Student

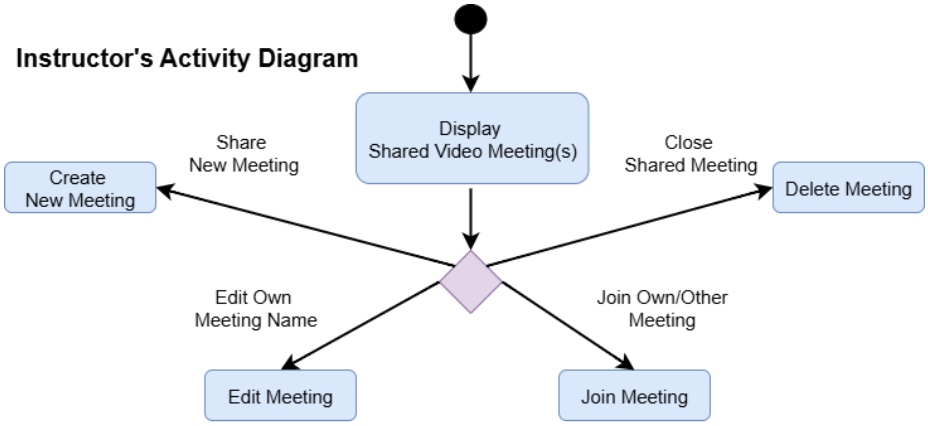


Figure 4.4.10 – Activity Diagram of the Video Conferencing Section from Enrolled/Created Class Module for Instructor

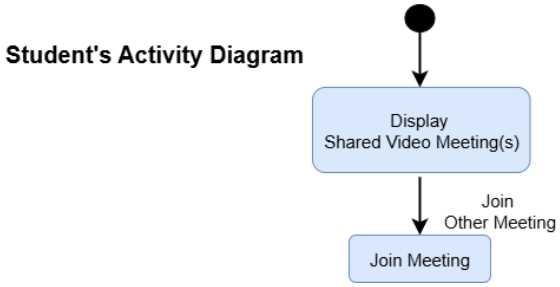


Figure 4.4.11 – Activity Diagram of the Video Conferencing Section from Enrolled/Created Class Module for Student

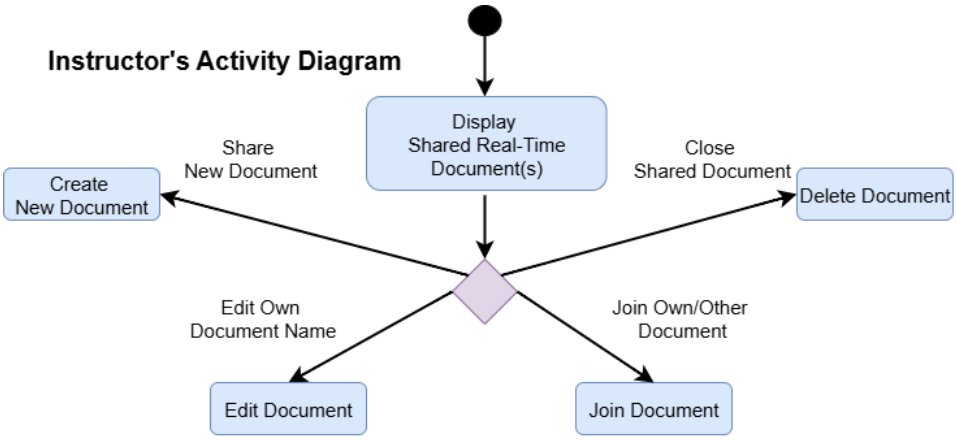


Figure 4.4.12 – Activity Diagram of the Document Collaboration Section from Enrolled/Created Class Module for Instructor

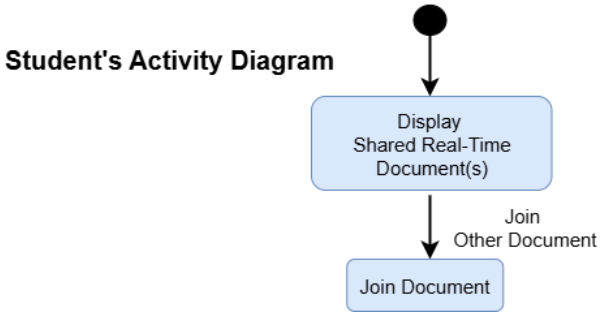


Figure 4.4.13 – Activity Diagram of the Document Collaboration Section from Enrolled/Created Class Module for Student

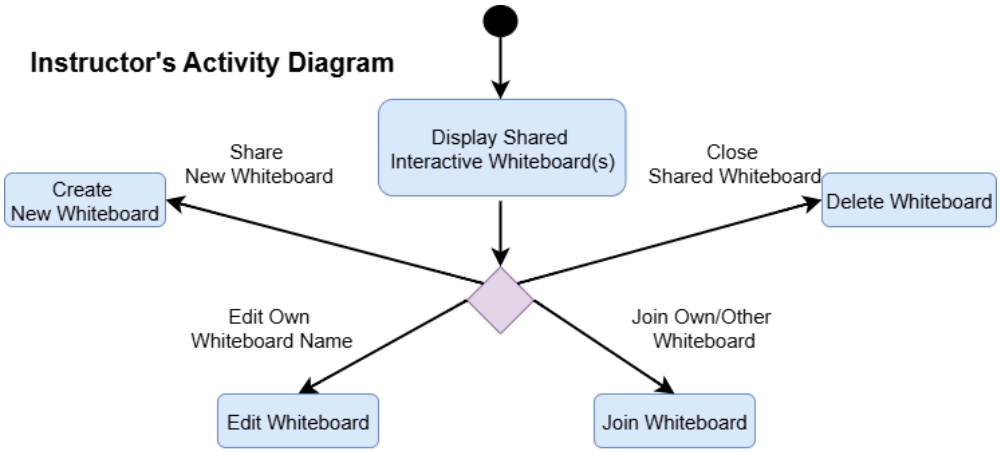


Figure 4.4.14 – Activity Diagram of the Interactive Whiteboard Section from Enrolled/Created Class Module for Instructor

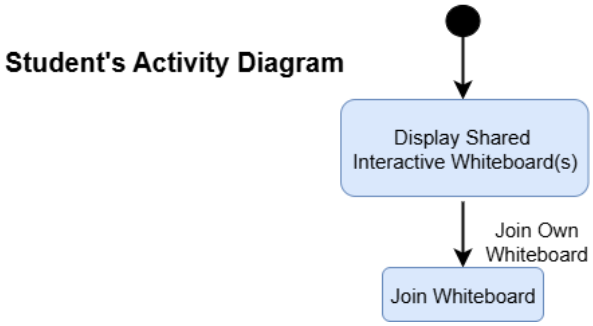


Figure 4.4.15 – Activity Diagram of the Interactive Whiteboard Section from Enrolled/Created Class Module for Student

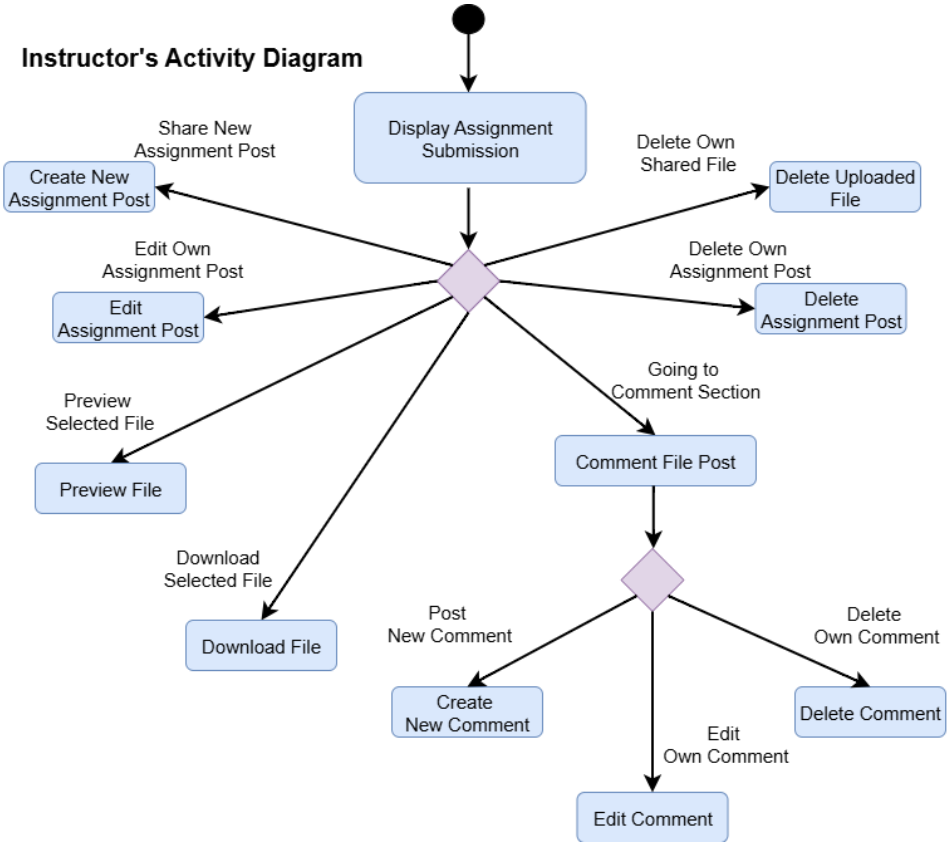


Figure 4.4.16 – Activity Diagram of the Assignment Submission Section from Enrolled/Created Class Module for Instructor

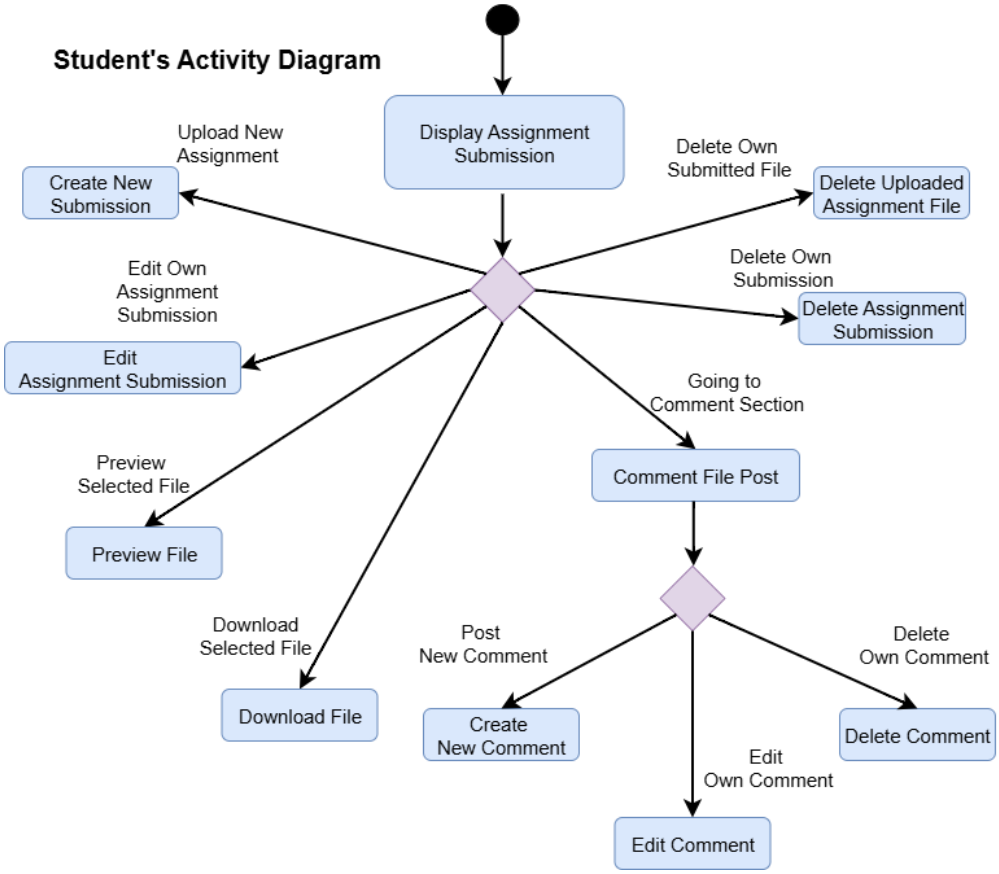


Figure 4.4.17 – Activity Diagram of the Assignment Submission Section from Enrolled/Created Class Module for Student

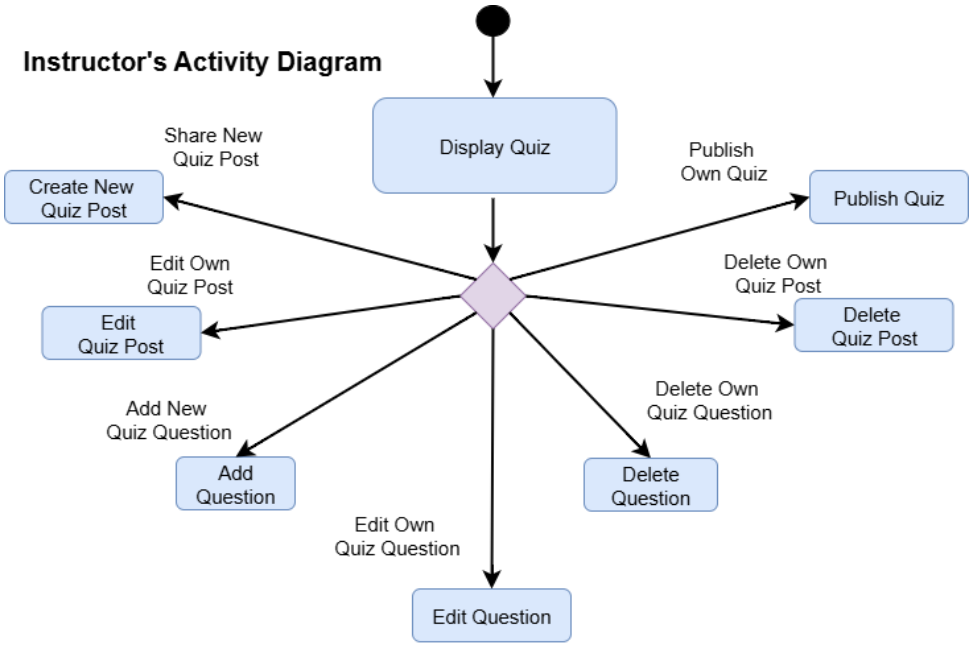


Figure 4.4.18 – Activity Diagram of the Quiz Section from Enrolled/Created Class Module for Instructor

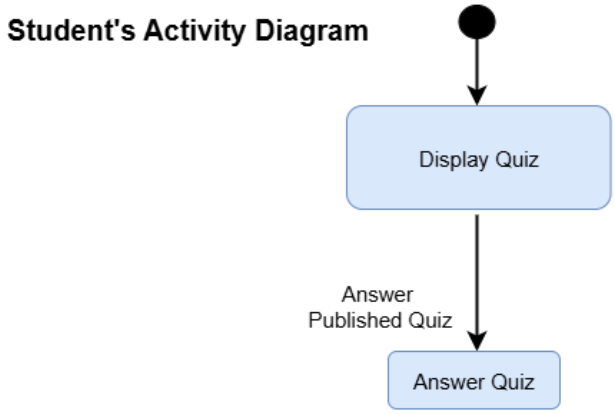


Figure 4.4.19 – Activity Diagram of the Quiz Section from Enrolled/Created Class Module for Student

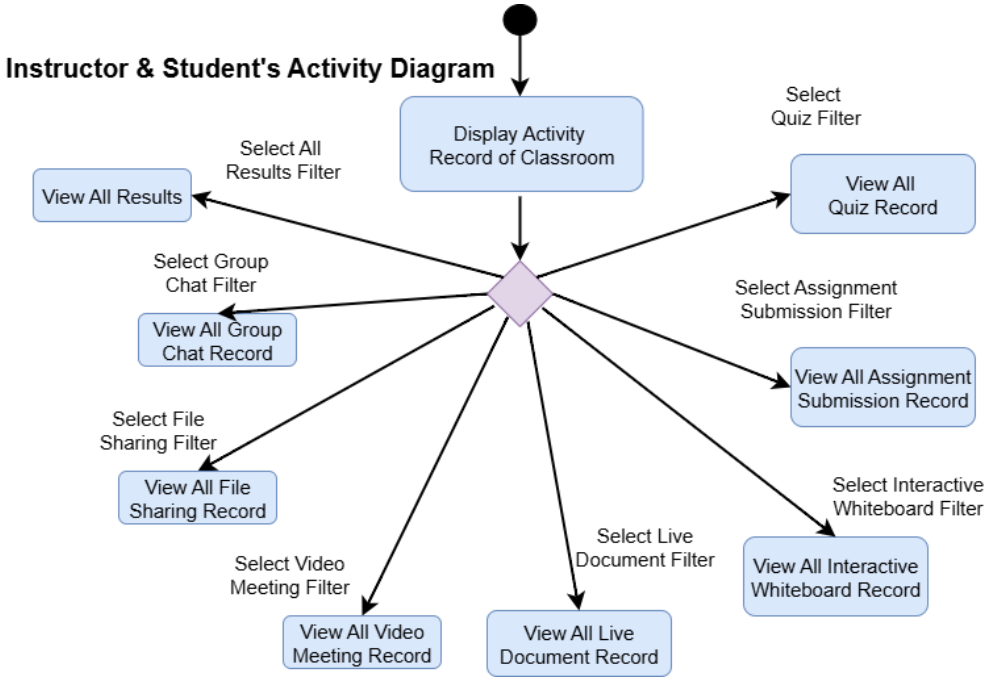


Figure 4.4.20 – Activity Diagram of the Search Function from Enrolled/Created Class Module for Instructor& Student

The Activity Diagrams represent the sequential flow of actions in the virtual classroom system, beginning with the Main Menu, where users can either Register, Login, or Quit (Figure 4.4.1). If the registration procedure went well, the user is redirected to the Login process, while a failure prompts a retry option. After a successful login, the user enters the User Panel, the main section for managing profile information, accessing classrooms, and utilizing class-related functions (Figure 4.4.2 - Figure 4.4.3). Within the User Panel, both students and instructors can view and update their profile on the same page (Figure 4.4.4). However, while instructors can create, join, remove, and leave classes, students do not have access to the create or remove class functionalities and can only leave classes they are enrolled in. Within the classroom, users can interact through various collaboration and interactive tools, including Group Chat, File Sharing, Video Conferencing, Document Collaboration, Interactive Whiteboard, Assignment Submission, Quiz, and Record Search (Figure 4.4.5 – Figure 4.4.20). Additionally, the system allows users to return from Enrolled/Created Classroom to User Panel. Both User Panel and Enrolled/Created Classroom process contain the Logout function, ensuring secure session termination. This diagram effectively models the logical flow of activities, focusing on user interactions and decision-making processes within the system.

4.5 Entity Relationship Diagram (ERD) and Description

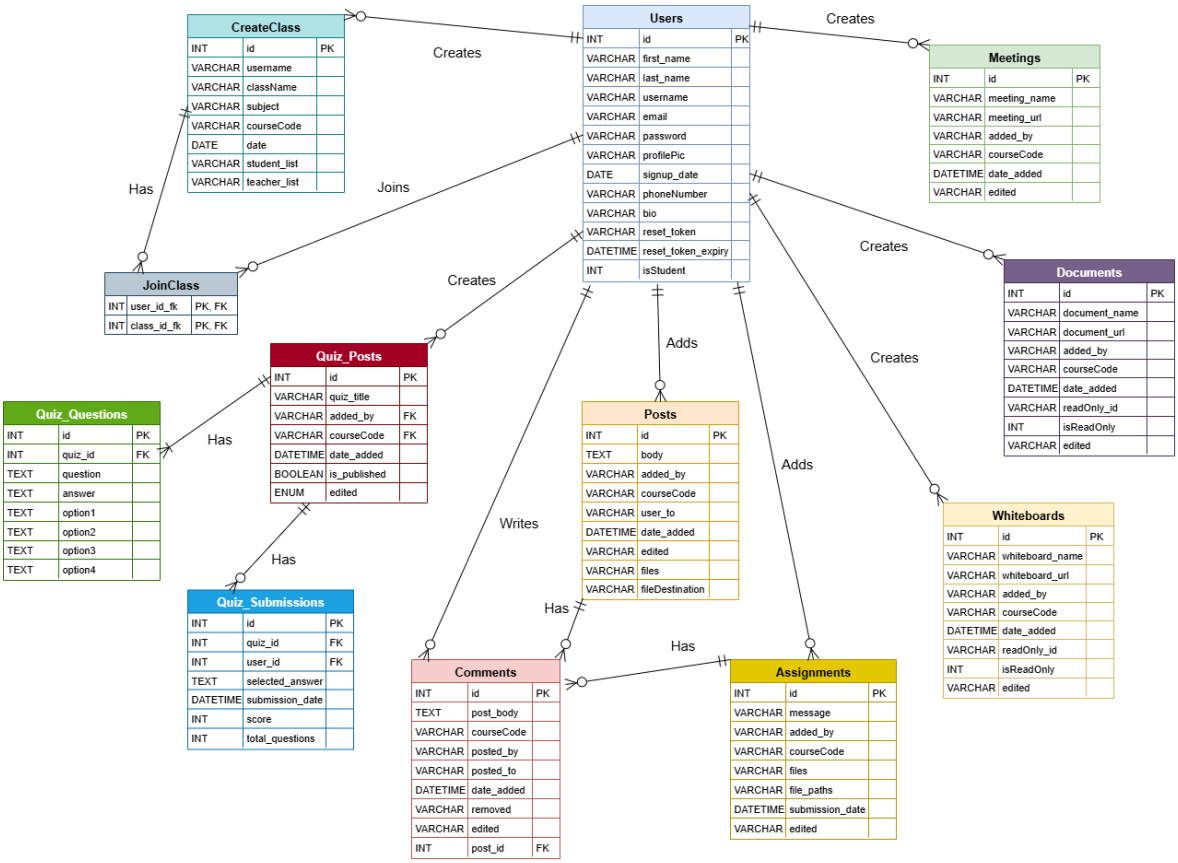


Figure 4.5.1 – ERD Diagram

The Entity Relationship Diagram (ERD) for the Virtual Classroom Platform models the structural backbone of the system by illustrating how data entities interrelate to support the full spectrum of user operations. Central to the design is the Users table, which connects to other core components such as class management (via the CreateClass and JoinClass tables, where a User creates zero or many Classes and joins zero or many Classes respectively), communication through Posts, and Comments (where a User adds zero or many Posts, and Posts have zero or many Comments). For collaboration and interactive tools, a User can create zero or many Meetings, Documents, Whiteboards, Assignments, and Quizzes (with one or many Questions, and zero or many Submissions) posts. These relationships ensure that all aspects of user authentication, class management, and collaborative functionalities are cohesively integrated, reflecting the operational flow and structural design depicted in the flowchart, block diagram, use case, and activity diagrams.

4.6 Flowcharts and Description

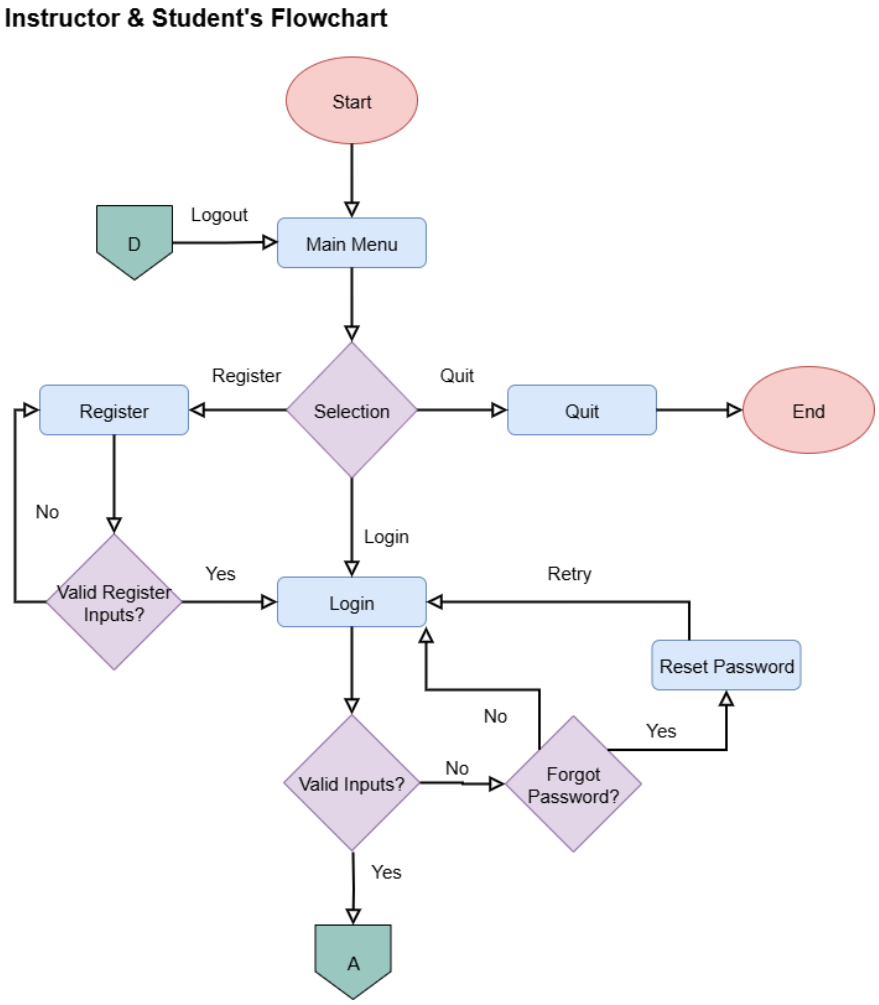


Figure 4.6.1 – Flowchart of the Authentication Module for Instructor and Student

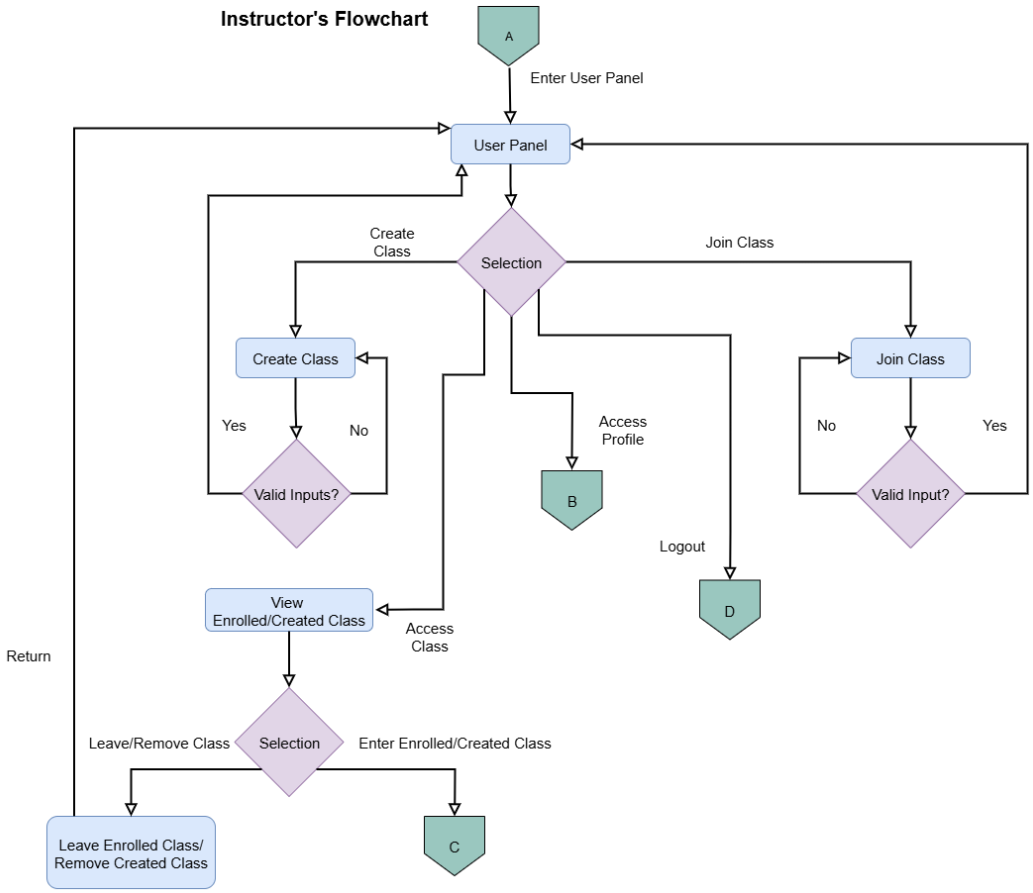


Figure 4.6.2 – Flowchart of the Class Management Module for Instructor

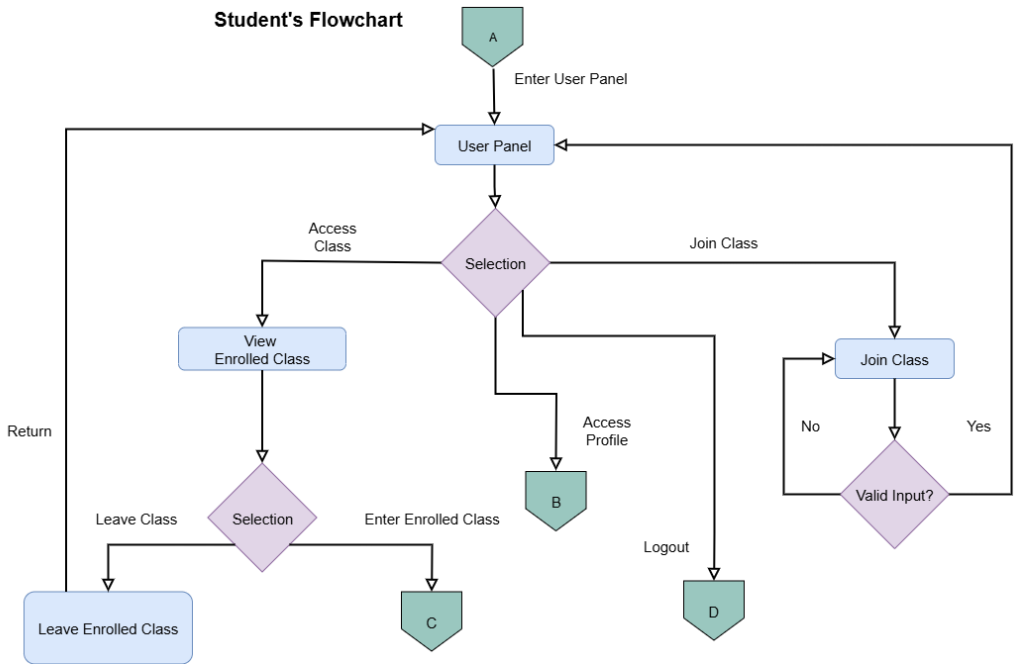


Figure 4.6.3 – Flowchart of the Class Management Module for Student

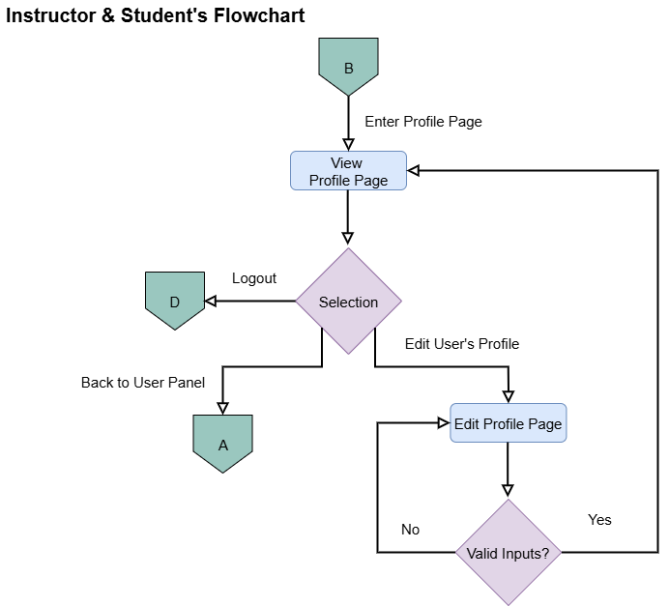


Figure 4.6.4 – Flowchart of the Profile Management Module for Instructor and Student

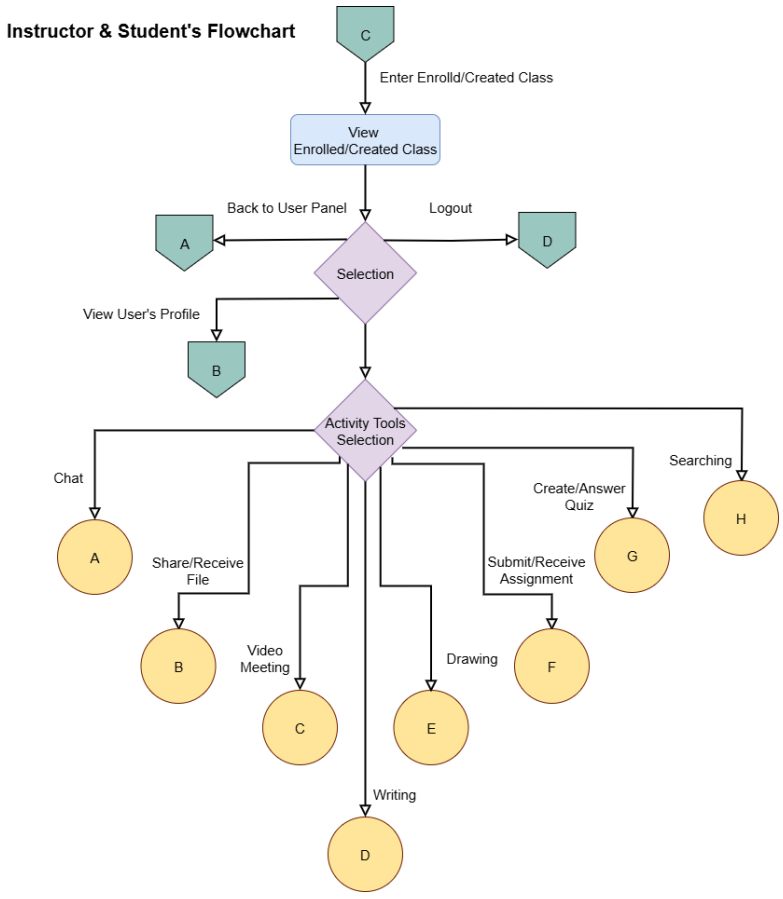


Figure 4.6.5 – Flowchart of the Enrolled/Created Class Module for Instructor & Student

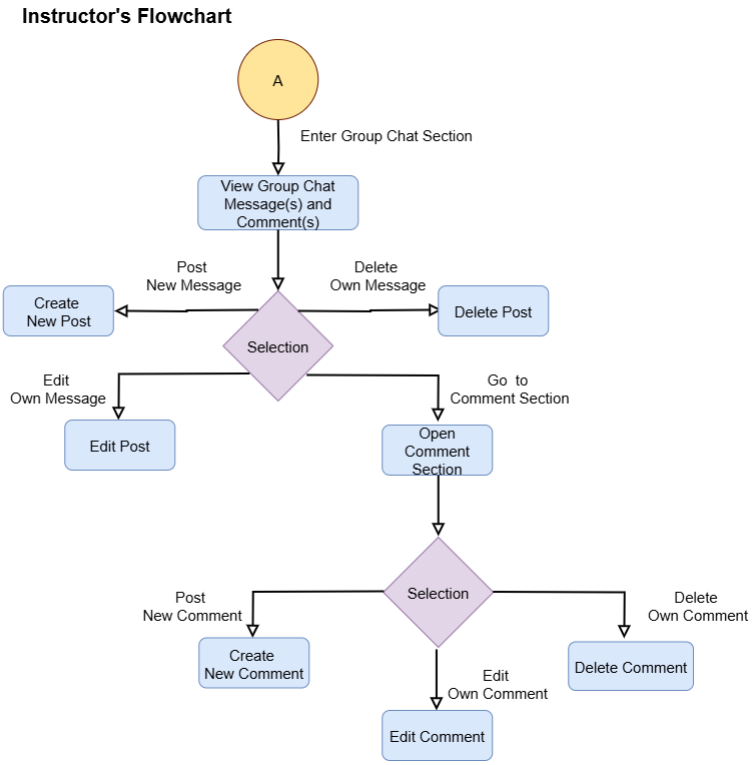


Figure 4.6.6 – Flowchart of the Group Chat Section from the Enrolled/Created Class Module for Instructor

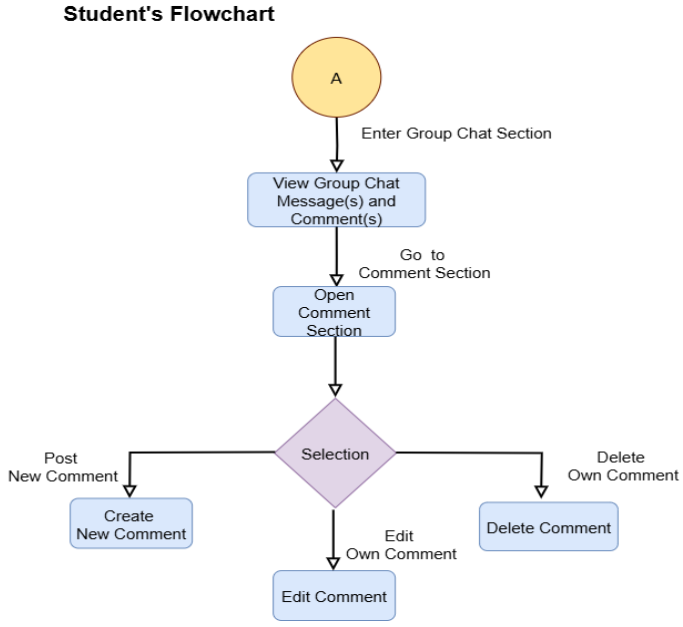


Figure 4.6.7 – Flowchart of the Group Chat Section from the Enrolled/Created Class Module for Student

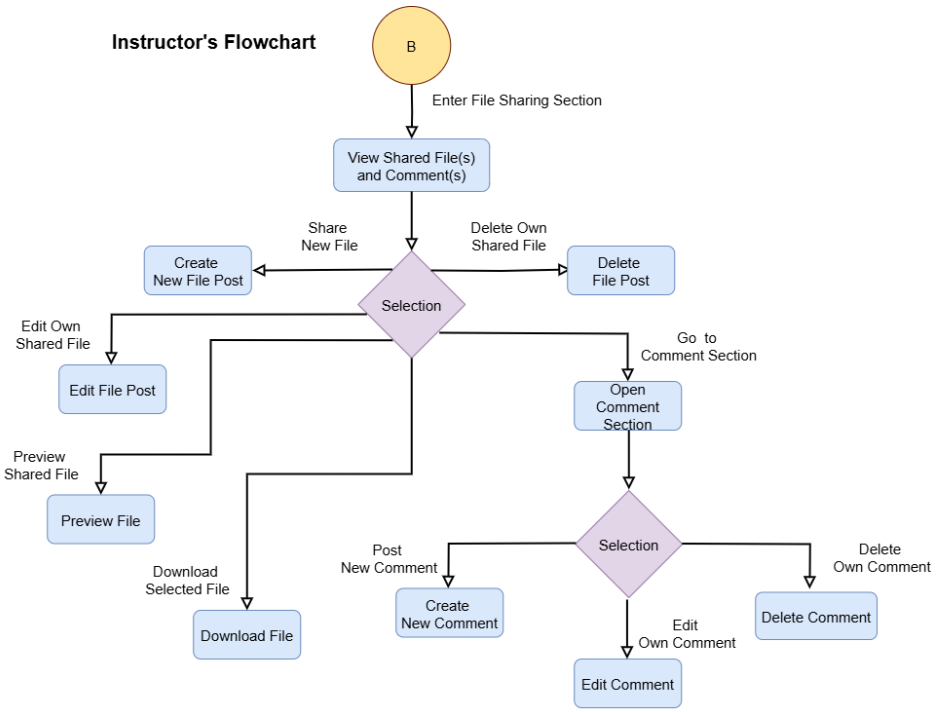


Figure 4.6.8 – Flowchart of the File Sharing Section from the Enrolled/Created Class Module for Instructor

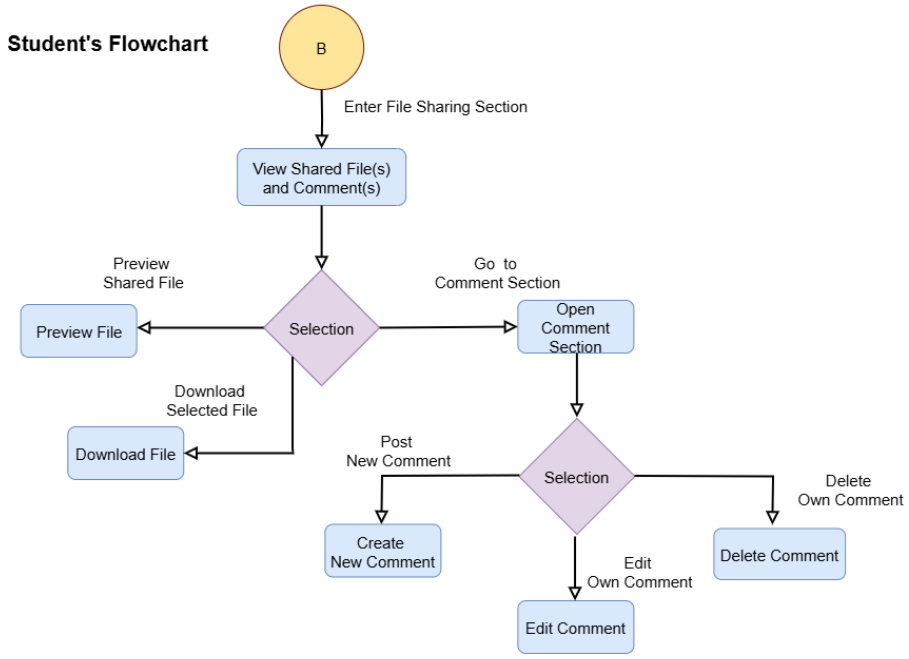


Figure 4.6.9 – Flowchart of the File Sharing Section from the Enrolled/Created Class Module for Student

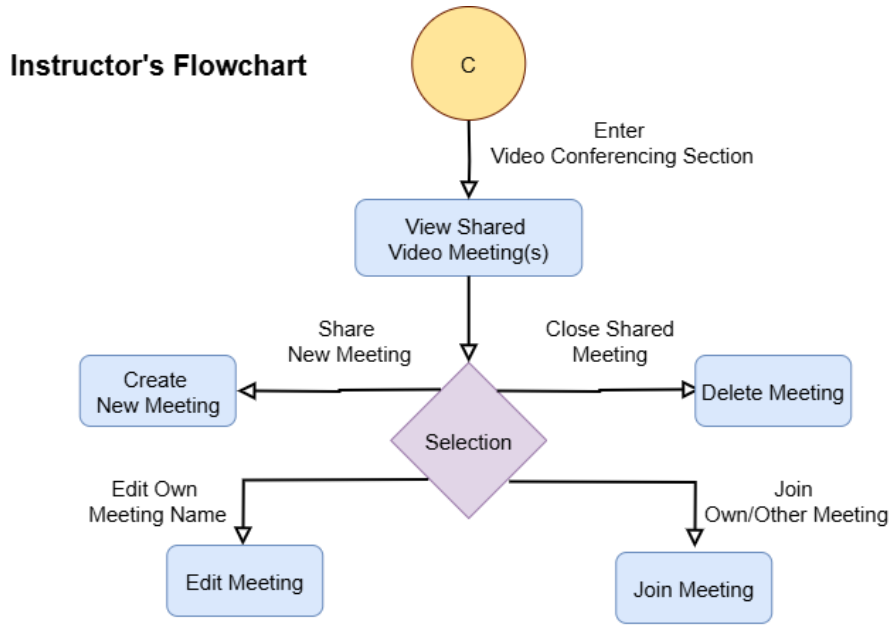


Figure 4.6.10 – Flowchart of the Video Conferencing Section from the Enrolled/Created Class Module for Instructor

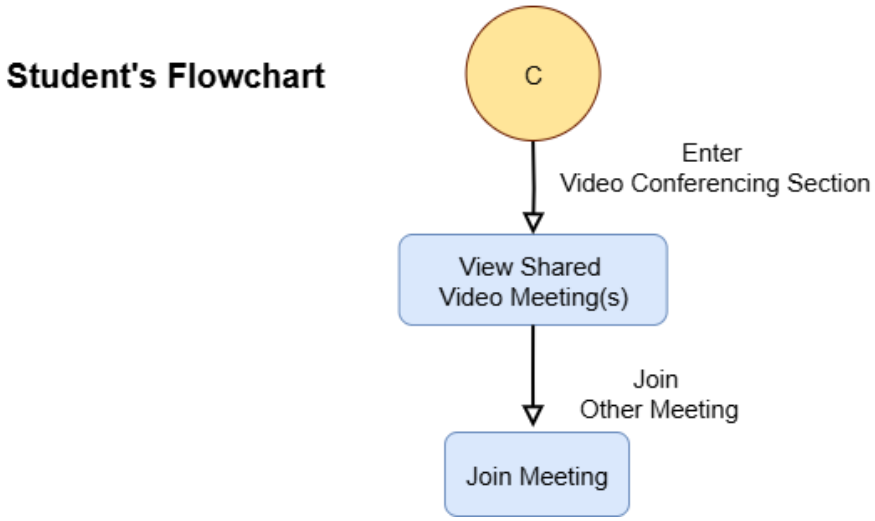


Figure 4.6.11 – Flowchart of the Video Conferencing Section from the Enrolled/Created Class Module for Student

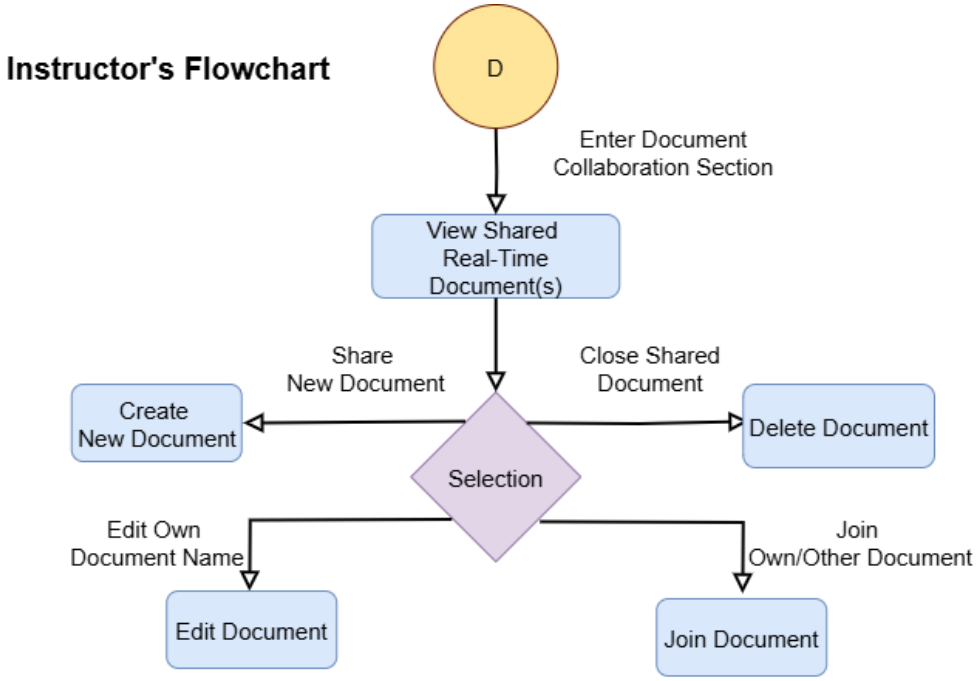


Figure 4.6.12 – Flowchart of the Document Collaboration Section from the Enrolled/Created Class Module for Instructor

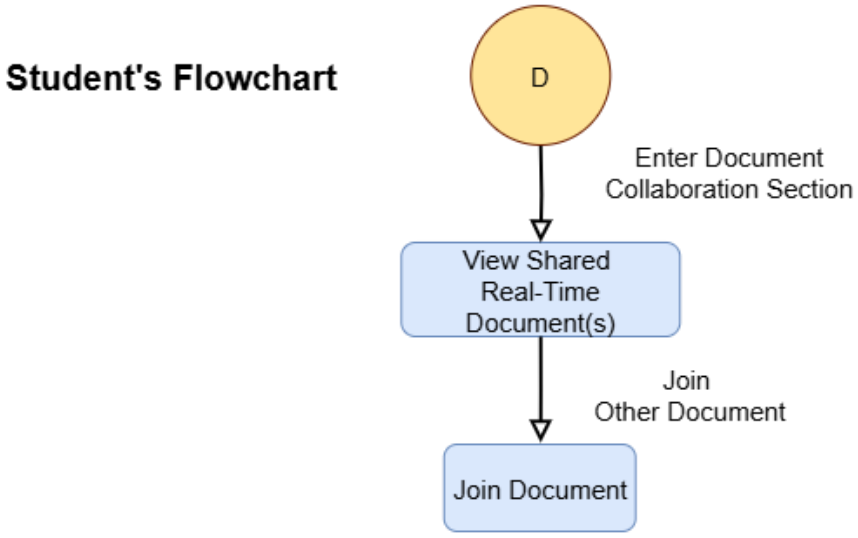


Figure 4.6.13 – Flowchart of the Document Collaboration Section from the Enrolled/Created Class Module for Student

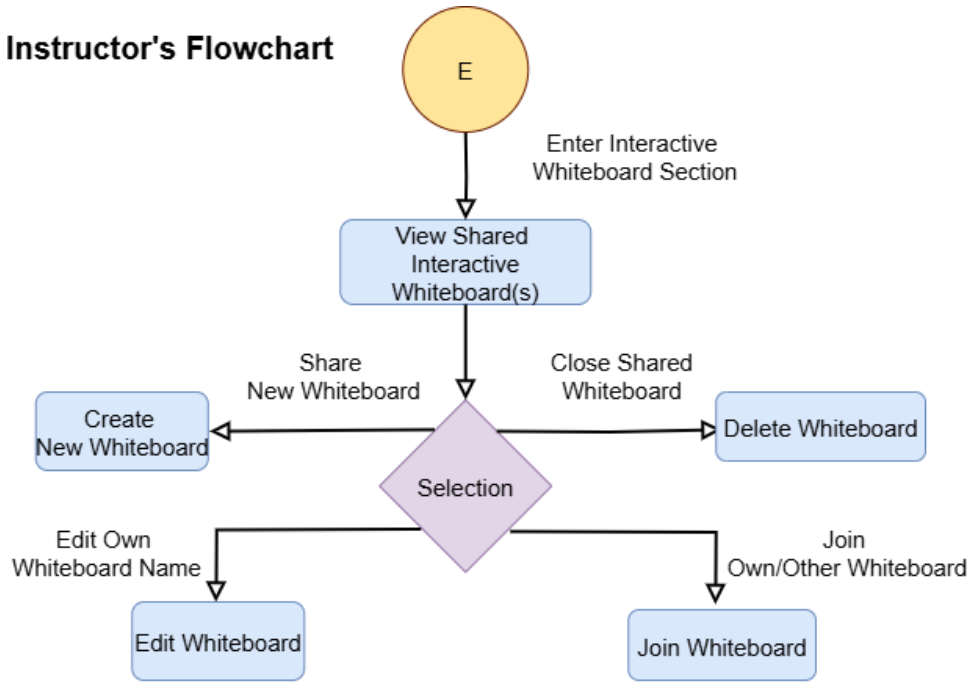


Figure 4.6.14 – Flowchart of the Interactive Whiteboard Section from the Enrolled/Created Class Module for Instructor

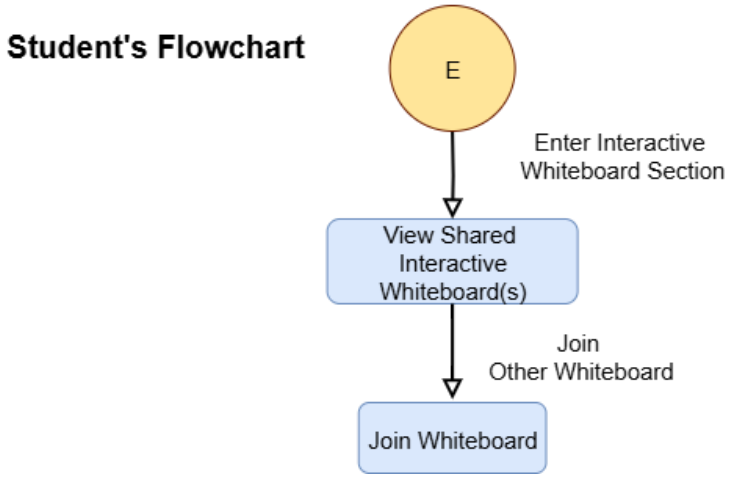


Figure 4.6.15 – Flowchart of the Interactive Whiteboard Section from the Enrolled/Created Class Module for Student

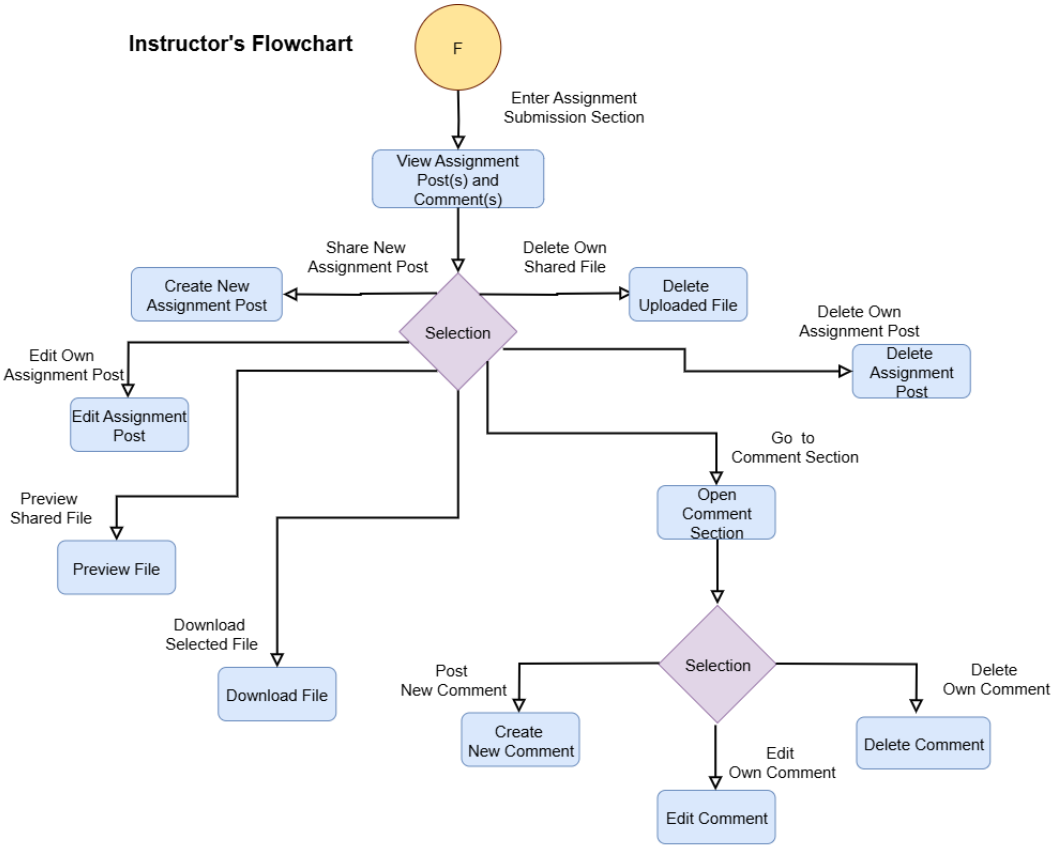


Figure 4.6.16 – Flowchart of the Assignment Submission Section from the Enrolled/Created Class Module for Instructor

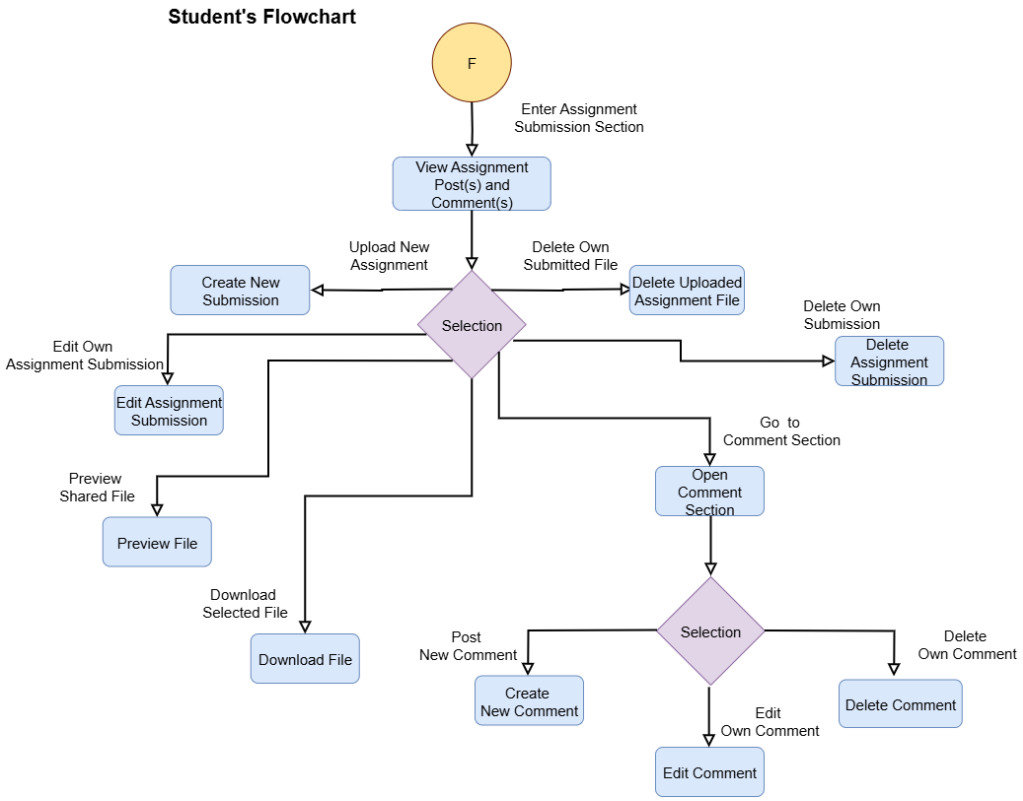


Figure 4.6.17 – Flowchart of the Assignment Submission Section from the Enrolled/Created Class Module for Student

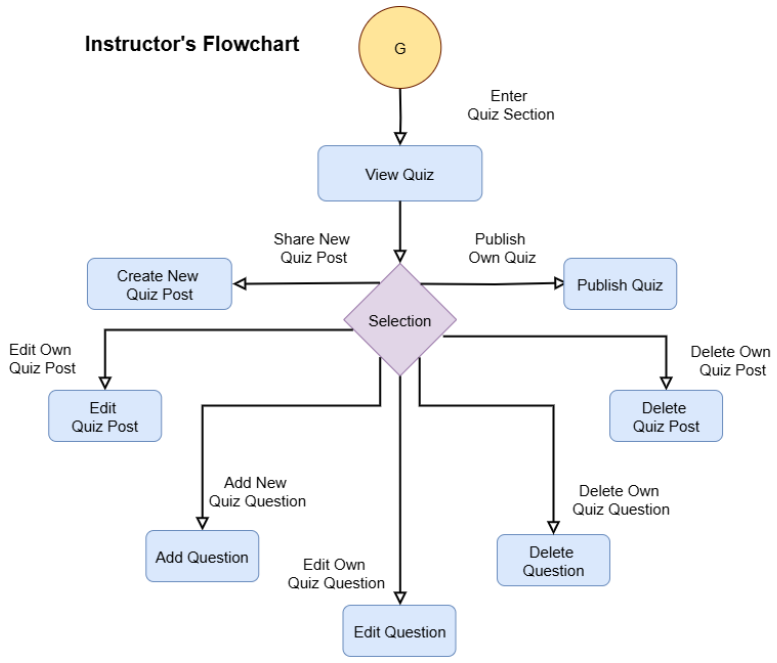


Figure 4.6.18 – Flowchart of the Quiz Section from the Enrolled/Created Class Module for Instructor

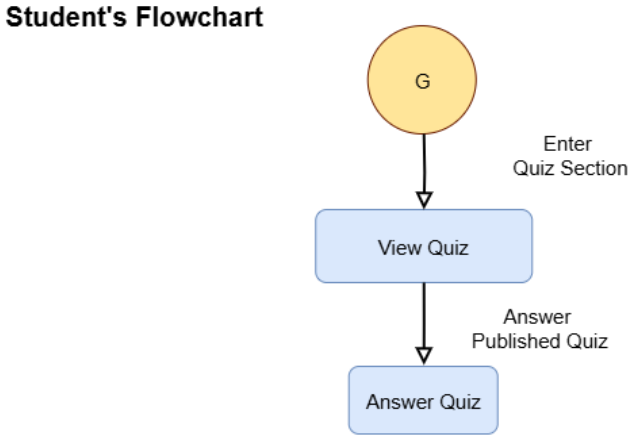


Figure 4.6.19 – Flowchart of the Quiz Section from the Enrolled/Created Class Module for Student

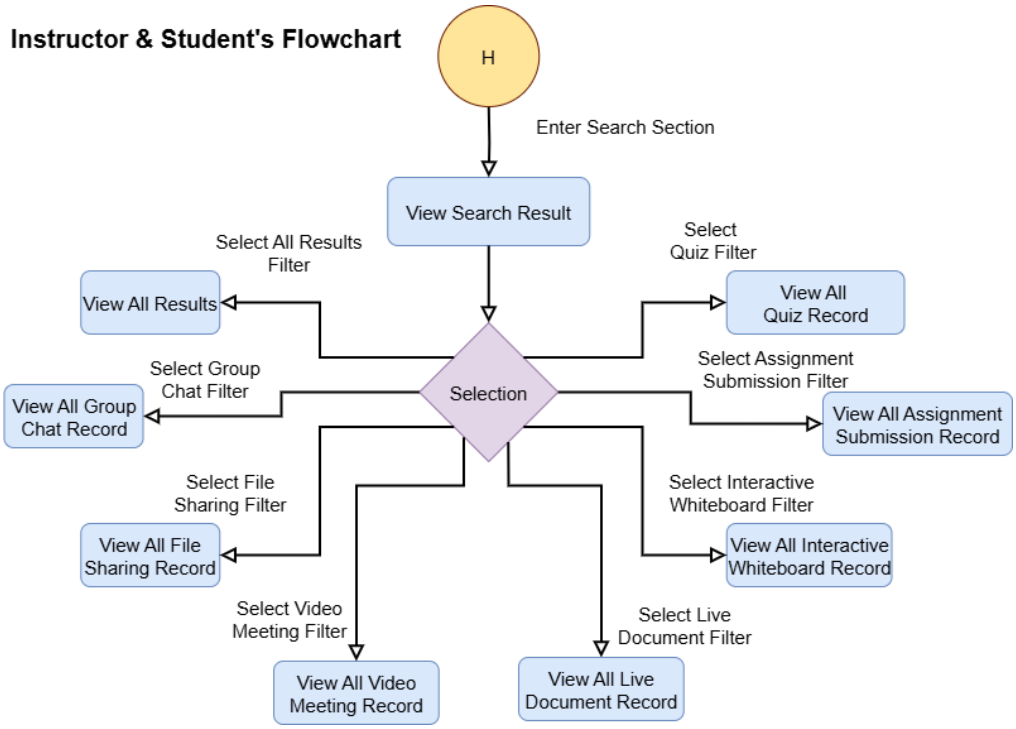


Figure 4.6.20 – Flowchart of the Search Feature from the Enrolled/Created Class Module for Instructor & Student

The virtual classroom platform begins with the user accessing the Main Menu, where they can choose to Register, Login, or Quit. If the user selects Register, they must provide valid input to complete the registration process (Figure 4.6.1). If the input is invalid, they are prompted to re-enter the required details. Once registered, the user can proceed to the Login page, where they enter their credentials. If the password is valid, they gain access to the User Panel, otherwise they have the option to Reset Password before attempting to log in again. Upon entering the User Panel, both students and instructors have access to core functionalities such as viewing or editing their profile and viewing Enrolled/Created Classes (Figure 4.6.2 - Figure 4.6.4). Instructors additionally have the ability to create, join, remove and leave a class. Students, on the other hand, do not have access to the class creation or removal functionalities. When creating or joining a class, valid inputs are required to proceed. Once enrolled in a class, the user gains access to various collaboration and interactive tools (Figure 4.6.5), including Group Chat, File Sharing, Video Conferencing, an Interactive Whiteboard, Real-time Document Collaboration, Assignment Submission, Quiz, and Record Search (Figure 4.6.6 - Figure 4.6.20). Additionally, users can choose to return to the User Panel with the option ‘Back’. At any point, they can choose to Logout and exit to the Main Menu once logged in, or if they select Quit from the main menu, the platform ends.

4.7 Wireframes and Description

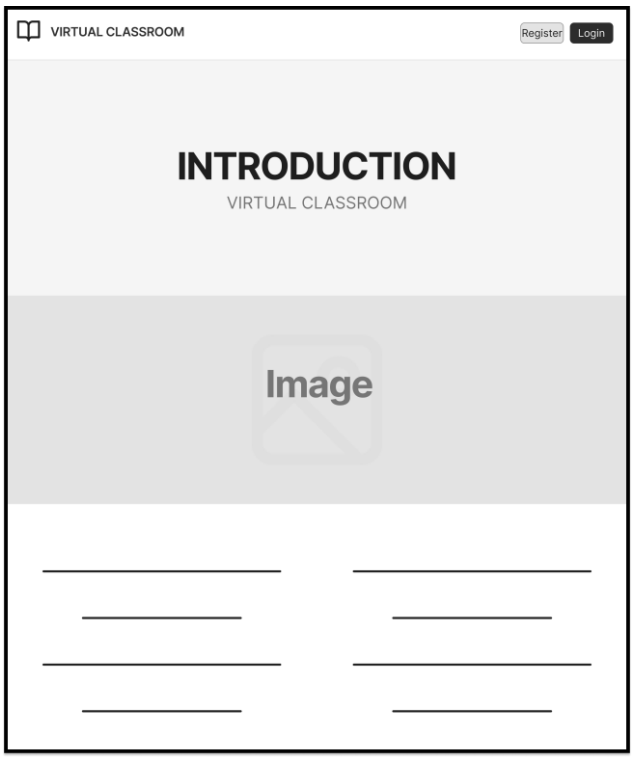


Figure 4.7.1 – Wireframe of Main Menu Page (Authentication Module)

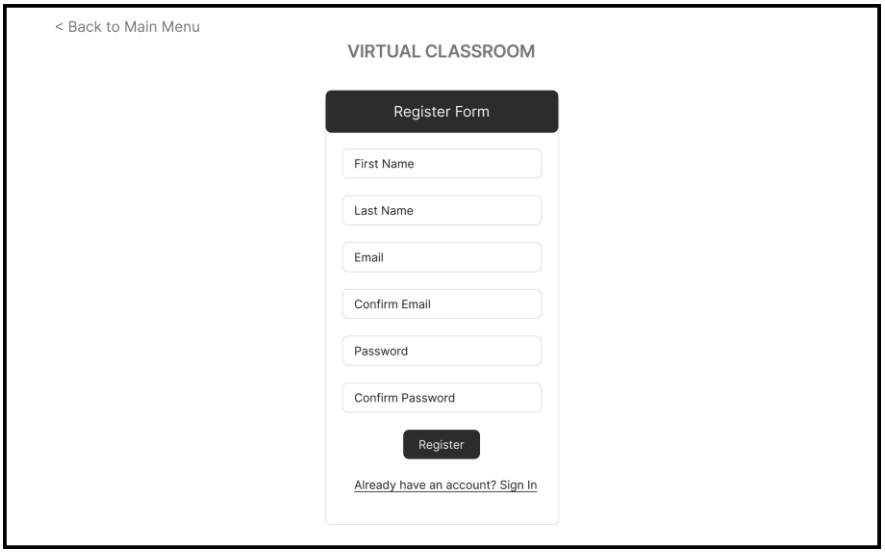


Figure 4.7.2 – Wireframe of the Registration Page (Authentication Module)

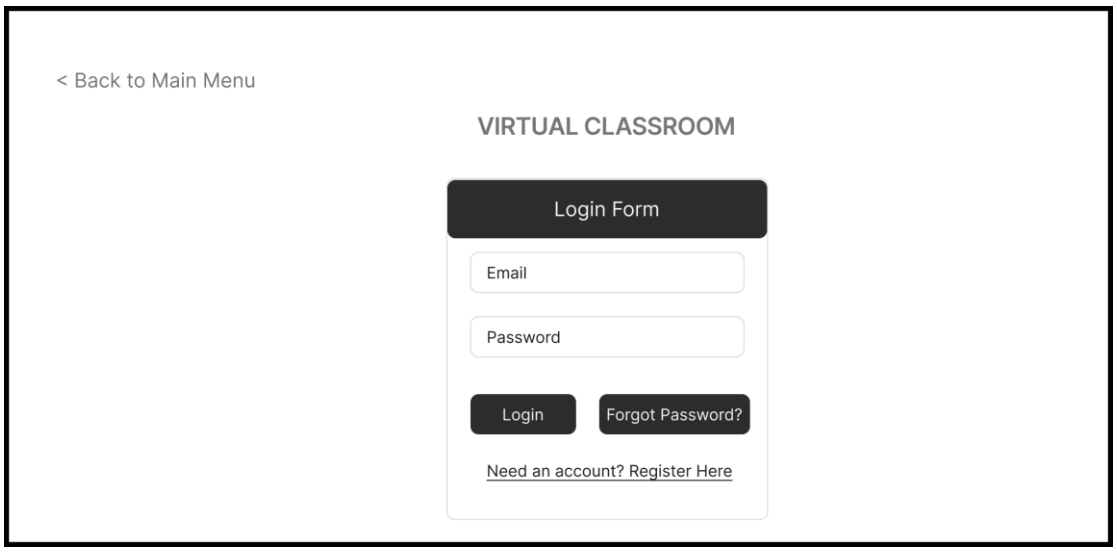


Figure 4.7.3 – Wireframe of the Login Page (Authentication Module)

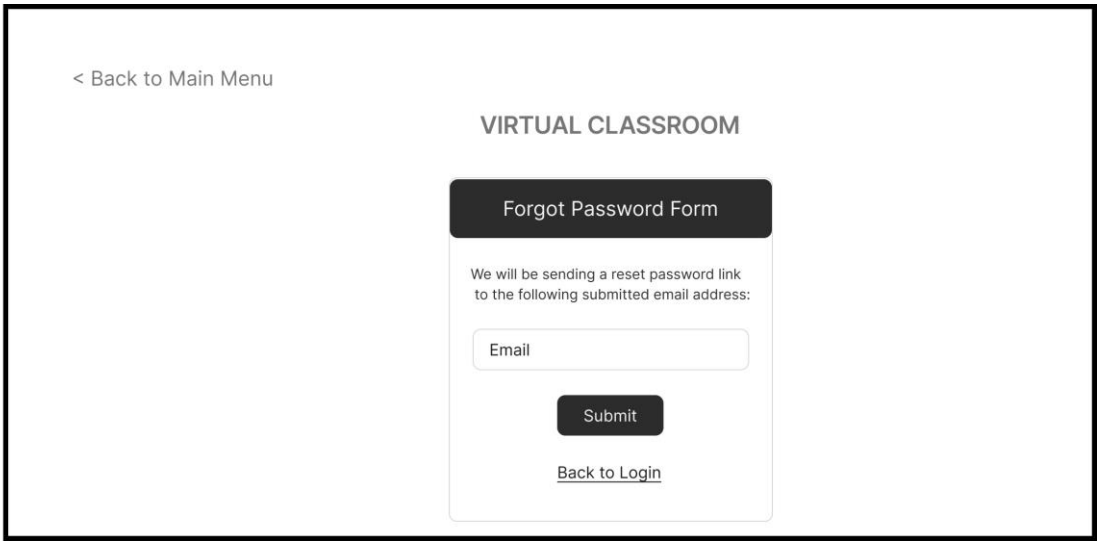


Figure 4.7.4 – Wireframe of the Forgot Password Page (Authentication Module)

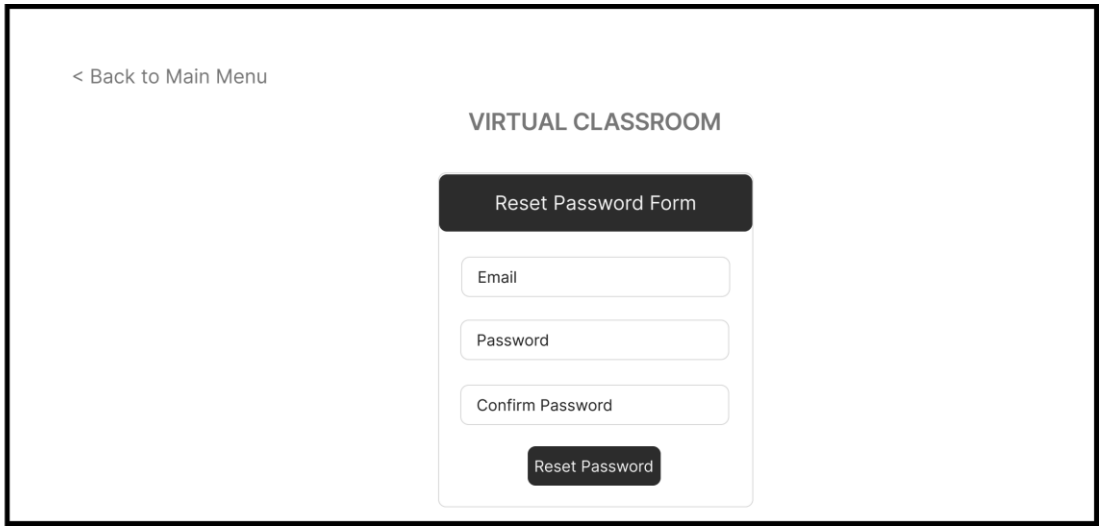


Figure 4.7.5 – Wireframe of the Reset Password Page (Authentication Module)

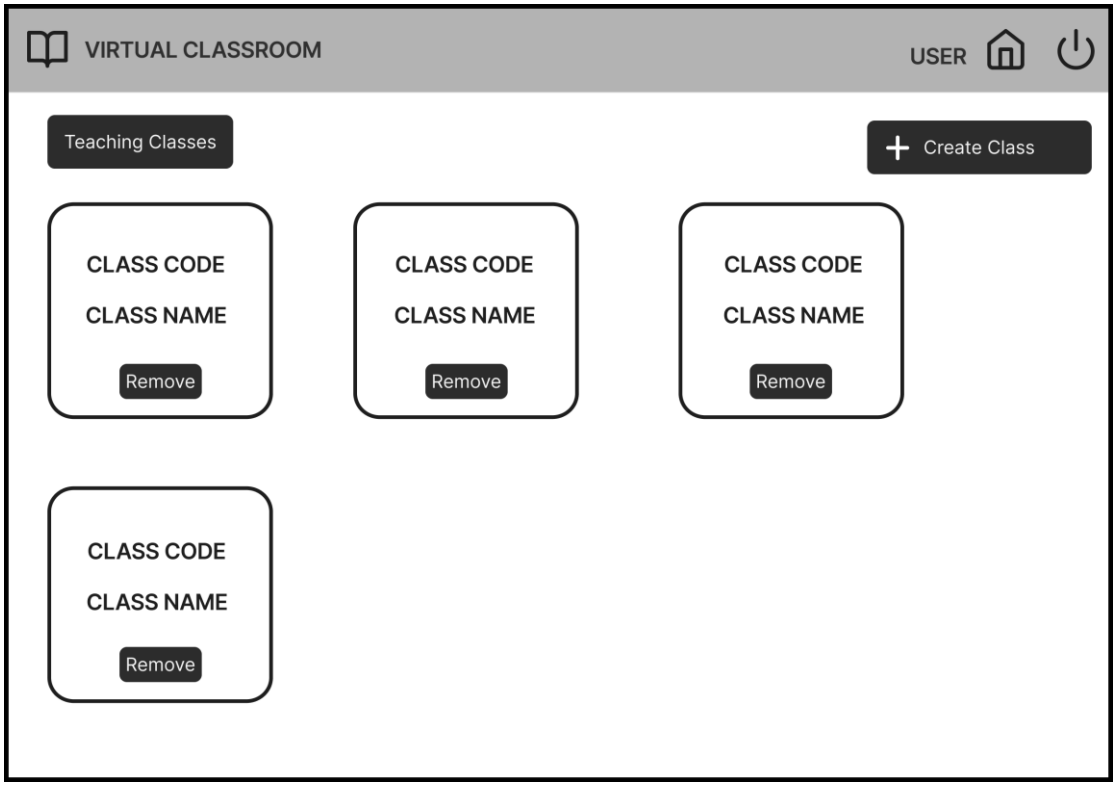


Figure 4.7.6 – Wireframe of the Instructor's User Panel Page (Class Management Module)

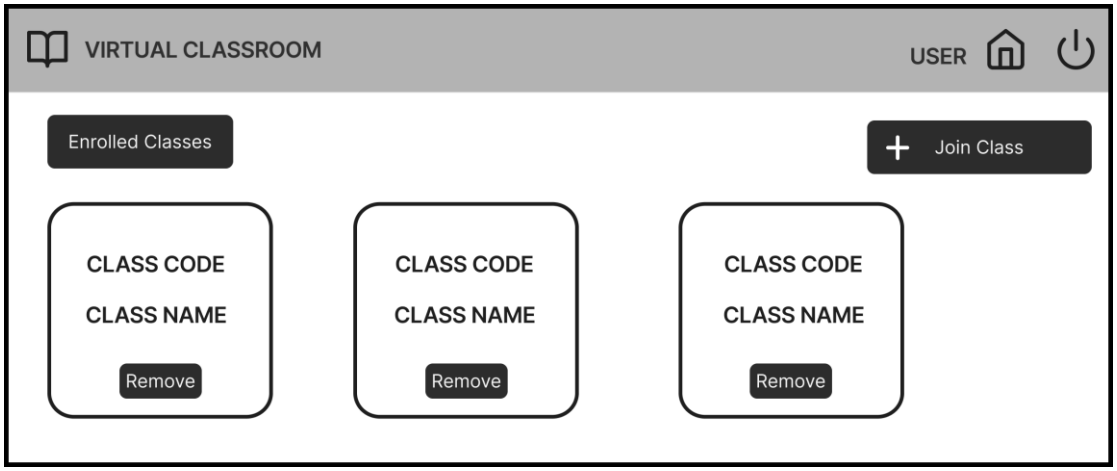


Figure 4.7.7 – Wireframe of the Student's User Panel Page (Class Management Module)

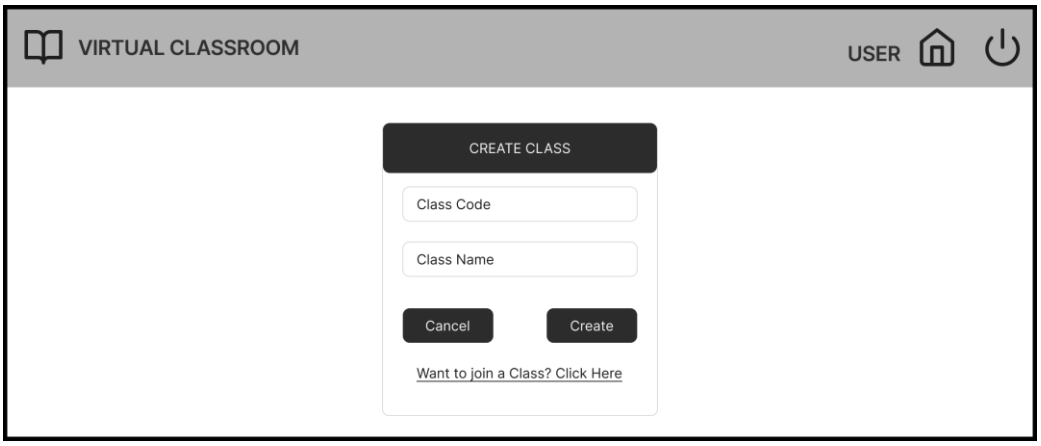


Figure 4.7.8 – Wireframe of the Instructor's Create Class Page (Class Management Module)

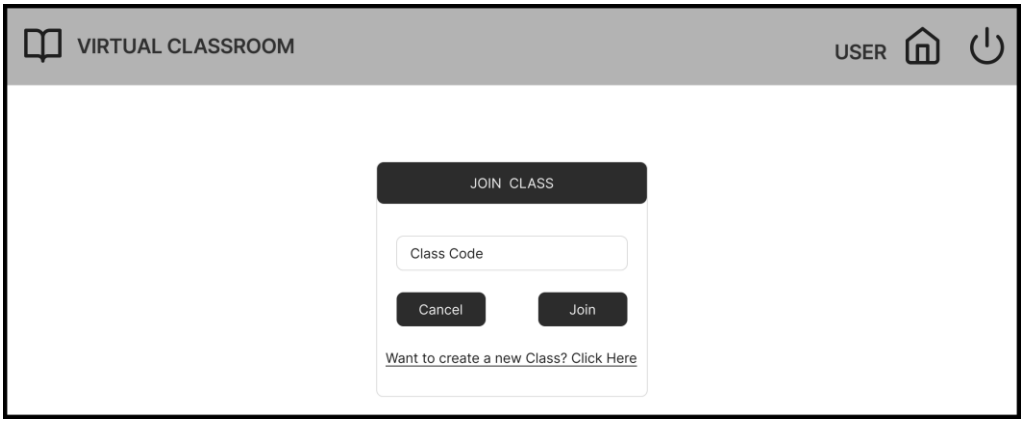


Figure 4.7.9 – Wireframe of the Student's Join Class Page (Class Management Module)

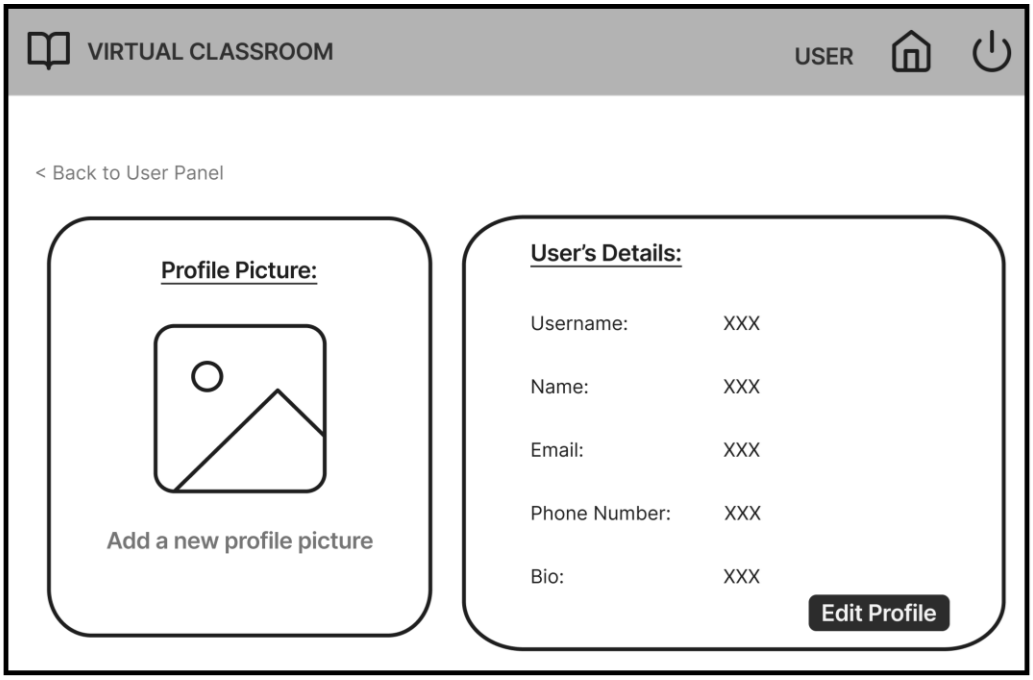


Figure 4.7.10 – Wireframe of the Profile Page (Profile Management Module)

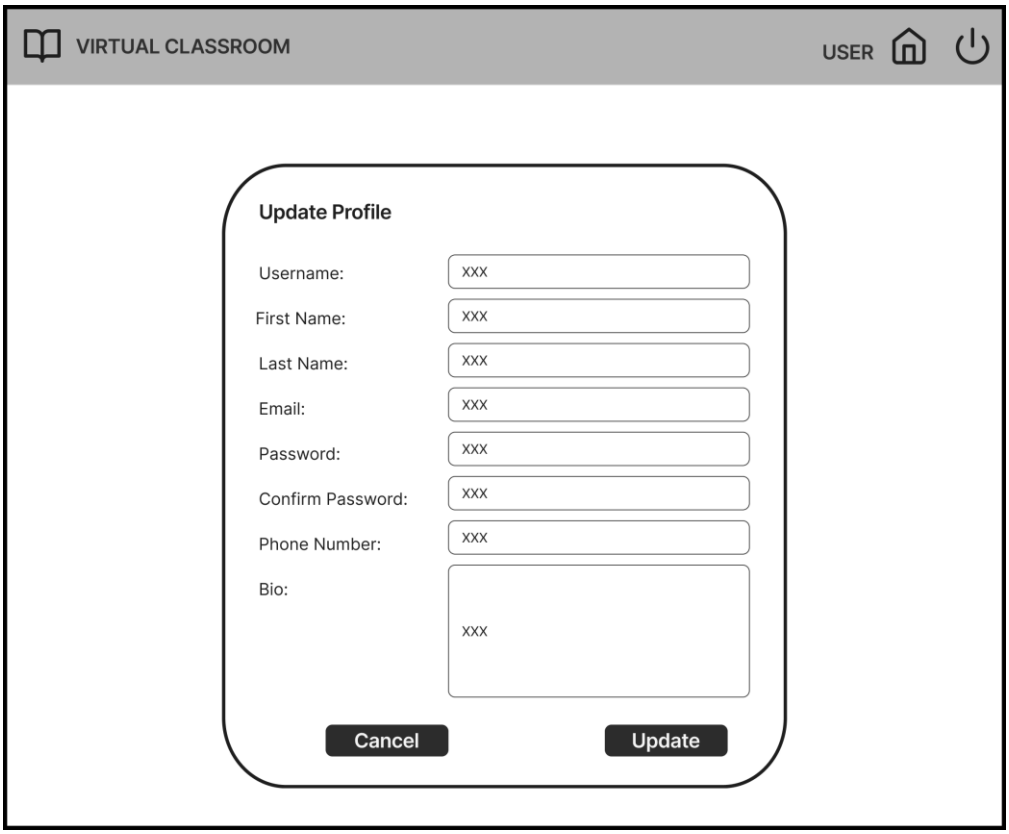


Figure 4.7.11 – Wireframe of the Profile Page Update Form (Profile Management Module)

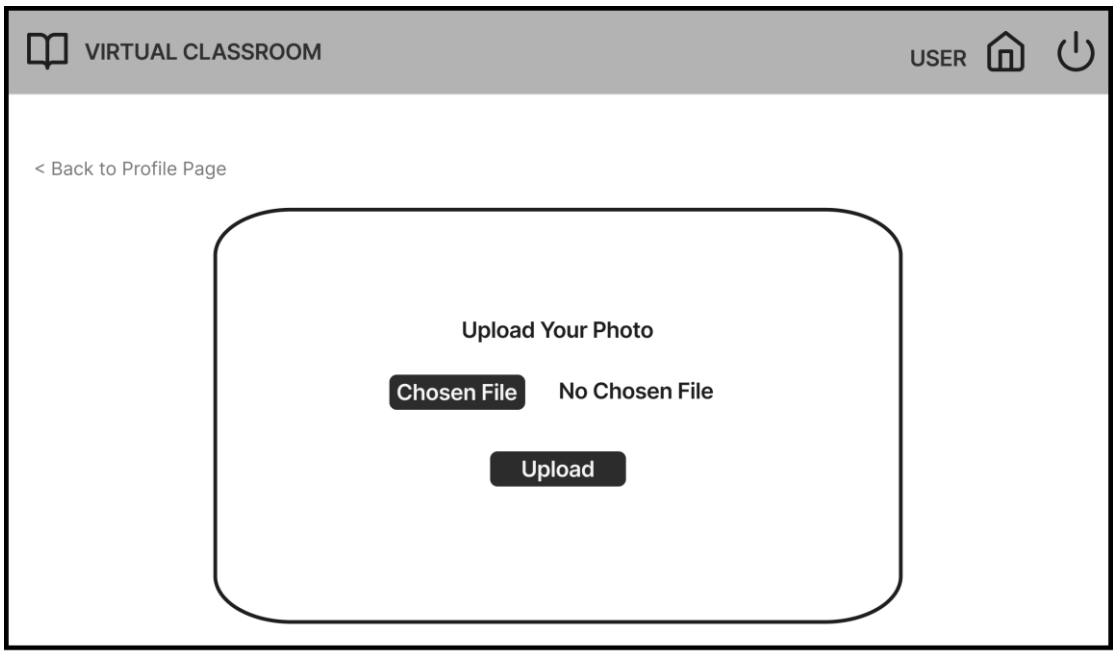


Figure 4.7.12 – Wireframe of the Profile Page Upload Profile Picture Page (Profile Management Module)

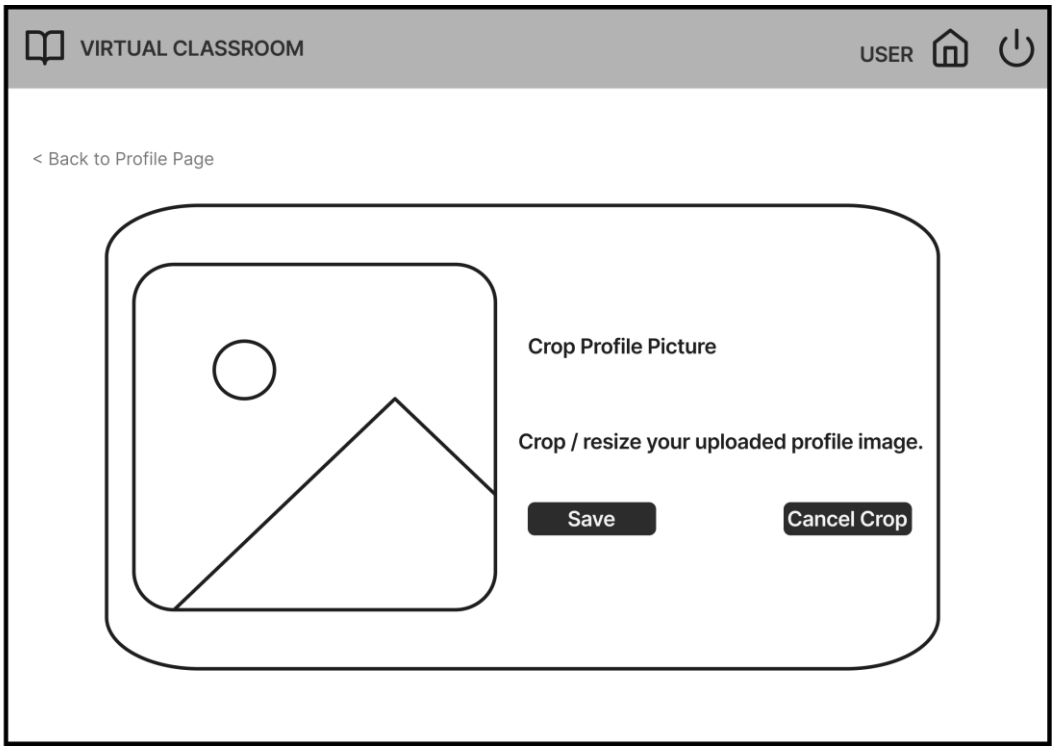


Figure 4.7.13 – Wireframe of the Profile Page Crop Profile Picture Page (Profile Management Module)

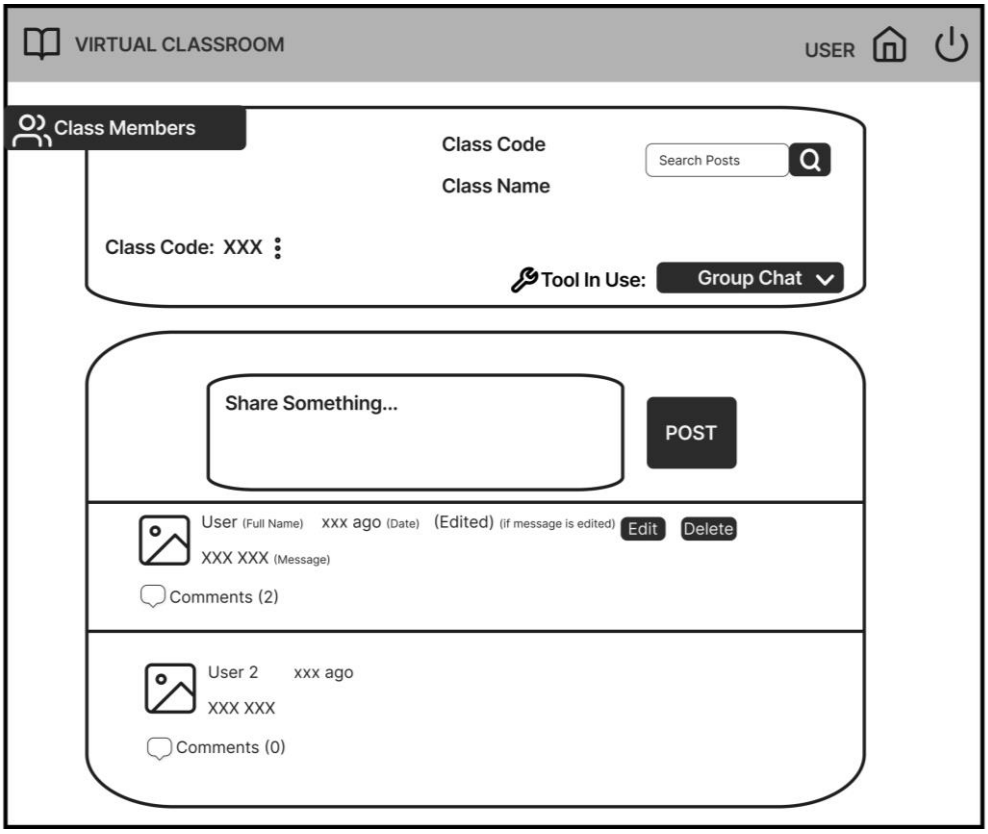


Figure 4.7.14 – Wireframe of the Instructor's Group Chat Section (Enrolled/Created Class Module)

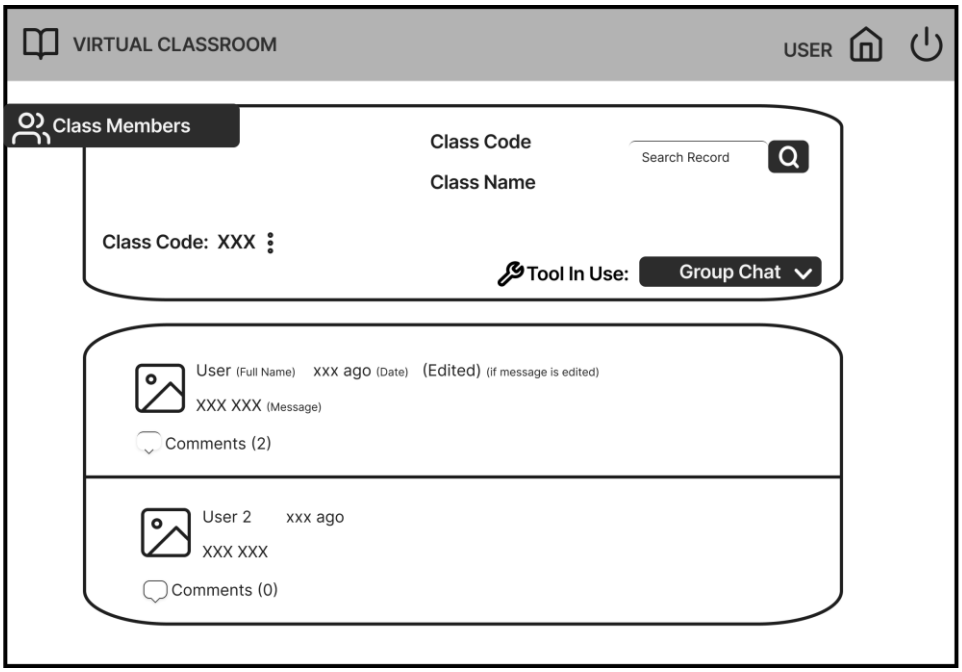


Figure 4.7.15 – Wireframe of the Student's Group Chat Section (Enrolled/Created Class Module)

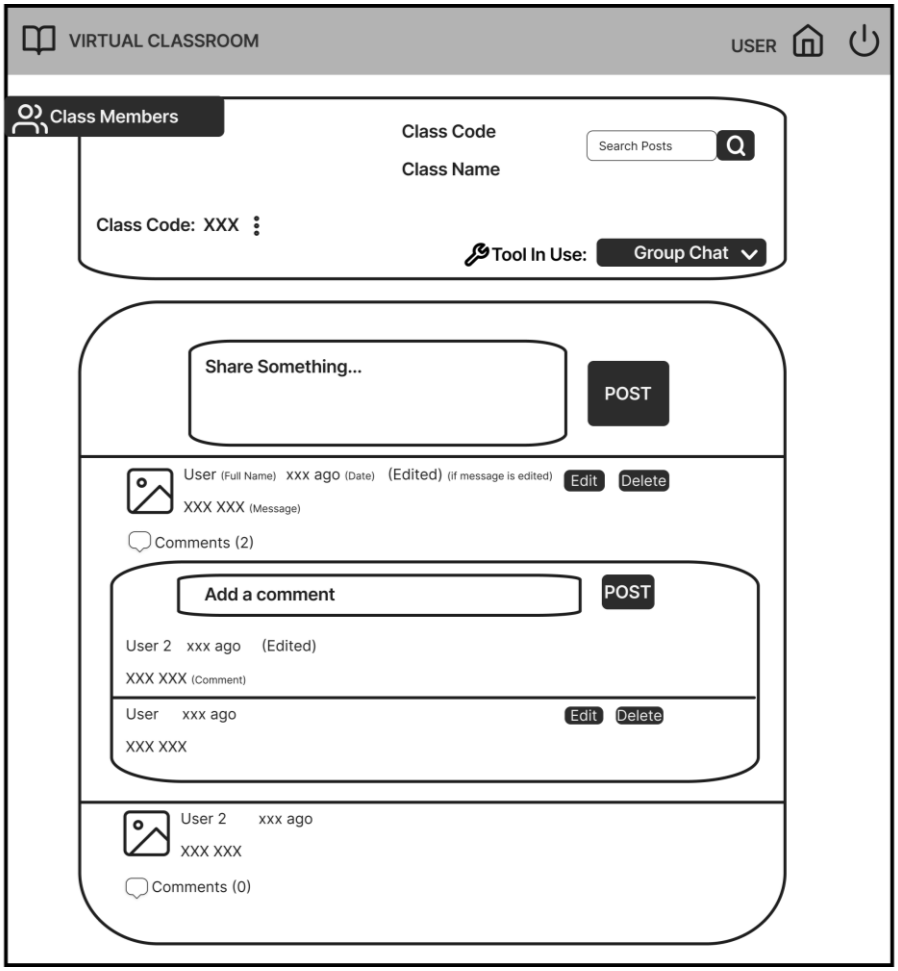


Figure 4.7.16 – Wireframe of the Instructor's Comment Section from Group Chat Section (Enrolled/Created Class Module)

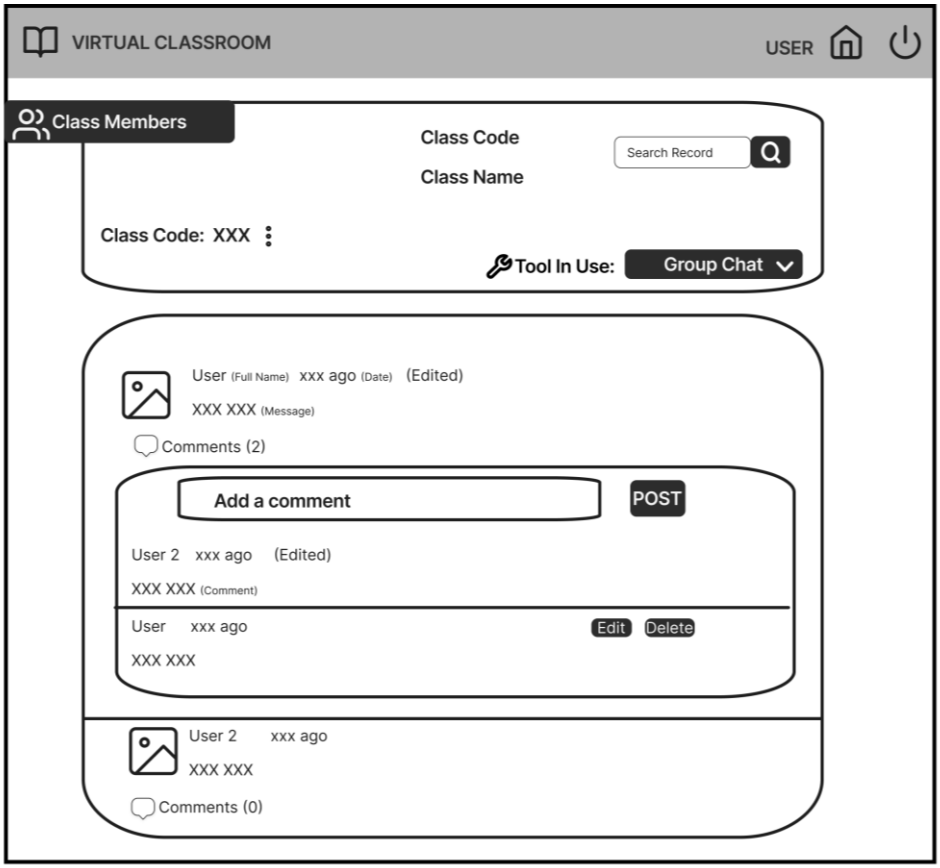


Figure 4.7.17 – Wireframe of the Student's Comment Section from Group Chat Section (Enrolled/Created Class Module)

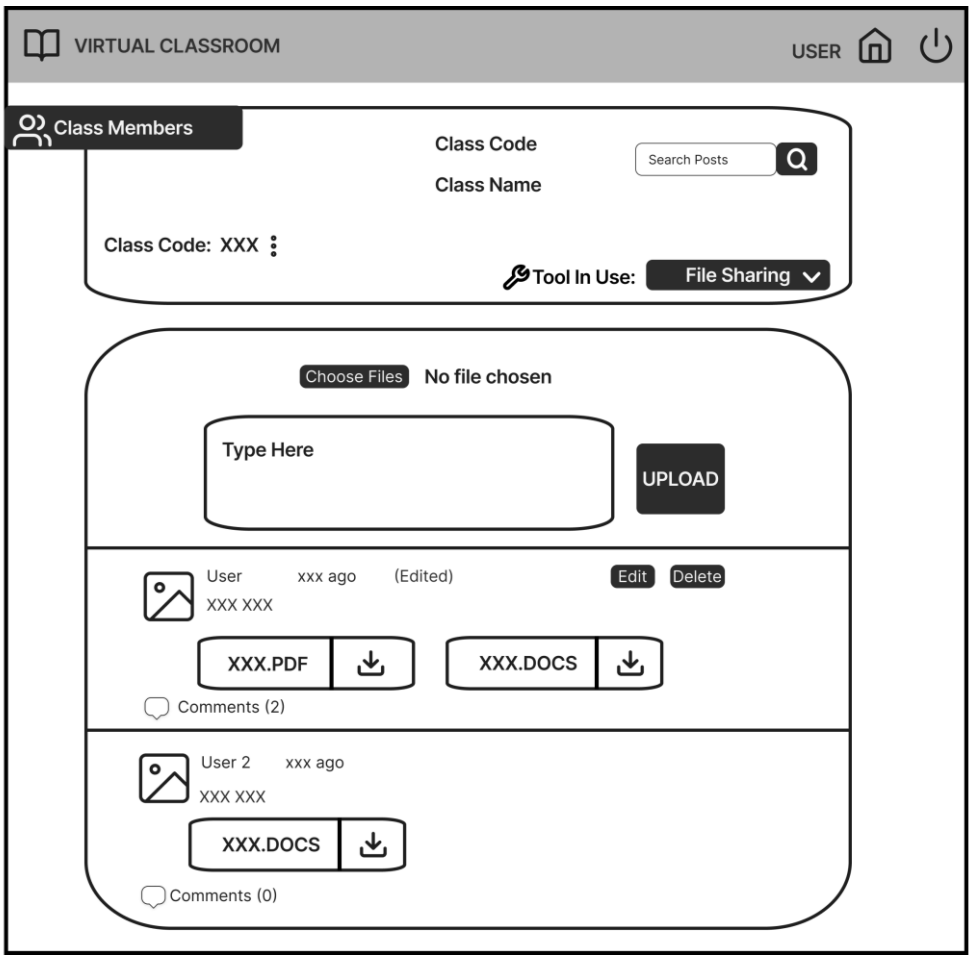


Figure 4.7.18 – Wireframe of the Instructor's File Sharing Section (Enrolled/Created Class Module)

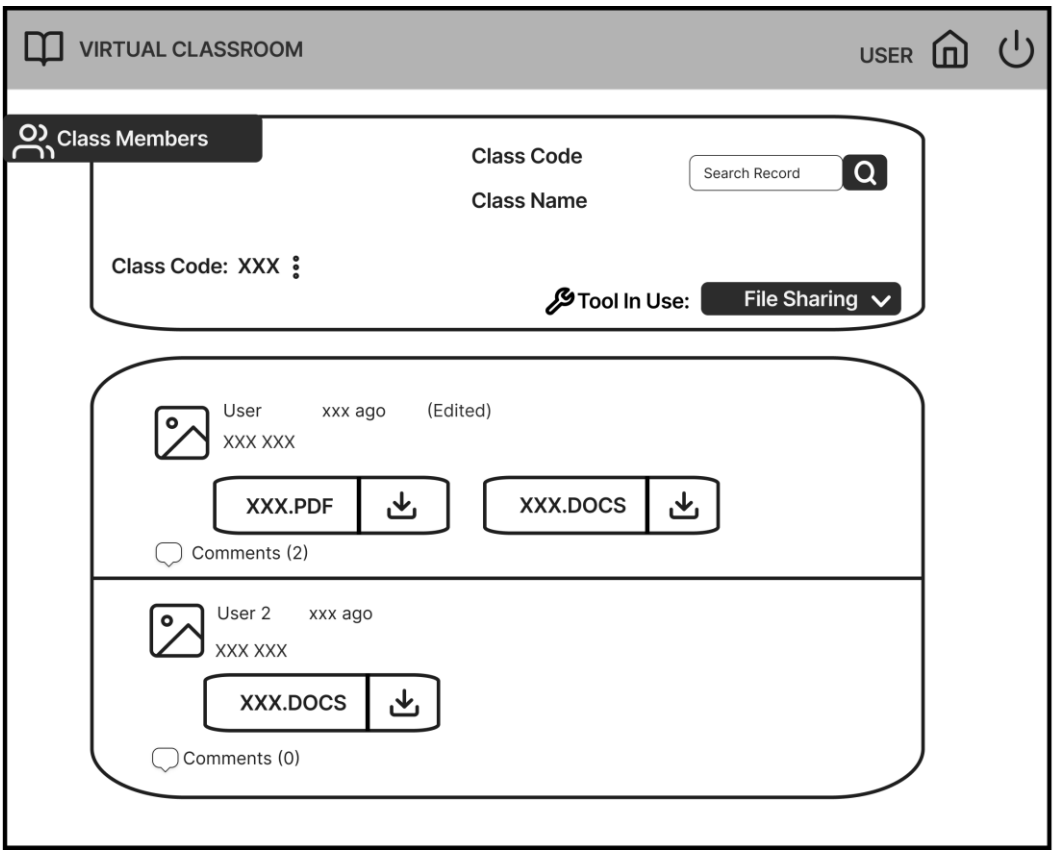


Figure 4.7.19 – Wireframe of the Student's File Sharing Section (Enrolled/Created Class Module)

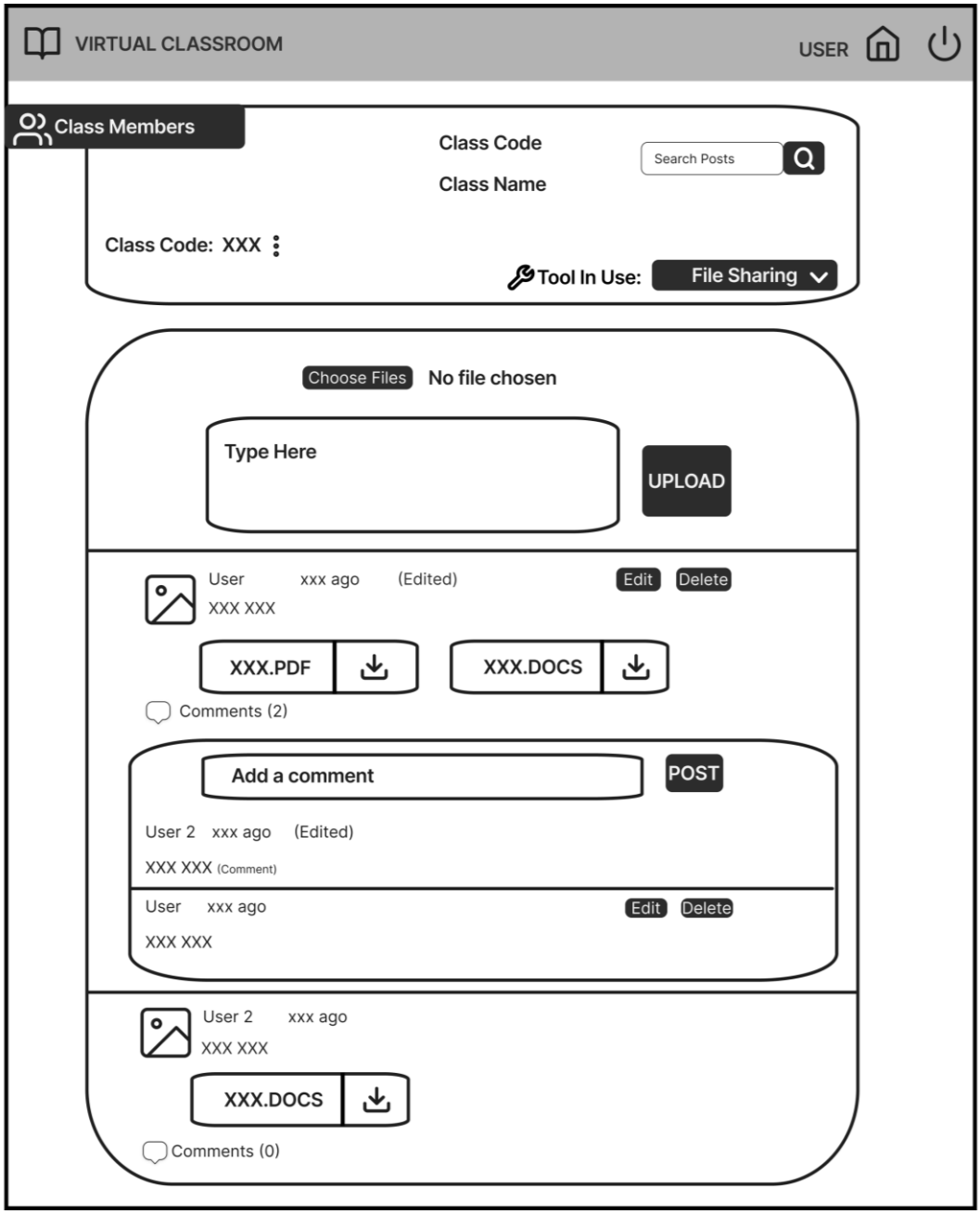


Figure 4.7.20 – Wireframe of the Instructor's Comment Section from File Sharing Section (Enrolled/Created Class Module)

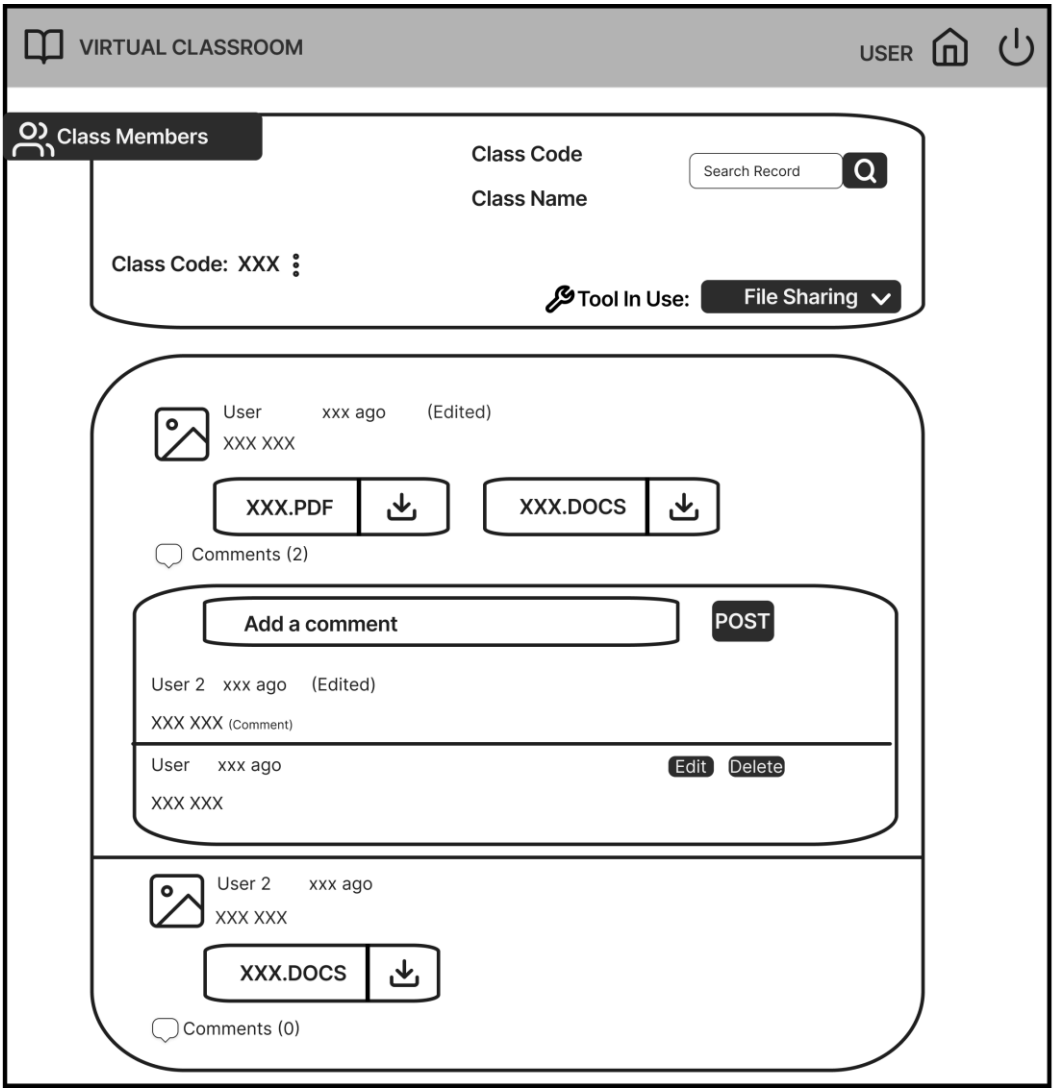


Figure 4.7.21 – Wireframe of the Instructor's Comment Section from File Sharing Section (Enrolled/Created Class Module)

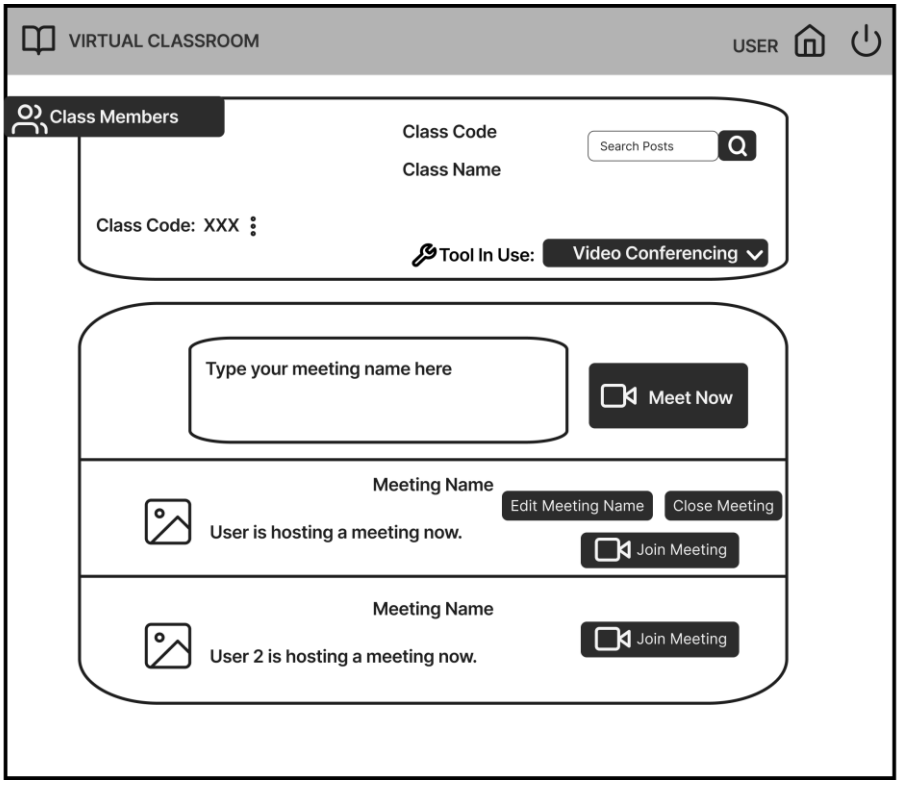


Figure 4.7.22 – Wireframe of the Instructor's Video Conferencing Section (Enrolled/Created Class Module)

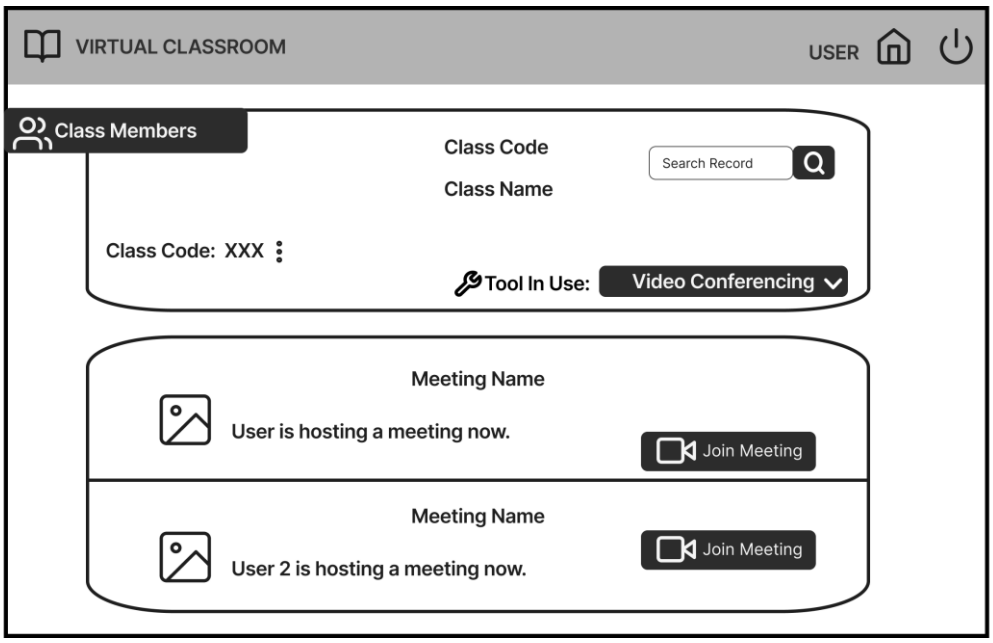


Figure 4.7.23 – Wireframe of the Student's Video Conferencing Section (Enrolled/Created Class Module)

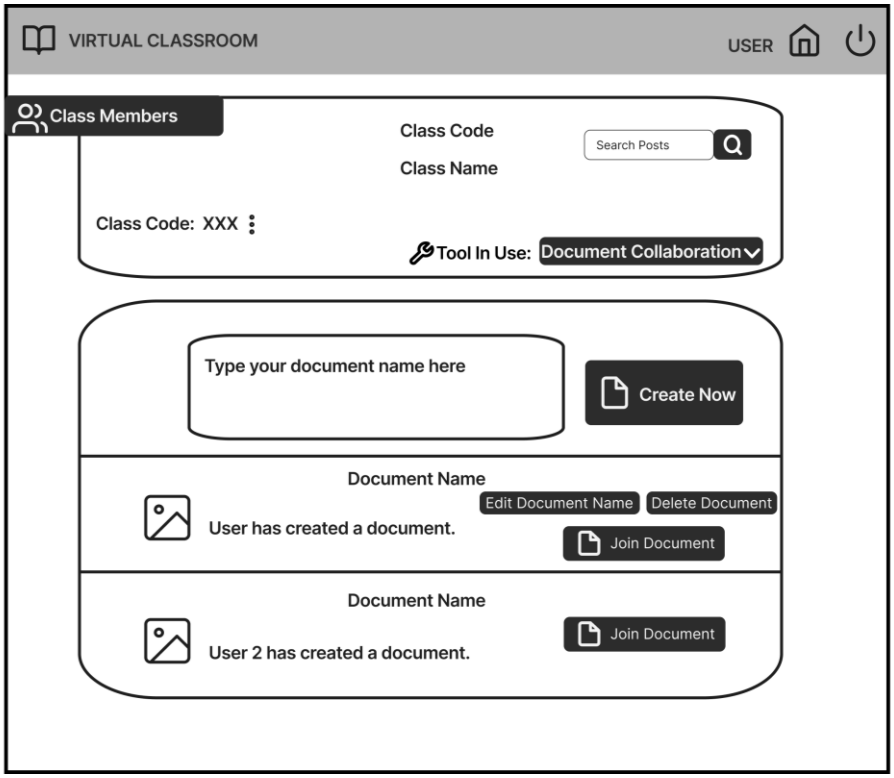


Figure 4.7.24 – Wireframe of the Instructor's Document Collaboration Section (Enrolled/Created Class Module)

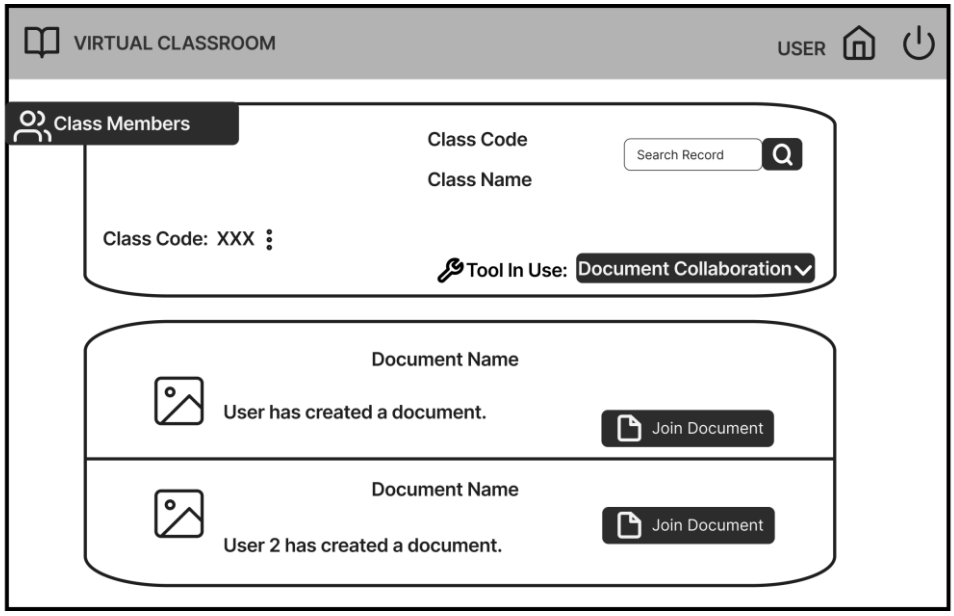


Figure 4.7.25 – Wireframe of the Student's Document Collaboration Section (Enrolled/Created Class Module)

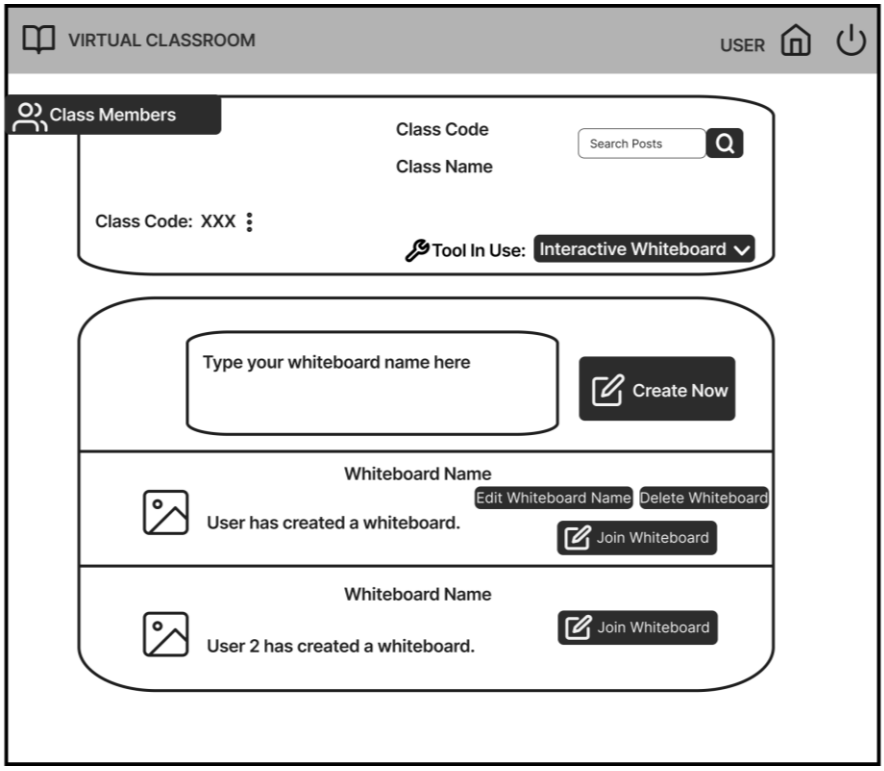


Figure 4.7.26 – Wireframe of the Instructor's Interactive Whiteboard Section (Enrolled/Created Class Module)

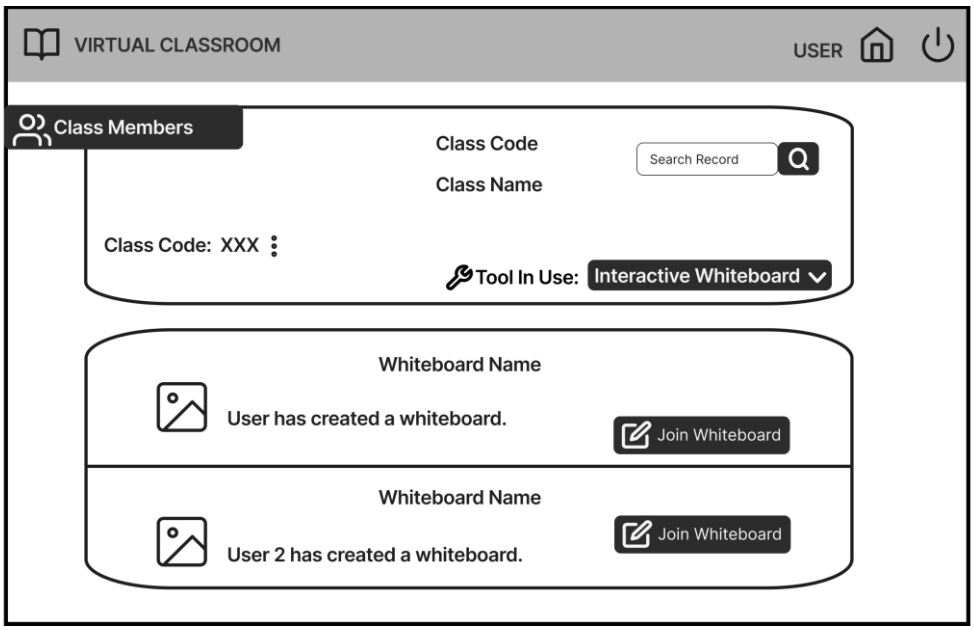


Figure 4.7.27 – Wireframe of the Student's Interactive Whiteboard Section (Enrolled/Created Class Module)

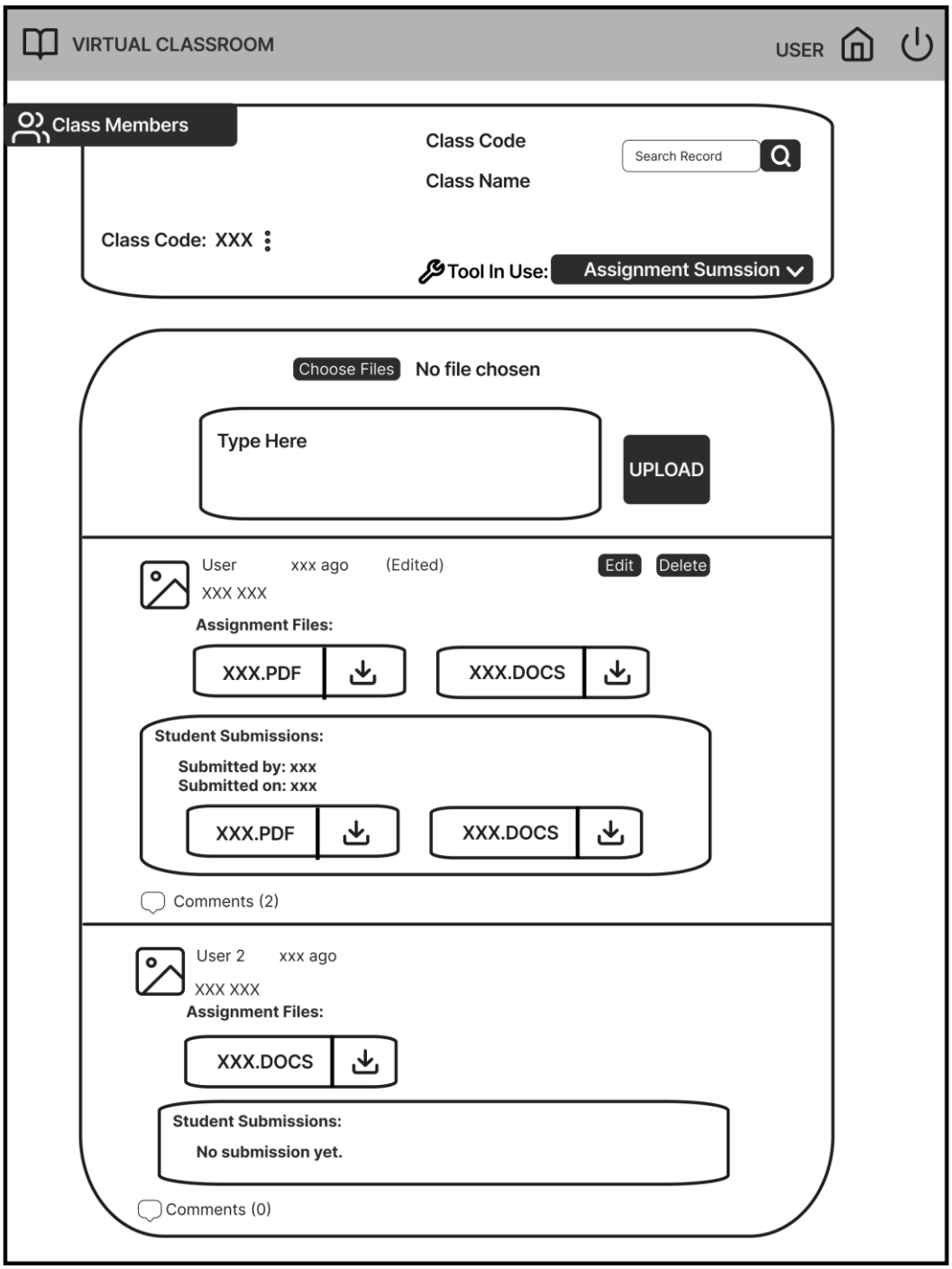


Figure 4.7.28 – Wireframe of the Instructor's Assignment Submission Section (Enrolled/Created Class Module)

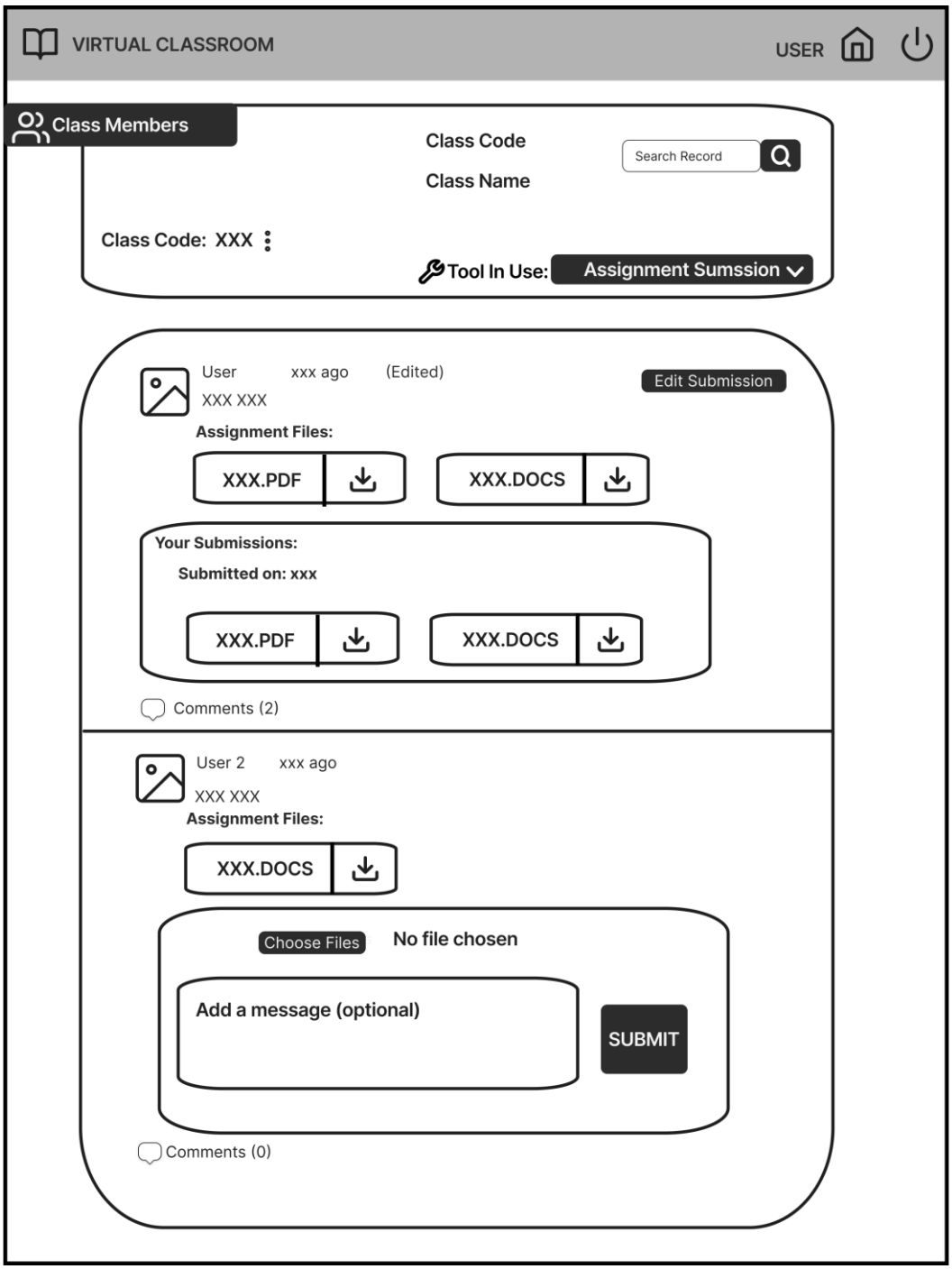


Figure 4.7.29 – Wireframe of the Student's Assignment Submission Section (Enrolled/Created Class Module)

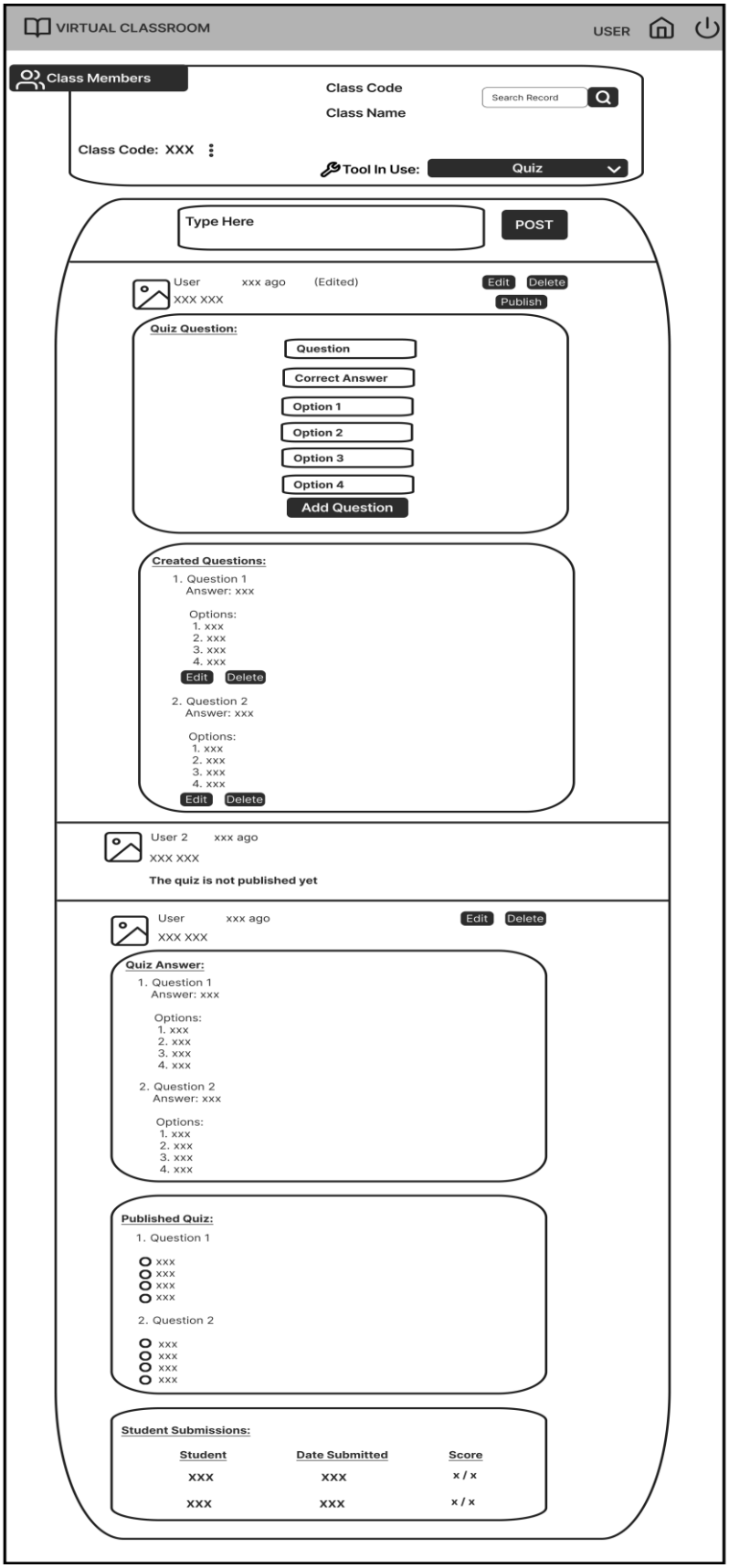


Figure 4.7.30 – Wireframe of the Instructor's Quiz Section (Enrolled/Created Class Module)

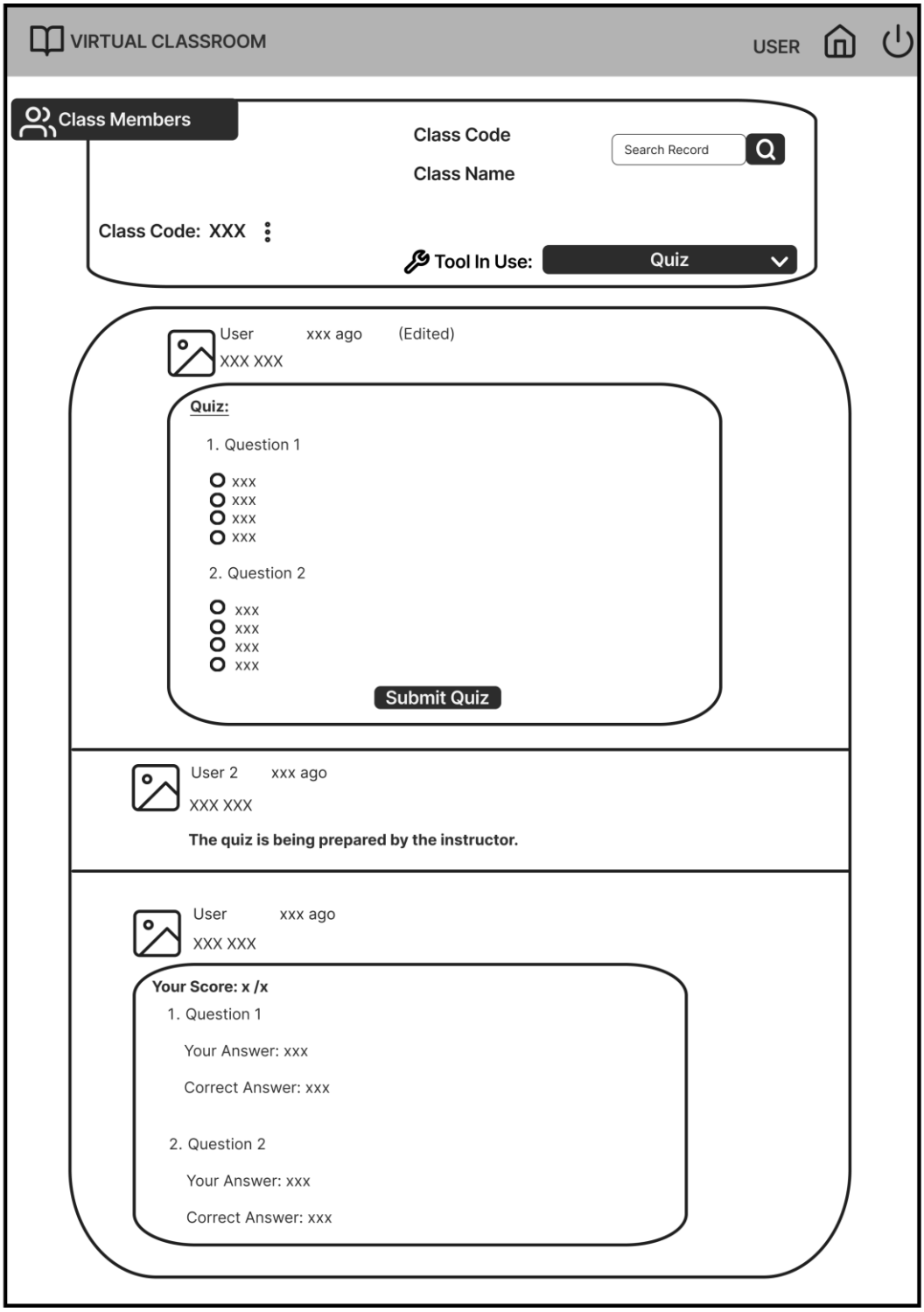


Figure 4.7.31 – Wireframe of the Student's Quiz Section (Enrolled/Created Class Module)

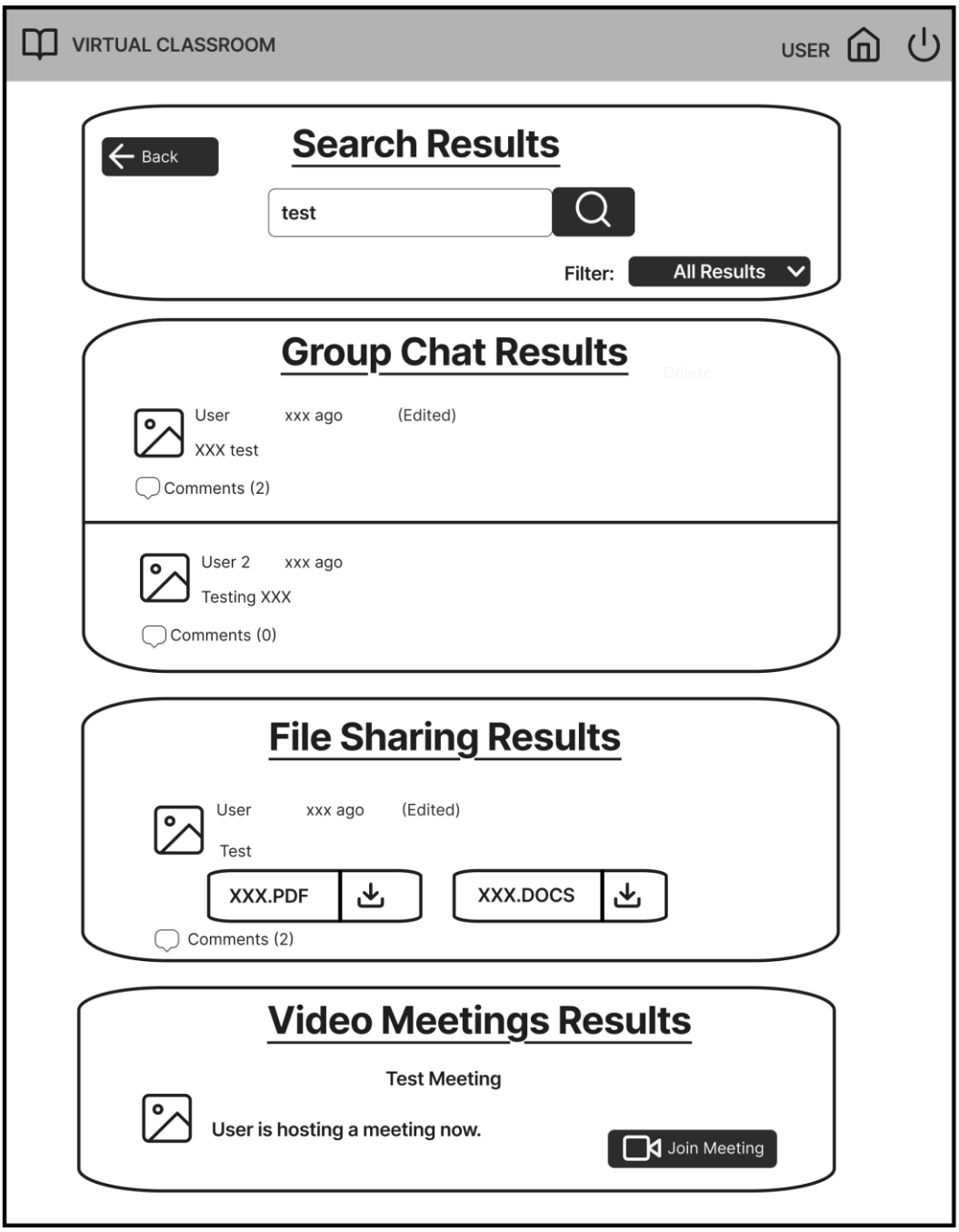


Figure 4.7.32 – Wireframe of the Search Results Page (Enrolled/Created Class Module)

All the wireframes are created to reflect the user-centric design emphasized in the proposed method, offering an intuitive experience to users.

4.8 Storyboard and Description

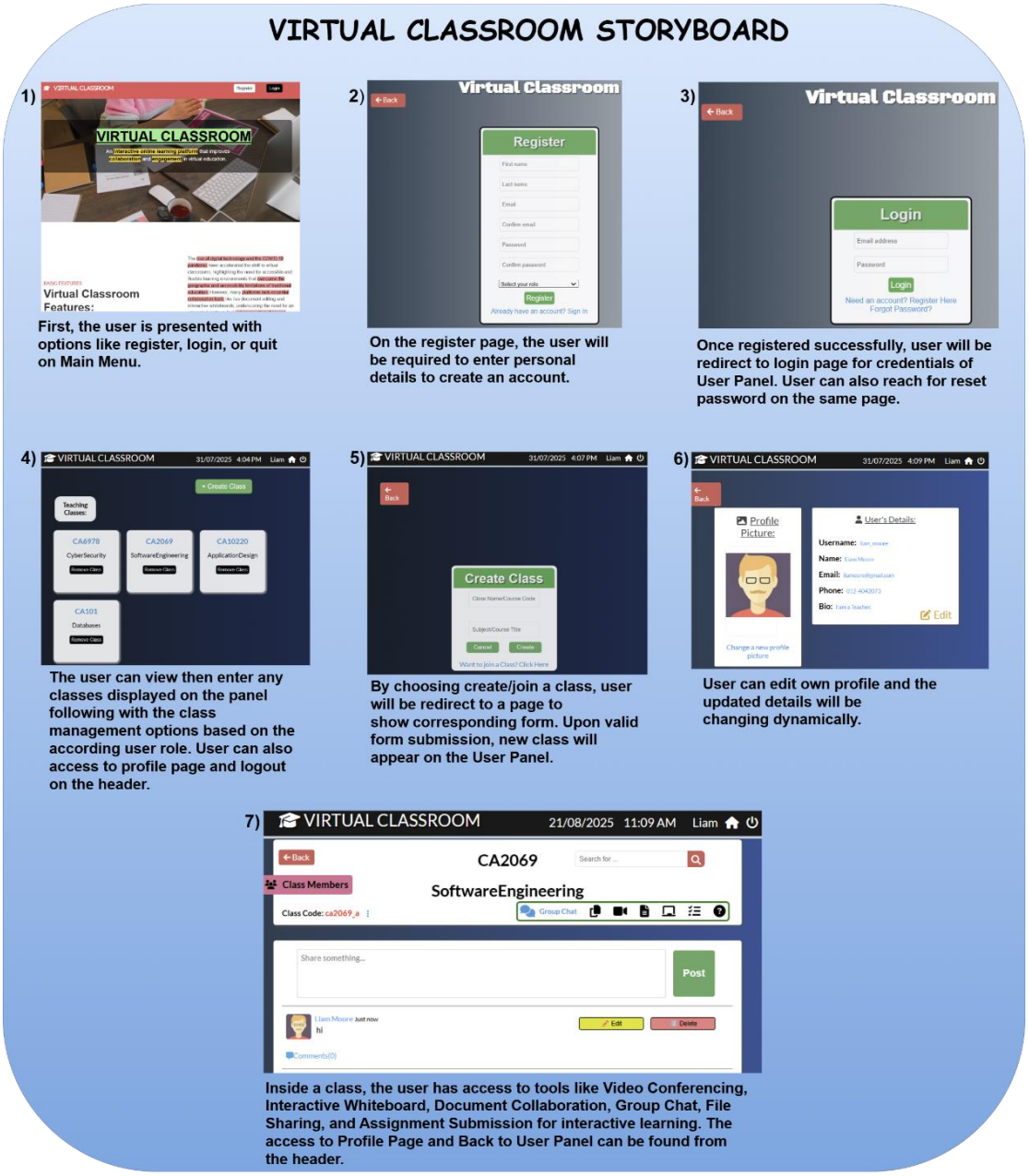


Figure 4.8.1 – Storyboard

The virtual classroom platform begins with the Main Menu, where users can select to either Register, Login, or Quit. If they select Register, they are taken to a registration form where they enter personal details. Once registered, they are brought to the Login screen to provide their credentials. If the credentials are correct, they gain access to the User Panel, otherwise, they have the option to reset their password by following the password recovery process. Upon entering the User Panel, users are presented with their current Enrolled or Created Classes, with the display and available options dynamically adjusted based on their role. Students can view and join classes they are enrolled in or leave them, while instructors can access classes they have created or joined and are provided with additional options such as Create a Class and Remove a Class. If the user chooses to create or join a class, they are led to a corresponding form where they can proceed with their intended action by inserting the correct inputs. Newly created/joined classes will be displayed on the User Panel dynamically. Users can also access their profile to view or alter their personal details from the header section of the User Panel. By selecting a class from the User Panel, users can access their corresponding Enrolled/Created Class Page, which offers various collaboration tools like Video Conferencing, Interactive Whiteboard, Live Document Collaboration, Group Chat, File Sharing, Assignment Submission, and Quiz, enabling them to participate in live sessions, collaborate with classmates, and more. Users can return to the User Panel at any time by selecting the Back to User Panel option from the header section. If they wish to log out, they can click Logout from the header, which returns them to the Main Menu. This comprehensive flow ensures a streamlined experience for users from registration to active participation in their virtual classroom.

CHAPTER 5

System Implementation

5.1 Hardware Setup

To ensure equal access for all users to the virtual lecture hall and classrooms, the system will be developed for desktop platforms. This means that users will only need a desktop or laptop to fully utilize the system.

5.2 Software Setup

5.2.1 Setup for Visual Studio Code

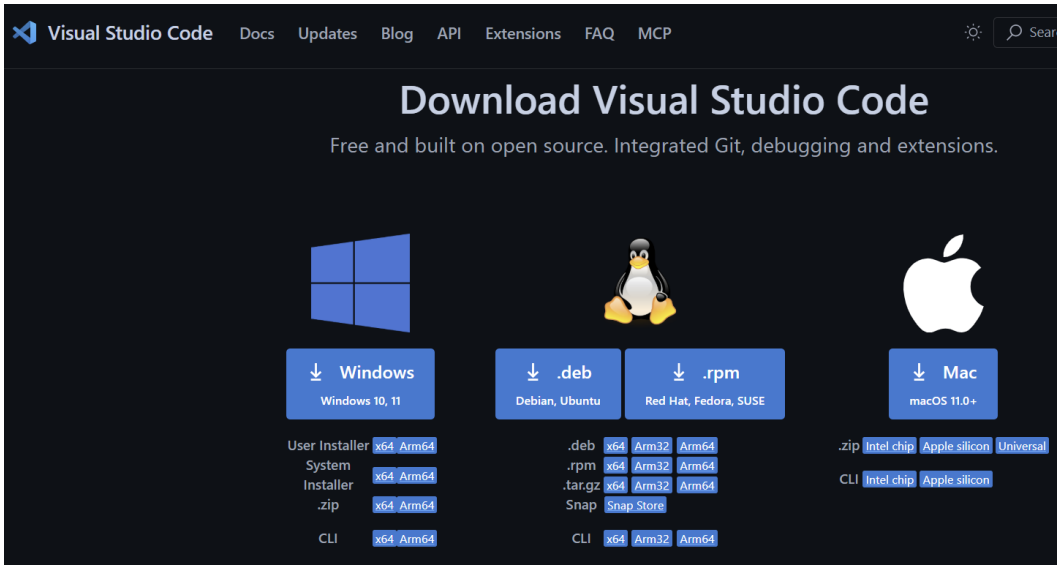


Figure 5.2.1 – Visual Studio Code Installation Page

Figure 5.2.2 – Visual Studio Code Setup

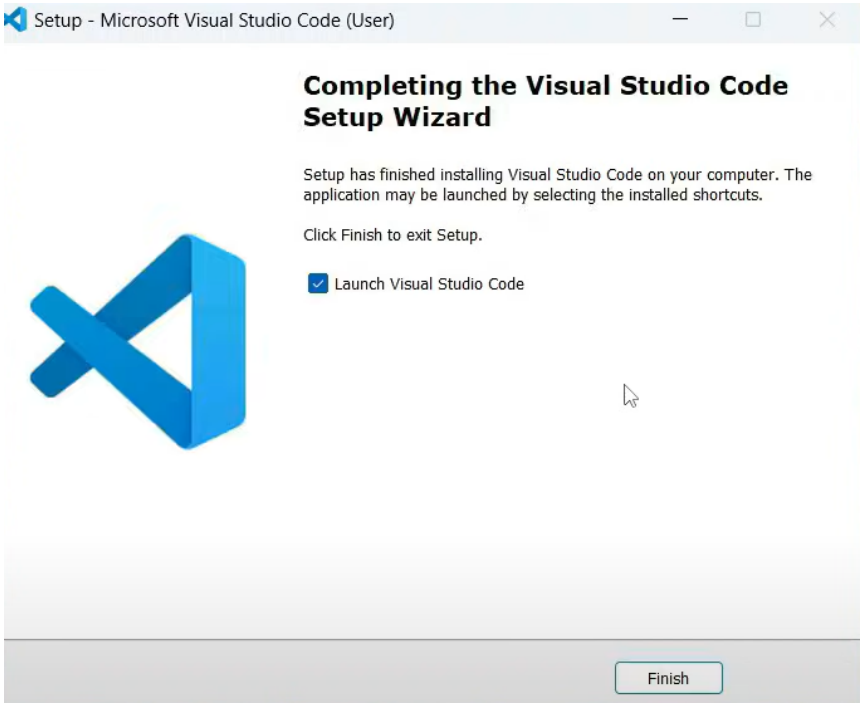


Figure 5.2.3 – Visual Studio Code Setup Wizard

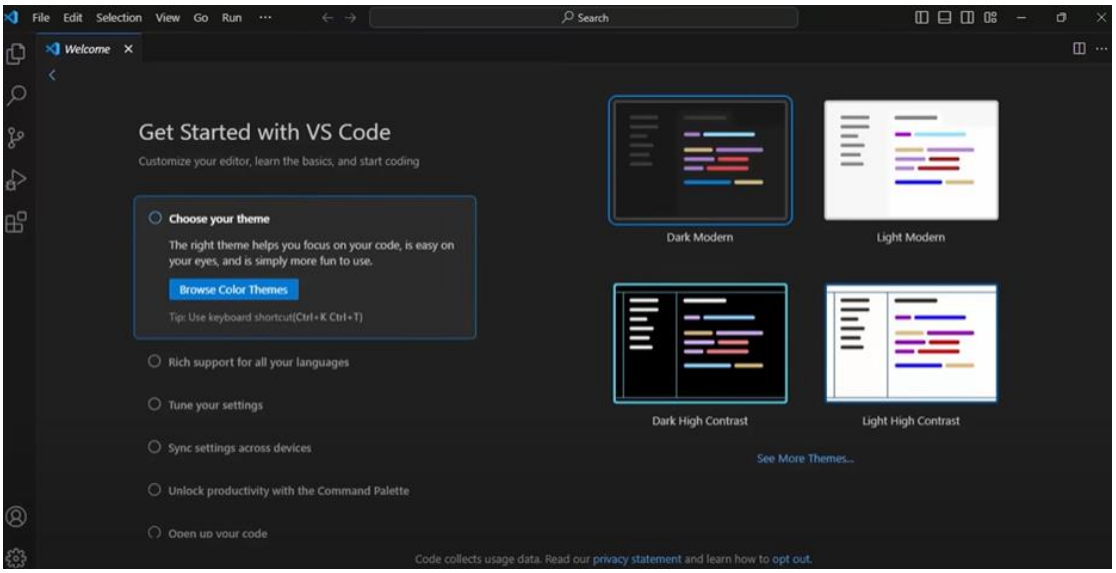


Figure 5.2.4 – Visual Studio Code Menu

Visual Studio Code is the first tool that needs to be installed. It's a source-code editor used for writing, debugging, and managing both frontend and backend code. To install, browse the official Visual Studio Code website (https://code.visualstudio.com/Download), download the latest version for the operating system, and run the Visual Studio Code Installer for further setup. Upon successful installation, the software is ready to be utilized.

5.2.2 Setup for XAMPP

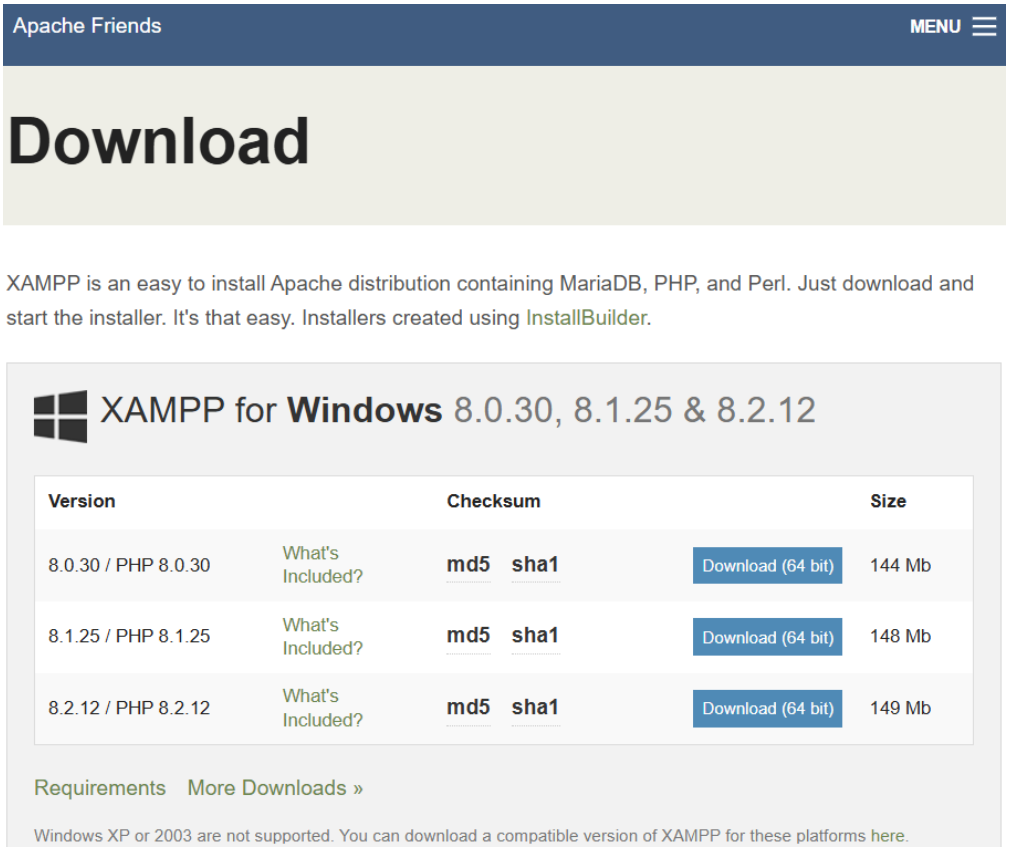


Figure 5.2.5 – XAMPP Installation Page

Figure 5.2.6 – XAMPP Setup

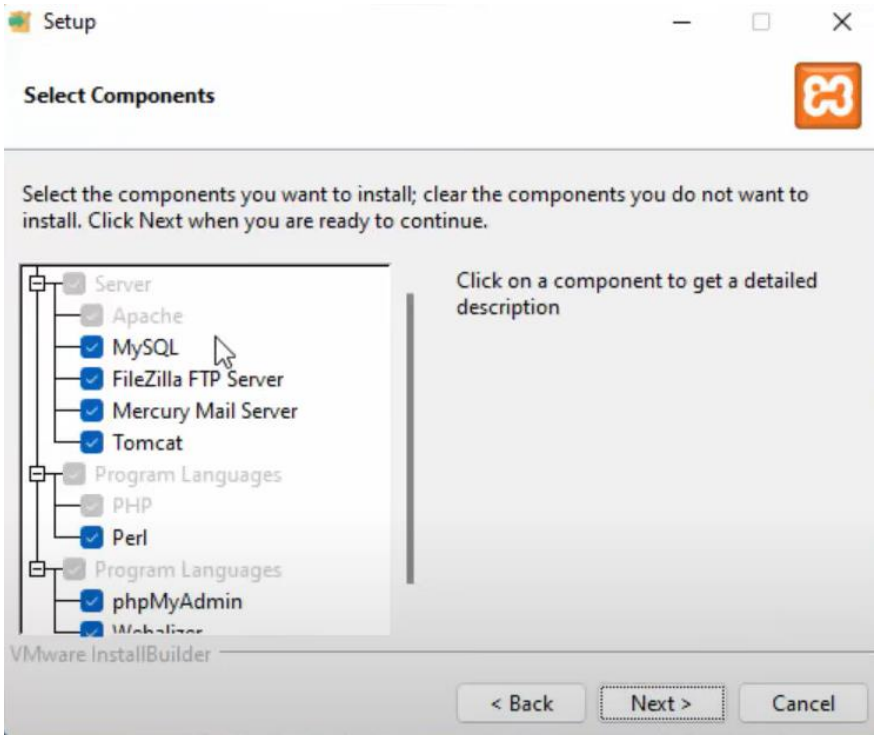


Figure 5.2.7 – XAMPP Setup Components

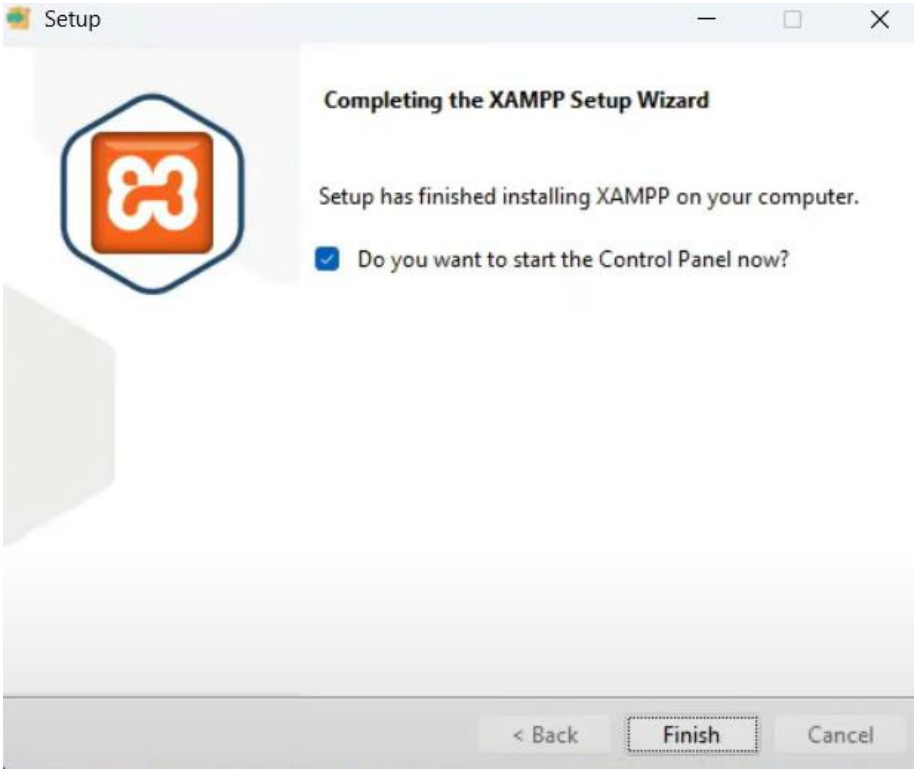


Figure 5.2.8 – XAMPP Setup Wizard

Figure 5.2.9 – XAMPP Menu

Next is XAMPP, a no-cost and open-source solution that offers Apache, MySQL, and PHP in a single package for developing websites locally. To setup XAMPP, go to the official XAMPP website and download the installer for the operating system (https://www.apachefriends.org/download.html). During the setup process, make sure that Apache, MySQL, and PHP are contained in the components that will be installed. After installation, run the XAMPP Control Panel and set off the Apache and MySQL services to run the local server and database management system. XAMPP can be confirmed to be set up correctly by navigating to http://localhost in your browser. To manage MySQL databases, phpMyAdmin can be used at http://localhost/phpmyadmin.

5.2.3 Setup for Node.js

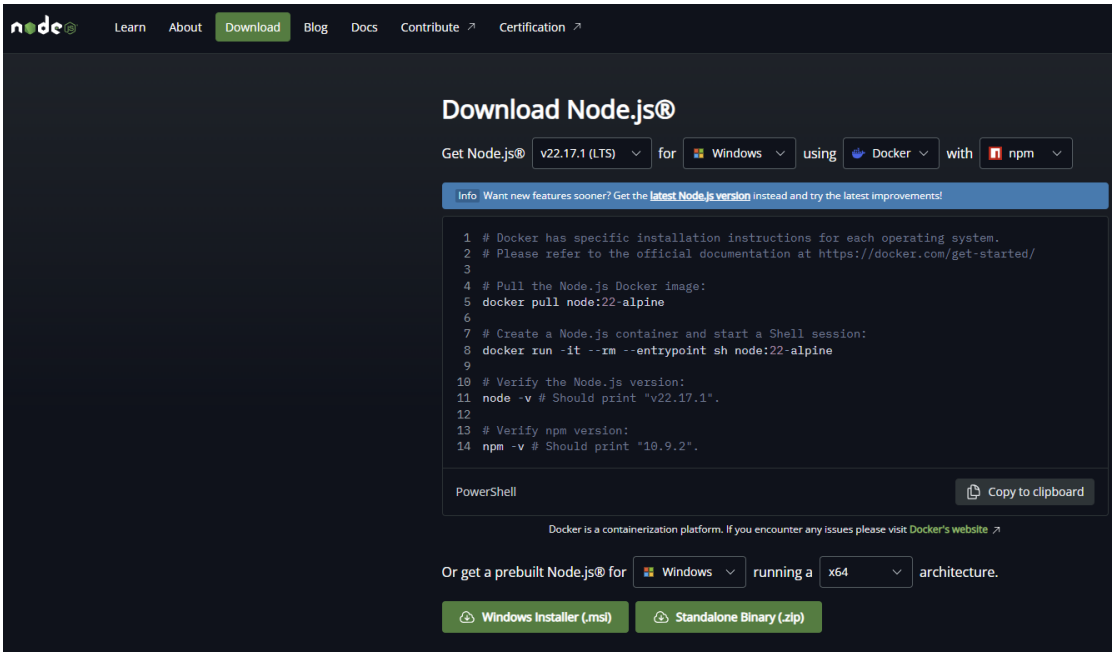


Figure 5.2.10 – Node.js Installation Page

Figure 5.2.11 – Node.js Setup

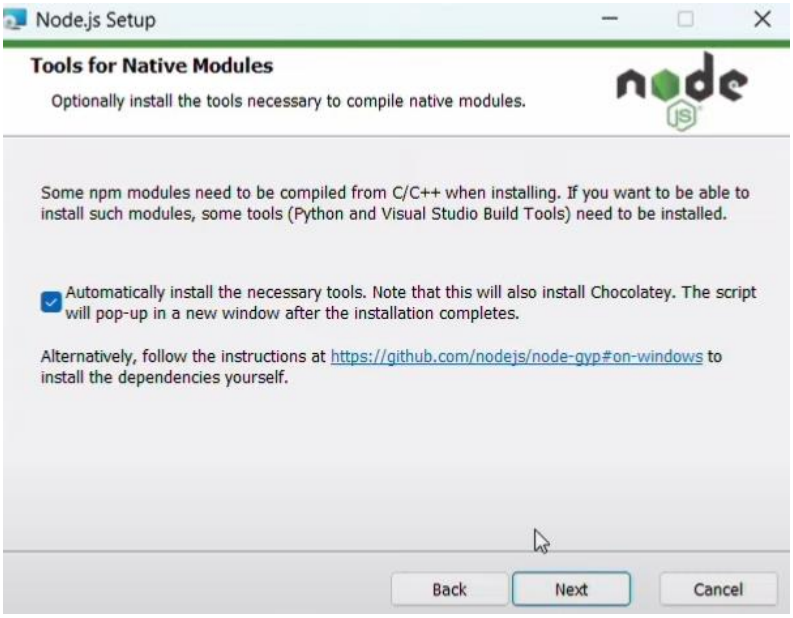


Figure 5.2.12 – Node.js Setup Tools Installation

Figure 5.2.13 – Node.js Setup Wizard

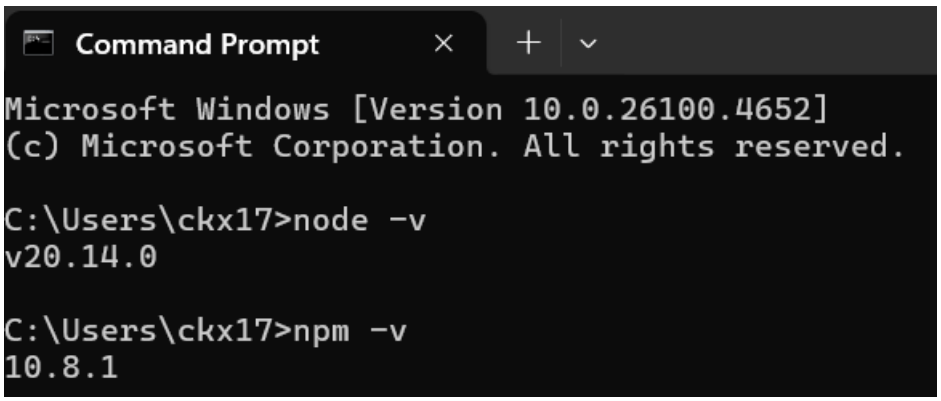


Figure 5.2.14 – Node.js Installation Confirmation

To kick off with Node.js, begin by heading to the official Node.js website and choose the version (https://nodejs.org/en/download). Select the prebuilt version to install on the operating system instead of the LTS (Long Term Support) version and the Current version. After downloading the installer for the operating system, launch the file and proceed with on-screen prompts to finish the setup. During the installation, confirm that the option to install npm (Node Package Manager) is checked, as it is an essential tool for managing packages in Node.js. After completing the installation, confirm the installation by launching a terminal or command prompt and entering 'node -v' to check the installed version of Node.js, and 'npm -v' to verify the installed version of npm. These commands should display the current version numbers of Node.js and npm, confirming that the installation was successful.

5.2.4 Setup for Composer

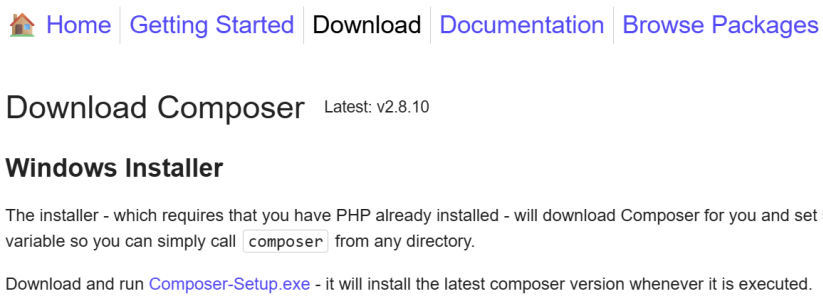


Figure 5.2.15 – Composer Installation Page

Figure 5.2.16 – Composer Setup

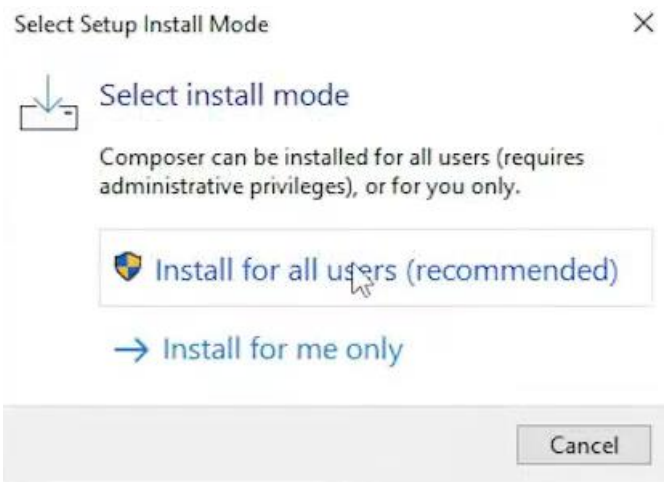


Figure 5.2.17 – Composer Setup Install Mode

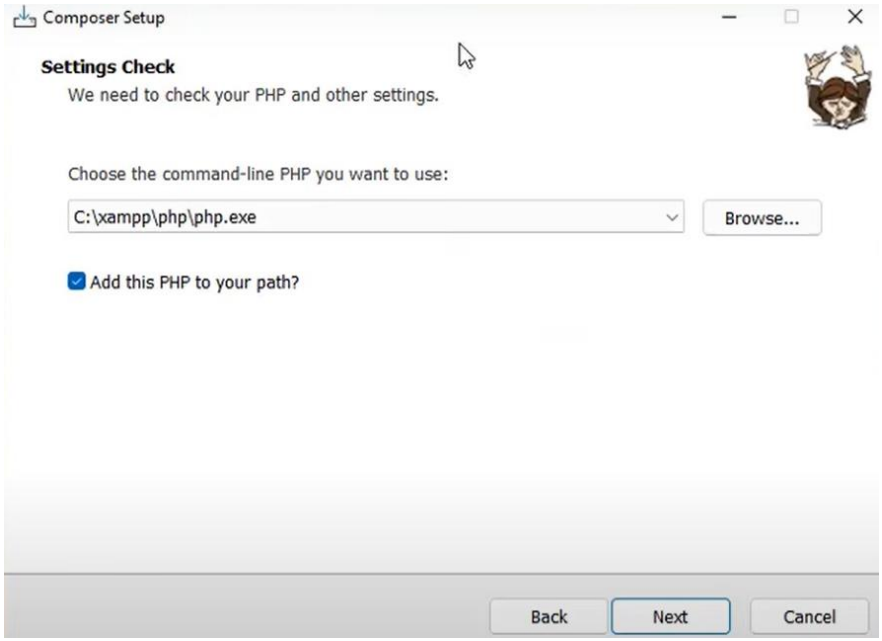


Figure 5.2.18 – Composer Setup Settings Check

Figure 5.2.19 – Composer Setup Wizard

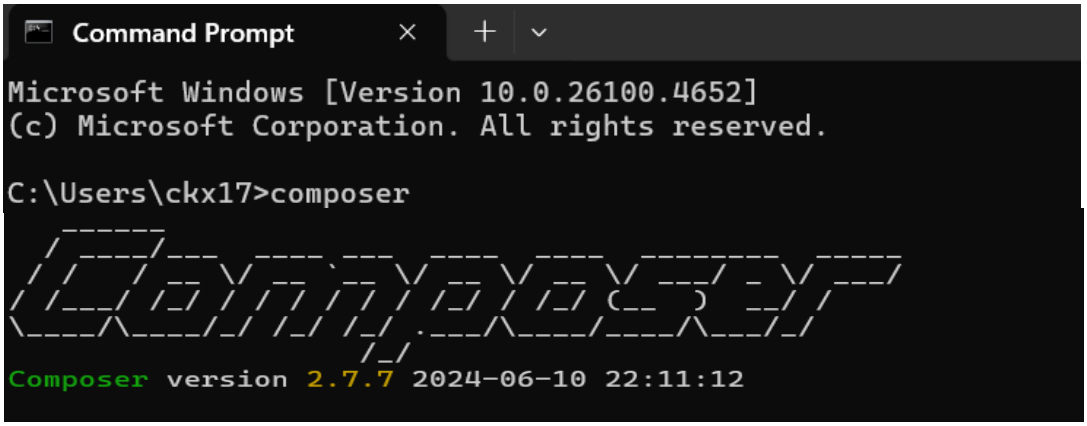


Figure 5.2.20 – Composer Installation Confirmation

To setup Composer, which is a dependency manager for PHP, visit the official Composer website (https://getcomposer.org/download/). Composer allows for managing project libraries and packages, making it easier to handle dependencies in any PHP projects. To begin, download the Composer installer for the operating system from the website. After installing Composer, verify that it's correctly installed by opening a terminal and typing 'composer'. This should display the version number of Composer, confirming that the installation was successful.

5.2.5 Setup for Socket.IO

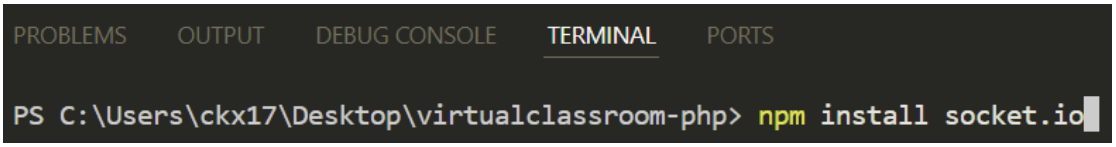


Figure 5.2.21 – Socket.IO Installation

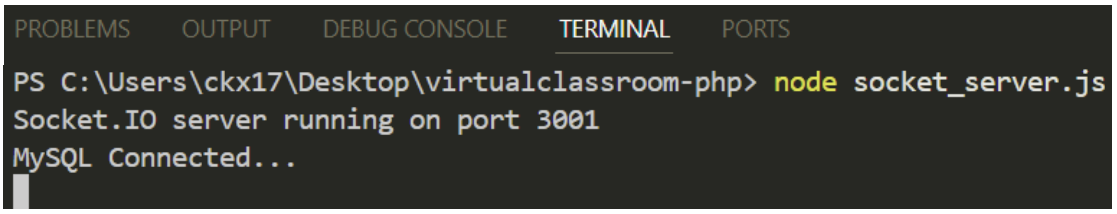


Figure 5.2.22 – Socket.IO Execution

To implement real-time communication, Socket.IO will need to set up on the project through the terminal of Visual Studio Code. It allows for real-time, two-way communication between the server and clients. To install it, first make sure to have Node.js installed. Then, run the 'npm install socket.io' command in the target project directory, which will install the latest version of Socket.IO. In the server script, a simple server can be created to listen for connections, then run 'node socket_server.js' on terminal to apply the real-time effect.

5.2.6 Setup for PHPMailer

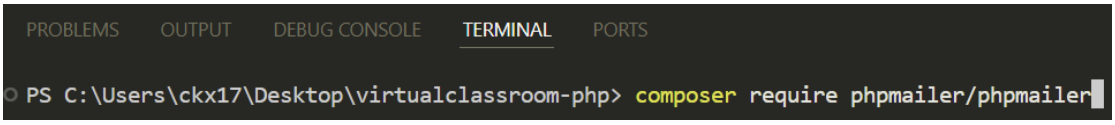


Figure 5.2.23 - PHPMailer Installation

For email functionality such as password recovery, PHPMailer will be utilized, as it is a popular PHP library for transmitting emails. To set up PHPMailer, first install it on the terminal of Visual Studio Code with 'composer require phpmailer/phpmailer'. After installation, emails can be sent by configuring SMTP settings to create and send an email message.

5.2.7 Setup for FilePond

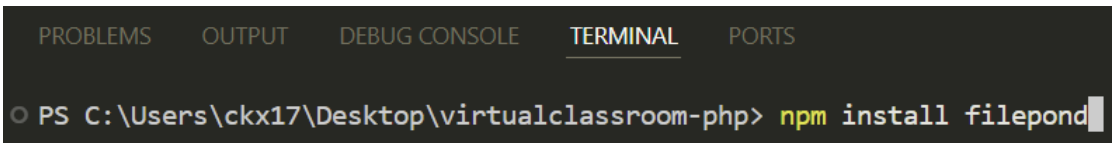


Figure 5.2.24 – FilePond Installation

For file upload functionality, FilePond is selected as it offers a smooth and user-friendly file upload interface with features like drag-and-drop support and progress indicators. To integrate FilePond into the project, install it on the terminal from Visual Studio Code with 'npm install filepond'. Then, initialize FilePond in JavaScript code, making sure to target the file input element where users can select files to upload.

5.2.8 Setup for Jitsi Meet

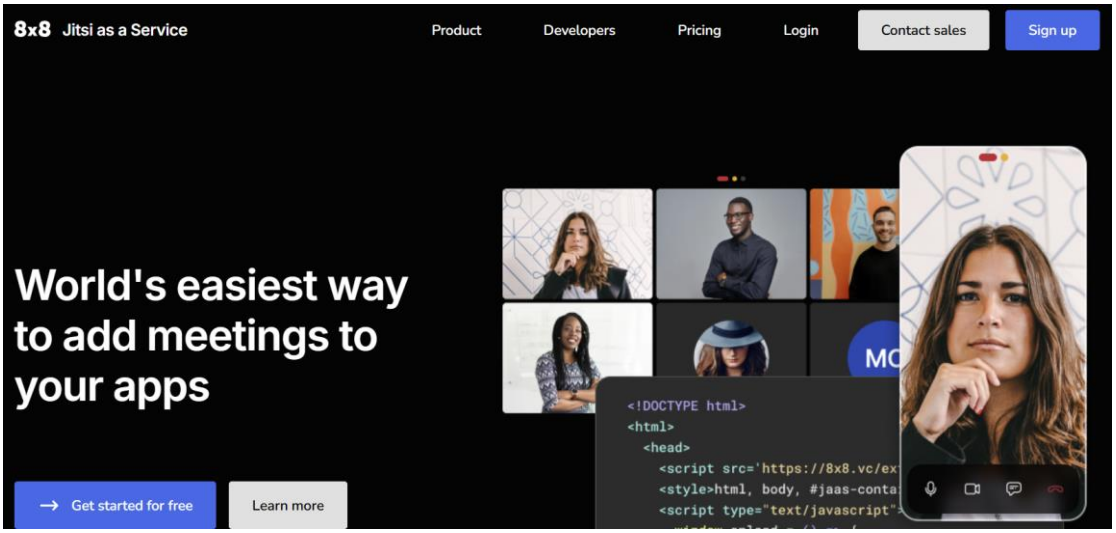


Figure 5.2.25 – Jitsi as a Service (JaaS) HomePage

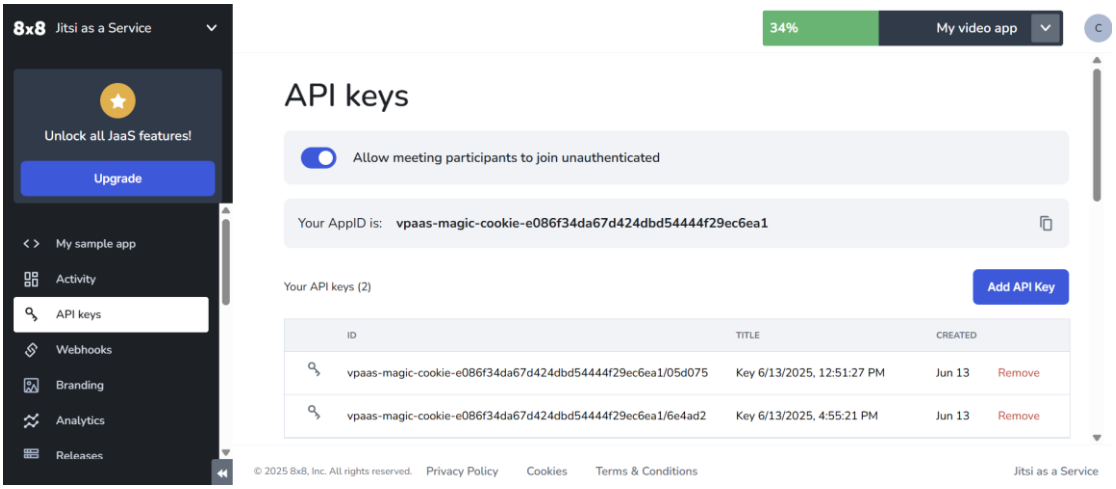


Figure 5.2.26 – Jitsi as a Service (JaaS) API keys Page

Jitsi Meet is a video conferencing solution that can be used for live class sessions. To set up Jitsi Meet, use Jitsi as a Service (JaaS) by signing up for the service to access its cloud-hosted APIs (https://jaas.8x8.vc/#/apikeys). After obtaining the necessary API credentials, integrate the Jitsi Meet SDKs into the project for the implementation.

5.2.9 Setup for Etherpad

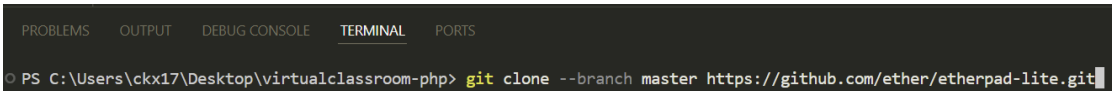


Figure 5.2.27 – Etherpad Repository Clone

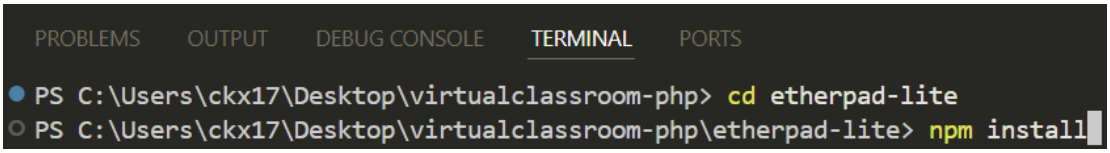


Figure 5.2.28 – Etherpad Dependency Packages Installation

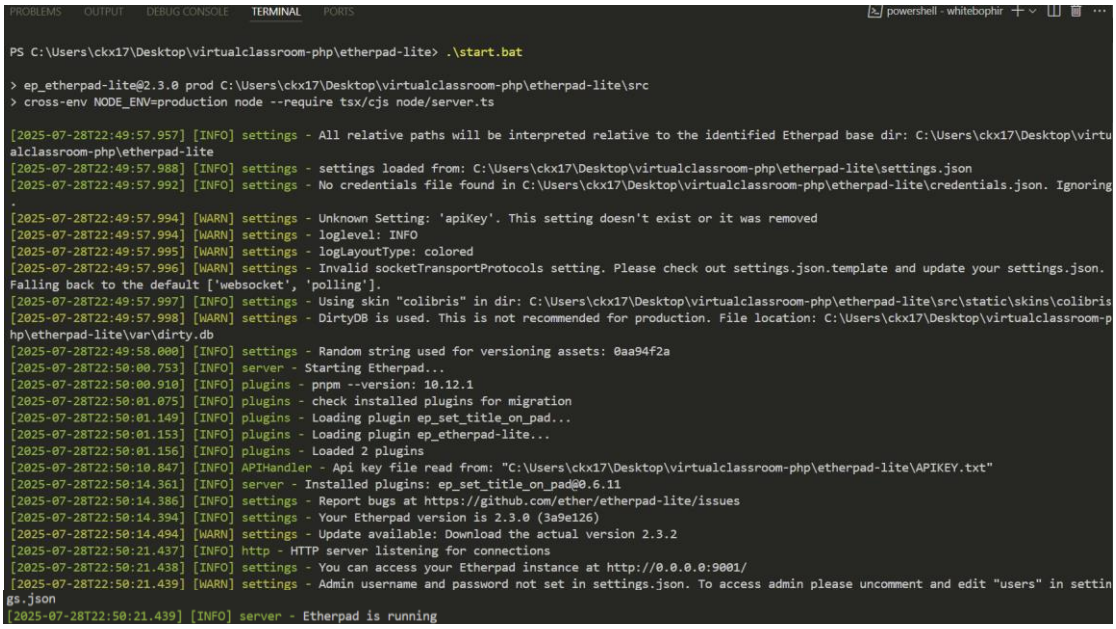


Figure 5.2.29 – Etherpad Execution

Etherpad is a real-time document editing tool designed for group collaboration. To install Etherpad, clone the Etherpad repository from GitHub via ‘git clone --branch master https://github.com/ether/etherpad-lite.git’ and install dependencies via ‘npm install’ on the terminal of Visual Studio Code. After that, start the server locally with the ‘.\start.bat’ command after moving to the Etherpad directory. This will make the Etherpad application accessible at http://localhost:9001 by default.

5.2.10 Setup for WBO

Figure 5.2.30 – WBO Repository Clone

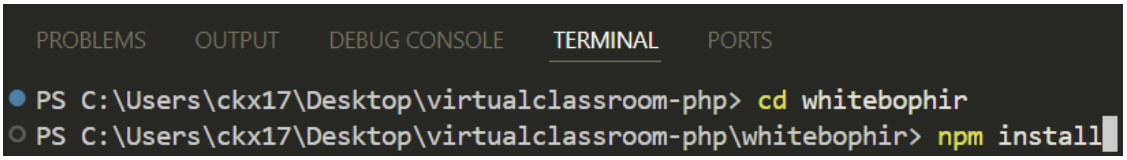


Figure 5.2.31 – WBO Execution Dependency Packages Installation

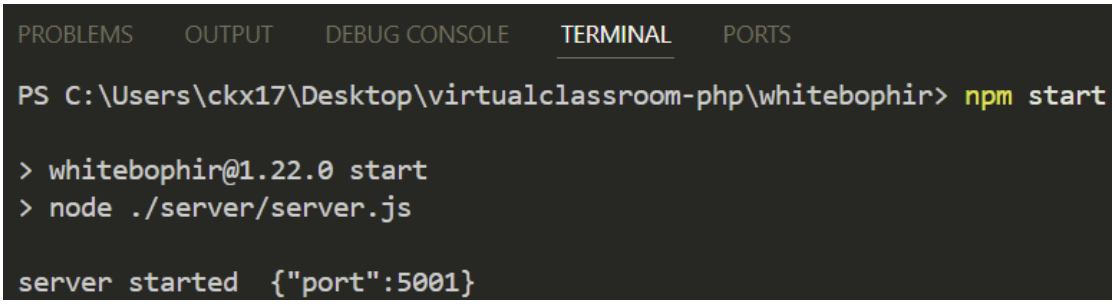


Figure 5.2.32 – WBO Execution

WBO is a collaborative whiteboard for drawing and note-taking. To set up WBO, clone the WBO repository from GitHub via git clone https://github.com/lovasoa/whitebophir.git and install dependencies via npm install on the terminal of Visual Studio Code. It requires having Node.js installed and running it using the npm start command after moving to WBO directory to get the whiteboard running on the local server.

5.3 System Operation

5.3.1 Homepage

Once the user has entered the virtual classroom system, the homepage will display a brief overview of the system, with options to register or log in.

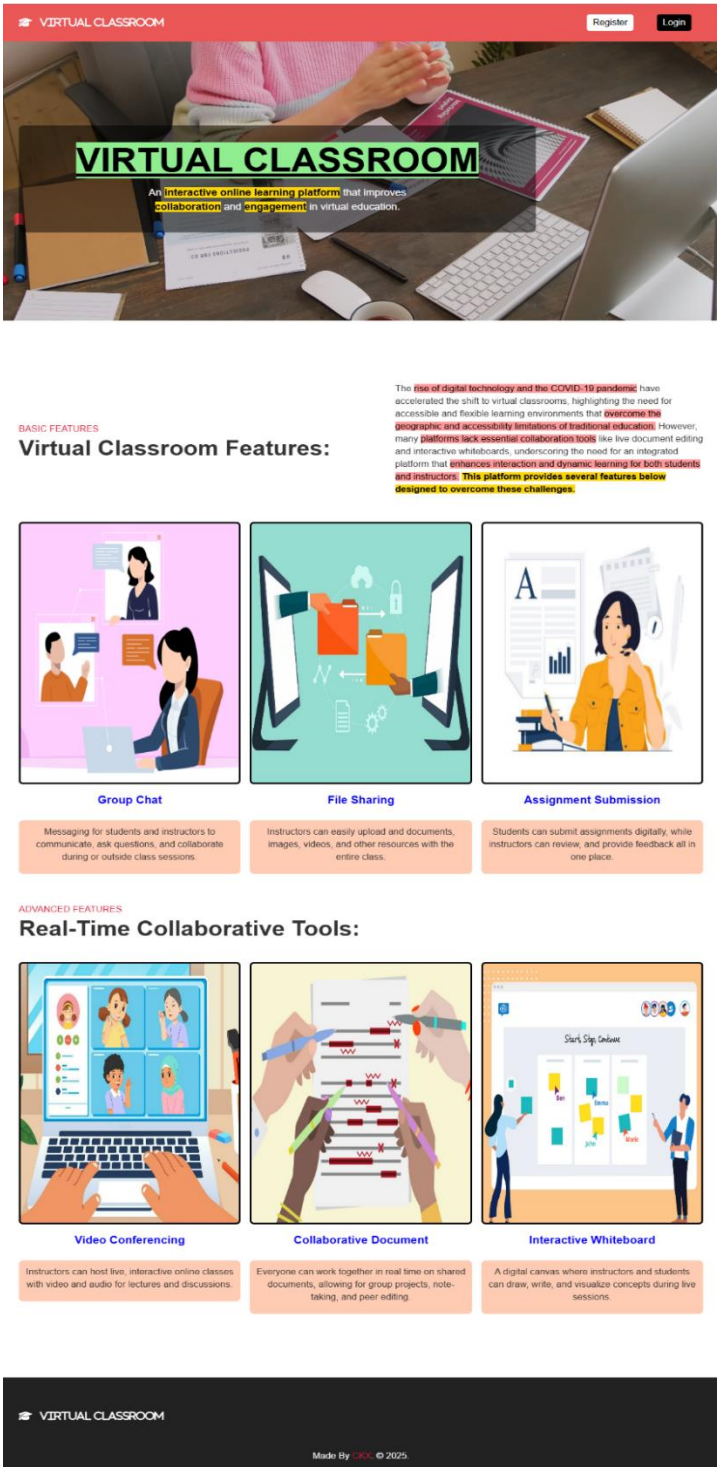


Figure 5.3.1 – HomePage

5.3.2 Authentication

5.3.2.1 Registration

The registration process begins by collecting the required user inputs, which are validated to ensure accuracy. Once the information is correctly provided, the system creates the personal account and brings the user to the login page.

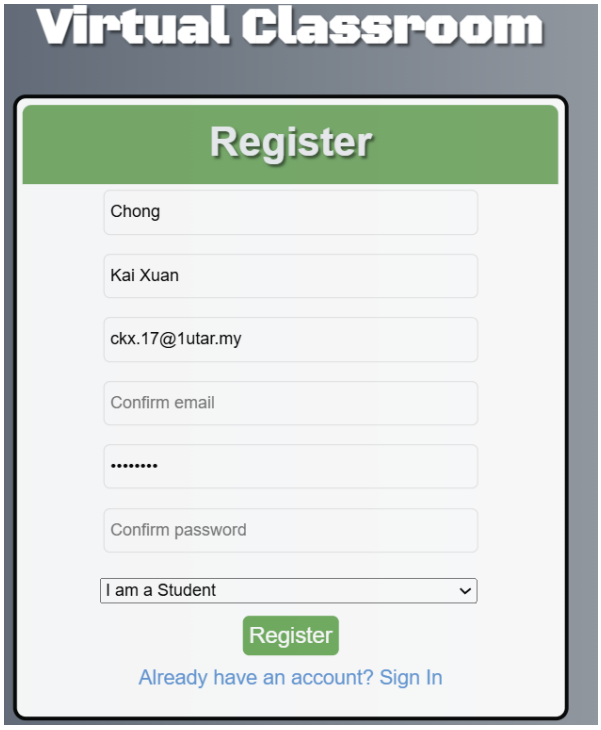


Figure 5.3.2 – Register Page

5.3.2.2 Login

Similarly, the entry process allows users to authenticate their credentials, granting them access to their personal panel upon successful login.

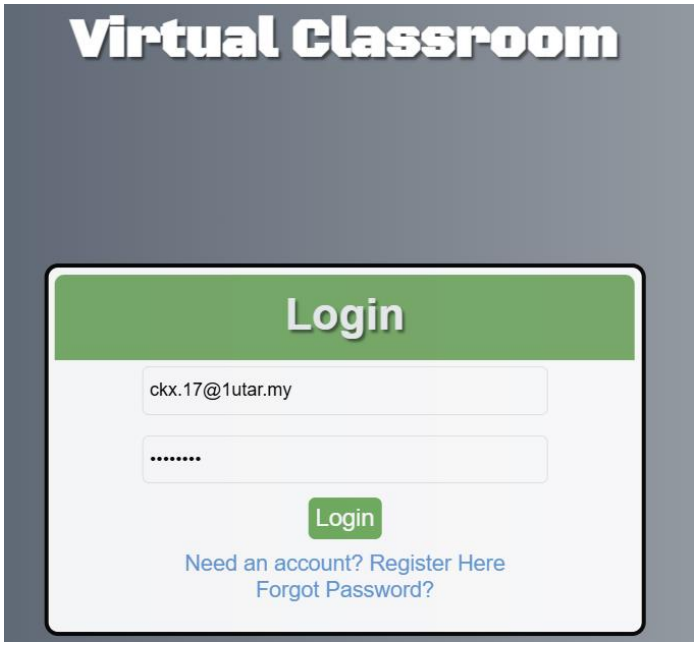


Figure 5.3.3 – Login Page

5.3.2.3 Password Recovery

For users who forget their passwords, a reset password link is sent to their email when they enter their registered email address. Following this, they will be taken to a reset password page where they can securely set a new password, effectively completing the password recovery process.

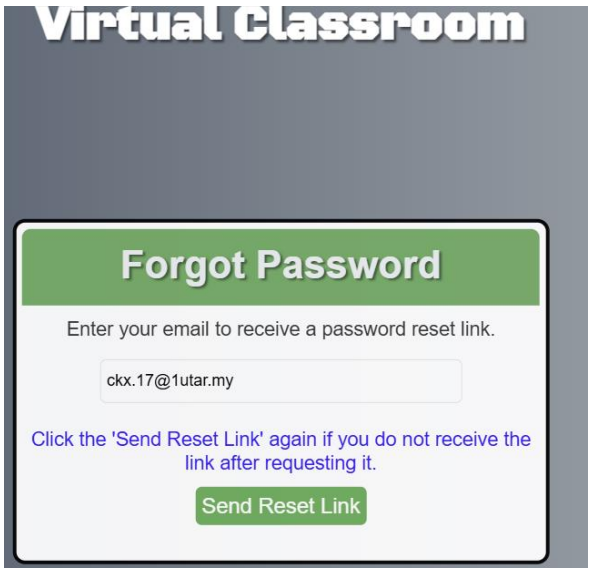


Figure 5.3.4 – Forgot Password Page

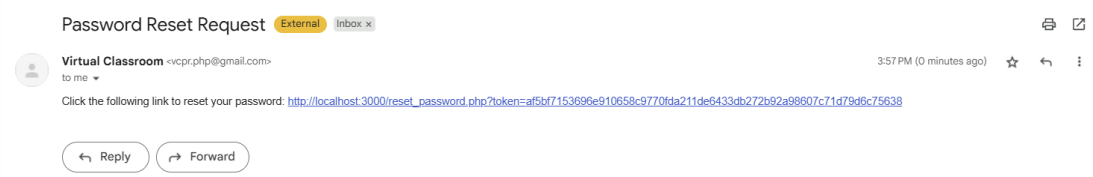


Figure 5.3.5 – Password Reset Email

Figure 5.3.6 – Reset Password Page

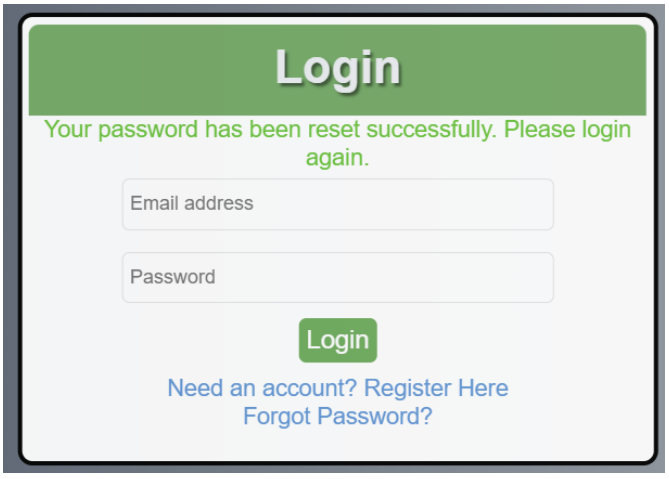


Figure 5.3.7 – Password Reset Message

5.3.3 User Panel

5.3.3.1 Main Page (Instructor Side)

Instructors can view all the classrooms they have created or enrolled in. For classrooms they've joined, instructors can choose to leave, causing the class to disappear from their user panel. For classrooms they've created, they can remove the class entirely from the system.

Figure 5.3.8 – Instructor's User Panel Page

5.3.3.2 Class Management (Instructor Side)

By clicking on the create class button from the main page of the user panel, instructors can access options to create new classes or join existing ones.

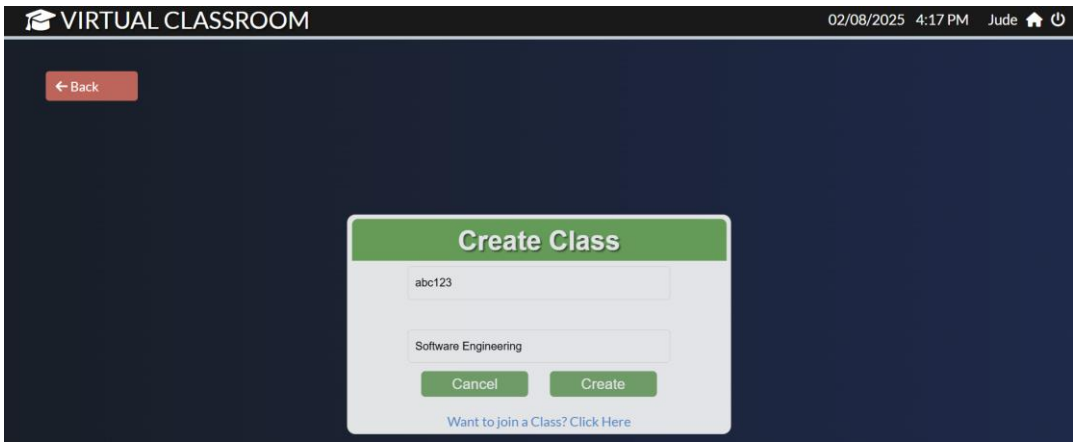


Figure 5.3.9 –Instructor's Create Class Page

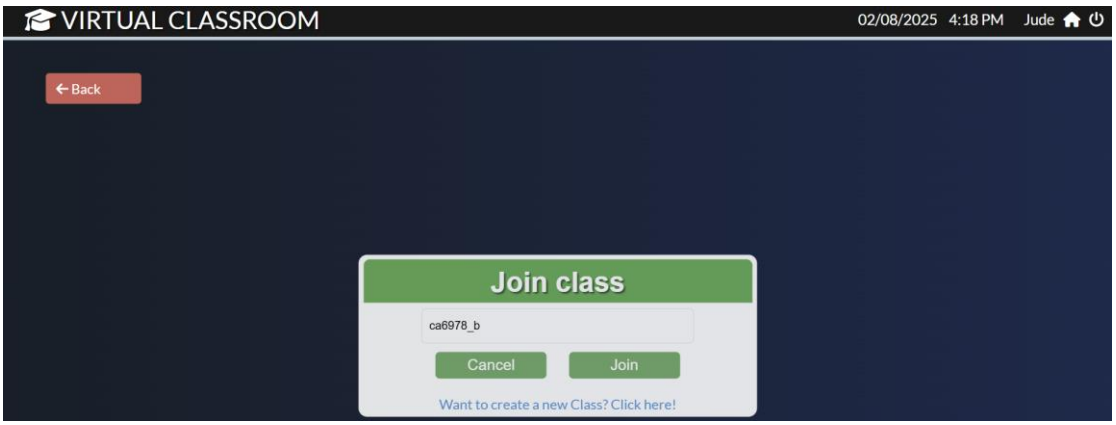


Figure 5.3.10 –Instructor's Join Class Page

5.3.3.3 Main Page (Student Side)

On the other hand, students can view all their enrolled classrooms. Similar to the instructors, they can leave any classroom they are enrolled in, which will remove it from their panel.

Figure 5.3.11 – Student's User Panel Page

5.3.3.4 Class Management (For Students)

Students are able to join a class with its corresponding class code by clicking the join button on the main page of the user panel.

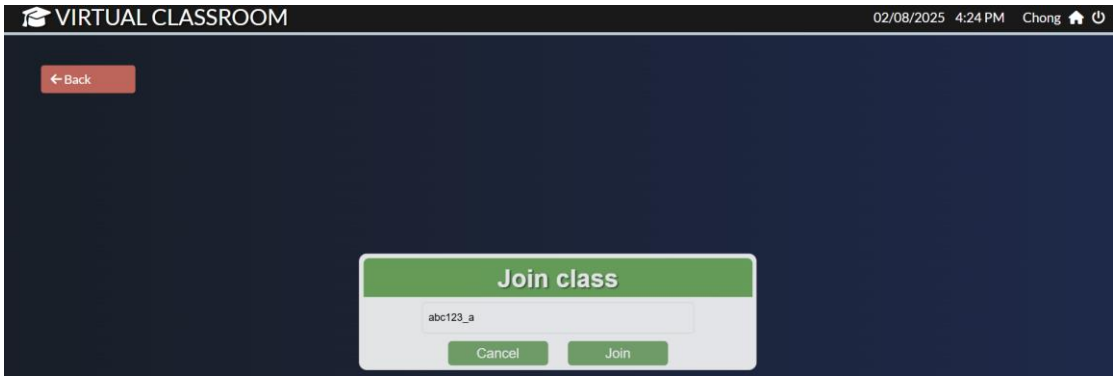


Figure 5.3.12 – Student's Join Class Page

5.3.4 User Profile

5.3.4.1 User Profile Management

Users can view and update their details by clicking on their username in the header, which leads to the profile page.

Figure 5.3.13 - Header

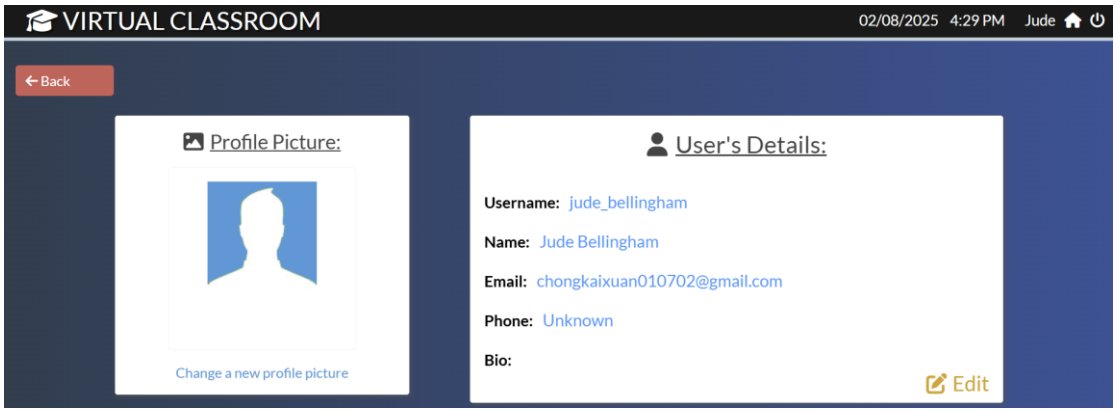


Figure 5.3.14 – Profile Page

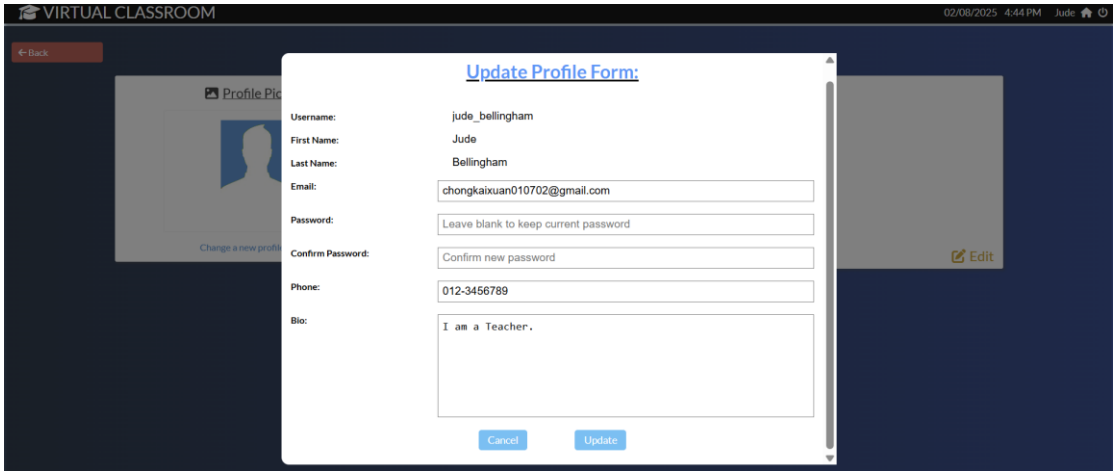


Figure 5.3.15 – Profile Update Form

Figure 5.3.16 – Profile Page after Details Updated

5.3.4.2 Profile Picture Management

Users are also able to alter their profile picture by uploading a new photo and then cropping it.

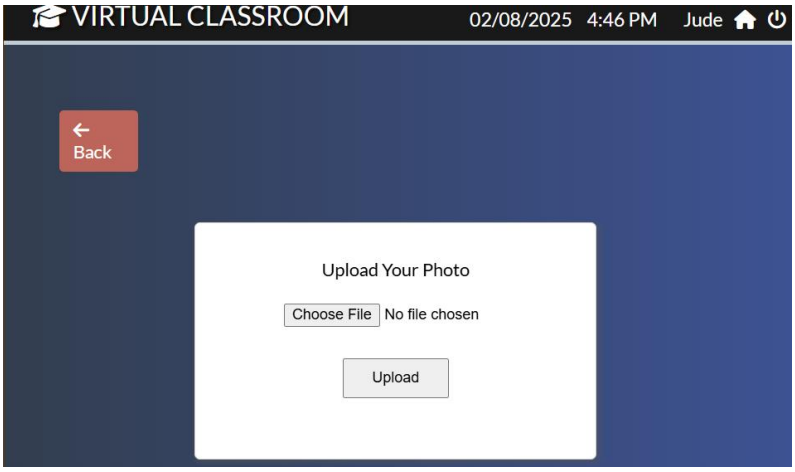


Figure 5.3.17 – Profile Picture Upload Page

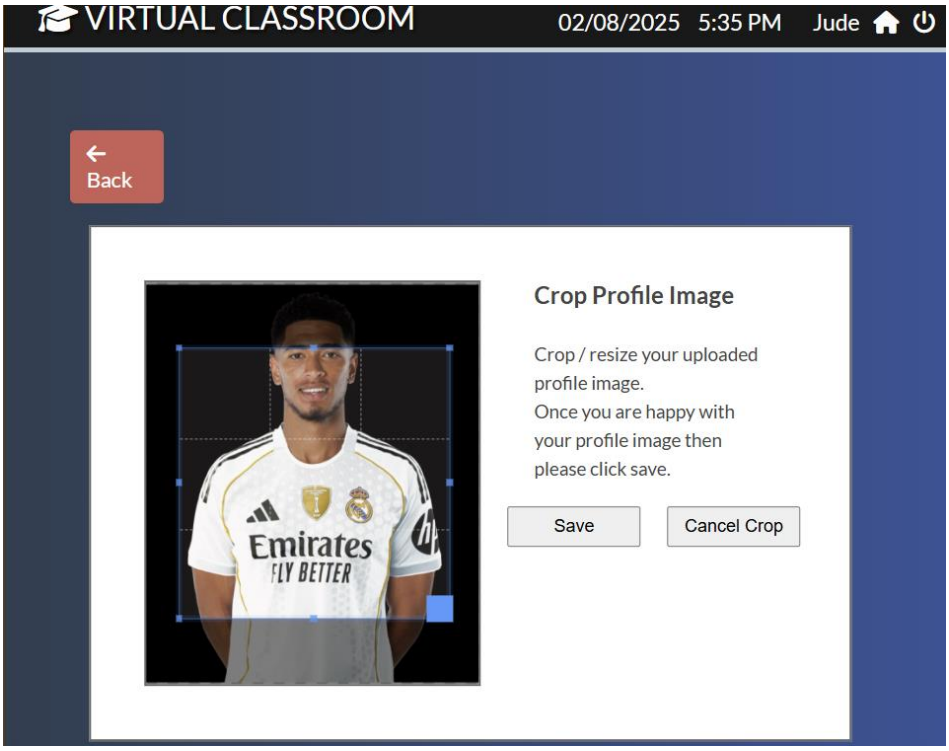


Figure 5.3.18 – Profile Picture Cropping Page

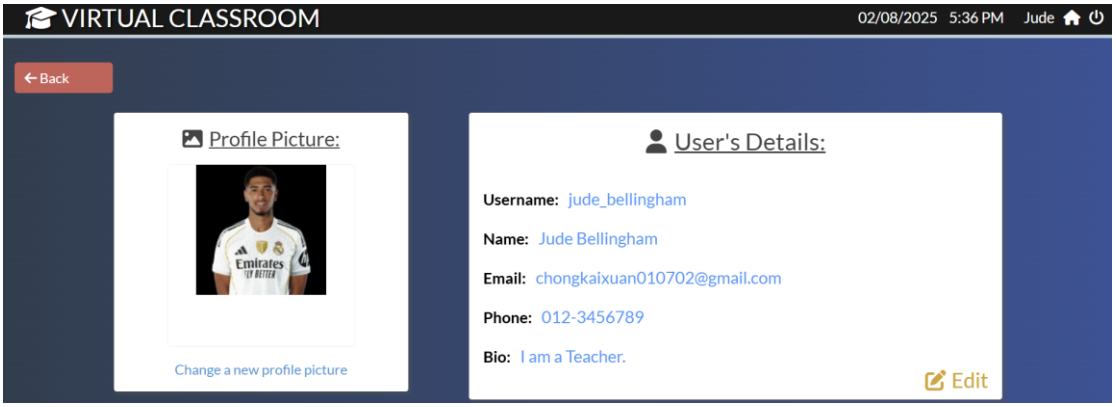


Figure 5.3.19 – Profile Page after Picture Updated

5.3.5 Virtual Classroom

Users can enter any classes that are displayed on the main page of the user panel, which will lead them to the classroom page.

Figure 5.3.20 – Classroom Page

Figure 5.3.21 – Member List from Classroom Page

5.3.5.1 Group Chat Section (Instructor Side)

Instructors can initiate a discussion by creating a post, enabling real-time communication on academic matters and other topics. Additionally, instructors can also manage their posts and comments by ammending or deleting them.

Figure 5.3.22 – Instructor's Group Chat Section from Classroom Page

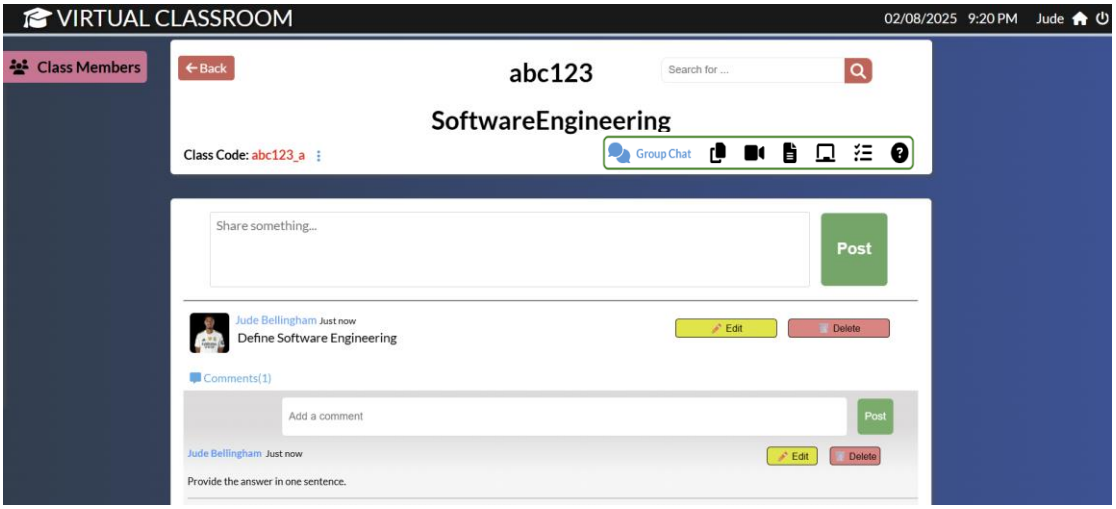


Figure 5.3.23 – Instructor's Comment Section from Classroom Page

5.3.5.2 Group Chat Section (Student Side)

Students can engage in real-time chats with instructors or peers within the classroom. They also can edit or delete their comments, similar to instructors.

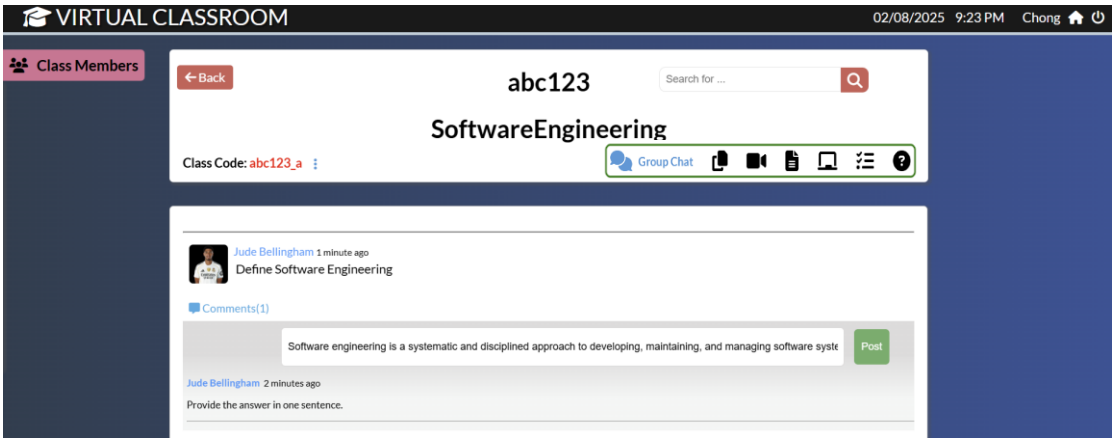


Figure 5.3.24 – Student's Group Chat Section from Classroom Page

Figure 5.3.25 – Student's Comment Section from Classroom Page

5.3.5.3 File Sharing Section (Instructor Side)

Instructors can share learning materials by creating posts that contain files, allowing all classroom members to receive resources in real time. Furthermore, instructors can edit or delete their uploaded files and related comments.

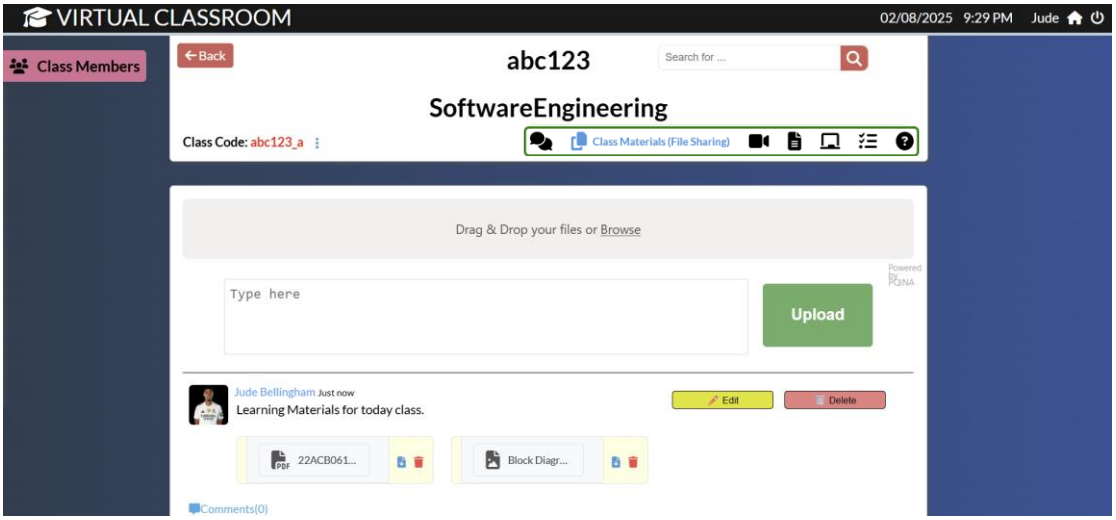


Figure 5.3.26 – Instructor's File Sharing Section from Classroom Page

5.3.5.4 File Sharing Section (Student Side)

Students can access learning resources by previewing or downloading them, as well as share their feedback regarding uploaded files. Students also can edit or delete their comments.

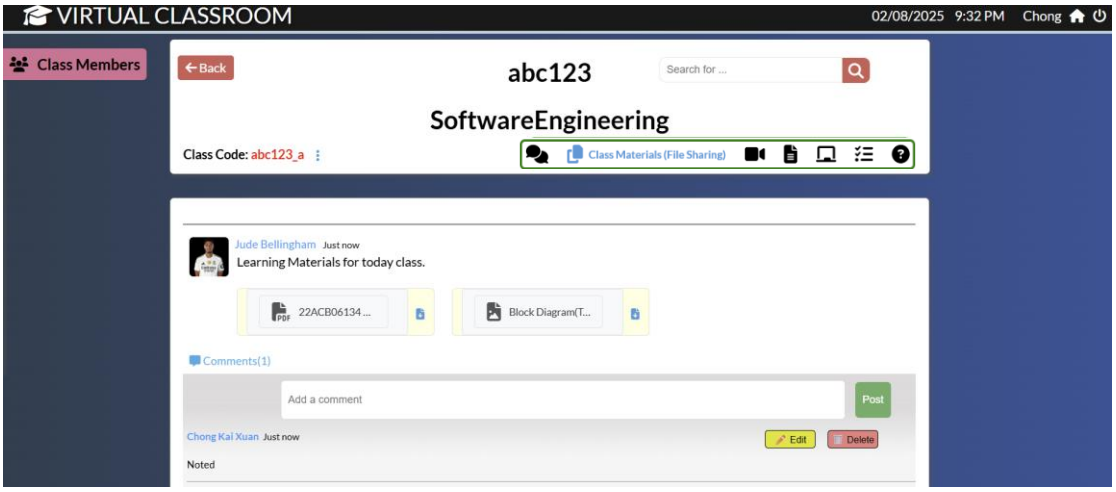


Figure 5.3.27 – Student's File Sharing Section from Classroom Page

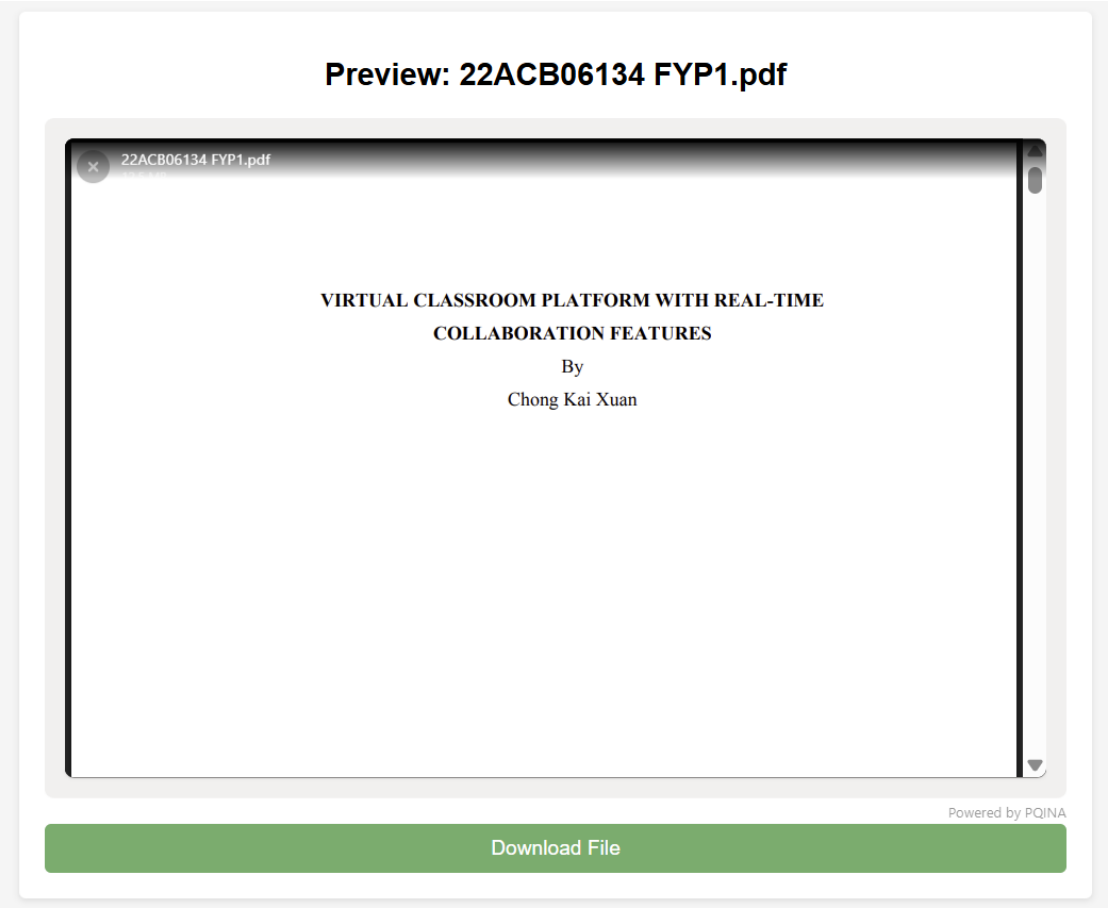


Figure 5.3.28 – Shared File Preview Page

5.3.5.5 Video Conferencing Section (Instructor Side)

Instructors can initiate a video meeting for live sessions by creating a post that includes access to the meeting room. This allows the classroom to join real-time lessons. Additionally, Jitsi Meet will take the user's details from the classroom system to display them on the video meeting. Instructors can also edit the meeting name or delete existing meetings in this section.

Figure 5.3.29 – Instructor's Video Conferencing Section from Classroom Page

Figure 5.3.30 – Instructor's Video Conferencing Pre-Configuration Page

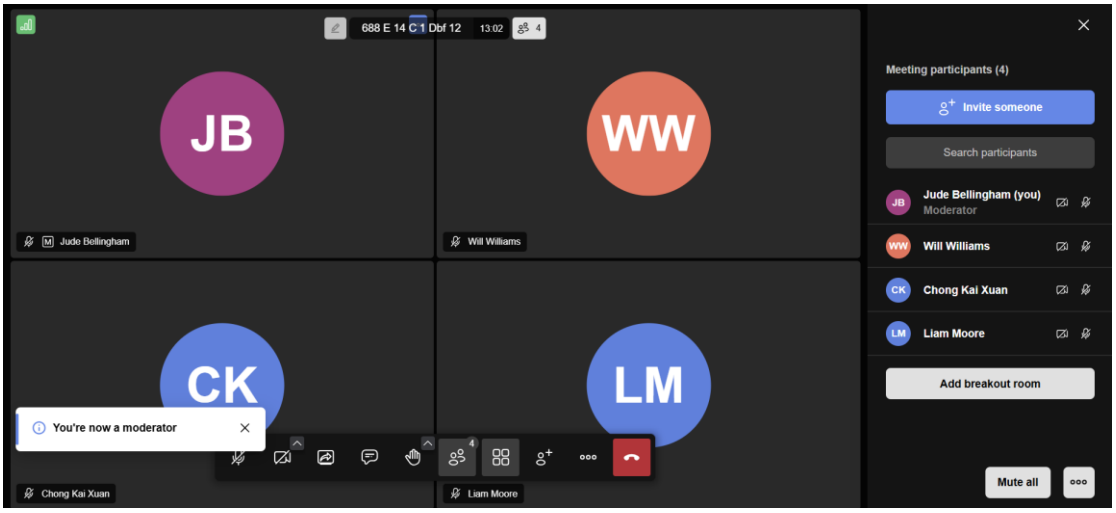


Figure 5.3.31 – Instructor's Video Conferencing Page

5.3.5.6 Video Conferencing Section (Student Side)

Students can join video meetings initiated by the instructor to participate in live lessons.

Figure 5.3.32 – Student's Video Conferencing Section from Classroom Page

Figure 5.3.33 – Student's Video Conferencing Pre-Configuration Page

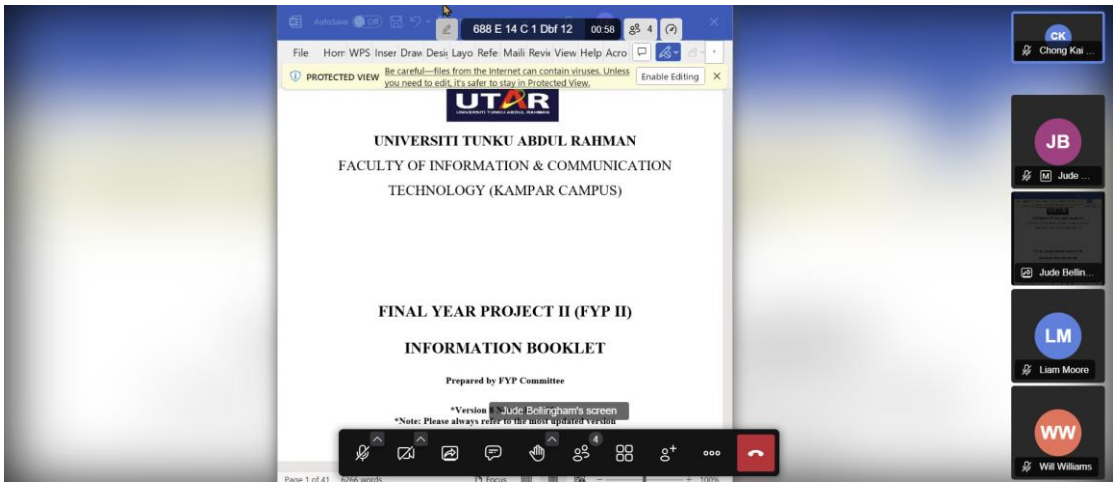


Figure 5.3.34 – Student's Video Conferencing Page

5.3.5.7 Document Collaboration Section (Instructor Side)

Instructors can start a regular or read-only online document on this section by creating a post with access to the document. This enables the entire classroom to collaborate in real time. Moreover, Etherpad will take the user's details from the classroom system to display them on the document. Instructors are also able to edit their document name and delete any existing documents in this section.

Figure 5.3.35 – Instructor's Document Collaboration Section from Classroom Page

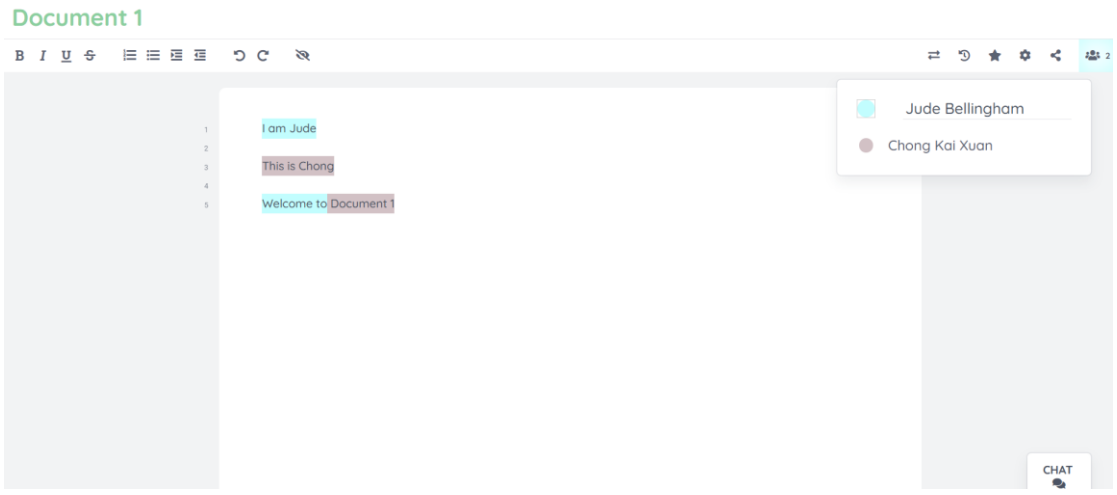


Figure 5.3.36 – Instructor's Document Collaboration Page

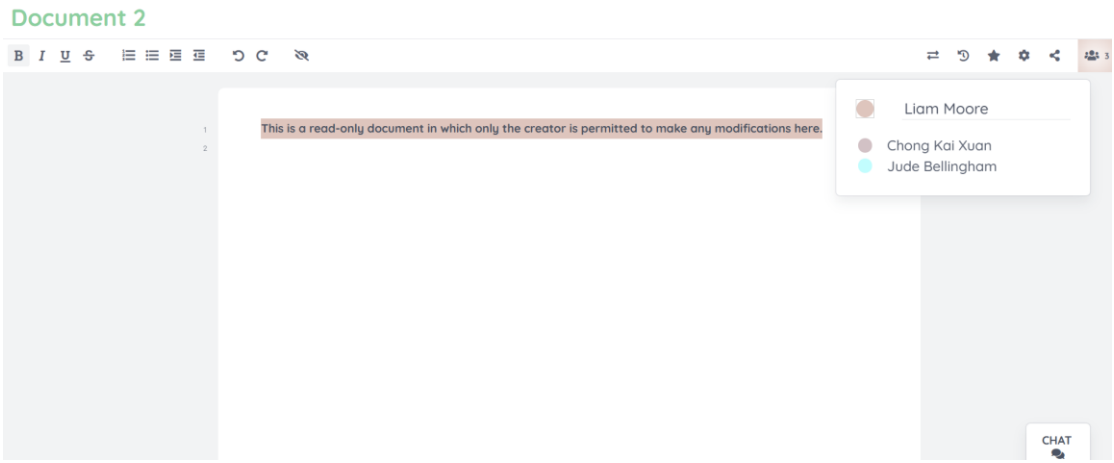


Figure 5.3.37 – Instructor's Read-Only Document Collaboration Page

5.3.5.8 Document Collaboration Section (Student Side)

Students can join an online document created by the instructor to collaborate on exercises in real time. For regular documents, students are allowed to collaborate on them. However, they can only view modifications made by the creator of the document while accessing for read-only version.

Figure 5.3.38 – Student's Document Collaboration Section from Classroom Page

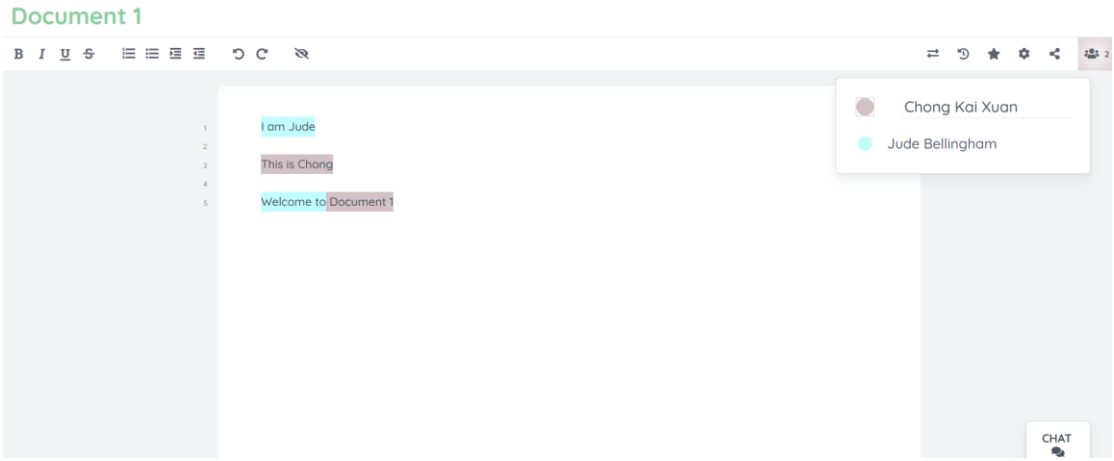


Figure 5.3.39 – Student's Document Collaboration Page

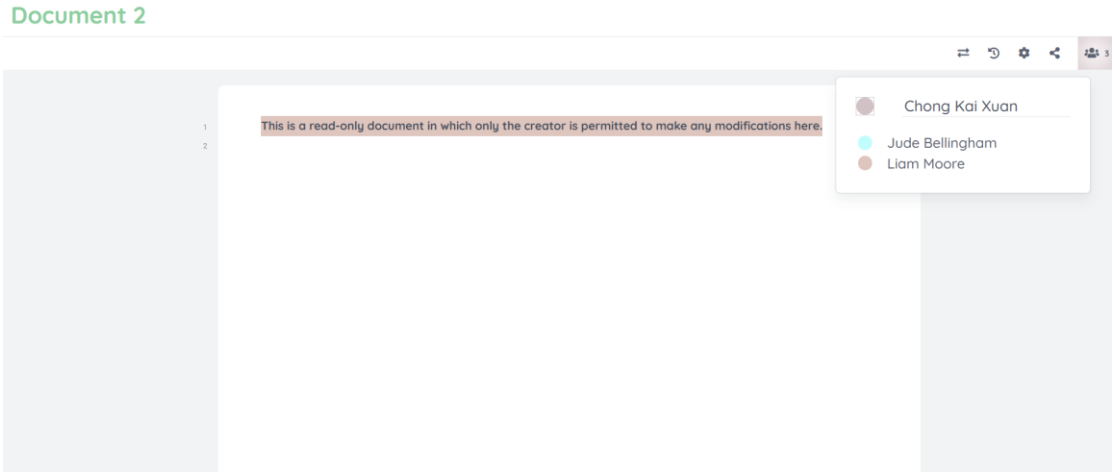


Figure 5.3.40 – Student's Read-Only Document Collaboration Page

5.3.5.9 Interactive Whiteboard Section (Instructor Side)

Instructors can start a regular or read-only interactive whiteboard on this section by creating a post with access to the whiteboard. This allows the entire class to view notes and explanations in real time. Furthermore, WBO will take the user's details from the classroom system to display them on the whiteboard. Instructors are also able to edit their whiteboard name and delete any existing whiteboards in this section.

Figure 5.3.41 – Instructor's Interactive Whiteboard Section from Classroom Page

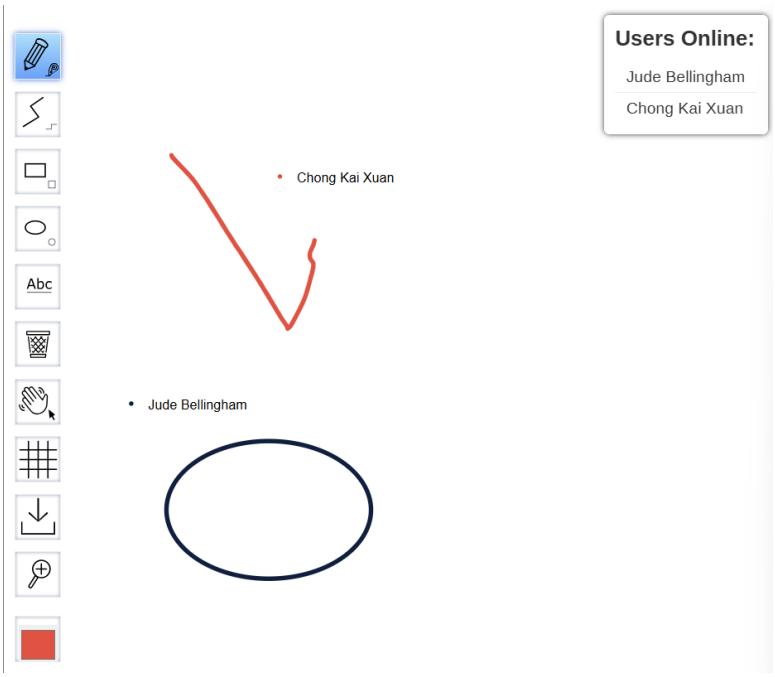


Figure 5.3.42 – Instructor's Interactive Whiteboard Page

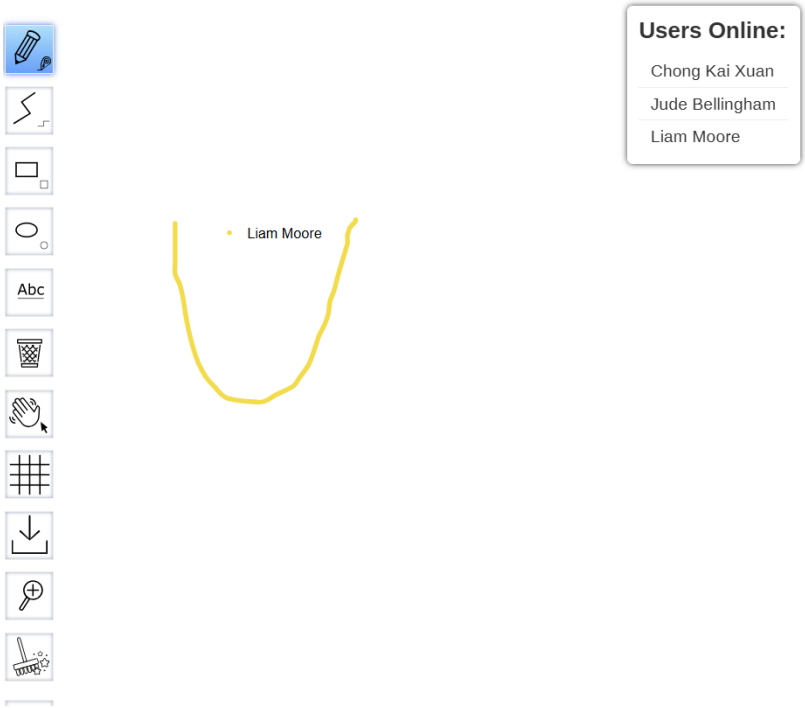


Figure 5.3.43 – Instructor's Read-Only Interactive Whiteboard Page

5.3.5.10 Interactive Whiteboard Section (Student Side)

Students can join an interactive whiteboard created by the instructor to view notes and explanations in real time. For regular whiteboards, students are allowed to collaborate on them. However, they can only view modifications made by the creator of the whiteboard while accessing for read-only version.

Figure 5.3.44 – Student's Interactive Whiteboard Section from Classroom Page

Figure 5.3.45 – Instructor's Interactive Whiteboard Page

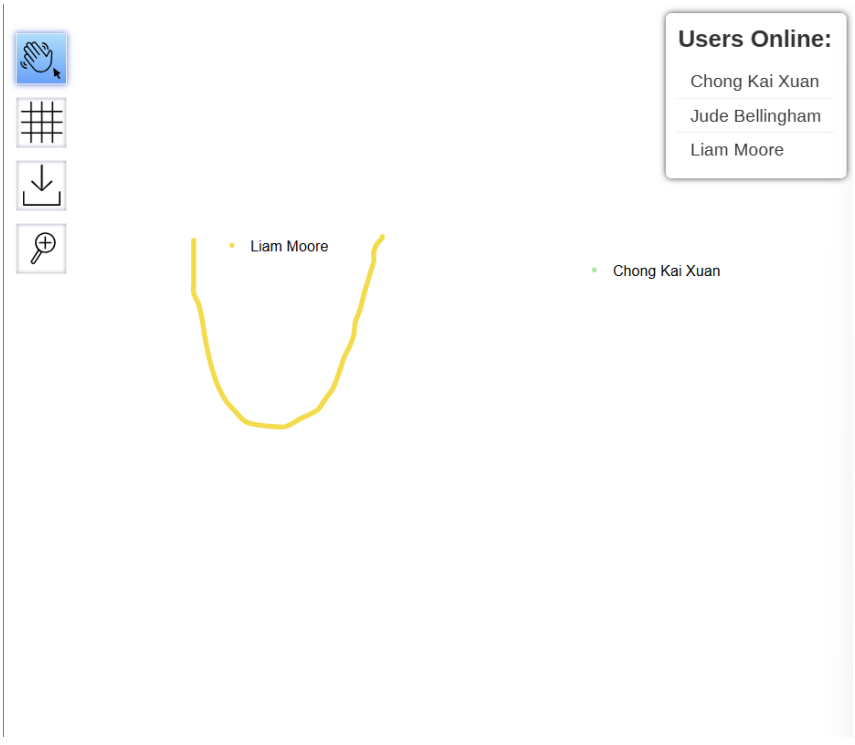


Figure 5.3.46 – Instructor's Read-Only Interactive Whiteboard Page

5.3.5.11 Assignment Submission Section (Instructor Side)

Instructors can collect assignment submissions by creating a post that includes assignment instructions, uploaded files, and submission sub-sections. This enables everyone in the classroom to submit their completed assignment. Instructors can also edit or delete their instructions, uploaded files and posts.

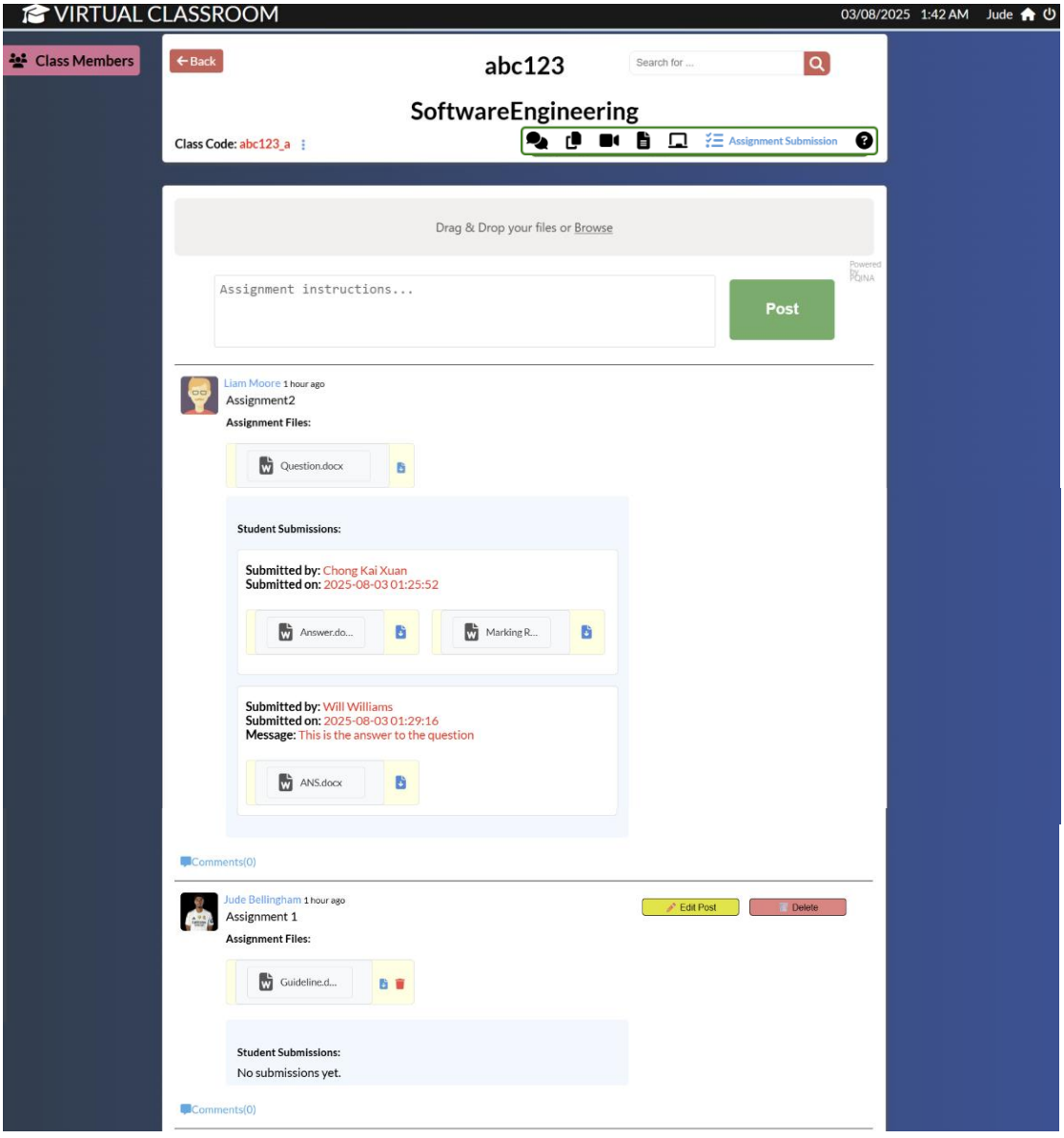


Figure 5.3.47 – Instructor's Assignment Submission Section from Classroom Page

5.3.5.12 Assignment Submission Section (Student Side)

Students can submit assignments in response to the instructor's post and are also able to resubmit their assignments by replacing previously uploaded files.

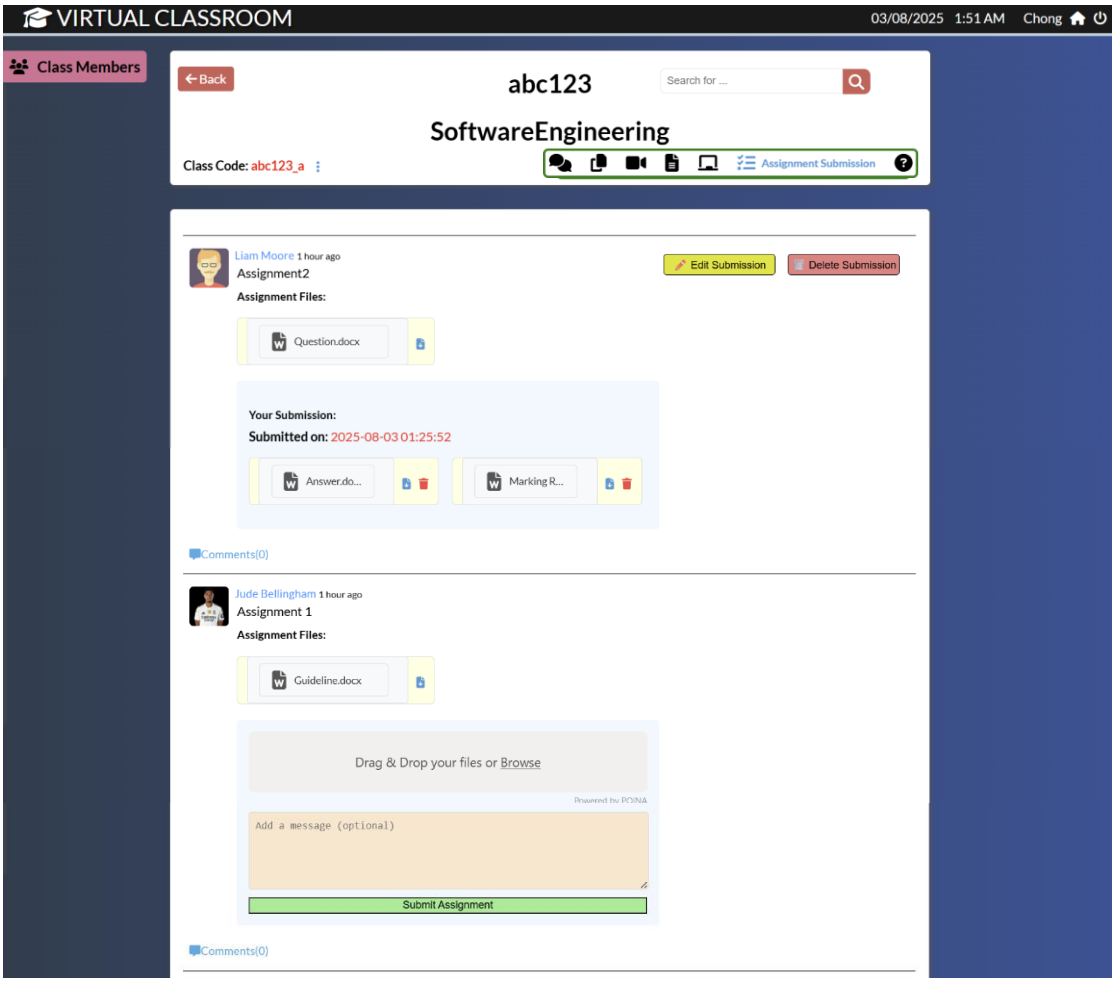
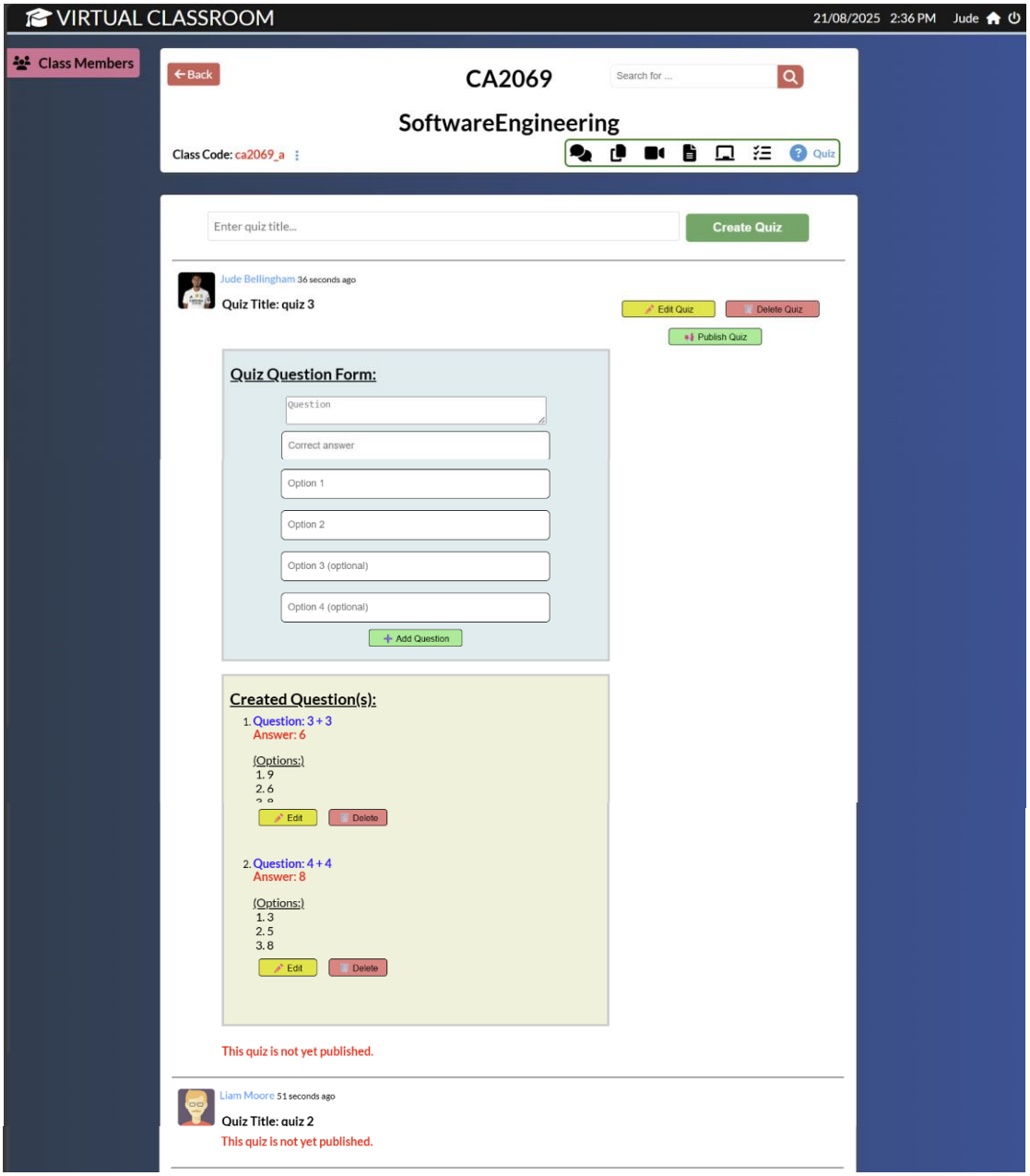


Figure 5.3.48 – Student's Assignment Submission Section from Classroom Page

5.3.5.13 Quiz Section (Instructor Side)

Instructors can publish a quiz and collect responses by creating a post that includes quiz answers, published quiz, and submission sub-sections. This enables every student in the classroom to view and respond to the published quiz. Instructors can also edit or delete their unpublished quiz questions and quiz posts.



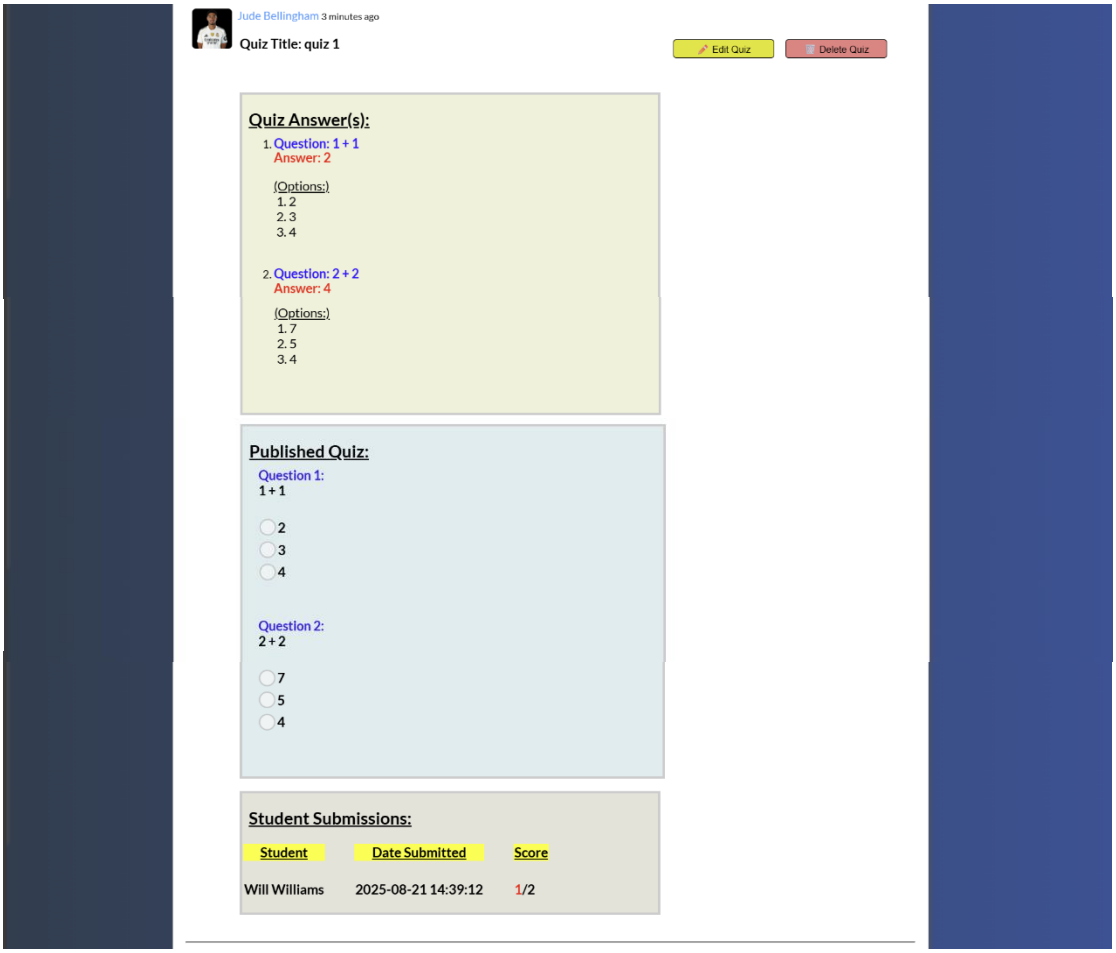


Figure 5.3.49 – Instructor's Quiz Section from Classroom Page

5.3.5.14 Quiz Section (Student Side)

Students can submit quiz responses to the instructor's post and are also able to view all their scores from the previous quizzes.

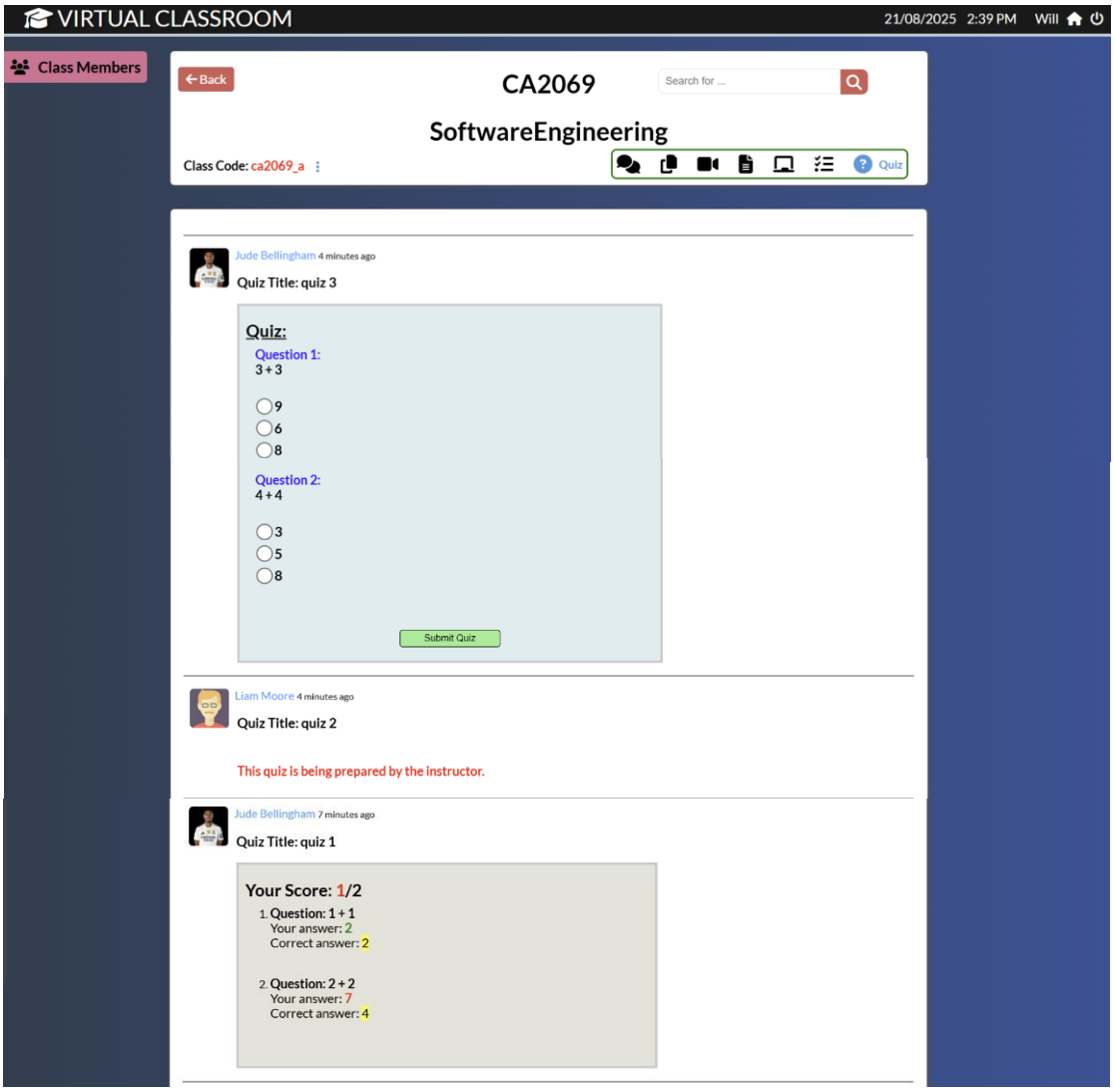


Figure 5.3.50 – Student's Quiz Section from Classroom Page

5.3.5.15 Search Section

All users can search for posts within the classroom by entering relevant keywords such as the creator's name or other details specific to the post. The search results can be filtered by sections or viewed across all sections. However, users cannot modify posts from search results or receive dynamic updates from the search in real time, which distinguishes its function from other classroom sections.

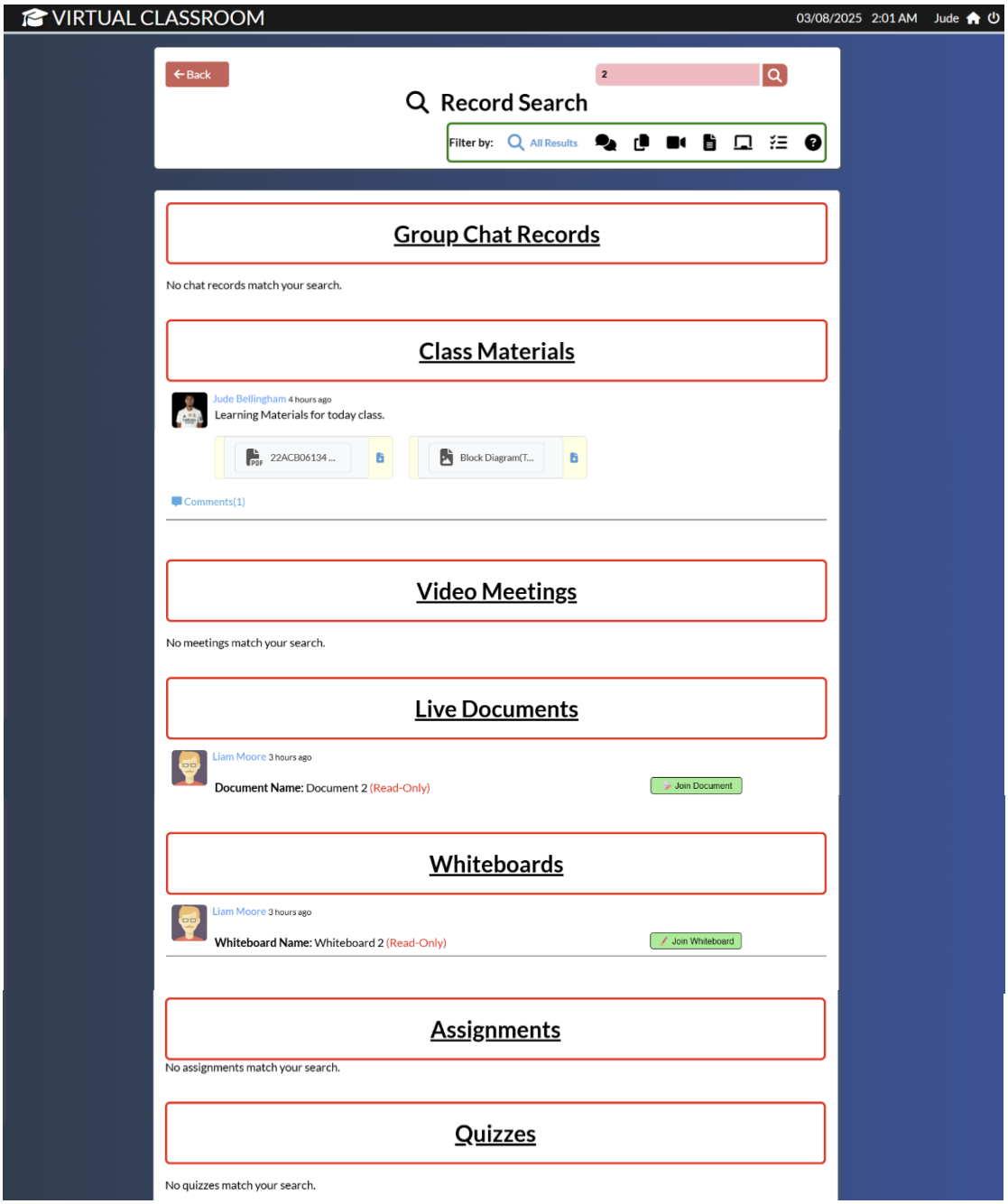


Figure 5.3.51 – Search Results Page

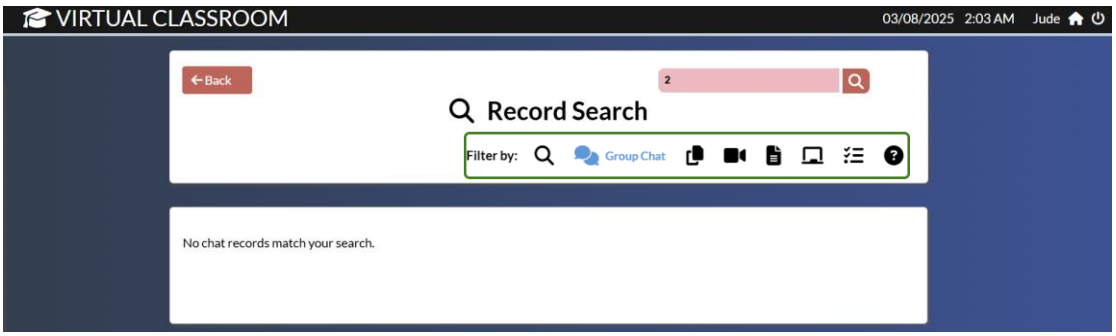


Figure 5.3.52 – Group Chat Filter of Search Results Page

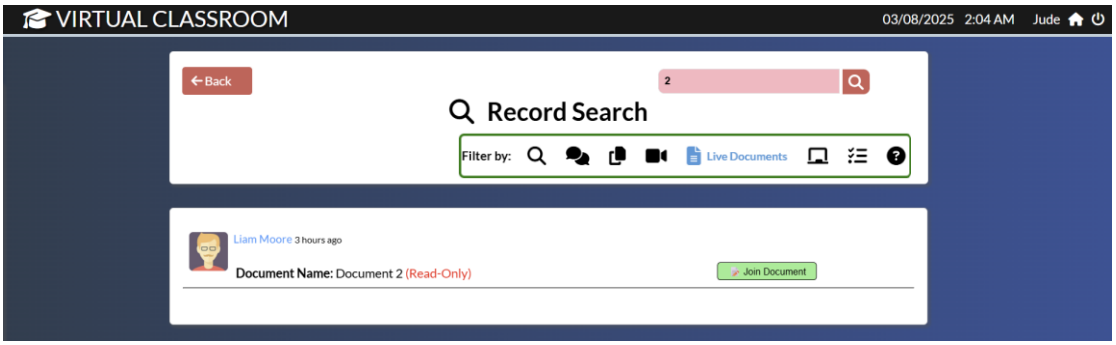


Figure 5.3.53 – Document Collaboration Filter of Search Results Page

5.3.6 Logout

At last, clicking on the logout icon from the header will terminate sessions seamlessly, which brings the users back to the home page.

Figure 5.3.54 – Logout Feature from Header

5.4 Implementation Issues and Challenges

The first implementation challenge encountered was related to the file-sharing module, specifically around the efficiency of file uploads and downloads, particularly when handling large files such as learning materials and assignment submissions. File size limitations and network reliability during the upload process were critical concerns. The system was required to manage multiple concurrent uploads without introducing performance bottlenecks, all while maintaining strict access control. This challenge was successfully addressed by implementing a file upload system that enforces a size limit to prevent server overload, checks for upload errors to ensure network reliability, uses unique file naming to support concurrent uploads without conflicts, and applies strict file permissions to maintain security.

The second challenge stemmed from the limitations of the AJAX technique for dynamic content updates. While AJAX enabled request-response interactions, it lacked the real-time and push-based mechanism for instantaneous updates. This became particularly problematic for interactive elements such as posts, comments, and collaboration tools, where seamless and live updates were essential. The solution involved transitioning from AJAX to Socket.IO, which provided the necessary real-time communication. This change addressed the issue by implementing a more efficient synchronization mechanism, enabling smooth data flow between the client and server while preventing server overload and delays.

The third issue lay in real-time collaboration tools such as videoconferencing (Jitsi Meet), interactive whiteboards (WBO), and document collaboration (Etherpad), as this was the first time encountering the implementation of these features. One significant challenge in implementing these tools was ensuring seamless data transfer and synchronization between the classroom system and the collaboration tools, maintaining data consistency and accurately reflecting user identities. This challenge became particularly complex when managing different user roles and applying them within the tools, such as instructors and students. For example, in the case of interactive whiteboards (WBO), which did not have a pre-built read-only mode, a custom solution was developed to create a read-only version with proper access controls based on user roles. This challenge was addressed by leveraging custom-built APIs for each tool (video conferencing, document collaboration, and whiteboarding), which facilitated real-time data synchronization and seamless role-based access control, ensuring that user identities were accurately reflected and appropriate permissions, such as read-only access for students, were enforced in the WBO and Etherpad.

CHAPTER 6

System Evaluation and Discussion

6.1 System Testing and Performance Metrics

After the development of the project, it is important to confirm that the Virtual Classroom Platform is functioning according to its intended purpose.

6.1.1 Black-Box Testing

Black-box testing is selected as the primary testing methodology for the Virtual Classroom Platform because it focuses on evaluating the system's operation from the end-user point of view without needing any understanding of the internal code structure. This technique aligns with the project's aim of ensuring a user-friendly and robust platform for both students and instructors with varying levels of technical skill. Black-box testing will ensure that the system fulfils the functional requirements outlined in Chapter 3, covering all major functionalities that include authentication, class management, profile management, and collaboration tools.

The testing will simulate end-users (students and instructors), who will interact with the platform's user interface. Inputs will be provided through the frontend (e.g., forms, buttons, collaboration tools), and outputs (e.g., successful login, file uploads, real-time updates) will be verified against expected results.

6.1.2 Test Cases

A comprehensive set of black-box test cases for the Virtual Classroom Platform that are organized by module (Authentication Module, Class Management Module, Profile Management Module, Enrolled/Created Classroom Module) has been created to validate the system.

6.1.2.1 Authentication Module Test Cases

Test Case Number	Description	Preconditions	Inputs	Expected Output	Pass/Fail Criteria
1	Register a new user	User is on the register page, not logged in	Valid inputs: username, email, password, confirm password, and user role	User account created, redirected to login page	Pass: Account created and redirection occurs Fail: Error message displayed
2	Register with invalid username	User is on the register page, not logged in	Invalid username (e.g., "David123"), other valid inputs	Error message regarding invalid username displayed	Pass: Error message displayed Fail: Account created
3	Register with invalid email	User is on the register page, not logged in	Invalid email (e.g., "user@invalid")	Error message regarding invalid email displayed	Pass: Error message displayed Fail: Account created
4	Register with invalid password	User is on the register page, not logged in	Invalid password (e.g., “abc123”)	Error message regarding invalid password displayed	Pass: Error message displayed Fail: Account created
5	Register with	User is on the register page, not logged in	Password and confirm password do not match	Error message regarding password	Pass: Error message displayed

	mismatched passwords			mismatch displayed	Fail: Account created
6	Login with valid credentials	User has a registered account	Valid email and password	Redirected to User Panel	Pass: Successful login and redirection Fail: Error message displayed
7	Login with invalid inputs	User has a registered account	Invalid email or password	Error message regarding invalid login inputs displayed	Pass: Error message displayed Fail: Login succeeds
8	Password recovery	User is on the login page, forgets password	Registered email address	Reset password link sent to email, redirected to reset password page by clicking the link via email	Pass: Email received and redirection occurs Fail: Error message displayed
9	Password recovery with invalid email	User is on the login page, forgets password	Unregistered email address	Error message regarding unregistered email displayed	Pass: Error message displayed Fail: Email received
10	Reset password with valid password	User is on the reset password page	New password, confirm password	Password updated, redirected to login page	Pass: Password updated and

					redirection occurs Fail: Error message displayed
11	Reset password with invalid password	User is on the reset password page	Invalid password (e.g., “abc123”)	Error message regarding invalid password displayed	Pass: Error message displayed Fail: Password Reset
12	Reset password with mismatched passwords	User is on the reset password page	Password and confirm password do not match	Error message regarding password mismatch displayed	Pass: Error message displayed Fail: Password Reset

Table 6.1.1 – Authentication Module Test Cases

6.1.2.2 Class Management Module Test Cases

Test Case Number	Description	Preconditions	Inputs	Expected Output	Pass/Fail Criteria
1	Instructor creates a class	Instructor is on User Panel	Valid class name and code	Class created, appears in User Panel	Pass: Class created and displayed Fail: Error message displayed
2	Instructor creates a class with invalid input	Instructor is on User Panel	Invalid class name and code	Error message regarding invalid class creation inputs displayed	Pass: Class created and displayed Fail: Error message displayed
3	Instructor joins a class	Instructor is on User Panel	Valid class code	Class added to User Panel	Pass: Class added Fail: Error message displayed
4	Instructor joins a class with invalid class code	Instructor is on User Panel	Invalid class code	Error message regarding invalid class code displayed	Pass: Error message displayed Fail: Class added
5	Instructor removes a created class	Instructor is on User Panel and class created	Select class, click "Remove"	Class removed from User Panel and system	Pass: Class removed from system Fail: Class remains

6	Instructor leaves a joined class	Instructor is on User Panel and joined a class	Select class, click "Leave"	Class removed from User Panel	Pass: Class removed from panel Fail: Class remains
7	Student joins a class	Student is on User Panel	Valid class code	Class added to User Panel	Pass: Class added Fail: Error message displayed
8	Student joins a class with invalid class code	Student is on User Panel	Invalid class code	Error message regarding invalid class code displayed	Pass: Error message displayed Fail: Class added
9	Student leaves a class	Student is on User Panel and enrolled in a class	Select class, click "Leave"	Class removed from User Panel	Pass: Class removed from panel Fail: Class remains

Table 6.1.2 – Class Management Module Test Cases

6.1.2.3 Profile Management Module Test Cases

Test Case Number	Description	Preconditions	Inputs	Expected Output	Pass/Fail Criteria
1	View user profile	User is logged in	Click username in header	Profile page displays user details	Pass: Details displayed correctly Fail: Incorrect details
2	Update user profile	User is on profile page	Valid profile details inputs	Profile updated and displayed	Pass: Details updated and displayed Fail: Update fails
3	Update user profile with invalid inputs	User is on profile page	Invalid profile details inputs	Error message regarding invalid details input displayed	Pass: Error message displayed Fail: Details updated
4	Upload profile picture	User is on profile page	Upload valid image file (e.g., JPG, PNG)	Image uploaded, cropped, and updated	Pass: Image updated Fail: Upload fails
5	Upload invalid profile picture	User is on profile page	Upload invalid file (e.g., non-image file)	Error message regarding invalid image file displayed	Pass: Error message displayed Fail: File uploaded

Table 6.1.3 – Profile Management Module Test Cases

6.1.2.4 Enrolled/Created Classroom Module Test Cases

Test Case Number	Description	Preconditions	Inputs	Expected Output	Pass/Fail Criteria
Basic Features					
1	Access classroom	User is on User panel and created/joined a class	Select class from User Panel	Classroom page loads with collaboration tools	Pass: Class loads correctly Fail: Incorrect class loaded
2	View classroom members	User is in the classroom	Click "Class Members"	A member list that shows instructor(s) and students who are members of the class.	Pass: Member List appears Fail: Member List not displayed
3	Enlarge class code	User is in the classroom	Click on the option button beside the class code then click "Expand"	A pop-up appear that display the class code in bigger font size	Pass: Pop-up appears Fail: Pop-up not displayed
4	Switch Classroom Tools	User is in the classroom	Select any tool from the tool section	The tool section appears correctly according to the selected tool	Pass: Selected tool section appears Fail: Incorrect tool section displayed
5	Logout from classroom	User is in classroom	Click logout from header	Session terminated and redirected to homepage	Pass: Redirected to homepage Fail: Session persists

Group Chat					
6	Instructor posts in group chat	Instructor is in the classroom	Create post with text	Post appears in group chat in real time	Pass: Post displayed instantly Fail: Post not displayed
7	Instructor posts in group chat with empty input	Instructor is in the classroom	Create post with empty input	A warning displayed to notify instructor	Pass: Warning displayed Fail: Post Created
8	Instructor edits post	Instructor is in the classroom and created post	Edit post with valid input	Post updated in real time	Pass: Changes reflected instantly Fail: Changes not applied
9	Instructor edits post with empty input	Instructor is in the classroom and created post	Edit post with empty input	A warning displayed to notify instructor	Pass: Warning displayed Fail: Post updated
10	Instructor deletes post	Instructor is in the classroom and created post	Delete post	Post deleted in real time	Pass: Post removed instantly Fail: Post not deleted
11	Instructor comments in group chat	Instructor is in the classroom	Add comment to post	Comment appears in real time	Pass: Comment displayed instantly Fail: Comment not displayed

12	Instructor edits comment in group chat	Instructor is in the classroom	Edit comment with valid input	Comment updated in real time	Pass: Changes reflected instantly Fail: Changes not applied
13	Instructor edits comment in group chat with empty input	Instructor is in the classroom	Edit comment with empty input	A warning displayed to notify instructor	Pass: Warning displayed Fail: Comment updated
14	Instructor deletes comment in group chat	Instructor is in the classroom	Delete comment	Comment deleted in real time	Pass: Comment removed instantly Fail: Comment not deleted
15	Student comments in group chat	Student is in the classroom	Add comment to post	Comment appears in real time	Pass: Comment displayed instantly Fail: Comment not displayed
16	Student edits comment in group chat	Student is in the classroom	Edit comment with valid input	Comment updated in real time	Pass: Changes reflected instantly Fail: Changes not applied
17	Student edits comment in group chat	Student is in the classroom	Edit comment with empty input	A warning displayed to notify student	Pass: Warning displayed

	with empty input				Fail: Comment updated
18	Student deletes comment in group chat	Student is in the classroom	Delete comment	Comment deleted in real time	Pass: Comment removed instantly Fail: Comment not deleted
File Sharing Feature					
19	Instructor creates file post with message in file sharing	Instructor is in the classroom	Upload valid file type and write message	File post created and accessible to class	Pass: Post created Fail: File Post creation fails
20	Instructor creates file post without message in file sharing	Instructor is in the classroom	Upload valid file type only	File post created and accessible to class	Pass: Post created Fail: File Post creation fails
21	Instructor creates file post with invalid file in file sharing	Instructor is in the classroom	Upload invalid file type	A warning displayed to notify instructor	Pass: Warning displayed Fail: File Post created
22	Instructor creates file post with message only in file sharing	Instructor is in the classroom	Write message without upload any files	A warning displayed to notify instructor	Pass: Warning displayed Fail: File Post created
23	Instructor edits file post	Instructor is in the classroom and created file post	Edit file post with valid file type	File Post updated in real time	Pass: Changes reflected instantly

					Fail: Changes not applied
24	Instructor edits file post with empty input	Instructor is in the classroom and created file post	Edit file post with empty input	The file post will remain the same before it is edited	Pass: Changes not applied Fail: Changes reflected instantly
25	Instructor deletes uploaded file only	Instructor is in the classroom and created file post	Click the delete icon of the uploaded file from file post	Uploaded file deleted in real time	Pass: Uploaded file removed instantly Fail: Uploaded file not deleted
26	Instructor deletes file post	Instructor is in the classroom and created file post	Delete file post	File Post deleted in real time	Pass: File Post removed instantly 25Fail: File Post not deleted
27	Instructor comments in file sharing	Instructor is in the classroom	Add comment to file post	Comment appears in real time	Pass: Comment displayed instantly Fail: Comment not displayed
28	Instructor edits comment in file sharing	Instructor is in the classroom	Edit comment with valid input	Comment updated in real time	Pass: Changes reflected instantly Fail: Changes not applied

29	Instructor edits comment in file sharing with empty input	Instructor is in the classroom	Edit comment with empty input	A warning displayed to notify instructor	Pass: Warning displayed Fail: Comment updated
30	Instructor deletes comment in file sharing	Instructor is in the classroom	Delete comment	Comment deleted in real time	Pass: Comment removed instantly Fail: Comment not deleted
31	Student comments in file sharing	Student is in the classroom	Add comment to file post	Comment appears in real time	Pass: Comment displayed instantly Fail: Comment not displayed
32	Student edits comment in file sharing	Student is in the classroom	Edit comment with valid input	Comment updated in real time	Pass: Changes reflected instantly Fail: Changes not applied
33	Student edits comment in file sharing with empty input	Student is in the classroom	Edit comment with empty input	A warning displayed to notify student	Pass: Warning displayed Fail: Comment updated
34	Student deletes comment in file sharing	Student is in the classroom	Delete comment	Comment deleted in real time	Pass: Comment removed instantly

					Fail: Comment not deleted
35	User downloads file in file sharing	User is in classroom	Click download icon of uploaded file from file post	File downloaded successfully	Pass: File downloaded Fail: Download fails
36	User previews file in file sharing	User is in classroom	Click on uploaded file from file post	Preview page appears and displays the uploaded file	Pass: Preview page appears and displays file Fail: Preview page not appear
Video Meeting Feature					
37	Instructor creates meeting post in video meeting	Instructor is in the classroom	Create post with meeting name	Meeting post appears with system-generated Jitsi Meet link in real time	Pass: Meeting post displayed instantly Fail: Meeting post not displayed
38	Instructor creates meeting post with empty input in video meeting	Instructor is in the classroom	Create post with empty input	A warning displayed to notify instructor	Pass: Warning displayed Fail: Meeting post created
39	Instructor edits meeting post	Instructor is in the classroom and created meeting post	Edit meeting post with valid input	Meeting post updated in real time	Pass: Changes reflected instantly Fail: Changes not applied

40	Instructor edits meeting post with empty input	Instructor is in the classroom and created meeting post	Edit meeting post with empty input	A warning displayed to notify instructor	Pass: Warning displayed Fail: Meeting post updated
41	Instructor deletes meeting post	Instructor is in the classroom and created meeting post	Delete meeting post	Meeting post deleted in real time	Pass: Meeting post removed instantly Fail: Meeting post not deleted
42	User joins video meeting	User is in the classroom	Click "Join Meeting" button from the meeting post	Joins meeting with user details pre-filled in the meeting configuration page	Pass: User joins the meeting successfully with correct user details Fail: Join fails or incorrect details
43	User interacts and collaborates in video meeting	User is in the Jitsi Meet	Click and utilize every feature from Jitsi Meet	Interacts and collaborates with everyone with features provided (screen sharing, text chat, and so on) from Jitsi Meet	Pass: User interacts and collaborates with everyone Fail: Jitsi Meet features fail
Online Document Feature					
44	Instructor creates regular/read-only	Instructor is in the classroom	Create post with document name	Document post appears with system-generated	Pass: Document post displayed instantly

	document post in online document			Etherpad link in real time	Fail: Document post not displayed
45	Instructor creates regular/read-only document post with empty input in online document	Instructor is in the classroom	Create post with empty input	A warning displayed to notify instructor	Pass: Warning displayed Fail: Document post created
46	Instructor edits document post	Instructor is in the classroom and created document post	Edit document post with valid input	Document post updated in real time	Pass: Changes reflected instantly Fail: Changes not applied
47	Instructor edits document post with empty input	Instructor is in the classroom and created document post	Edit document post with empty input	A warning displayed to notify instructor	Pass: Warning displayed Fail: Document post updated
48	Instructor deletes document post	Instructor is in the classroom and created document post	Delete document post	Document post deleted in real time	Pass: Document post removed instantly Fail: Document post not deleted

49	User joins online document	User is in the classroom	Click "Join Document" button from the document post	Joins document with username displayed on Etherpad	Pass: User joins the document successfully with correct username Fail: Join fails or incorrect details
50	User collaborates in online document	User is in the Etherpad	Edit document in Etherpad	Document accessible and all users can edit	Pass: Document editable by all Fail: Edit fails
51	User joins read-only online document	User is in the classroom	Click "Join Document" button from the document post	Joins read-only document with username displayed and user role set on Etherpad	Pass: User joins the read-only document successfully with correct username and user role Fail: Join fails or incorrect details
52	Instructor writes in read-only online document	Instructor is in the Etherpad	Edit document in read-only Etherpad	Students can view, only instructor edits	Pass: Document editable by instructor Fail: Edit fails
53	Student spectates in read-only	Student is in the Etherpad	Spectate document in read-only Etherpad	Students can view, only instructor edits	Pass: Read-only enforced

	online document				Fail: Students can edit
Interactive Whiteboard Feature					
54	Instructor creates regular/read-only whiteboard post in interactive whiteboard	Instructor is in the classroom	Create post with whiteboard name	Whiteboard post appears with system-generated WBO link in real time	Pass: Whiteboard post displayed instantly Fail: Whiteboard post not displayed
55	Instructor creates regular/read-only whiteboard post with empty input in interactive whiteboard	Instructor is in the classroom	Create post with empty input	A warning displayed to notify instructor	Pass: Warning displayed Fail: Whiteboard post created
56	Instructor edits whiteboard post	Instructor is in the classroom and created whiteboard post	Edit whiteboard post with valid input	Whiteboard post updated in real time	Pass: Changes reflected instantly Fail: Changes not applied
57	Instructor edits whiteboard post with empty input	Instructor is in the classroom and created whiteboard post	Edit whiteboard post with empty input	A warning displayed to notify instructor	Pass: Warning displayed Fail: Whiteboard post updated
58	Instructor deletes whiteboard post	Instructor is in the classroom and created	Delete whiteboard post	Whiteboard post deleted in real time	Pass: Whiteboard post removed instantly

		whiteboard post			Fail: Whiteboard post not deleted
59	User joins interactive whiteboard	User is in the classroom	Click "Join Whiteboard" button from the whiteboard post	Joins whiteboard with username displayed on WBO	Pass: User joins the whiteboard successfully with correct username Fail: Join fails or incorrect details
60	User collaborates on interactive whiteboard	User is in the WBO	Edit whiteboard in WBO	Whiteboard accessible and all users can draw	Pass: Whiteboard drawable by all Fail: Edit fails
61	User joins read-only interactive whiteboard	User is in the classroom	Click "Join Whiteboard" button from the whiteboard post	Joins read-only whiteboard with username displayed and user role set on WBO	Pass: User joins the read-only whiteboard successfully with correct username and user role Fail: Join fails or incorrect details
62	Instructor draws on read-only	Student is in the WBO	Edit whiteboard in read-only WBO	Students can view, only instructor draws	Pass: Whiteboard drawable by instructor

	interactive whiteboard				Fail: Edit fails
63	Student spectates on read-only interactive whiteboard	Student is in the WBO	Spectate whiteboard in read-only WBO	Students can view, only instructor draws	Pass: Read-only enforced Fail: Students can draw
Assignment Submission Feature					
64	Instructor creates assignment post	Instructor is in the classroom	Create assignment post with instructions and file	Assignment post created, submission enabled	Pass: Assignment post created Fail: Assignment post creation fails
65	Instructor creates assignment post with invalid file type	Instructor is in the classroom	Upload invalid file type	A warning displayed to notify instructor	Pass: Warning displayed Fail: Assignment post created
66	Instructor creates assignment post with instruction only	Instructor is in the classroom	Write instructions without uploading any files	Assignment post created without uploaded file	Pass: Assignment post created Fail: Assignment post creation fails
67	Instructor creates assignment post with uploaded file only	Instructor is in the classroom	Uploading file without writing any instructions	A warning displayed to notify instructor	Pass: Warning displayed Fail: Assignment post created

68	Instructor edits assignment post	Instructor is in the classroom and created assignment post	Edit assignment post with new instructions and valid file type	Assignment Post updated in real time	Pass: Changes reflected instantly Fail: Changes not applied
69	Instructor edits assignment post with empty input	Instructor is in the classroom and created assignment post	Edit assignment post with empty input	The assignment post will remain the same before it is edited	Pass: Changes not applied Fail: Changes reflected instantly
70	Instructor deletes uploaded file only	Instructor is in the classroom and created assignment post	Click the delete icon of the uploaded file from assignment post	Uploaded file deleted in real time	Pass: Uploaded file removed instantly Fail: Uploaded file not deleted
71	Instructor deletes assignment post	Instructor is in the classroom and created assignment post	Delete assignment post	Assignment post deleted in real time	Pass: Assignment post removed instantly Fail: Assignment post not deleted
72	User downloads uploaded file from assignment post	User is in classroom	Click download icon of uploaded file from assignment post	File downloaded successfully	Pass: File downloaded Fail: Download fails

73	User previews file from assignment post	User is in classroom	Click on uploaded file from assignment post	Preview page appears and displays the uploaded file	Pass: Preview page appears and displays file Fail: Preview page not appear
74	Student submits assignment	Student is in the classroom	Upload assignment file and add message	Submission appears with submitted file and message	Pass: Assignment submitted Fail: Submission fails
75	Student submits assignment with invalid file type	Student is in the classroom	Upload invalid file type	A warning displayed to notify student	Pass: Warning displayed Fail: Assignment submission created
76	Student submits assignment with message only	Student is in the classroom	Write message without uploading any files	A warning displayed to notify student	Pass: Warning displayed Fail: Assignment submission created
77	Student submits assignment with uploaded file only	Student is in the classroom	Uploading file without writing any message	Assignment submission created without message	Pass: Assignment submission created Fail: Assignment

					submission fails
78	Student resubmits assignment	Student is in classroom, previously submitted	Upload new file to replace submission	New file replaces old	Pass: File replaced Fail: Replacement fails
79	Student resubmits assignment with empty input	Student is in classroom, previously submitted	Edit assignment submission with empty input	The assignment submission will remain the same before it is edited	Pass: Changes not applied Fail: Changes reflected instantly
80	Student deletes submitted file only	Student is in classroom, previously submitted	Click the delete icon of the submitted file from assignment submission	Submitted file deleted in real time	Pass: Submitted file removed instantly Fail: Submitted file not deleted
81	Student deletes assignment submission	Student is in classroom	Delete assignment post	Assignment submission deleted in real time	Pass: Assignment submission removed instantly Fail: Assignment submission not deleted
82	User downloads submitted file from	User is in classroom	Click download icon of submitted file from	File downloaded successfully	Pass: File downloaded

	assignment submission		assignment submission		Fail: Download fails
83	User previews file from assignment submission	User is in classroom	Click on submitted file from assignment submission	Preview page appears and displays the submitted file	Pass: Preview page appears and displays file Fail: Preview page not appear
84	Instructor comments under assignment post	Instructor is in the classroom	Add comment to assignment post	Comment appears in real time	Pass: Comment displayed instantly Fail: Comment not displayed
85	Instructor edits comment under assignment post	Instructor is in the classroom	Edit comment with valid input	Comment updated in real time	Pass: Changes reflected instantly Fail: Changes not applied
86	Instructor edits comment under assignment post with empty input	Instructor is in the classroom	Edit comment with empty input	A warning displayed to notify instructor	Pass: Warning displayed Fail: Comment updated
87	Instructor deletes comment under	Instructor is in the classroom	Delete comment	Comment deleted in real time	Pass: Comment removed instantly

	assignment post				Fail: Comment not deleted
88	Student comments under assignment post	Student is in the classroom	Add comment to assignment post	Comment appears in real time	Pass: Comment displayed instantly Fail: Comment not displayed
89	Student edits comment under assignment post	Student is in the classroom	Edit comment with valid input	Comment updated in real time	Pass: Changes reflected instantly Fail: Changes not applied
90	Student edits comment under assignment post with empty input	Student is in the classroom	Edit comment with empty input	A warning displayed to notify student	Pass: Warning displayed Fail: Comment updated
91	Student deletes comment under assignment post	Student is in the classroom	Delete comment	Comment deleted in real time	Pass: Comment removed instantly Fail: Comment not deleted
Quiz Feature					
92	Instructor creates quiz post	Instructor is in the classroom	Create quiz post with valid input	Quiz post created, quiz question creation enabled	Pass: Quiz post created

					Fail: Quiz post creation fails
93	Instructor creates quiz post with empty input	Instructor is in the classroom	Create quiz post with no input inserted	A warning displayed to notify instructor	Pass: Warning displayed Fail: Quiz post created
94	Instructor edits quiz post	Instructor is in the classroom and created quiz post	Edit quiz post with new valid input	Quiz Post updated in real time	Pass: Changes reflected instantly Fail: Changes not applied
95	Instructor edits quiz post with empty input	Instructor is in the classroom and created quiz post	Edit quiz post with empty input	The quiz post will remain the same before it is edited	Pass: Changes not applied Fail: Changes reflected instantly
96	Instructor deletes quiz post	Instructor is in the classroom and created quiz post	Delete quiz post	Quiz post deleted in real time	Pass: Quiz post removed instantly Fail: Quiz post not deleted
97	Instructor creates quiz question	Instructor is in the classroom and has created a quiz post	Create quiz question with valid input	Quiz question created, quiz question added	Pass: Quiz question created Fail: Quiz question creation fails
98	Instructor creates quiz	Instructor is in the classroom	Create quiz question with	A warning displayed to	Pass: Warning displayed

	question with empty input	and has created a quiz post	no input inserted	notify instructor	Fail: Quiz question created
99	Instructor edits quiz question	Instructor is in the classroom and has created a quiz post	Edit quiz question with new valid input	Quiz question updated in real time	Pass: Changes reflected instantly Fail: Changes not applied
100	Instructor edits quiz question with empty input	Instructor is in the classroom and has created a quiz post	Edit quiz question with empty input	The quiz question will remain the same before it is edited	Pass: Changes not applied Fail: Changes reflected instantly
101	Instructor deletes quiz question	Instructor is in the classroom and created quiz post	Delete quiz question	Quiz question deleted in real time	Pass: Quiz question removed instantly Fail: Quiz question not deleted
102	Instructor publishes quiz	Instructor is in the classroom and created quiz post	Publish quiz post with question added	Quiz published, quiz response from students enabled	Pass: Quiz published Fail: Quiz publish fails
103	Instructor publishes quiz with no questions added	Instructor is in the classroom and created quiz post	Publish quiz post with zero questions added	A warning displayed to notify instructor	Pass: Warning displayed Fail: Quiz published
104	Student submits quiz	Student is in the classroom	Answer quiz by filling up all the questions,	Respond submitted, the score of the	Pass: Respond recorded and score calculated

			then click the 'Submit Quiz' button	quiz is displayed	Fail: Respond submit fails
105	Student submits quiz with no answer	Student is in the classroom	Click the 'Submit Quiz' button with no answer selected	A warning displayed to notify instructor	Pass: Warning displayed Fail: Submission recorded
Search Feature					
106	Search posts in classroom	User is in the classroom	Enter keyword	Relevant posts displayed, filtered by section	Pass: Correct posts displayed Fail: Incorrect results
107	Search posts in classroom with mismatched input	User is in the classroom	Enter mismatch input	"No Result" message displayed	Pass: No result message displayed Fail: No feedback
108	Search posts in classroom with empty input	User is in the classroom	Enter empty input	A warning displayed to notify user	Pass: Warning displayed Fail: Redirect to result page
109	Switch Result Filter	User is in the search page	Select any filter from the filter section	The filter section appears correctly according to the selected filter	Pass: Selected filter section appears Fail: Incorrect filter section displayed

110	User downloads any file from search page	User is in the search page	Click download icon of any file from any post on search page	File downloaded successfully	Pass: File downloaded Fail: Download fails
111	User previews any file from search page	User is in the search page	Click on any file from any post on search page	Preview page appears and displays the selected file	Pass: Preview page appears and displays file Fail: Preview page not appear
112	User joins any meeting/ document/ whiteboard from search page	User is in the search page	Click on join button from any meeting/ document/ whiteboard post on search page	Joins meeting, document or whiteboard with correct username and user role	Pass: User joins in successfully with correct user details Fail: Join fails or incorrect details

Table 6.1.4 – Enrolled/Created Classroom Module Test Cases

6.1.3 User Testing

User testing will be done to assess the usability, accessibility, and other non-functional requirements of the Virtual Classroom Platform outlined in Chapter 3. This type of testing involves real end-users, such as students and instructors, who interact with the system in realistic scenarios to perform typical tasks, including logging in, uploading assignments, managing profiles, and using collaboration tools like whiteboards and online documents. Unlike black-box testing, which focuses on verifying system functionality, user testing emphasizes the platform's intuitiveness and user-friendliness. After completing the tasks, users will also be asked to complete a survey to share their impressions and any difficulties they encountered. This feedback will help identify usability issues that may not be revealed through black-box testing. The insights gained from user testing will be used to make iterative improvements, guaranteeing that the platform not only meets functional requirements but also delivers a smooth and satisfying experience for all users.

To further evaluate the effectiveness and robustness of the system, a survey and the following performance metrics from user testing were defined and measured.

Metric	**Description**	**Target Threshold (** ≥ 15/20 respondents voted for …**)**
Response Time	Time taken for system to respond to any user actions	(0 - 2 second)
System Availability	The uptime percentage of the system	≥ 99% uptime
File Upload Success Rate	Successful file uploads	"All"
Message/Comment Delivery Latency	Time taken for a chat message/comment to appear on recipient's screen	< 1 second
Real-time Collaboration Tools Sync Delay	Time difference between changing and reflecting on another user's screen in Jitsi Meet/Etherpad/WBO	"Yes"
Error Rate	Functional errors or crashes during operation	"No"
Compatibility	System compatibility across browsers (Chrome, Firefox, Edge) and devices	"Good - Excellent"
Usability	Overall ease of use and intuitiveness	"Easy (5) – Very Easy (6)"
Authentication Process Reliability	Security and ease of login, registration, and password reset	"Mostly – Fully Secure"
Feedback Tool Effectiveness	Effectiveness of interactive tools like quizzes, chat, and file sharing	"Effective(4) - Very Effective (5)"

Table 6.1.5 – Performance Metrics

6.2 Testing Result

6.2.1 Authentication Module Test Cases Result

Test Case Number	Description	Preconditions	Inputs	Expected Output	Pass/Fail Criteria	Result
1	Register a new user	User is on the register page, not logged in	Valid inputs: username, email, password, confirm password, and user role	User account created, redirected to login page	Pass: Account created and redirection occurs Fail: Error message displayed	**Pass**
2	Register with invalid username	User is on the register page, not logged in	Invalid username (e.g., "David123"), other valid inputs	Error message regarding invalid username displayed	Pass: Error message displayed Fail: Account created	**Pass**
3	Register with invalid email	User is on the register page, not logged in	Invalid email (e.g., "user@invalid")	Error message regarding invalid email displayed	Pass: Error message displayed Fail: Account created	**Pass**
4	Register with invalid password	User is on the register page, not logged in	Invalid password (e.g., “abc123”)	Error message regarding invalid password displayed	Pass: Error message displayed Fail: Account created	**Pass**

5	Register with mismatched passwords	User is on the register page, not logged in	Password and confirm password do not match	Error message regarding password mismatch displayed	Pass: Error message displayed Fail: Account created	**Pass**
6	Login with valid credentials	User has a registered account	Valid email and password	Redirected to User Panel	Pass: Successful login and redirection Fail: Error message displayed	**Pass**
7	Login with invalid inputs	User has a registered account	Invalid email or password	Error message regarding invalid login inputs displayed	Pass: Error message displayed Fail: Login succeeds	**Pass**
8	Password recovery	User is on the login page, forgets password	Registered email address	Reset password link sent to email, redirected to reset password page by clicking the link via email	Pass: Email received and redirection occurs Fail: Error message displayed	**Pass**
9	Password recovery with invalid email	User is on the login page, forgets password	Unregistered email address	Error message regarding unregistered	Pass: Error message displayed	**Pass**

				email displayed	Fail: Email received	
10	Reset password with valid password	User is on the reset password page	New password, confirm password	Password updated, redirected to login page	Pass: Password updated and redirection occurs Fail: Error message displayed	**Pass**
11	Reset password with invalid password	User is on the reset password page	Invalid password (e.g., “abc123”)	Error message regarding invalid password displayed	Pass: Error message displayed Fail: Password Reset	**Pass**
12	Reset password with mismatched passwords	User is on the reset password page	Password and confirm password do not match	Error message regarding password mismatch displayed	Pass: Error message displayed Fail: Password Reset	**Pass**

Table 6.2.1 – Authentication Module Test Cases Result

6.2.2 Class Management Module Test Cases Result

Test Case Number	Description	Preconditions	Inputs	Expected Output	Pass/Fail Criteria	Result
1	Instructor creates a class	Instructor is on User Panel	Valid class name and code	Class created, appears in User Panel	Pass: Class created and displayed Fail: Error message displayed	**Pass**
2	Instructor creates a class with invalid input	Instructor is on User Panel	Invalid class name and code	Error message regarding invalid class creation inputs displayed	Pass: Class created and displayed Fail: Error message displayed	**Pass**
3	Instructor joins a class	Instructor is on User Panel	Valid class code	Class added to User Panel	Pass: Class added Fail: Error message displayed	**Pass**
4	Instructor joins a class with invalid class code	Instructor is on User Panel	Invalid class code	Error message regarding invalid class code displayed	Pass: Error message displayed Fail: Class added	**Pass**
5	Instructor removes a created class	Instructor is on User Panel and class created	Select class, click "Remove"	Class removed from User Panel and system	Pass: Class removed from system	**Pass**

					Fail: Class remains	
6	Instructor leaves a joined class	Instructor is on User Panel and joined a class	Select class, click "Leave"	Class removed from User Panel	Pass: Class removed from panel Fail: Class remains	**Pass**
7	Student joins a class	Student is on User Panel	Valid class code	Class added to User Panel	Pass: Class added Fail: Error message displayed	**Pass**
8	Student joins a class with invalid class code	Student is on User Panel	Invalid class code	Error message regarding invalid class code displayed	Pass: Error message displayed Fail: Class added	**Pass**
9	Student leaves a class	Student is on User Panel and enrolled in a class	Select class, click "Leave"	Class removed from User Panel	Pass: Class removed from panel Fail: Class remains	**Pass**

Table 6.2.2 – Class Management Module Test Cases Result

6.2.3 Profile Management Module Test Cases Result

Test Case Number	Description	Preconditions	Inputs	Expected Output	Pass/Fail Criteria	Result
1	View user profile	User is logged in	Click username in header	Profile page displays user details	Pass: Details displayed correctly Fail: Incorrect details	**Pass**
2	Update user profile	User is on profile page	Valid profile details inputs	Profile updated and displayed	Pass: Details updated and displayed Fail: Update fails	**Pass**
3	Update user profile with invalid inputs	User is on profile page	Invalid profile details inputs	Error message regarding invalid details input displayed	Pass: Error message displayed Fail: Details updated	**Pass**
4	Upload profile picture	User is on profile page	Upload valid image file (e.g., JPG, PNG)	Image uploaded, cropped, and updated	Pass: Image updated Fail: Upload fails	**Pass**
5	Upload invalid profile picture	User is on profile page	Upload invalid file (e.g., non-image file)	Error message regarding invalid image file displayed	Pass: Error message displayed Fail: File uploaded	**Pass**

Table 6.2.3 – Profile Management Module Test Cases Result

6.2.4 Enrolled/Created Classroom Module Test Cases Result

Test Case Number	Description	Preconditions	Inputs	Expected Output	Pass/Fail Criteria	Result
Basic Features						
1	Access classroom	User is on User panel and created/joined a class	Select class from User Panel	Classroom page loads with collaboration tools	Pass: Class loads correctly Fail: Incorrect class loaded	**Pass**
2	View classroom members	User is in the classroom	Click "Class Members"	A member list that shows instructor(s) and students who are members of the class.	Pass: Member List appears Fail: Member List not displayed	**Pass**
3	Enlarge class code	User is in the classroom	Click on the option button beside the class code then click "Expand"	A pop-up appear that display the class code in bigger font size	Pass: Pop-up appears Fail: Pop-up not displayed	**Pass**
4	Switch Classroom Tools	User is in the classroom	Select any tool from the tool section	The tool section appears correctly according to the selected tool	Pass: Selected tool section appears Fail: Incorrect tool section displayed	**Pass**

5	Logout from classroom	User is in classroom	Click logout from header	Session terminated and redirected to homepage	Pass: Redirected to homepage Fail: Session persists	**Pass**
Group Chat						
6	Instructor posts in group chat	Instructor is in the classroom	Create post with text	Post appears in group chat in real time	Pass: Post displayed instantly Fail: Post not displayed	**Pass**
7	Instructor posts in group chat with empty input	Instructor is in the classroom	Create post with empty input	A warning displayed to notify instructor	Pass: Warning displayed Fail: Post Created	**Pass**
8	Instructor edits post	Instructor is in the classroom and created post	Edit post with valid input	Post updated in real time	Pass: Changes reflected instantly Fail: Changes not applied	**Pass**
9	Instructor edits post with empty input	Instructor is in the classroom and created post	Edit post with empty input	A warning displayed to notify instructor	Pass: Warning displayed Fail: Post updated	**Pass**

10	Instructor deletes post	Instructor is in the classroom and created post	Delete post	Post deleted in real time	Pass: Post removed instantly Fail: Post not deleted	**Pass**
11	Instructor comments in group chat	Instructor is in the classroom	Add comment to post	Comment appears in real time	Pass: Comment displayed instantly Fail: Comment not displayed	**Pass**
12	Instructor edits comment in group chat	Instructor is in the classroom	Edit comment with valid input	Comment updated in real time	Pass: Changes reflected instantly Fail: Changes not applied	**Pass**
13	Instructor edits comment in group chat with empty input	Instructor is in the classroom	Edit comment with empty input	A warning displayed to notify instructor	Pass: Warning displayed Fail: Comment updated	**Pass**
14	Instructor deletes comment in group chat	Instructor is in the classroom	Delete comment	Comment deleted in real time	Pass: Comment removed instantly Fail: Comment not deleted	**Pass**

15	Student comments in group chat	Student is in the classroom	Add comment to post	Comment appears in real time	Pass: Comment displayed instantly Fail: Comment not displayed	**Pass**
16	Student edits comment in group chat	Student is in the classroom	Edit comment with valid input	Comment updated in real time	Pass: Changes reflected instantly Fail: Changes not applied	**Pass**
17	Student edits comment in group chat with empty input	Student is in the classroom	Edit comment with empty input	A warning displayed to notify student	Pass: Warning displayed Fail: Comment updated	**Pass**
18	Student deletes comment in group chat	Student is in the classroom	Delete comment	Comment deleted in real time	Pass: Comment removed instantly Fail: Comment not deleted	**Pass**
File Sharing Feature						
19	Instructor creates file post with	Instructor is in the classroom	Upload valid file type and write message	File post created and accessible to class	Pass: Post created	**Pass**

	message in file sharing				Fail: File Post creation fails	
20	Instructor creates file post without message in file sharing	Instructor is in the classroom	Upload valid file type only	File post created and accessible to class	Pass: Post created Fail: File Post creation fails	**Pass**
21	Instructor creates file post with invalid file in file sharing	Instructor is in the classroom	Upload invalid file type	A warning displayed to notify instructor	Pass: Warning displayed Fail: File Post created	**Pass**
22	Instructor creates file post with message only in file sharing	Instructor is in the classroom	Write message without upload any files	A warning displayed to notify instructor	Pass: Warning displayed Fail: File Post created	**Pass**
23	Instructor edits file post	Instructor is in the classroom and created file post	Edit file post with valid file type	File Post updated in real time	Pass: Changes reflected instantly Fail: Changes not applied	**Pass**
24	Instructor edits file post with empty input	Instructor is in the classroom and created file post	Edit file post with empty input	The file post will remain the same before it is edited	Pass: Changes not applied Fail: Changes	**Pass**

					reflected instantly	
25	Instructor deletes uploaded file only	Instructor is in the classroom and created file post	Click the delete icon of the uploaded file from file post	Uploaded file deleted in real time	Pass: Uploaded file removed instantly Fail: Uploaded file not deleted	**Pass**
26	Instructor deletes file post	Instructor is in the classroom and created file post	Delete file post	File Post deleted in real time	Pass: File Post removed instantly Fail: File Post not deleted	**Pass**
27	Instructor comments in file sharing	Instructor is in the classroom	Add comment to file post	Comment appears in real time	Pass: Comment displayed instantly Fail: Comment not displayed	**Pass**
28	Instructor edits comment in file sharing	Instructor is in the classroom	Edit comment with valid input	Comment updated in real time	Pass: Changes reflected instantly Fail: Changes not applied	**Pass**

29	Instructor edits comment in file sharing with empty input	Instructor is in the classroom	Edit comment with empty input	A warning displayed to notify instructor	Pass: Warning displayed Fail: Comment updated	**Pass**
30	Instructor deletes comment in file sharing	Instructor is in the classroom	Delete comment	Comment deleted in real time	Pass: Comment removed instantly Fail: Comment not deleted	**Pass**
31	Student comments in file sharing	Student is in the classroom	Add comment to file post	Comment appears in real time	Pass: Comment displayed instantly Fail: Comment not displayed	**Pass**
32	Student edits comment in file sharing	Student is in the classroom	Edit comment with valid input	Comment updated in real time	Pass: Changes reflected instantly Fail: Changes not applied	**Pass**
33	Student edits comment in file sharing	Student is in the classroom	Edit comment with empty input	A warning displayed to notify student	Pass: Warning displayed	**Pass**

	with empty input				Fail: Comment updated	
34	Student deletes comment in file sharing	Student is in the classroom	Delete comment	Comment deleted in real time	Pass: Comment removed instantly Fail: Comment not deleted	**Pass**
35	User downloads file in file sharing	User is in classroom	Click download icon of uploaded file from file post	File downloaded successfully	Pass: File downloaded Fail: Download fails	**Pass**
36	User previews file in file sharing	User is in classroom	Click on uploaded file from file post	Preview page appears and displays the uploaded file	Pass: Preview page appears and displays file Fail: Preview page not appear	**Pass**
Video Meeting Feature						
37	Instructor creates meeting post in video meeting	Instructor is in the classroom	Create post with meeting name	Meeting post appears with system-generated Jitsi Meet link in real time	Pass: Meeting post displayed instantly Fail: Meeting	**Pass**

					post not displayed	
38	Instructor creates meeting post with empty input in video meeting	Instructor is in the classroom	Create post with empty input	A warning displayed to notify instructor	Pass: Warning displayed Fail: Meeting post created	**Pass**
39	Instructor edits meeting post	Instructor is in the classroom and created meeting post	Edit meeting post with valid input	Meeting post updated in real time	Pass: Changes reflected instantly Fail: Changes not applied	**Pass**
40	Instructor edits meeting post with empty input	Instructor is in the classroom and created meeting post	Edit meeting post with empty input	A warning displayed to notify instructor	Pass: Warning displayed Fail: Meeting post updated	**Pass**
41	Instructor deletes meeting post	Instructor is in the classroom and created meeting post	Delete meeting post	Meeting post deleted in real time	Pass: Meeting post removed instantly Fail: Meeting post not deleted	**Pass**

42	User joins video meeting	User is in the classroom	Click "Join Meeting" button from the meeting post	Joins meeting with user details pre-filled in the meeting configuration page	Pass: User joins the meeting successfully with correct user details Fail: Join fails or incorrect details	**Pass**
43	User interacts and collaborates in video meeting	User is in the Jitsi Meet	Click and utilize every feature from Jitsi Meet	Interacts and collaborates with everyone with features provided (screen sharing, text chat, and so on) from Jitsi Meet	Pass: User interacts and collaborates with everyone Fail: Jitsi Meet features fail	**Pass**
Online Document Feature						
44	Instructor creates regular/read-only document post in online document	Instructor is in the classroom	Create post with document name	Document post appears with system-generated Etherpad link in real time	Pass: Document post displayed instantly Fail: Document post not displayed	**Pass**
45	Instructor creates regular/read-only document	Instructor is in the classroom	Create post with empty input	A warning displayed to notify instructor	Pass: Warning displayed	**Pass**

	post with empty input in online document				Fail: Document post created	
46	Instructor edits document post	Instructor is in the classroom and created document post	Edit document post with valid input	Document post updated in real time	Pass: Changes reflected instantly Fail: Changes not applied	**Pass**
47	Instructor edits document post with empty input	Instructor is in the classroom and created document post	Edit document post with empty input	A warning displayed to notify instructor	Pass: Warning displayed Fail: Document post updated	**Pass**
48	Instructor deletes document post	Instructor is in the classroom and created document post	Delete document post	Document post deleted in real time	Pass: Document post removed instantly Fail: Document post not deleted	**Pass**
49	User joins online document	User is in the classroom	Click "Join Document" button from the document post	Joins document with username displayed on Etherpad	Pass: User joins the document successfully with correct username	**Pass**

					Fail: Join fails or incorrect details	
50	User collaborates in online document	User is in the Etherpad	Edit document in Etherpad	Document accessible and all users can edit	Pass: Document editable by all Fail: Edit fails	**Pass**
51	User joins read-only online document	User is in the classroom	Click "Join Document" button from the document post	Joins read-only document with username displayed and user role set on Etherpad	Pass: User joins the read-only document successfully with correct username and user role Fail: Join fails or incorrect details	**Pass**
52	Instructor writes in read-only online document	Instructor is in the Etherpad	Edit document in read-only Etherpad	Students can view, only instructor edits	Pass: Document editable by instructor Fail: Edit fails	**Pass**
53	Student spectates in read-only online document	Student is in the Etherpad	Spectate document in read-only Etherpad	Students can view, only instructor edits	Pass: Read-only enforced	**Pass**

					Fail: Students can edit	
Interactive Whiteboard Feature						
54	Instructor creates regular/read-only whiteboard post in interactive whiteboard	Instructor is in the classroom	Create post with whiteboard name	Whiteboard post appears with system-generated WBO link in real time	Pass: Whiteboard post displayed instantly Fail: Whiteboard post not displayed	**Pass**
55	Instructor creates regular/read-only whiteboard post with empty input in interactive whiteboard	Instructor is in the classroom	Create post with empty input	A warning displayed to notify instructor	Pass: Warning displayed Fail: Whiteboard post created	**Pass**
56	Instructor edits whiteboard post	Instructor is in the classroom and created whiteboard post	Edit whiteboard post with valid input	Whiteboard post updated in real time	Pass: Changes reflected instantly Fail: Changes not applied	**Pass**
57	Instructor edits whiteboard post with empty input	Instructor is in the classroom and created whiteboard post	Edit whiteboard post with empty input	A warning displayed to notify instructor	Pass: Warning displayed	**Pass**

					Fail: Whiteboard post updated	
58	Instructor deletes whiteboard post	Instructor is in the classroom and created whiteboard post	Delete whiteboard post	Whiteboard post deleted in real time	Pass: Whiteboard post removed instantly Fail: Whiteboard post not deleted	**Pass**
59	User joins interactive whiteboard	User is in the classroom	Click "Join Whiteboard" button from the whiteboard post	Joins whiteboard with username displayed on WBO	Pass: User joins the whiteboard successfully with correct username Fail: Join fails or incorrect details	**Pass**
60	User collaborates on interactive whiteboard	User is in the WBO	Edit whiteboard in WBO	Whiteboard accessible and all users can draw	Pass: Whiteboard drawable by all Fail: Edit fails	**Pass**
61	User joins read-only interactive whiteboard	User is in the classroom	Click "Join Whiteboard" button from the	Joins read-only whiteboard with username	Pass: User joins the read-only whiteboard successfully	**Pass**

			whiteboard post	displayed and user role set on WBO	with correct username and user role Fail: Join fails or incorrect details	
62	Instructor draws on read-only interactive whiteboard	Student is in the WBO	Edit whiteboard in read-only WBO	Students can view, only instructor draws	Pass: Whiteboard drawable by instructor Fail: Edit fails	**Pass**
63	Student spectates on read-only interactive whiteboard	Student is in the WBO	Spectate whiteboard in read-only WBO	Students can view, only instructor draws	Pass: Read-only enforced Fail: Students can draw	**Pass**
Assignment Submission Feature						
64	Instructor creates assignment post	Instructor is in the classroom	Create assignment post with instructions and file	Assignment post created, submission enabled	Pass: Assignment post created Fail: Assignment post creation fails	**Pass**
65	Instructor creates assignment post with	Instructor is in the classroom	Upload invalid file type	A warning displayed to notify instructor	Pass: Warning displayed	**Pass**

	invalid file type				Fail: Assignment post created	
66	Instructor creates assignment post with instruction only	Instructor is in the classroom	Write instructions without uploading any files	Assignment post created without uploaded file	Pass: Assignment post created Fail: Assignment post creation fails	**Pass**
67	Instructor creates assignment post with uploaded file only	Instructor is in the classroom	Uploading file without writing any instructions	A warning displayed to notify instructor	Pass: Warning displayed Fail: Assignment post created	**Pass**
68	Instructor edits assignment post	Instructor is in the classroom and created assignment post	Edit assignment post with new instructions and valid file type	Assignment Post updated in real time	Pass: Changes reflected instantly Fail: Changes not applied	**Pass**
69	Instructor edits assignment post with empty input	Instructor is in the classroom and created assignment post	Edit assignment post with empty input	The assignment post will remain the same before it is edited	Pass: Changes not applied Fail: Changes reflected instantly	**Pass**

70	Instructor deletes uploaded file only	Instructor is in the classroom and created assignment post	Click the delete icon of the uploaded file from assignment post	Uploaded file deleted in real time	Pass: Uploaded file removed instantly Fail: Uploaded file not deleted	**Pass**
71	Instructor deletes assignment post	Instructor is in the classroom and created assignment post	Delete assignment post	Assignment post deleted in real time	Pass: Assignment post removed instantly Fail: Assignment post not deleted	**Pass**
72	User downloads uploaded file from assignment post	User is in classroom	Click download icon of uploaded file from assignment post	File downloaded successfully	Pass: File downloaded Fail: Download fails	**Pass**
73	User previews file from assignment post	User is in classroom	Click on uploaded file from assignment post	Preview page appears and displays the uploaded file	Pass: Preview page appears and displays file Fail: Preview page not appear	**Pass**

74	Student submits assignment	Student is in the classroom	Upload assignment file and add message	Submission appears with submitted file and message	Pass: Assignment submitted Fail: Submission fails	**Pass**
75	Student submits assignment with invalid file type	Student is in the classroom	Upload invalid file type	A warning displayed to notify student	Pass: Warning displayed Fail: Assignment submission created	**Pass**
76	Student submits assignment with message only	Student is in the classroom	Write message without uploading any files	A warning displayed to notify student	Pass: Warning displayed Fail: Assignment submission created	**Pass**
77	Student submits assignment with uploaded file only	Student is in the classroom	Uploading file without writing any message	Assignment submission created without message	Pass: Assignment submission created Fail: Assignment submission fails	**Pass**
78	Student resubmits assignment	Student is in classroom, previously submitted	Upload new file to replace submission	New file replaces old	Pass: File replaced	**Pass**

					Fail: Replaced fails	
79	Student resubmits assignment with empty input	Student is in classroom, previously submitted	Edit assignment submission with empty input	The assignment submission will remain the same before it is edited	Pass: Changes not applied Fail: Changes reflected instantly	**Pass**
80	Student deletes submitted file only	Student is in classroom, previously submitted	Click the delete icon of the submitted file from assignment submission	Submitted file deleted in real time	Pass: Submitted file removed instantly Fail: Submitted file not deleted	**Pass**
81	Student deletes assignment submission	Student is in classroom	Delete assignment post	Assignment submission deleted in real time	Pass: Assignment submission removed instantly Fail: Assignment submission not deleted	**Pass**
82	User downloads submitted file from assignment submission	User is in classroom	Click download icon of submitted file from	File downloaded successfully	Pass: File downloaded Fail: Download fails	**Pass**

			assignment submission			
83	User previews file from assignment submission	User is in classroom	Click on submitted file from assignment submission	Preview page appears and displays the submitted file	Pass: Preview page appears and displays file Fail: Preview page not appear	**Pass**
84	Instructor comments under assignment post	Instructor is in the classroom	Add comment to assignment post	Comment appears in real time	Pass: Comment displayed instantly Fail: Comment not displayed	**Pass**
85	Instructor edits comment under assignment post	Instructor is in the classroom	Edit comment with valid input	Comment updated in real time	Pass: Changes reflected instantly Fail: Changes not applied	**Pass**
86	Instructor edits comment under assignment post with empty input	Instructor is in the classroom	Edit comment with empty input	A warning displayed to notify instructor	Pass: Warning displayed Fail: Comment updated	**Pass**

87	Instructor deletes comment under assignment post	Instructor is in the classroom	Delete comment	Comment deleted in real time	Pass: Comment removed instantly Fail: Comment not deleted	**Pass**
88	Student comments under assignment post	Student is in the classroom	Add comment to assignment post	Comment appears in real time	Pass: Comment displayed instantly Fail: Comment not displayed	**Pass**
89	Student edits comment under assignment post	Student is in the classroom	Edit comment with valid input	Comment updated in real time	Pass: Changes reflected instantly Fail: Changes not applied	**Pass**
90	Student edits comment under assignment post with empty input	Student is in the classroom	Edit comment with empty input	A warning displayed to notify student	Pass: Warning displayed Fail: Comment updated	**Pass**
91	Student deletes comment under	Student is in the classroom	Delete comment	Comment deleted in real time	Pass: Comment removed instantly	**Pass**

	assignment post				Fail: Comment not deleted	
Quiz Feature						
92	Instructor creates quiz post	Instructor is in the classroom	Create quiz post with valid input	Quiz post created, quiz question creation enabled	Pass: Quiz post created Fail: Quiz post creation fails	**Pass**
93	Instructor creates quiz post with empty input	Instructor is in the classroom	Create quiz post with no input inserted	A warning displayed to notify instructor	Pass: Warning displayed Fail: Quiz post created	**Pass**
94	Instructor edits quiz post	Instructor is in the classroom and created quiz post	Edit quiz post with new valid input	Quiz Post updated in real time	Pass: Changes reflected instantly Fail: Changes not applied	**Pass**
95	Instructor edits quiz post with empty input	Instructor is in the classroom and created quiz post	Edit quiz post with empty input	The quiz post will remain the same before it is edited	Pass: Changes not applied Fail: Changes reflected instantly	**Pass**
96	Instructor deletes quiz post	Instructor is in the classroom and created quiz post	Delete quiz post	Quiz post deleted in real time	Pass: Quiz post removed instantly	**Pass**

					Fail: Quiz post not deleted	
97	Instructor creates quiz question	Instructor is in the classroom and has created a quiz post	Create quiz question with valid input	Quiz question created, quiz question added	Pass: Quiz question created Fail: Quiz question creation fails	**Pass**
98	Instructor creates quiz question with empty input	Instructor is in the classroom and has created a quiz post	Create quiz question with no input inserted	A warning displayed to notify instructor	Pass: Warning displayed Fail: Quiz question created	**Pass**
99	Instructor edits quiz question	Instructor is in the classroom and has created a quiz post	Edit quiz question with new valid input	Quiz question updated in real time	Pass: Changes reflected instantly Fail: Changes not applied	**Pass**
100	Instructor edits quiz question with empty input	Instructor is in the classroom and has created a quiz post	Edit quiz question with empty input	The quiz question will remain the same before it is edited	Pass: Changes not applied Fail: Changes reflected instantly	**Pass**

101	Instructor deletes quiz question	Instructor is in the classroom and created quiz post	Delete quiz question	Quiz question deleted in real time	Pass: Quiz question removed instantly Fail: Quiz question not deleted	**Pass**
102	Instructor publishes quiz	Instructor is in the classroom and created quiz post	Publish quiz post with question added	Quiz published, quiz response from students enabled	Pass: Quiz published Fail: Quiz publish fails	**Pass**
103	Instructor publishes quiz with no questions added	Instructor is in the classroom and created quiz post	Publish quiz post with zero questions added	A warning displayed to notify instructor	Pass: Warning displayed Fail: Quiz published	**Pass**
104	Student submits quiz	Student is in the classroom	Answer quiz by filling up all the questions, then click the 'Submit Quiz' button	Respond submitted, the score of the quiz is displayed	Pass: Respond recorded and score calculated Fail: Respond submit fails	**Pass**
105	Student submits quiz with no answer	Student is in the classroom	Click the 'Submit Quiz' button with no answer selected	A warning displayed to notify instructor	Pass: Warning displayed Fail: Submission recorded	**Pass**
Search Feature						

106	Search posts in classroom	User is in the classroom	Enter keyword	Relevant posts displayed, filtered by section	Pass: Correct posts displayed Fail: Incorrect results	**Pass**
107	Search posts in classroom with mismatched input	User is in the classroom	Enter mismatch input	"No Result" message displayed	Pass:No result message displayed Fail: No feedback	**Pass**
108	Search posts in classroom with empty input	User is in the classroom	Enter empty input	A warning displayed to notify user	Pass: Warning displayed Fail: Redirect to result page	**Pass**
109	Switch Result Filter	User is in the search page	Select any filter from the filter section	The filter section appears correctly according to the selected filter	Pass: Selected filter section appears Fail: Incorrect filter section displayed	**Pass**
110	User downloads any file from search page	User is in the search page	Click download icon of any file from any post on search page	File downloaded successfully	Pass: File downloaded Fail: Download fails	**Pass**

111	User previews any file from search page	User is in the search page	Click on any file from any post on search page	Preview page appears and displays the selected file	Pass: Preview page appears and displays file Fail: Preview page not appear	**Pass**
112	User joins any meeting/ document/ whiteboard from search page	User is in the search page	Click on join button from any meeting/ document/ whiteboard post on search page	Joins meeting, document or whiteboard with correct username and user role	Pass: User joins in successfully with correct user details Fail: Join fails or incorrect details	**Pass**

Table 6.2.4 – Enrolled/Created Classroom Module Test Cases Result

6.2.5 User Testing Result

6.2.5.1 Survey Analysis

Question 1:

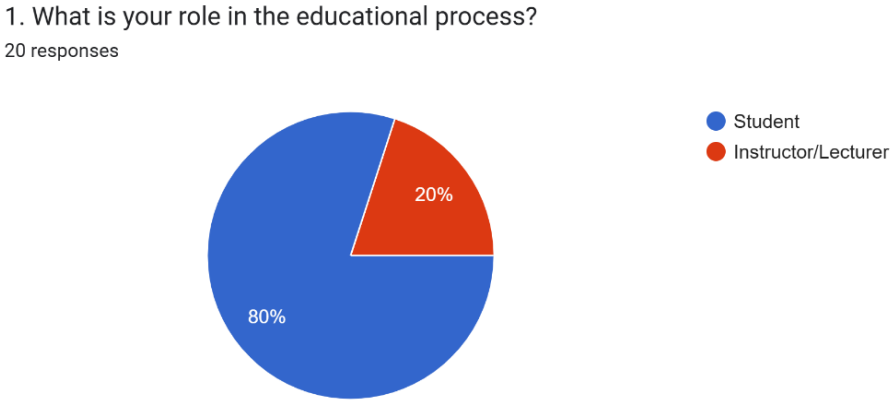


Figure 6.2.1 – Pie Chart of User Role

80% of the respondents identified as students, while 20% were instructors. This distribution ensures that the platform's usability and performance were assessed from both learner and facilitator perspectives. The feedback thus reflects a balanced insight into the platform's effectiveness for different user roles, which is crucial for validating system design across user journeys.

Question 2:

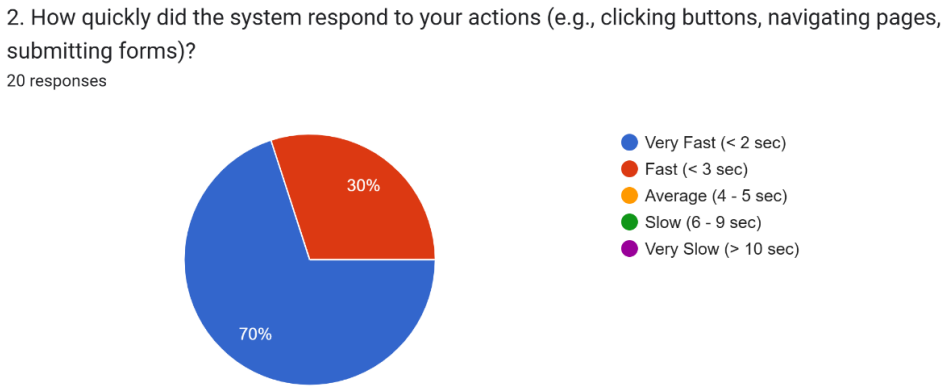


Figure 6.2.2 - Pie Chart of System Response Time

70% of users reported the system responded very fast (< 2 seconds), and the remaining 30% rated it as fast (< 3 seconds). This indicates excellent performance for the response time of the overall virtual classroom platform. Such quick responsiveness contributes positively to user experience and minimizes frustration during interactions, particularly for real-time educational activities.

Question 3:

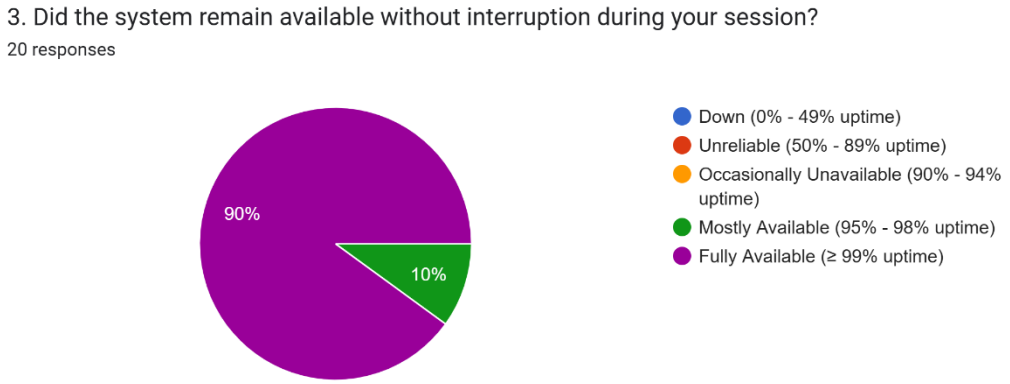


Figure 6.2.3 - Pie Chart of System Availability

90% of respondents experienced full system availability (≥ 99%), while 10% reported mostly available (95 – 98%). This suggests the platform is highly stable and reliable, with minimal downtime during sessions. These results support strong performance for the system availability of the platform, which is vital for maintaining continuous access during classes.

Question 4:

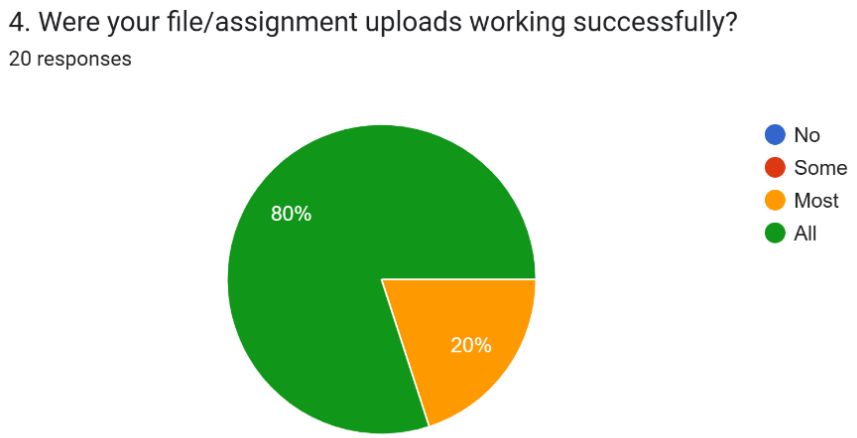


Figure 6.2.4 - Pie Chart of File Upload Success Rate

80% of users successfully uploaded all files or assignments, while 20% were successful with most uploads. This shows a high file upload success rate, indicating that the platform handles content submissions reliably. This functionality is essential for both students submitting work and instructors distributing materials.

Question 5:

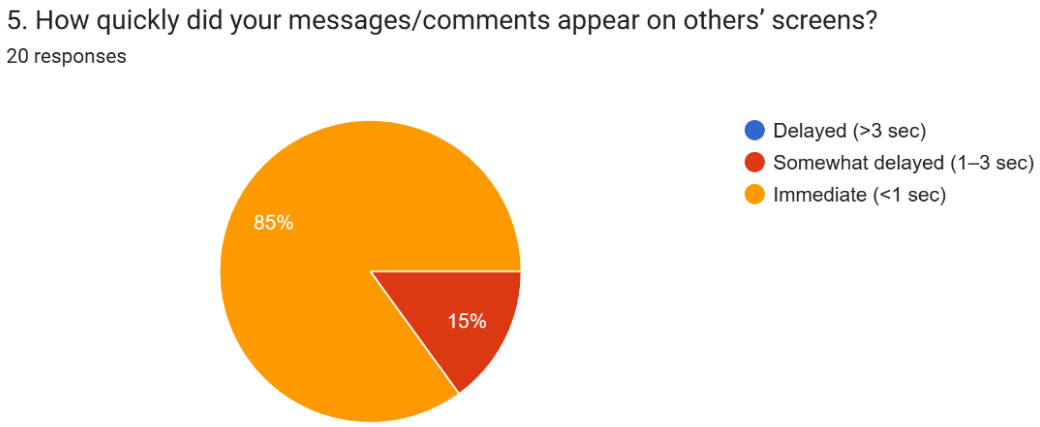


Figure 6.2.5 - Pie Chart of Message/Comment Delivery Latency

85% of users observed that their messages/comments appeared immediately (< 1 sec), and 15% experienced a slight delay (1–3 sec). These results demonstrate strong performance in message/comment delivery latency, which supports seamless communication during collaborative or synchronous activities.

Question 6:

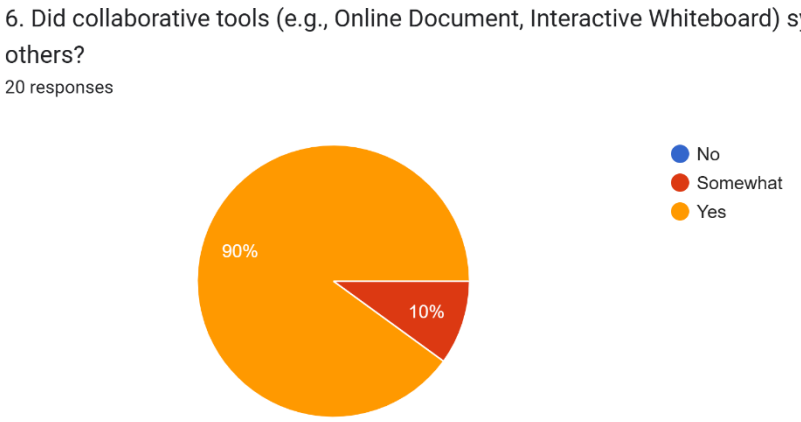


Figure 6.2.6 - Pie Chart of Real-Time Collaboration Tool Sync

90% of users reported that collaboration tools synced in real-time, while 10% noted somewhat real-time behavior. This suggests the system performs very well in maintaining real-time collaboration tool sync, which is crucial for group work and real-time instruction using shared documents or whiteboards.

Question 7:

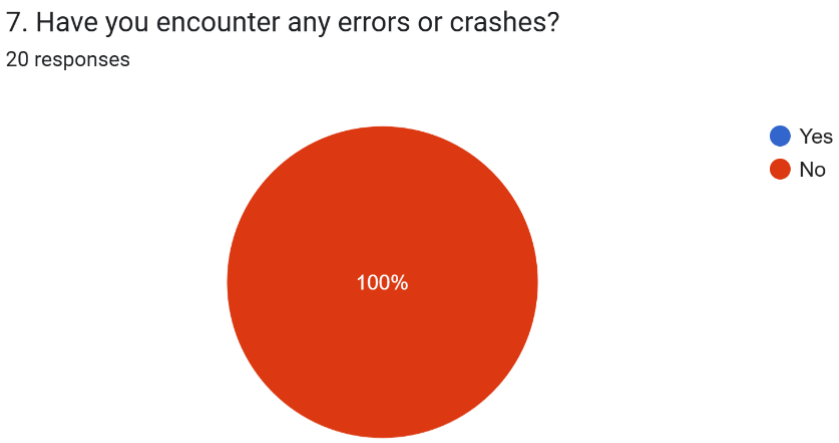


Figure 6.2.7 - Pie Chart of Error Rate

All respondents reported experiencing no errors or crashes, showing a 0% error rate during testing. This reflects excellent system stability and robustness, which contribute significantly to overall user satisfaction and trust.

Question 8:

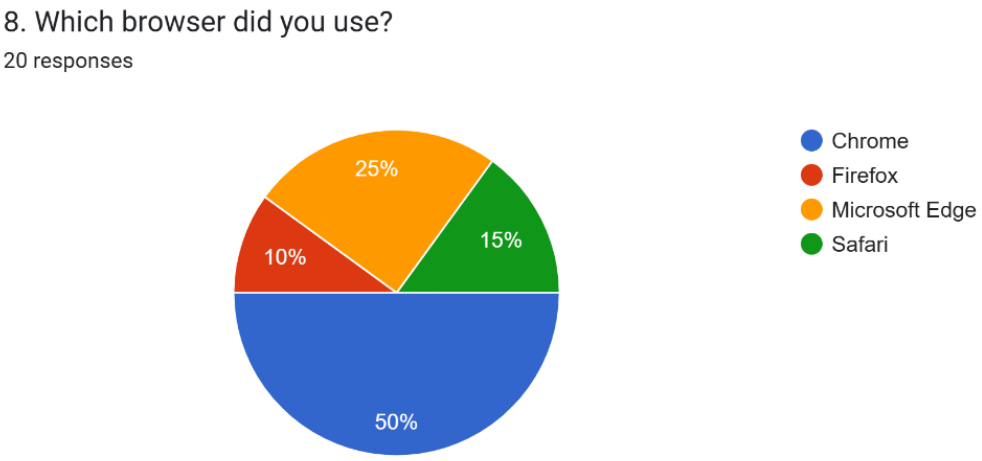


Figure 6.2.8 - Pie Chart of Compatibility

Chrome was the most commonly used browser (50%), followed by Microsoft Edge (25%), Safari (15%), and Firefox (10%). The diversity of browser usage ensures a fair test of the system's cross-browser compatibility and reflects real-world usage environments.

Question 9:

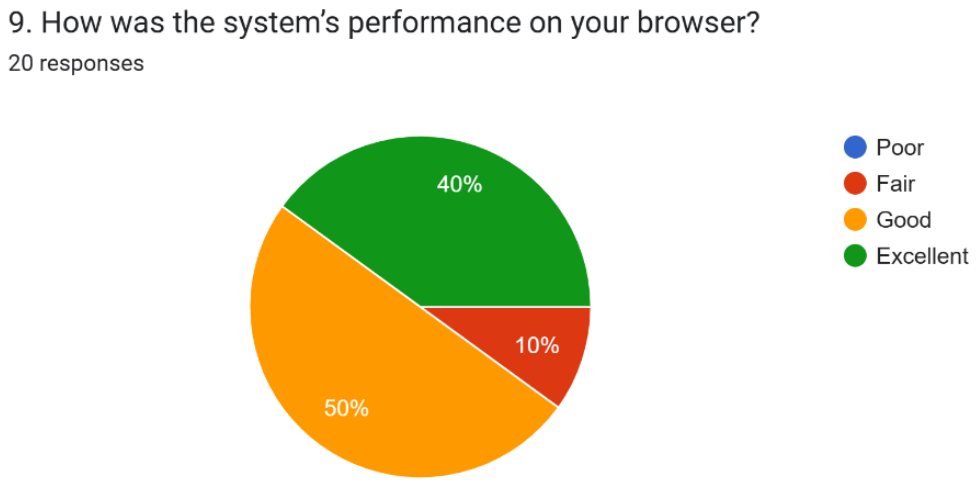


Figure 6.2.9 - Pie Chart of System's Performance on Browser

50% rated the performance as Good, 40% as Excellent, and only 10% as Fair. This shows that the platform performs reliably across browsers, though there may be minor optimizations needed for less common setups. It reflects positively on the compatibility metric, especially when considered alongside browser diversity.

Question 10:

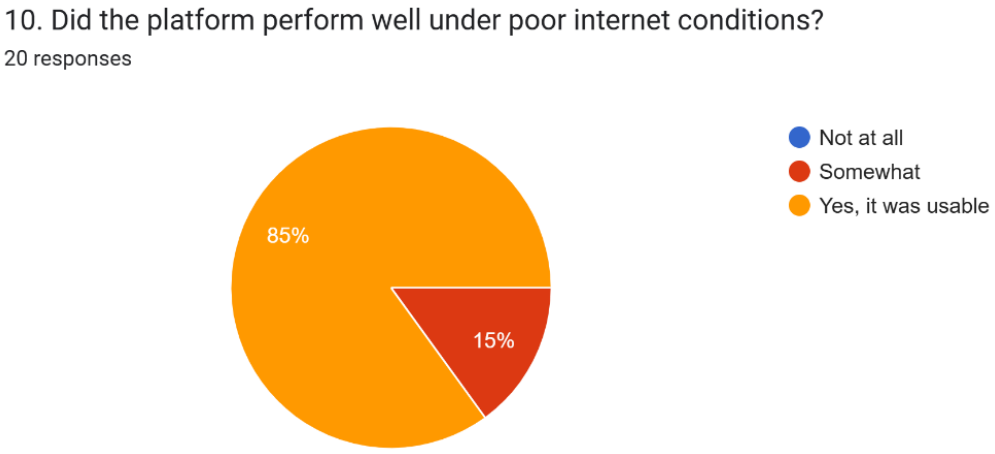


Figure 6.2.10 - Pie Chart of System Robustness

85% found the platform usable under poor internet, while 15% found it somewhat usable. This reflects well on the system's resilience and design efficiency under suboptimal network conditions, contributing to its performance under general system robustness.

Question 11:

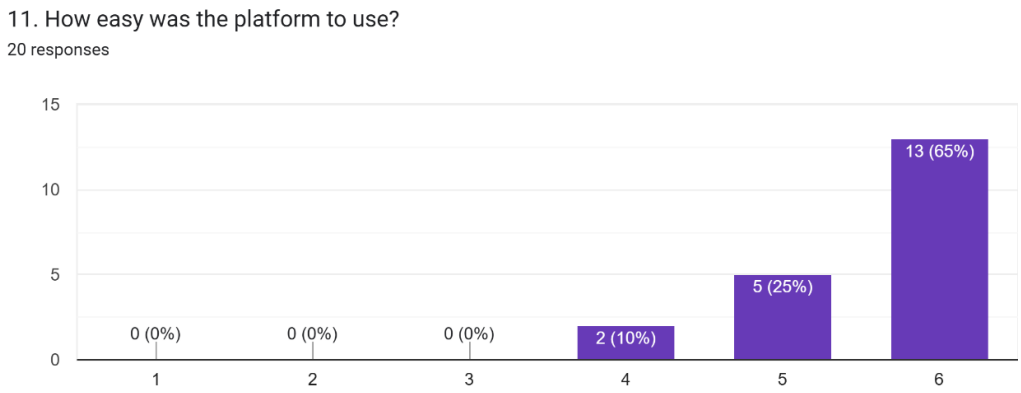


Figure 6.2.11 – Bar Graph of System's Ease of Use

65% rated it a 6 and 25% a 5 on the ease-of-use scale, with the remaining 10% selecting 4. This confirms that the platform is intuitive and user-friendly for the majority of users, aligning with high marks for the usability of the virtual classroom. A high usability score is essential for reducing training requirements and encouraging adoption.

Question 12:

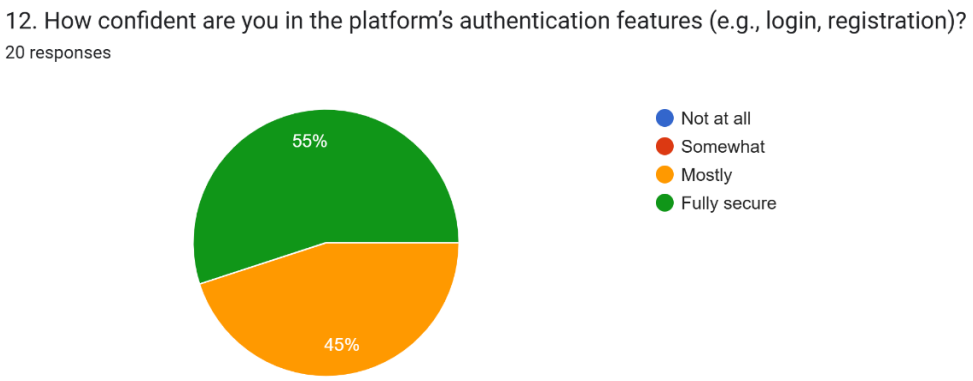


Figure 6.2.12 - Pie Chart of System's Authentication Process Reliability

55% of respondents were fully confident, and 45% were mostly confident in the platform's authentication mechanisms. This indicates high trust in the authentication process reliability, suggesting login and access controls are perceived as secure and stable.

Question 13:

Figure 6.2.13 - Pie Chart of System's Password Recovery Mechanism

90% reset their password easily, while 10% succeeded but found it difficult. This demonstrates that the password recovery process is largely effective, with only minor usability improvements needed for some users. It supports a high score for the authentication process of the system.

Question 14:

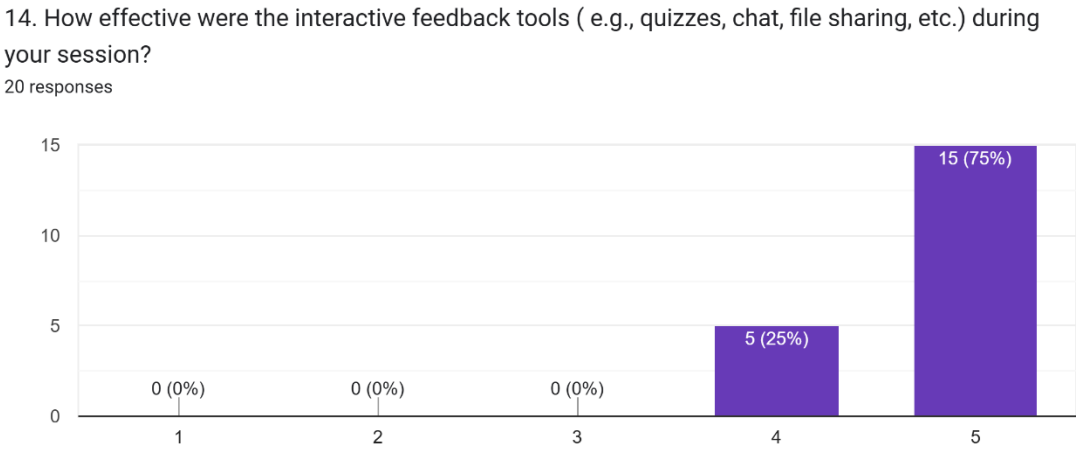


Figure 6.2.14 – Bar Graph of System Feedback Tool Effectiveness

75% rated the feedback tools as very effective (5), and 25% gave a 4, showing strong approval for these functionalities. This reflects excellent performance in the feedback tool effectiveness of the virtual classroom, indicating that the tools are supporting learning and engagement as intended.

6.2.5.2 Performance Metric Result

Based on the results from the user testing survey, the result of the performance metric has been achieved as well.

Metric	**Description**	**Target Threshold (** ≥ 15/20 respondents voted for …**)**	**Result**
Response Time	Time taken for system to respond to any user actions	(0 - 2 second)	**Pass**
System Availability	The uptime percentage of the system	≥ 99% uptime	**Pass**
File Upload Success Rate	Successful file uploads	"All"	**Pass**
Message/Comment Delivery Latency	Time taken for a chat message/comment to appear on recipient's screen	< 1 second	**Pass**
Real-time Collaboration Tools Sync Delay	Time difference between changing and reflecting on another user's screen in Jitsi Meet/Etherpad/WBO	"Yes"	**Pass**
Error Rate	Functional errors or crashes during operation	"No"	**Pass**
Compatibility	System compatibility across browsers (Chrome, Firefox, Edge) and devices	"Good - Excellent"	**Pass**
Usability	Overall ease of use and intuitiveness	"Easy (5) – Very Easy (6)"	**Pass**
Authentication Process Reliability	Security and ease of login, registration, and password reset	"Mostly – Fully Secure"	**Pass**
Feedback Tool Effectiveness	Effectiveness of interactive tools like quizzes, chat, and file sharing	"Effective (4) - Very Effective (5)"	**Pass**

Table 6.2.5 – Performance Metrics Result

6.3 Objectives Evaluation

The primary objective of this virtual classroom with real-time collaboration tools system is to enhance the virtual learning experience as well as address the diverse needs of both students and teachers at varying levels of online learning.

The first objective, to develop a comprehensive virtual classroom platform, has been fully attained through the construction and operation of a system that accommodates both synchronous and asynchronous learning modes. As described in previous chapters, the platform combines a user-friendly, web-based interface with robust backend architecture, enabling users to register, authenticate, manage profiles, create or join classes, and access collaboration tools without difficulty. The platform's simple interface allows users to navigate with ease and access all features without technical barriers, thereby fulfilling the requirement of a comprehensive solution. By integrating essential learning management functionalities with interactive elements, the platform effectively bridges the gap between traditional classroom experiences and digital learning spaces, offering an engaging and adaptable environment for both students and instructors.

The second objective, to integrate real-time collaboration features, has been successfully realized by embedding tools that enable immediate, dynamic interaction between participants. The inclusion of Jitsi Meet for live video conferencing, Etherpad for real-time document editing, and WBO for collaborative whiteboarding allows instructors and students to engage in discussions, co-author content, and visualize ideas synchronously. These features have been seamlessly integrated into the platform's classroom interface using iframes and APIs, eliminating the need to switch between multiple external systems. This approach enhances immersion, promotes active participation, and creates a learning experience that closely replicates the interactivity of in-person sessions.

The third objective, to facilitate peer interaction through interactive tools, has also been met through the development of a collaborative ecosystem that supports both formal and informal communication. Features such as group chat, file sharing, assignment submission, and quiz assessments encourage students to work together, exchange resources, and provide mutual academic support beyond scheduled lessons. These capabilities foster a stronger sense of community, helping learners interact more easily with one another, collaborate on assignments, and sustain meaningful interactions outside of live class sessions. By enabling communication in both synchronous and asynchronous formats, the platform promotes continuous learning and reinforces the social dimension of education, which is vital for student engagement and retention.

6.4 Concluding Remark

The evaluation of the virtual classroom platform demonstrates that the system performs reliably and aligns closely with the objectives defined at the start of the project. The integrated testing also verified that both functional and non-functional requirements were met, with the implemented features operating smoothly across different devices. The integration of real-time collaboration tools functioned without significant latency or stability issues, while the user interface proved intuitive for both instructors and students during trial sessions. Feedback from the evaluation stage highlighted the system's ability to facilitate active engagement, streamline collaborative work, and maintain consistent performance. Furthermore, the results indicate that the design solutions made during development, particularly the choice of lightweight, open-source tools and modular integration, contributed to the platform's flexibility and adaptability. While there remain opportunities for refinement and expansion, the evaluation confirms that the system delivers a stable and impactful foundation for enhancing the virtual learning experience.

CHAPTER 7

Conclusion and Recommendation

7.1 Conclusion

To sum up, this project addresses the critical challenges faced by traditional and existing online learning environments by developing a virtual classroom platform that prioritizes real-time collaboration, accessibility, and user engagement. Global events like the COVID-19 pandemic have sped up technological advancement, which has highlighted the demand for educational resources that blend the flexibility of distance learning with the interaction of traditional classroom settings. While existing platforms offer partial solutions, they often lack integrated real-time collaboration tools, struggle with technical reliability, and fail to foster meaningful peer interaction. In order to close the gap between digital and physical learning environments, this project develops a unified virtual classroom platform with real-time collaboration features.

While many virtual platforms suffer from fragmented workflows, delayed feedback, and limited peer engagement, traditional classrooms are limited by geography, strict schedules, and resource disparities. This platform tackles these issues by integrating essential real-time collaboration tools such as video conferencing, interactive whiteboard, and real-time document editing into a single, cohesive interface. This integration reduces technical complexity and enhances usability, particularly for users with limited resources or technological expertise. Additionally, these features also enable instructors to deliver dynamic lessons and provide immediate feedback, while students benefit from synchronous interactions that mimic the spontaneity of in-person learning. In order to address the isolation often experienced in online environments, the platform places a strong emphasis on peer-to-peer collaboration tools, such as group chat, file sharing, and assignment submission, which further fosters a sense of community.

This project contributes to the field of online education by transforming it into a more equitable, interactive, and effective experience. Its focus on real-time collaboration and accessibility directly tackles the digital divide, enabling students in remote or resource-limited areas to access high-quality education. For educators, the platform simplifies content delivery and offers tools for real-time feedback, empowering them to teach more effectively. Institutions can leverage this solution to reduce infrastructural costs, scale hybrid learning models, and improve student outcomes.

The project builds on the strengths of previous works while innovating in areas critical to modern education such as interactivity, inclusivity, and community. By unifying real-time collaboration tools, optimizing for diverse technological contexts, and fostering peer engagement with interactive tools, the platform redefines virtual learning as a dynamic, participatory process rather than a passive one. As education develops further in a post-pandemic world, solution like this will play a pivotal role in shaping an inclusive, globally accessible future for learners and educators alike.

7.2 Recommendation

Although the Virtual Classroom Platform successfully integrates core real-time collaboration tools and fulfills its primary objectives, there remain several areas where the system can be further optimized to improve user experience, inclusivity, and overall effectiveness. One significant improvement is the addition of a real-time private messaging feature, which would allow users to converse with each other individually alongside group discussions. While the current system emphasizes collective collaboration through shared tools such as group chat, whiteboards, and real-time document editing, the addition of private messaging would facilitate more personalized interactions between peers. This capability aligns closely with the project's objective of promoting active peer-to-peer engagement, as it enables students to seek clarification, collaborate on smaller tasks, or provide mutual support in a discreet and focused manner.

Another important recommendation will be the implementation of a notification system to alert users about new activities, updates, or announcements within their classroom. In traditional learning environments, students and instructors naturally stay informed through direct interaction. However, this immediacy is often missing in virtual settings. A structured notification system, which covers events such as assignment submissions, upcoming meetings, or instructor updates, would bridge this gap and help students remain engaged in real-time. This feature would not only replicate the dynamic environment of a physical classroom but also ensure that learners and educators remain consistently informed and connected, reducing the risk of missed information.

Furthermore, two features that were initially intended to be part of the project scope but were excluded due to time constraints are highly recommended for future development. The first is the recording feature for video meetings, which would provide substantial value for both students and instructors. Recorded sessions would enable students to revisit lectures at their own pace, ensuring flexibility for those unable to attend live sessions, while also serving as a valuable revision resource. For instructors, this feature would allow the reuse of lectures and facilitate asynchronous learning models, further enhancing the platform's adaptability. The second is mobile compatibility, which would extend accessibility to users who rely on smartphones or tablets rather than desktop computers. Considering the increasing reliance on mobile devices for educational access, ensuring mobile responsiveness and functionality would significantly broaden the platform's reach and impact, especially in resource-constrained environments.

In summary, future improvements to the platform should prioritize expanding its interactive and accessible features through private communication tools, real-time notifications, video recording functionality, and mobile support. These enhancements would bring the project into closer alignment with its overarching objectives but also elevate the platform to meet the evolving demands of modern virtual education. By addressing these areas, the system possesses the capability to become a more complete, user-centered, and sustainable solution for digital learning in diverse educational contexts.

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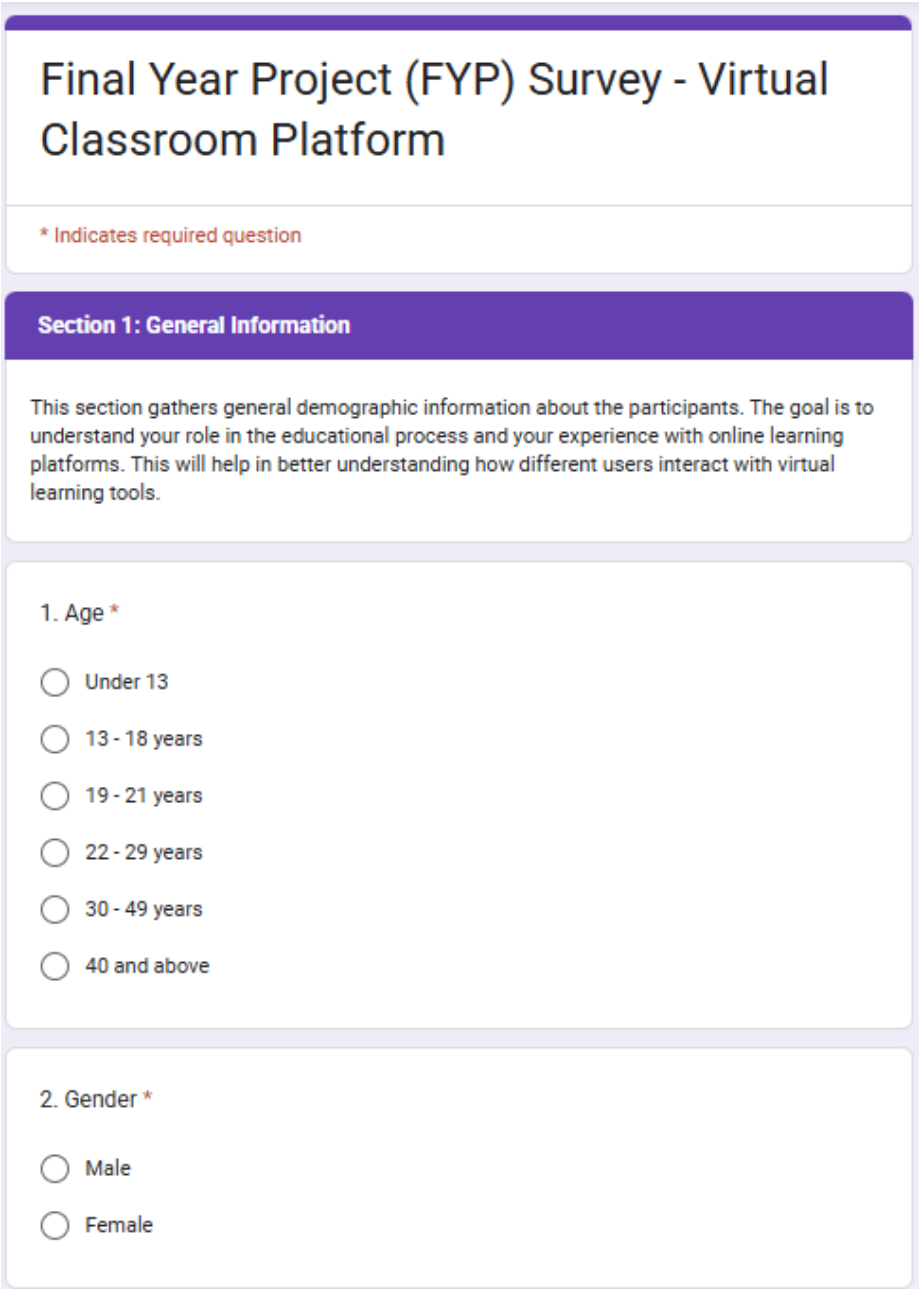
APPENDIX

Questionnaire Sample



Final Year Project (FYP) Survey - Virtual Classroom Platform

* Indicates required question

Section 1: General Information

This section gathers general demographic information about the participants. The goal is to understand your role in the educational process and your experience with online learning platforms. This will help in better understanding how different users interact with virtual learning tools.

1. Age *

- ◯ Under 13
- ◯ 13 - 18 years
- ◯ 19 - 21 years
- ◯ 22 - 29 years
- ◯ 30 - 49 years
- ◯ 40 and above

2. Gender *

- ◯ Male
- ◯ Female

3. What is your role in the educational process? *

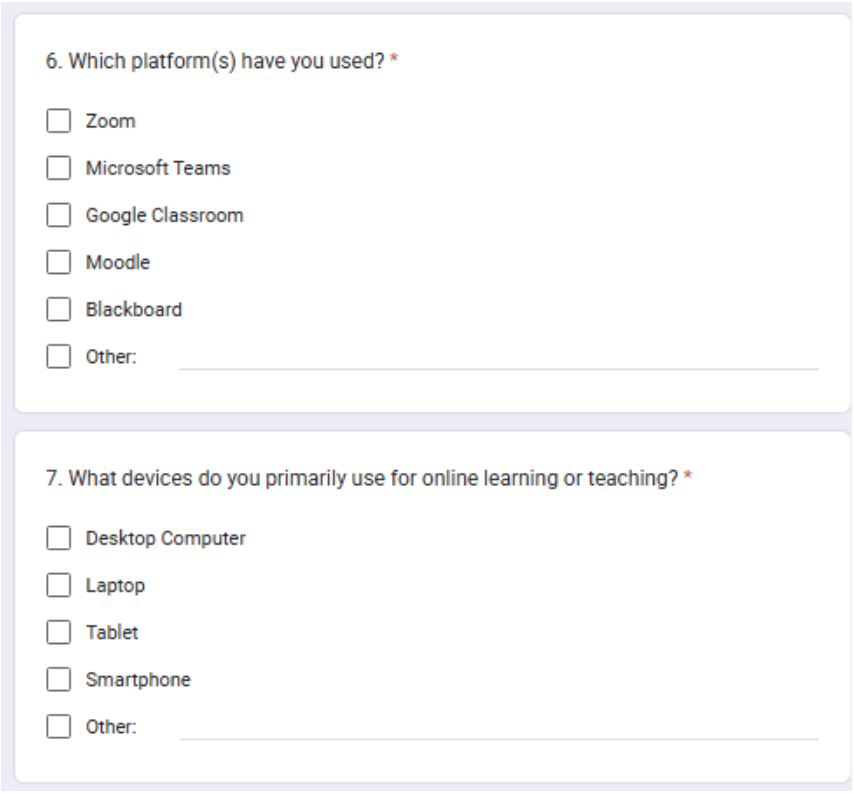
- ◯ Student
- ◯ Instructor/Lecturer

4. What type of educational institution are you associated with? *

- ◯ Primary School
- ◯ Secondary School
- ◯ Higher Education (College/University)
- ◯ Online Education Institution
- ◯ Other: _____

5. How often do you use online learning platforms? *

- ◯ Daily
- ◯ Weekly
- ◯ Occasionally
- ◯ Rarely



6. Which platform(s) have you used? *

- [ ] Zoom
- [ ] Microsoft Teams
- [ ] Google Classroom
- [ ] Moodle
- [ ] Blackboard
- [ ] Other: _____

7. What devices do you primarily use for online learning or teaching? *

- [ ] Desktop Computer
- [ ] Laptop
- [ ] Tablet
- [ ] Smartphone
- [ ] Other: _____

Section 2: Overall Feedback on Current Virtual Classroom Platforms

In this section, the questionnaire is seeking your overall feedback on current virtual classroom platforms, focusing on real-time collaboration features and overall satisfaction. Your feedback will help in understanding the strengths and weaknesses of existing platforms and inform the design of a more effective learning/teaching tool.

8. How would you rate the real-time collaboration features (e.g., interactive whiteboard, live document editing, and videoconferencing) of current virtual classroom platforms, considering potential limitations you've encountered? *

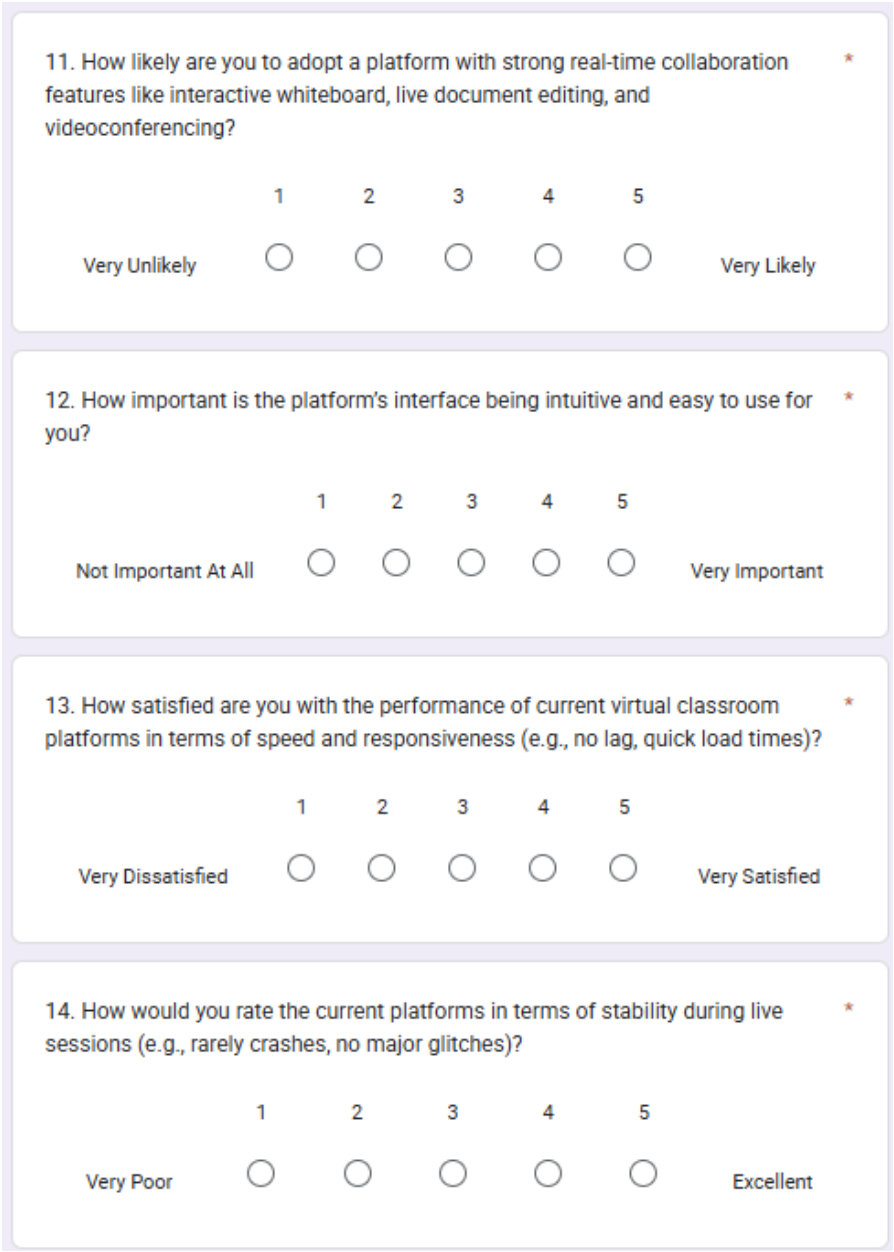
	1	2	3	4	5	
Very Dissatisfied	○	○	○	○	○	Very Satisfied

9. How well do current virtual classroom platforms support student engagement and participation? *

	1	2	3	4	5	
Very Poor	○	○	○	○	○	Excellent

10. What is the most significant improvement you would like to see in online learning platforms? (Select at least one) *

- ☐ Better real-time collaboration tools
- ☐ Improved video/audio quality
- ☐ More user-friendly interface
- ☐ More engagement and interaction features
- ☐ Better instructor-student communication



11. How likely are you to adopt a platform with strong real-time collaboration features like interactive whiteboard, live document editing, and videoconferencing? *

	1	2	3	4	5	
Very Unlikely	○	○	○	○	○	Very Likely

12. How important is the platform's interface being intuitive and easy to use for you? *

	1	2	3	4	5	
Not Important At All	○	○	○	○	○	Very Important

13. How satisfied are you with the performance of current virtual classroom platforms in terms of speed and responsiveness (e.g., no lag, quick load times)? *

	1	2	3	4	5	
Very Dissatisfied	○	○	○	○	○	Very Satisfied

14. How would you rate the current platforms in terms of stability during live sessions (e.g., rarely crashes, no major glitches)? *

	1	2	3	4	5	
Very Poor	○	○	○	○	○	Excellent

Section 3: Current Challenges in Online Learning and Teaching

In this section, the questionnaire is aiming to understand the challenges you face while using current online learning/teaching platforms. Your responses will provide valuable insights into the limitations of existing systems and help in designing a more effective virtual classroom that addresses these challenges.

15. What are the biggest challenges you face with current online learning/teaching platforms? *

- [ ] Lack of real-time interaction with instructors/lecturers/peers/students
- [ ] Difficulty collaborating on group projects
- [ ] Poor video/audio quality during sessions
- [ ] Lack of immediate feedback on assignments or activities
- [ ] Difficulty in understanding/providing content due to limited interactive tools
- [ ] Limited engagement methods with students/peers
- [ ] Other: _____

16. How challenging is it to collaborate in real-time on documents and projects in current online learning platforms? *

- ◯ Very Challenging
- ◯ Challenging
- ◯ Neutral
- ◯ Not Challenging
- ◯ Not Challenging at All

17. How challenging is it to use interactive tools like virtual whiteboards during online classes in current platforms? *

- ◯ Very Challenging
- ◯ Challenging
- ◯ Neutral
- ◯ Not Challenging
- ◯ Not Challenging at All

18. What challenges do you face when receiving feedback from instructors or providing feedback to students in current online platforms? *

- ☐ Lack of real-time feedback
- ☐ Feedback is delayed or not timely
- ☐ Feedback is unclear or difficult to understand
- ☐ Limited feedback on assignments or activities
- ☐ Difficulty in tracking feedback across platforms
- ☐ Other: _____

19. What challenges do you face when interacting with classmates or instructors outside of scheduled classes in current online platforms? *

- [ ] Lack of informal communication tools (e.g., group chats)
- [ ] Limited ways to connect with peers or instructors
- [ ] Difficulty accessing previous communication or resources
- [ ] Limited collaborative features outside of class
- [ ] Technical issues (e.g., connection issues, device compatibility)
- [ ] Other: _____

20. How often do you experience technical issues, such as slow internet or device compatibility problems, during online learning/teaching sessions? *

- ◯ Never
- ◯ Rarely
- ◯ Occasionally
- ◯ Frequently
- ◯ Always

Section 4: Desired Features for a Virtual Classroom Platform

Here, the questionnaire would like to know what features(functional & non-functional) you would like to see in a virtual classroom platform. These features will help in prioritizing the tools and functionalities that matter most to users like you, in order to create a more interactive and engaging online learning/teaching environment.

21. Which of the following features would you like to see included in a virtual classroom platform? *

	Not Needed	Needed
Live video conferencing with the whole class	○	○
Real-time document collaboration (e.g., Google Docs-like functionality)	○	○
Interactive whiteboard for drawing and solving problems	○	○
Real-time chat functionality	○	○
File sharing and resource management tools	○	○
Breakout rooms for small group discussions	○	○
Polling or live quizzes during lessons	○	○
Instant feedback on assignments or classwork	○	○
Recorded lessons for future reference	○	○

22. How essential is it for a virtual classroom platform to support both synchronous (live classes) and asynchronous (recorded lessons, discussion boards) learning options? *

- ◯ Very Essential
- ◯ Essential
- ◯ Neutral
- ◯ Not Very Essential
- ◯ Not Essential at All

23. How important is it for a virtual classroom platform to provide high-quality video and audio even in low-bandwidth conditions (e.g., slow internet)? *

- ◯ Very Important
- ◯ Important
- ◯ Neutral
- ◯ Not Very Important
- ◯ Not Important at All

24. How important are user authentication features (e.g., register, login, reset password, etc.) for a virtual classroom platform? *

- ◯ Very Important
- ◯ Important
- ◯ Neutral
- ◯ Not Very Important
- ◯ Not Important at All

25. How would you like to use the interactive whiteboard during online classes? *

- [ ] Drawing/annotating diagrams or concepts
- [ ] Collaborating on problems or exercises together
- [ ] Sharing lecture notes or slides for real-time interaction
- [ ] Solving equations or mathematical problems together
- [ ] Other: _____

26. How would you like to use videoconferencing during online classes? *

- [ ] Participating in/Organizing live discussions and Q&A sessions
- [ ] Attending group meetings or collaborative sessions
- [ ] Receiving real-time feedback from instructors/Providing real-time feedback to students
- [ ] Watching and interacting with live demonstrations or presentations
- [ ] Asking questions during the lecture
- [ ] Other: _____

27. How would you like to use real-time document collaboration during online classes? *

- [ ] Collaborating with peers on group assignments or projects
- [ ] Taking shared notes or summaries during lectures
- [ ] Providing or receiving immediate feedback on assignments
- [ ] Creating or editing documents together as a class (e.g., brainstorming sessions)
- [ ] Other: _____

28. How important is it for the platform to be accessible on a wide range of devices, including low-end or older devices? *

- ◯ Very Important
- ◯ Important
- ◯ Neutral
- ◯ Not Very Important
- ◯ Not Important at All

Section 5: Collaboration and Peer Interaction

This section focuses on peer-to-peer interaction and collaboration in the virtual classroom setting. The questionnaire wants to understand how important collaboration tools/features are to you and which features would encourage more meaningful engagement with classmates/students during online classes.

29. How important is peer-to-peer interaction in an online class for you? *

- ◯ Very Important
- ◯ Important
- ◯ Neutral
- ◯ Not Very Important
- ◯ Not Important at All

30. How often would you like to participate in/organize group activities or collaborative tasks in a virtual classroom setting? *

- ◯ Frequently (At least once per week)
- ◯ Occasionally (1-2 times per month)
- ◯ Rarely (Less than once a month)
- ◯ Never

31. How important is it for the platform to be able to support collaboration large-scale classes or sessions (e.g., 100+ students) without performance degradation (e.g., lag, crashes)? *

- ◯ Very Important
- ◯ Important
- ◯ Neutral
- ◯ Not Very Important
- ◯ Not Important at All

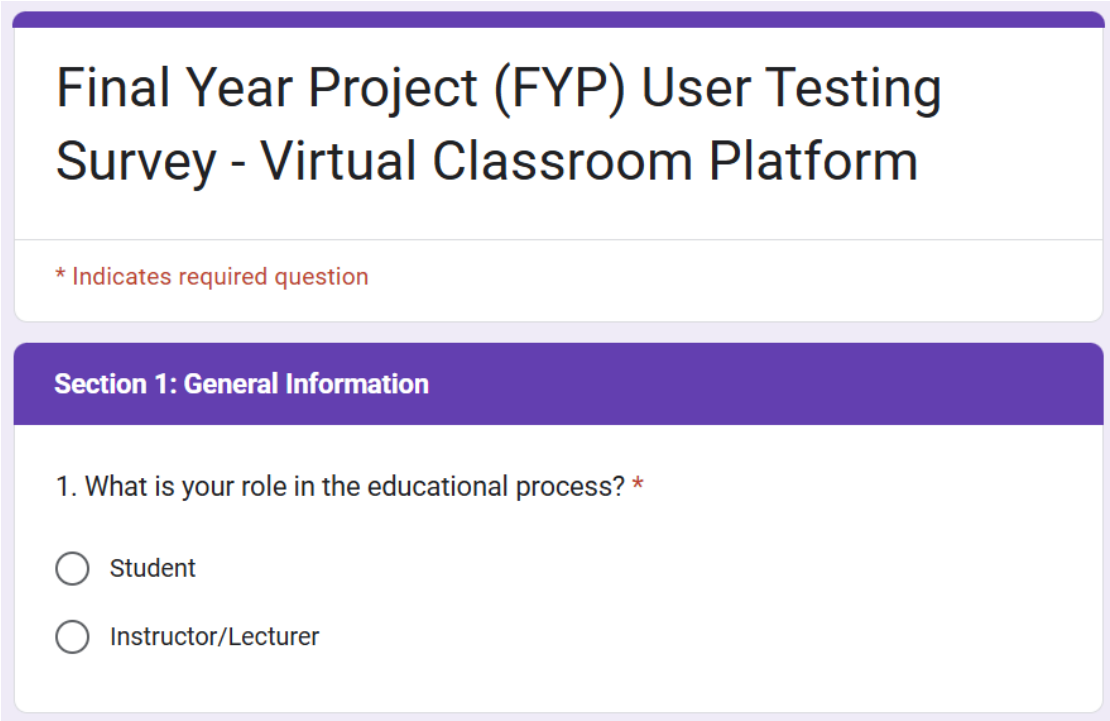
32. Which features would encourage you to engage more with your peers or students both during and outside online classes? *

- ☐ Group chats for collaboration
- ☐ Virtual study groups or breakout rooms
- ☐ Discussion forums or bulletin boards
- ☐ Peer review tools for assignments
- ☐ Collaborative tools for group projects
- ☐ Other: _____

33. What kind of feedback would you expect to receive from instructors/lecturers/peers or provide to students/peers in the online learning platform? *

- ☐ Real-time feedback during classes
- ☐ Feedback on assignments or projects
- ☐ Peer-to-peer feedback on group work
- ☐ Feedback on participation or engagement in discussions
- ☐ General progress or performance feedback
- ☐ Other: _____

User Testing Survey Sample



Final Year Project (FYP) User Testing Survey - Virtual Classroom Platform

* Indicates required question

Section 1: General Information

1. What is your role in the educational process? *

- ◯ Student
- ◯ Instructor/Lecturer

Section 2: System Performance

2. How quickly did the system respond to your actions (e.g., clicking buttons, navigating pages, submitting forms)? *

- ◯ Very Fast (< 2 sec)
- ◯ Fast (< 3 sec)
- ◯ Average (4 - 5 sec)
- ◯ Slow (6 - 9 sec)
- ◯ Very Slow (> 10 sec)

3. Did the system remain available without interruption during your session? *

- ◯ Down (0% - 49% uptime)
- ◯ Unreliable (50% - 89% uptime)
- ◯ Occasionally Unavailable (90% - 94% uptime)
- ◯ Mostly Available (95% - 98% uptime)
- ◯ Fully Available (≥ 99% uptime)

4. Were your file/assignment uploads working successfully? *

- ◯ No
- ◯ Some
- ◯ Most
- ◯ All

5. How quickly did your messages/comments appear on others' screens? *

- ◯ Delayed (>3 sec)
- ◯ Somewhat delayed (1–3 sec)
- ◯ Immediate (<1 sec)

6. Did collaborative tools (e.g., Online Document, Interactive Whiteboard) sync in real-time with others? *

- ◯ No
- ◯ Somewhat
- ◯ Yes

7. Have you encounter any errors or crashes? *

- ◯ Yes
- ◯ No

Section 3: Compatibility & Accessibility

8. Which browser did you use? *

- ◯ Chrome
- ◯ Firefox
- ◯ Microsoft Edge
- ◯ Safari
- ◯ Other: _____

9. How was the system's performance on your browser? *

- ◯ Poor
- ◯ Fair
- ◯ Good
- ◯ Excellent

10. Did the platform perform well under poor internet conditions? *

- ◯ Not at all
- ◯ Somewhat
- ◯ Yes, it was usable

Section 4: Usability, Security & Feedback

11. How easy was the platform to use? *

	1	2	3	4	5	6	
Very Difficult	○	○	○	○	○	○	Very Easy

12. How confident are you in the platform's authentication features (e.g., login, registration)? *

- ○ Not at all
- ○ Somewhat
- ○ Mostly
- ○ Fully secure

13. Were you able to reset your password successfully? *

- ○ Yes, it worked easily
- ○ Yes, but it was difficult
- ○ No, I couldn't reset it
- ○ I had to ask for help

14. How effective were the interactive feedback tools (e.g., quizzes, chat, file sharing, etc.) during your session? *

	1	2	3	4	5	
Not effective	○	○	○	○	○	Very effective

Poster


FINAL YEAR PROJECT
VIRTUAL CLASSROOM PLATFORM WITH REAL-TIME COLLABORATION FEATURES
Project Developer: Chong Kai Xuan
Project Supervisor: Dr. Suthashini a/p Subramaniam
Introduction:
Education has shifted from traditional classrooms to online learning, driven by technology and the need for flexibility. However, many virtual platforms lack integrated collaboration tools, limiting engagement and effectiveness. This project aims to bridge that gap by developing a unified virtual classroom that seamlessly combines several real-time collaboration and interactive features, creating a more dynamic, inclusive, and engaging learning experience.
Project Objectives:
Develop a Comprehensive Virtual Classroom Platform
Integrate the Real-Time Collaboration Features
Facilitate Peer Interaction through Interactive Tools
Methods:
Development Model: Agile Methodology
Frontend Development: HTML, CSS, JavaScript, Socket.IO
Backend Development: PHP
Database Management: MySQL
Local Development & Testing: XAMPP
Integrated Real-Time Collaboration & Interactive Tools:
Video Conferencing
Real-Time Document Editing
Collaborative Whiteboarding
Real-Time Chatting
File Sharing
Assignment Submission
Quiz Assessments
Discussion:
Building on previous works, this platform innovates in key areas like interactivity, inclusivity, and community. By unifying real-time collaboration tools, optimizing for diverse technologies, and promoting peer engagement, it transforms virtual learning into a dynamic, participatory experience.
Conclusions:
This platform bridges the digital divide by providing real-time collaboration and accessibility, enabling students in remote areas to access quality education. It simplifies content delivery for educators, offering real-time feedback tools for more effective teaching. Additionally, institutions can leverage this solution to reduce infrastructural costs, scale hybrid learning models, and improve student outcomes.
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