Virtual Learning Environment for 'Technology enhanced classrooms' in Ladies' College Colombo 7

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A dissertation submitted for the Degree of Master of Information Technology

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ABSTRACT

The purpose of the developed web application is to establish a platform for education in order to integrate learning experiences in an advanced and innovative way where students have access to learning material from any part of the world. It opens up a well-equipped educational repository for transparent communication between all parties of the school such as students, management, teachers, and parents to enhance the respective academic experiences at Ladies College. The goal is to develop a virtual learning environment for the school where the students can engage in retrieving school notes, study materials online and engage in assignments and educational tasks online, whilst the parents also can view the assignment marks and grades as the teachers input their comments and results. In today's world, digital instrumentation arranges for universal and instant access to limitless intelligence and study materials, thus making a change in schools and education

In 2018 Ladies College, the intended client of this application launched smart classrooms inclusive of interactive digital boards for the entire school. Since the school currently does not use a virtual learning environment and the resources and study material shared via the interactive boards cannot be stored in a centralized location for the students to access anywhere and at any time, it can be a wastage of resources. This led to the requirement of developing a virtual learning environment for the technology-enhanced classrooms at Ladies' College.

The developed system is an online platform that offers students and teachers digital solutions and has successfully achieved all objectives. The client end of the architecture in the VLE application developed is an Angular 8 application that communicates with the system user and makes backend API calls. Node JS backend framework was used to develop the server end and Firebase as database. In order to evaluate the system a planned quality assurance process was used. The VLE application which was proposed and developed has been gainfully implemented at Ladies' College. The application was implemented to be transferable; it can be simply deployed in any classroom/school.

DECLARATION

The thesis is my original work and has not been submitted previously for a degree at this or any other university/institute.

To the best of my knowledge it does not contain any material published or written by another person, except as acknowledged in the text.

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This is to certify that this thesis is based on the work of Ms. W. M. V. K Thilakaratne under my supervision. The thesis has been prepared according to the format stipulated and is of acceptable standard.

Certified by:
Supervisor Name:

_____

Signature: Date:

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List of Acronyms

UCSC - University of Colombo School of Computing

MIT - Masters in Information Technology

VLE – Virtual Learning Environment

UML - Unified Modeling Language

SDLC - Software Development Life Cycle

UI - User Interfaces

GUI – Graphical User Interface

CRUD – Create Read Update Delete

SCORM - Sharable Content Object Reference Model

API – Application User Interface

NODE JS – Node Java Script

HEI – Higher Education Institutes

SCSS – Superset Cascading Style Sheet

MOOC – Massive Online Open Course

DFES – Department of Education and Skills

INTRODUCTION

An extensive revolution in Sri Lankan education has taken place with the launch of smart classrooms for the entire school at Ladies' College Colombo. These smart boards are intended to transform each classroom into a state of the art learning space, which will foster curiosity and encourage interactive learning. Smart classrooms have been established in most parts of the world. The pen and paper is converting into tabs or laptops and the blackboards into smart interactive boards [1].

It is expected that the smart classrooms will transform the traditional teaching methods into a more interactive, immersive and engaging learning experience which will equip students with practical skills that will be valuable both in the classroom and beyond.

Ladies' College does not currently pursue a system where the students can access all study material shared and presented through the above said interactive smart boards, while creating a disadvantage for the students in this manner it also leads to a wastage of resources, therefore it is essential that the target client is also equipped with a virtual learning environment.

Even though there are many virtual, learning environments in today's world most of them are not integrated with interactive smart boards for live interactive teaching where the tasks given to a student can be showcased on a board digitally. The developed application allows whiteboard technology that is accessible and easy to use for teachers and students alike. This application will be a cross platform whiteboard solution, which creates a more interactive experience for classroom teaching. In simple terms, this application is an integration between virtual learning environment, and an interactive whiteboard.

1.1 Motivation

Ladies' College currently encompasses with the need for both a virtual learning environment and a live interactive mode of teaching, which both students and teachers can engage in, so that they could fully utilize the launched interactive boards in the school. Competence, as well as potency, was the main reason for the proposed requirement. A research was done in realistic surroundings of a conventional college environment with educators who utilize digital technology along with their teaching practices.

The familiar element in productive VLE utilization was the teacher, principally his or her eagerness for both the subject educated and the usage of technology in their teaching in common. The utilization of a VLE is very important when students misses lessons that have being conducted or when they have to catch up on a particular subject area [2].

This project where a VLE has being implemented is able to furnish a possibility for colleges and teachers to utilize class preparation time more productively and thus to supply a superior environment for student learning and motivation. The teachers, students and parents will interact with this application through a password shielded user account. The implemented application is accessible from anywhere and anytime as it is a web based application

This application is a user-friendly application which can also be used by end users who are not in a technical mindset and who have no competent technological knowledge, the system provides an easy navigation process to users, the application possess a good speed and covers many activities conducted by the school.

1.2 Identification of the problem

The implementation of any innovation makes the world a better, simpler, and efficient place. The implementation of a VLE results in no exception. There are many phenomenon's in education. It was much needed in Ladies' College to look beyond traditional techniques of teaching, in connection with more modern and appealing academic expertise, which would delegate students to experience an academic process on level with that recommended by other leading colleges in the world.

The problem under consideration is that even though the client Ladies' college has launched smart interactive boards, the school does not have an application that connects both teachers, parents and students. Therefore, they need a system with a live interactive board and a virtual learning environment that will enable them to fully utilize and take maximum benefit of the interactive boards without leading to a wastage of resources.

This system developed directly addresses the problem as it enables students to access study material shared on the interactive board even from home. In addition, it encourages interaction within the classroom by using the system integrated to the interactive board thus fully utilizing the usage of interactive boards.

In the developed system, the teacher is able to provide the students with marks for the activities done on the interactive board. The students are able to view the marks and results through the system , parents are able to view the same and all study material uploaded to the system as presentations , documents and audio recordings and automated report generations with final grade and average which are also sent to parents are some high level features that address the above existing drawbacks. Further, through the parent's portal they are able to make payments of the school fees.

1.3 Objectives

The objectives of the system are listed below

1. Educational process becomes more flexible.

In the current manual process the school uses the students take down the notes or need to get printed material, with the development of the VLE, the academic process enhances to be efficient and effective. Encountering sustained and free access to all learning materials, students can easily attend to their studies by aligning it with other extracurricular activities.

2. High-quality education available for students from remote areas.

There are many students who are currently boarded in the school who are from very remote areas of Sri Lanka, once they travel to their homes it would be a massive advantage to access study materials and submit online assignments, the developed system makes high-quality education available for students living in remote areas or even traveling abroad for various reasons.

3. Simple management to analyze efficiency

The implemented VLE supports instructors and teachers to scheme lessons, generate reports as well as provide supplementary study packs and be a pillar to anyone who looks forward to receive it. With this VLE it is also simplified to examine the potency of the current curriculum and renovate where change requests are brought.

4. More learning materials

Both education and technologies have a high impact on our lifestyles today. They contribute to the knowledge of humanity. Education assists the improvement and development of mankind therefore it is much needed not only to narrow down to education on text books but to explore various types of study material around the world. In order to compete with a fast changing world student should be equipped with various learning materials. The developed system allows teachers to share and present more learning materials.

5. Live interactive learning

Though Ladies College has launched interactive boards, they did not have a system that enables students and teachers to engage with each other and view the inter activities done. The developed system enhances to the real-time, interactive online teaching activities between teachers and students using digital technology.

6. Organized resource utilization along with time and space restrictions removed.

Students can study with recordings any time with what they have missed and enhance their understanding of knowledge through this application.

7. Students can experience whiteboard interactive tasks as high-resolution image or PDF

The main purpose of the interactive boards is that the students are able to carry out activities on the interactive board. Therefore, after the task or lesson is completed the lesson will be as a PDF document being able to download.

8. Student report card generation and online payment portal

The teachers are able to enter marks for the respective students for all subjects and get the report card generated and it is auto emailed to the parents, adding speed and effectiveness to the process. The parents have the benefit to make online school fees payments along with this system that also enables administrators to view the updated fees structures.

1.4 Scope

- This core objective of the developed system is a virtual learning environment for the school that presents study materials, academic activities and interactions within a subject syllabus and provide for the different stages of learning and a live interactive whiteboard application that enables students to interactively engage in assignments and activities.

The requirements have been classified in to four modules

1.4.1 Live interactive board module for drawings and assignments

1. The interactive smart board application will be launched in every smart board of each class.
2. The students can make drawings of what is being thought in the interactive board.
3. The students can actively participate in the assignments through the board
4. Parents can view the marks of assignments and drawings done interactively on the board.
5. Through a comprehensive parents portal the parents are able to view the assignments with answers and drawings done by student.

1.4.2 Study material upload module for different sections

1. Study material is uploaded to each grade separately and the student is able to filter it as per grade and subject.
2. The materials will be uploaded as SCORM objects to increase interactivity and real time marks generation.
3. There will be audio recordings of each class taken place to which the student can listen at a different time.

1.4.3 Student report card generation

1. The teachers can select the student whose report card has to be generated.
2. The teacher can input marks for each of the subjects the student has taken.
3. The teacher will be able to view the report and the average mark of the student once the report card is generated.
4. The report is automatically emailed to the parent once the teacher clicks on generate report.

1.4.4 Online payment of school fees module

1. The admin user can update the fees for separate sections of the school, and parents can view the same.
2. The parents can make an online payment through the system and be notified about it.
3. The fees for all extracurricular activities will be available in this module.
4. The administrative user of the system will generate a report of the online school fees payments.

1.5 Summary

The introduction chapter concludes an recapitulation of the problem under consideration , how it has being addressed and how the prevailing problems in a manual system has being mitigated, this chapter further discusses an extensive scope , a motivation that led to the accomplishment of a successful project and also the objectives. The center of attention of chapter 02 is an extensive literature review and a background research conducted on prevailing VLE applications.

1.6 Structure of the dissertation

The dissertation of the project a "Virtual Learning Environment for 'Technology enhanced classrooms 'of Ladies' College Colombo 7 began with an introduction in chapter 01. Next in chapter 02, the informative background and descriptions regarding prevailing perspectives are elaborated. Chapter 03 further explains the methodologies that have being used to implement the project, and it provides a comprehensive description about the proposed solution. Chapter 04 is inclusive of the implementation of the project and the technology used to achieve its objectives. The testing scope and the evaluation criteria of the project is described in chapter 05.The limitations of the currently developed solution and further extendibility of the system is discussed as conclusion of dissertation in chapter 06. References are provided after the conclusion of the dissertation, which is followed by the appendix.

BACKGROUND

2.1 Introduction

The background chapter is inclusive of the literature review and begins the foundation for the VLE application development, elaborated in the methodology chapter. In order to present, a detailed literature review a collection of data and information was conducted from various materials such as research articles, educational websites and books.

The dimensions of academic technology to solve the concerns occurring in the traditional classroom education enabled it to cover a path to real-time and research based teaching and learning methods by integrating and including suitable technological tools such as, computer-based training, smart technology and VLE in education. The interactive whiteboard is an innovation capable of replacing the traditional blackboard and teaching method and the outdated overhead projector equipment in order to increase the social and physical development of students. However, there are various pros and cons of smart boards in the classroom evident the technology to various benefits and disadvantages, which are easily noticeable. The well-detected advantages and disadvantages of using digital boards in classroom regulate as well as enhance the potential of teachers to instruct and students to learn better.

Numerous studies denote the precedence of utilizing interactive boards in the classroom. One such advantage of carrying out smart technology is the formation of blended and individualized learning environment, which strengthens the mental and physical development of students. Additionally, technology allows the teachers with the up to date smart and virtual teaching methodologies to strengthen the abstract and practical academic foundation that provides for interactive, attractive, and fun learning atmosphere in the classroom.

2.2 Literature review on virtual leaning environments

This literature review is more general, considering various good practices and existing frameworks for VLE systems in schools and universities, including the VLE, which is a mainstream e-learning system. This thesis is focused mainly on the development of a VLE system that is considered as both a leaning environment and a live interactive board.

According to DFES, virtual learning environment (VLE) is an integrated system containing a number of facilities that allow practitioners and learners to interact with one another within an online environment [3]. Britain and Liber describe the VLE as a learning management system (LMS) that blends the functionality of computer-mediated communications software (such as e-mail, bulletin boards, or newsgroups) and online methods of delivering course materials [4]. Nicholson, (2007) states Electronic learning (e-learning) has no single definition; it is both multidisciplinary and interdisciplinary, covering a wide range of research topics with scholars from different disciplines conducting e-learning-related research, ranging from content design to associated policy [5].

Moreover, McGill et al. mentioned that in higher education institutes s, e-learning systems are considered at the institutional level (such as learning management systems - LMS), implemented for the entire institution for enrolling students or for platforms supporting massive online open courses (MOOCs) and at the local level, supporting only a single class, course, or lesson [6].

Further, according to Liber, Oleg and Mark Johnson from the beginning, personal learning environments present many advantages as they encourage dialog and critical argument about the contents. Every student can achieve mastery of competences by learning different contents, knowledge is dynamic and there is a direct link with students' reality, it is an active and collaborative process, favors a continuous evaluation and, above all, ensures constant feedback. They also involve a double learning, since besides the command of digital skills, competences linked to the learning content itself are achieved [7].

2.3 Review of similar systems

Enhancing the digital experience for students is vital for today's schools, and VLEs can help stimulate learning, encourage collaboration, and improve curriculum delivery. A strategic review of existing VLEs is listed below.

1. **Schoology**

Schoology [8] is a social networking service and virtual learning environment for K-12 school and higher education institutions that allows users to create, manage, and share academic content. Also known as, a learning management system (LMS) or course management system (CMS), the cloud-based platform provides tools needed to manage an online classroom. Schoology can help teachers contact students with homework and more. They can post daily reminders or updates. They can message students, manage the assignment calendar and put new assignments.

The features of Schoology includes attendance records, online gradebook, tests and quizzes, and homework droboxes. The social media features facilitate collaboration among a class, a group, or a school. The system can be integrated with existing school reporting and information systems and provides the security, filters and support that school districts require.

Advantages of Schoology

- In order to increase usability it has many similarities to vital social networking sites.
- A major level of consideration has being given to the security aspect as it is mainly students who utilizing the application.
- In order to enhance teaching facilities it supplies efficient tools [9].

Disadvantages of Schoology

- Students there is an ability for the students focus to deviate away from academics.
- Two user accounts cannot be accessed from one computer.
- Teachers cannot moderate student comments/discussions [9].

The below figure 2.1 displays a page in the Schoology system.
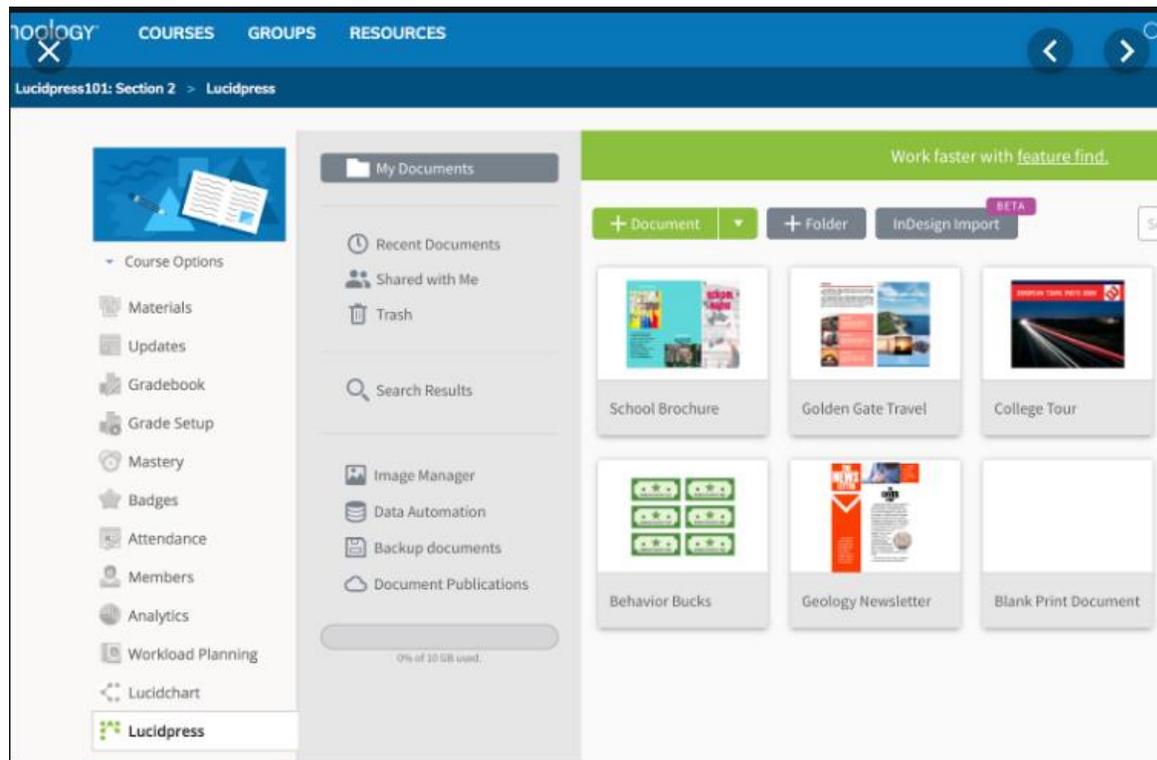
Figure 2.1 A screen of the Schoology application [10]

2. Blackboard Learn

Blackboard [11] is a proprietary LMS. This means hosting can either be provided by Blackboard or leased to users. This LMS company specializes in higher education, corporate, and government trainings. Students can customize the settings of their Blackboard interface to align with their preferences for greater ease of use. Scoring tools support individual and group grading.

Advantages of Blackboard Learn

- It does what it is intended to do such as connecting students and teachers alike. Security is in place for student safety
- Through eliminating paper teachers able to upload assignments online.
- It is an advanced application for assignments and quizzes [12].

Disadvantages of Blackboard Learn

- Students face difficulties with submitting assignments and receiving assignments.
- Novice users face difficulties in navigating through the system, as it is not simplified.
- The path to assignments is unclear.[12].

The below figure 2.2 displays a page in the Blackboard Learn system.
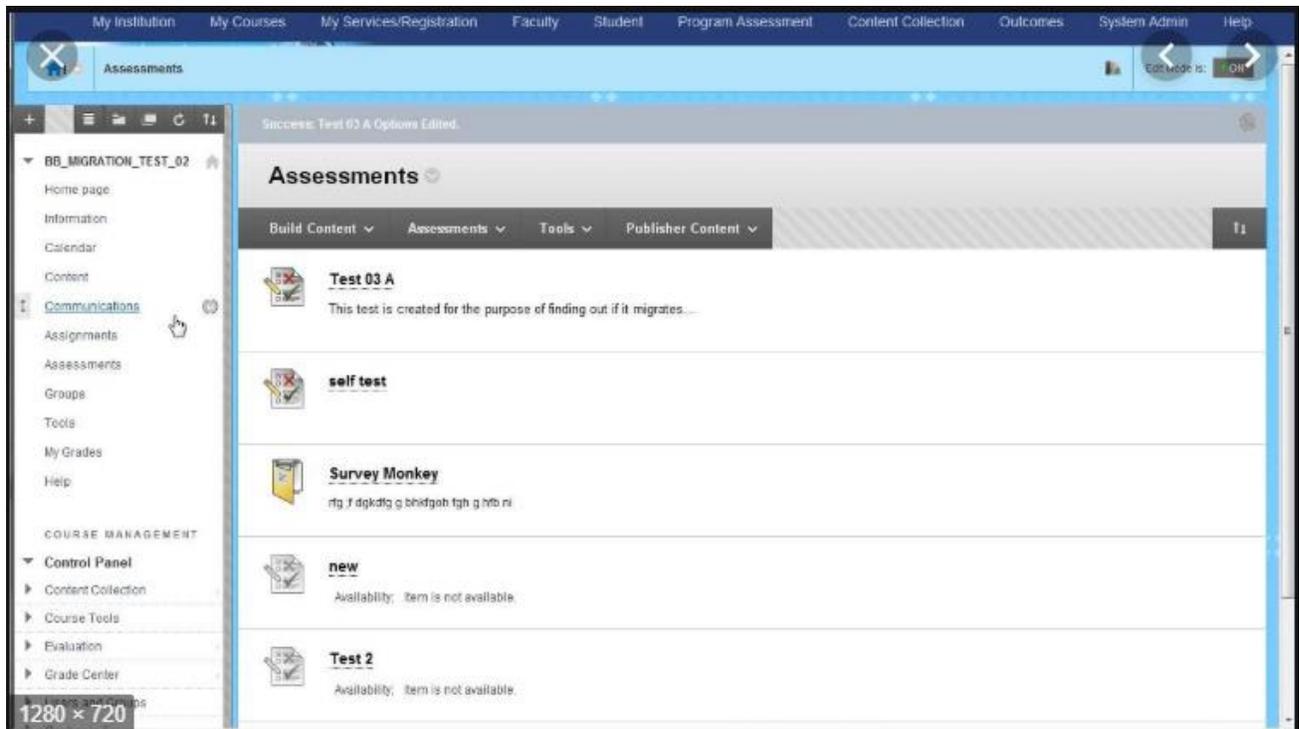
Figure 2.2 A screen of the Blackboard Learn application [13]

3. Canvas

Canvas [11] is an open-source LMS for K-12 and higher education institutions. This means that administrative users of these organizations can access the source code and make enhancements to the software. Canvas is easy-to-use for students and academics.

Canvas provides an app center, which allows administrators to choose which educational tools they decide to install for their organization. For example, administrators can decide whether it is necessary to integrate with DropBox, or OneDrive. Canvas's Arc feature supports easy video uploads, and supports student and instructor 'conversations' below videos regarding video content Canvas's Arc feature also supports one-on-one web conferencing with students, and web conferencing with a larger classroom audience. The below figure 2.3 displays a page in the Canvas system.
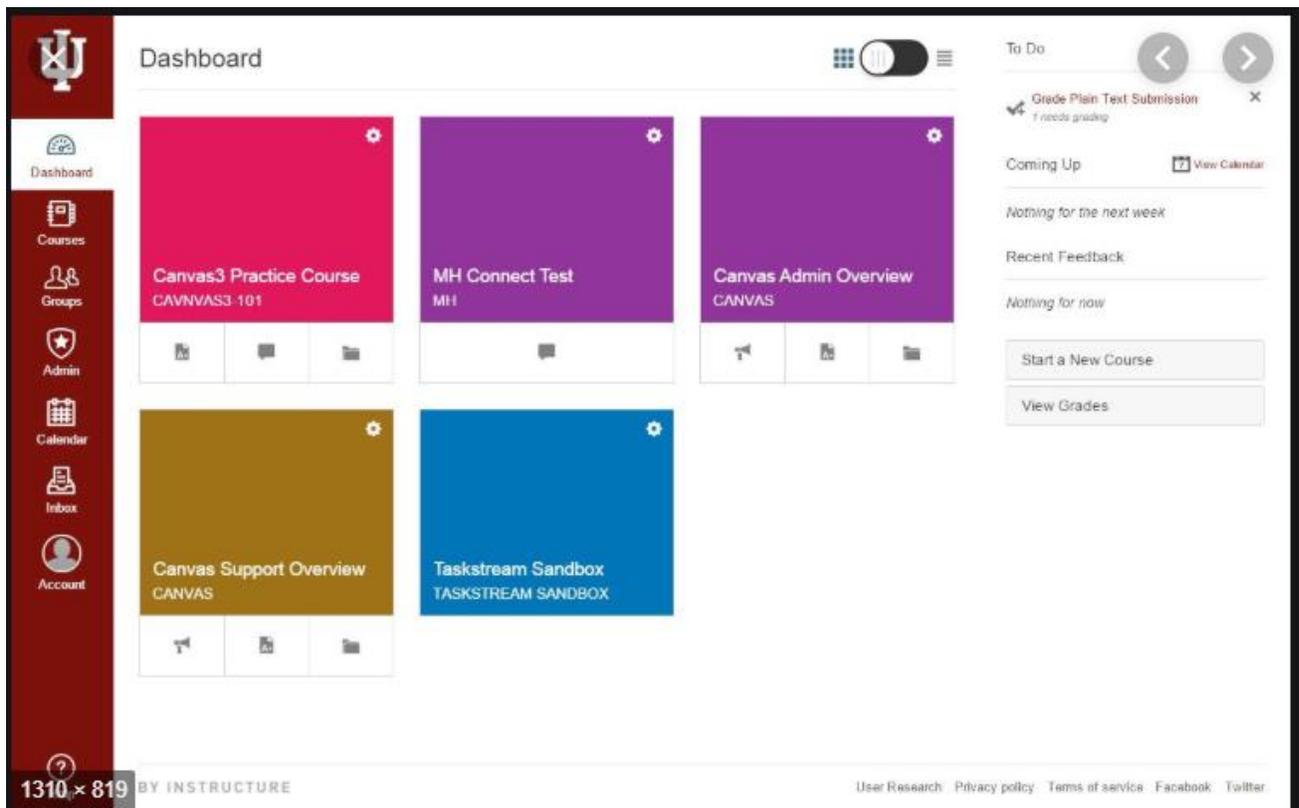
Figure 2.3 A screen of the Canvas application [14]

Advantages of Canvas

- Students are aware on their respective positions within a course or subject as there is a grading control with a constantly available gradebook.
- The students receive automated reminders for assignments, so they are highly unlikely to miss an assignment.
- The home page is inclusive of a calendar that populates all upcoming assignments [14].

Disadvantages of Canvas

- The assignment gets deleted from the application if the lecturer does not put the submission date as 'midnight' , therefore that feature needs enhancements
- A video conferencing tool personalized for the application is not available [14].

4. Moodle

Moodle [11] is an open-source LMS designed for K-12 and higher education. Moodle provides content authoring tools such as the gamification of exams and course content. Moodle includes features such as word count for student writing assignments, and the ability for students to choose groups online for group projects. Checklist and attendance tracking makes it easy for teachers to assess student engagement. The below figure 2.4 displays a page in the Moodle system.
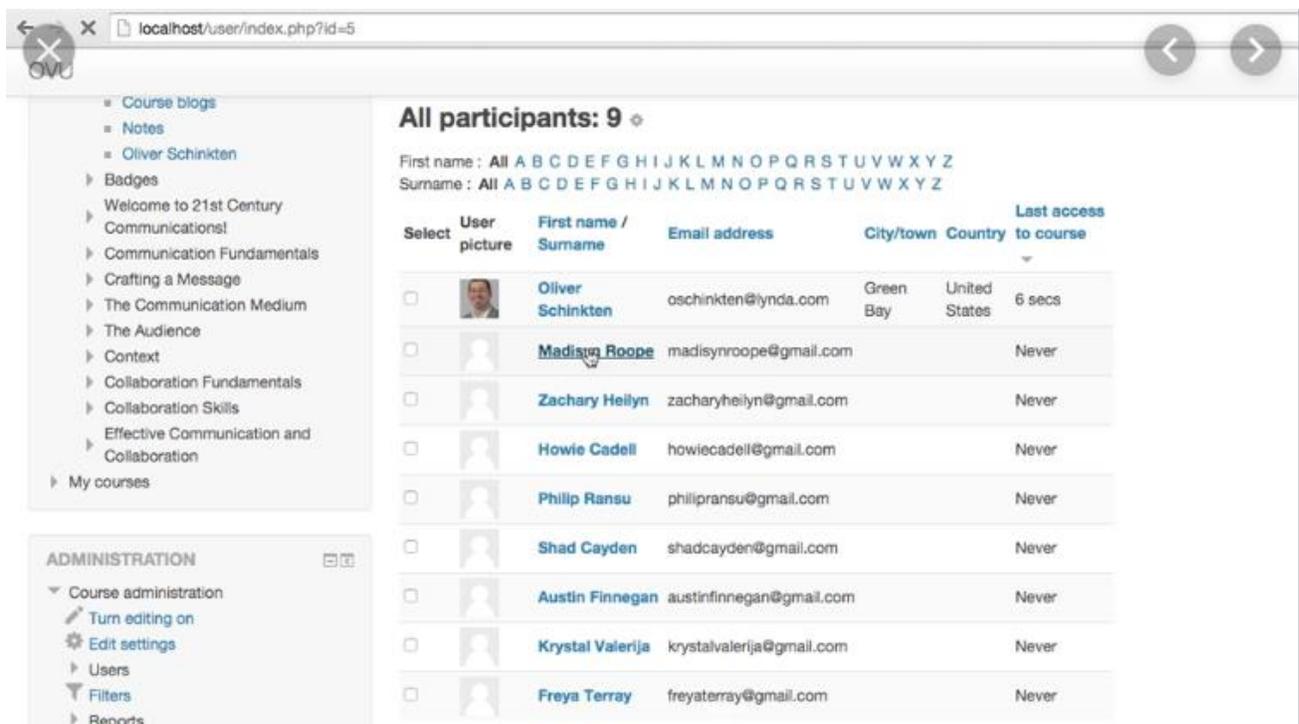
Figure 2.4 A screen of the Moodle application [15]

Advantages of Moodle

- Utilizing Moodle LMS is an open sourced system and free of expenses.
- Personalized according to the end client's requirement.
- No restrictions on the number of users or limitations to add more and it serves numerous users.
- The user has the privilege of adding substantial amounts of add-ons and plug-ins to the Moodle LMS and he can make the LMS to have various functionalities as he desires [16].

Disadvantages of Moodle

- Moodle LMS has a fundamental UI, which cannot be classifies as user friendly, for an example, if the user clicks on any course, the user would not be presented with any tool tips. The UI of the Dashboard is difficult to understand [16].
- Moodle has no committed 24*7 support, the client will have to access the community forums and has to submit his problems and await for the applicable support engineer to provide feedback. Assuming there is an urgent problem, it will be tough to solve [16].

5. CertCentral

The cloud-based, proprietary LMS by CertCentral [11] is hosted by the vendor with no implementation fees and no training fees. CertCentral's easy-to-use platform is designed by academics for academics to conduct higher education and continuing education programs online.

Deliver courses or exams on mobile, tablet, or desktop devices–and enable students access anywhere, anytime as long as that student is connected to Wi-Fi. CertCentral's streamlined platform allows easy construction and delivery of courses or exams online. Incorporate multimedia-rich materials seamlessly, and track student engagement statistics (e.g., percentage of video watched). eAutomated certificate generation makes it easy to send custom completion certificates to students that pass programs.

The below figure 4.5 displays a page in the CertCentral system.
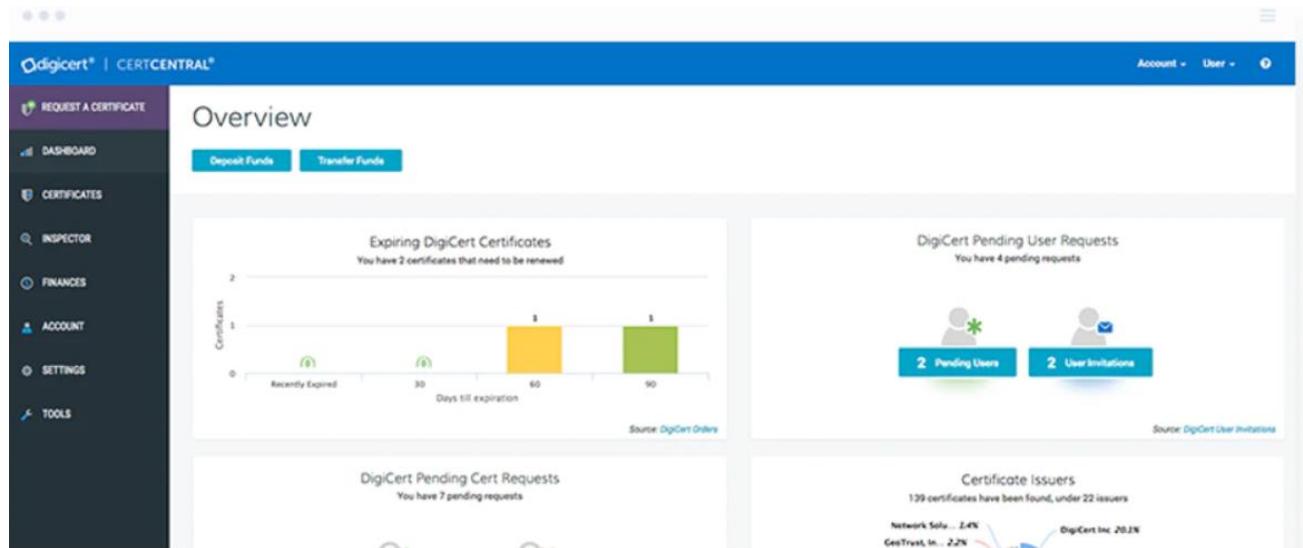
Figure 2.5 A screen of the CertCentral application [17]

Advantages of CertCentral

- A SaaS platform that is cost-effective for initial setup and upgrades.
- The platform is compatible with multiple devices [18].

Disadvantages of CertCentral

- New users find it hard to navigate through the systems, as the path is complexed.
- The path to assignments is not clear. [18].

2.4 Summary

Below table 2.1 depicts an outlined comparison among the functionalities accessible in proposed system and the existing systems.

Functionalities	Proposed application	Moodle	CertCentral	Canvas	Blackboard Learn
Student Report Card generator	Yes	No	No	No	No
School fees payment system	Yes	No	No	No	No
Live Interactive lessons	Yes	Yes	No	No	Yes
Uploading study materials : PDF, PPT, Audio recordings	Yes	Yes	Yes	Yes	Yes

Table 2.1 Contrast of the implemented application with existing applications

There are many existing applications of VLE however, most applications are not providing an integrated service of virtual learning environments and live interactive learning systems.

METHODOLOGY

3.1 Introduction

In a software implementation project, analyzing and design are elemental details. That was the principal idea, which is being initiated throughout the previous chapters. This chapter contains facts on the project analyzing and the design. Development methodology is discussed sequentially in order to provide a comprehensible idea about the developed system. The analyzing part of this chapter accommodates features regarding the system as a web application and the grounds. The design component describes the architecture of the application and a briefing description of the process.

By selecting proper design techniques the accurate application can be developed. Deciding on a suitable software methodology is a vital part of any project implementation, as there were many requirements that were analyzed and incorporated time to time Agile methodology was used. A test plan inclusive of functional and nonfunctional test cases was created. By enabling many evaluations required changes was incorporated in to the product as the Agile methodology makes room for changes time to time. The time duration is altered , requirements appear and progress as the project is implemented.

3.2 System Analysis

Universities and schools incur a very high cost, labor and schedule in developing VLE systems; however, a completely successful VLE system development by which the users are occupied and acquiring the most use of it by achieving advantages at the college, teachers, and student level cannot yet be accomplished [3]. Since there are many existing systems as per the data collected the developed system has covered features, which are not in existing systems.

The scope covers not only the functionalities of a VLE but also a live interactive classroom, which helps Ladies' College to take the maximum usage of the interactive boards that they have launched in the classrooms. Features such as student report card generation, sharing study material content and also live interactive drawings and assignments have been taken as major functionalities.

The system is all about improving the quality of life of students, teachers and parents who are in Ladies' College. Thus, giving them an opportunity to experience technology along with education and utilizing the interactive boards they have in an effective and efficient manner.

3.2.1 Requirement Analysis

The core objective of this system is assisting the goals of the learning process by using a technological device. Providing a better guidance on the lessons and enabling students to face the world in a more competent manner. By achieving that, it will upgrade the standard of life of students, parents and teachers. The students can have a better idea about the textbook lessons through other means of educational content and study material shared on the developed VLE. The students can rely on self-learning through being equipped with a vast range of educational materials. This will also solve an issue of children accessing unwanted material from the web, as they will be restricted to use a system to access study material.

3.2.2 Functional Requirements

Following are the identified users of the VLE.

- Admin user
- Student
- Teacher
- Parent

According to the analysis conducted, the following functionalities of the system were identified:

Admin user

- Manage student and parent profile
- Manage payments of school fees
- Manage school information
- Manage teachers information
- Manage study materials
- Manage generation of school report card

Teacher

- Upload study materials such as school notes, past papers, voice recordings.
- Prepare digital learning content and display on interactive board while teaching.
- Input remarks on assignment graded.
- Input marks for automatic student report card generation.

Student

- Download study materials such as school notes, past papers, voice recordings.
- Submit assignments.
- View lessons in the interactive board.
- Engage in drawings in the interactive board.
- Engage in assignments in the interactive board.
- View results.
- View announcements.

Parents

- Download study materials such as school notes, past papers, voice recordings.
- View results.
- View announcements.
- View payment information.
- Make online payments for school fees.

3.2.3 High level use case diagram for the VLE.

The below figure 3.1 is the high-level use case diagram of the developed virtual learning environment.
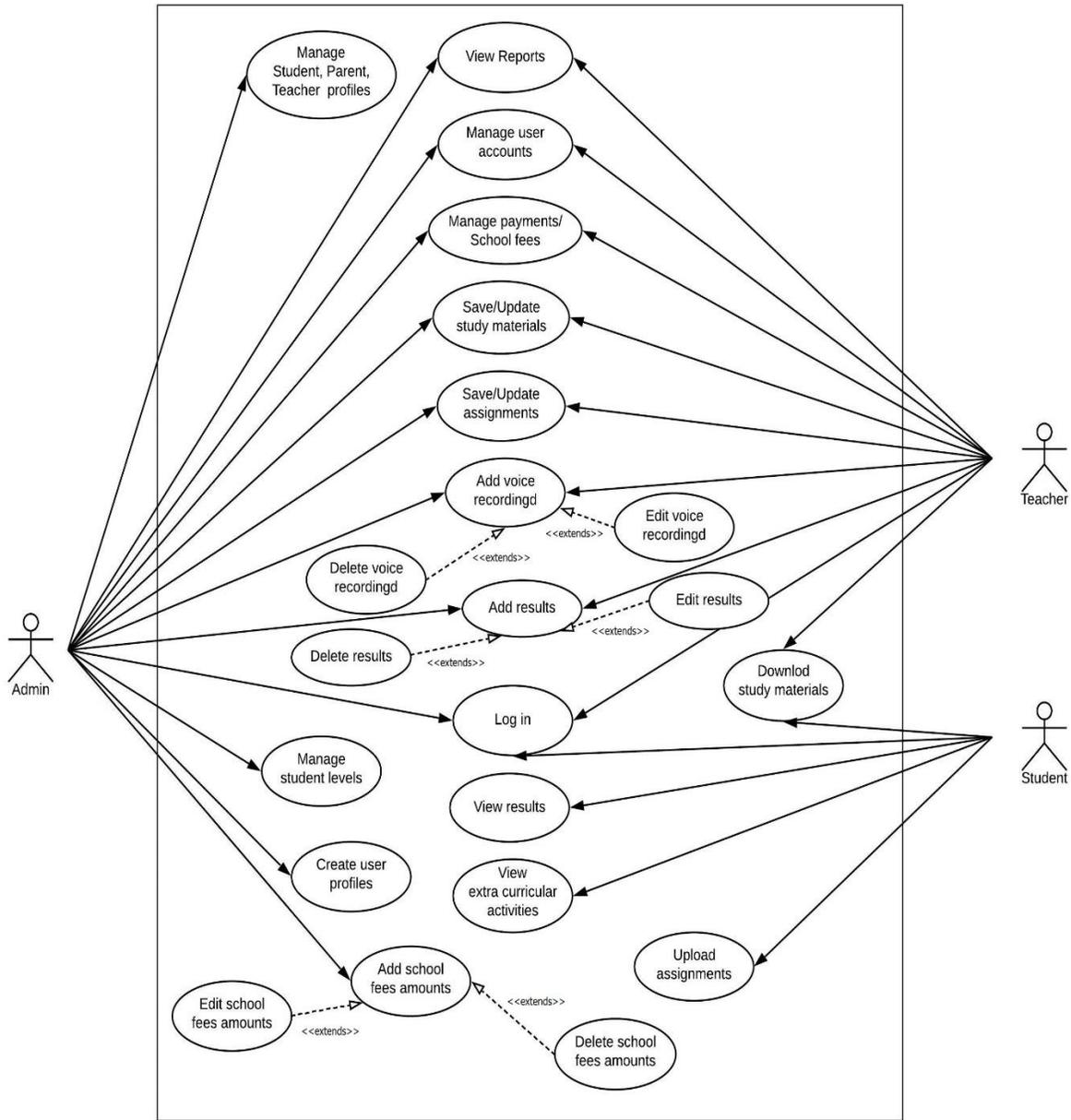
Figure 3.1 High Level Use case diagram of the VLE

The following tables 3.1 – 3.2   are the detailed functional related to the above high-level features. Descriptive set features for each section have been explained using use case diagrams.

3.2.4 Use case scenario -Student and parent profile management

Name	Manage student, parent, teacher profiles
Description	The records of students and teachers can be added and edited, which means creating a new record and updating information such as email, grade etc.
Actor	Admin
Workflow of the process	
Basic Flow	

Once a user logs in to the VLE system the user will adds s new student, teacher and parent to the system.

A.   Add Student , teacher , parent accounts

1. The user should select "Add student" / "Add teacher" sub menu item from the main menu.

2. If the current user's level has permission to **add** new user profile, then system will load user profile screen.

3. If the user has no access, there will be a message stating restriction of access.

4. User will enter all mandatory fields and click on save button to add user profile data to the system.

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1. **Update student , teacher and parent profile**

2. End user will select "Student / Teacher" option from the main menu.

3. As user's role of permission is enable to **update** existing user profile the application will load update user accounts page.

4. If the user has no access, the application will denote a message stating restriction of access.

5. The user can change all necessary fields and click save button to edit user profile data of the system.

6. System user can change user's name, grade, section, email, contact number, and other personal data of a retrieved student from this page.

Alternate Flows	
Title	**Description**
Creating an account fails.	If the User entered an invalid user details, the following occurs: 1. The system describes the reasons why the user failed registration. 2. If current user has no permission to add new user profile to the system, then system will restrict the user registration by displaying message as "access is denied".
Pre-Conditions	
Title	**Description**
Active user	• The user logs in to the system • The user add/ edit user profiles
Post-Conditions	
Title	**Description**
Success	Add or edit user information accurately. Registered user is registered as user of the system.
Failure	Inserting information that leads to exceptions through invalid input.

Table 3.1 Use Case– Add/ Edit user profiles

The below figure 3.2 is the use case diagram for the functionality manage user profile.
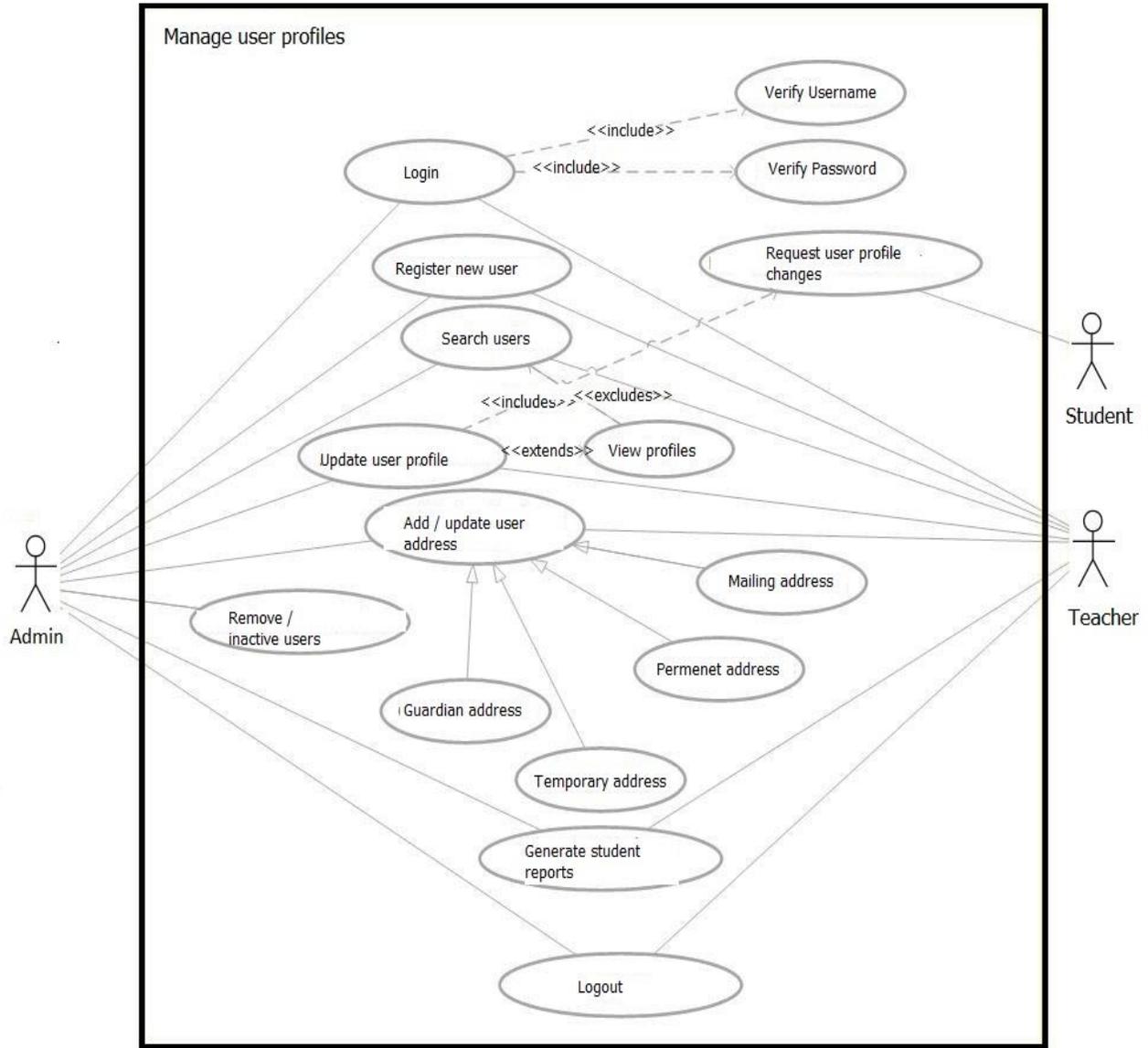
Figure 3.2 Use case diagram of Manage user profiles

3.2.5 Use case scenario – Manage study materials

Name	Manage study materials
Brief Description	Teachers can upload study materials for the different grades and different subjects
Actor(s)	Teacher
Workflow of the process	
Basic Flow	

This use case starts when a system user is logged in to the system and try to upload study materials

A. Upload study material

1. System user should select "Study Material" menu from main menu.

2. If the user has access granted to **upload study material,** then system will load upload study material screen.

3. Else, system will display message as access is denied.

4. System user can fill all necessary fields with subject, grade and study material type and click "Add" button to add the relevant study material.

5. If user wants to add material type, then user can select another type from the type drop down and do the above steps as it.

6. Finally, user should click "Save" button to upload the material to the mentioned subjects and grades.

B. Delete uploaded study material

1. System user should click on the "delete" Button on the study material grid

2. If the user has access granted to **delete study material,** then system will load the message 'Are you sure you want to delete? '.

3. Else, system will display message as access is denied.

4. System user can select multiple materials and delete many at the same time.

Alternate Flows	
Title	**Description**
Fails to upload study material	1. When user logged in has no permission to do so 2. Study material does not fall under PDF, PPT or Voice recording. 3. Study material exceeds size limit.

Pre-Conditions	
Title	**Description**
Active user	User should be login to the system before uploading, deleting study material.

Post-Conditions	
Title	**Description**
Uploading study material successfully	Successfully save study material to database.
Delete study material successfully	Deleted study material is removed from the database.

Extension Points	
None	

Table 3.2 Use case scenario – Uploading study materials

The below figure 3.3 is the use case diagram for the functionality upload study materials.
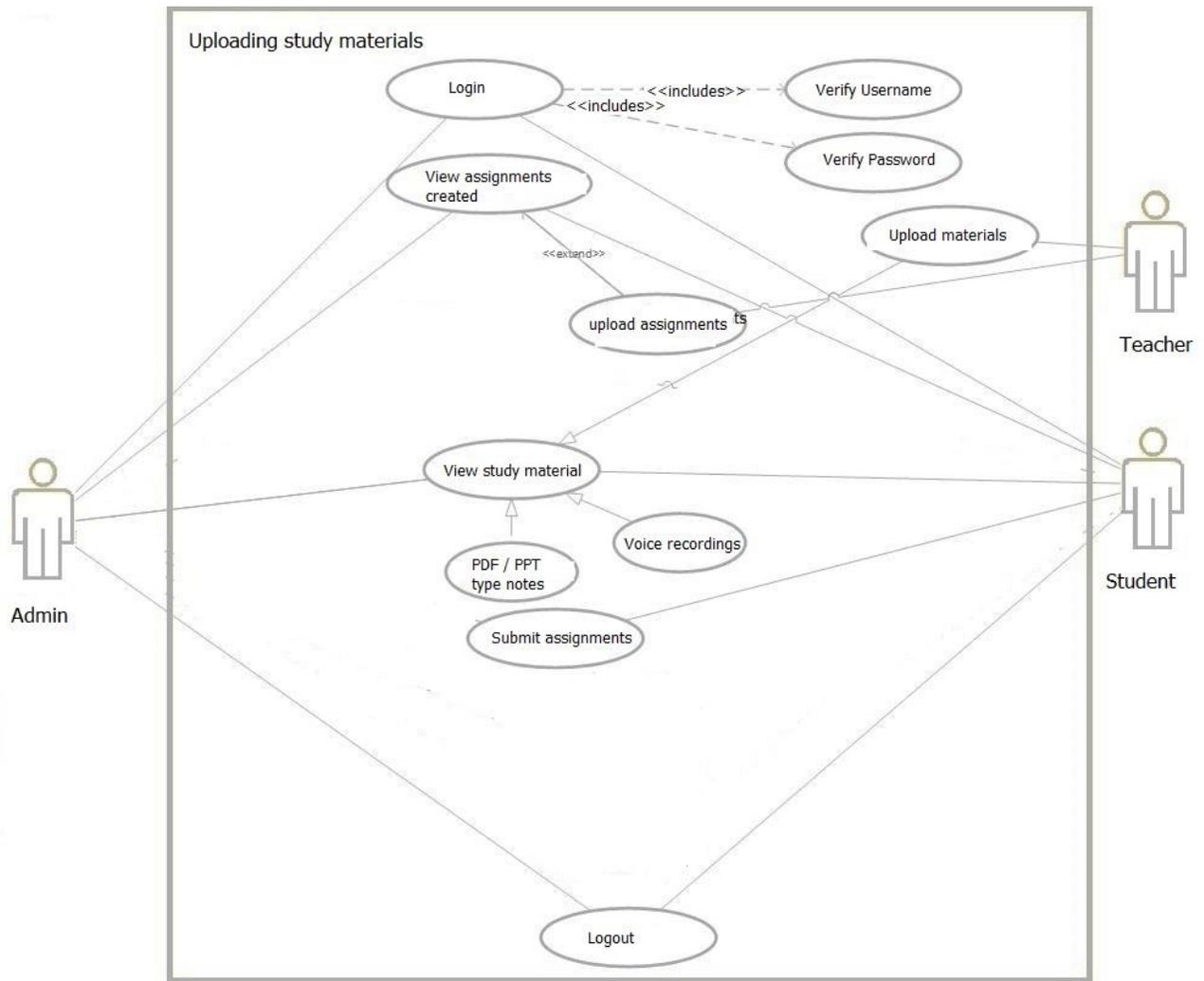
Figure 3.3 Use case diagram of upload study materials

3.2.6 High level sequence diagram

Below figure 3.4 is the sequence diagram for the VLE - admin user
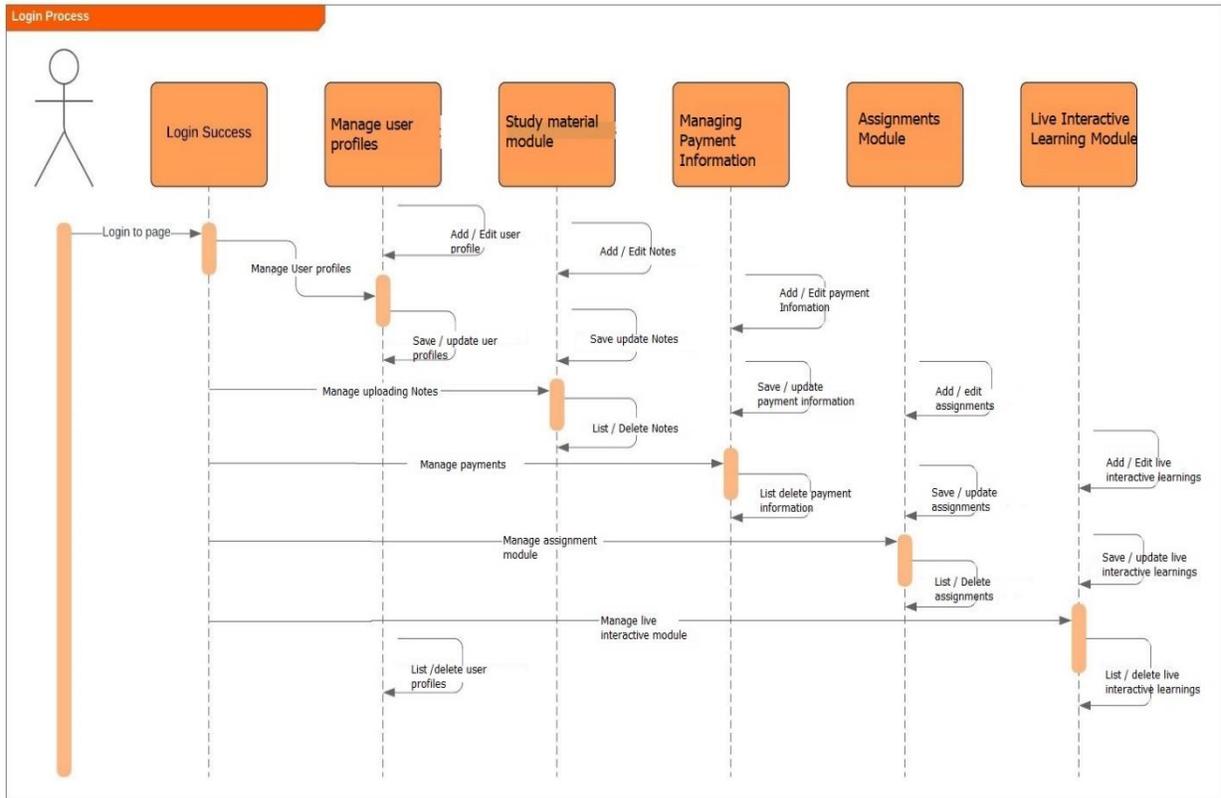
Figure 3.4 High-level sequence diagram of the VLE

Once an admin user logs in to the system, he is displayed with five options in the left navigational panel. He has the capability to create, read update and delete these functionalities, the functionalities are managing user profiles, uploading study materials by providing the subject and grade, managing payments received for school fees, adding assignments and working on the live interactive learning modules.

Once the admin user navigates to manage user profiles section he can add students, teachers and parents and give their personal information. Upon successful user creation, these user types are created in the database. The user can update their information at any time and also delete user profiles.

The next functionality displayed as per the above sequence diagram is uploading study materials, there are three types of study material that can be uploaded to the system. They are power points, PDF documents and voice recordings. The admin user can delete the uploaded study material as required.

Managing payment is the next functionality this user is enabled. Where he can add and update the relevant school fees for each of the sections primary, middle and upper school. The user can also view the payments received.

In the assignments module the user can upload both essay type and MCQ type questions, the user is also able to remove any assignments uploaded to the system, before uploading the assignment, the user has to select the type of the assignment.

In the live interaction module the user can view the marks of the assignments and also drawings of the students, they can upload interactions while teaching and the students can upload their answers and tasks in real time.

3.3 Non - functional requirements

The performance attributes such as scalability, usability, accuracy, reliability of the system is very important, even though they are not functional components of a system such attributes define how the actual system should perform actions that is been expected to perform. Below elaborated are such nonfunctional requirements that were expected from the proposed system and is now achieved.

3.3.1 Performance requirements

The user needs to retrieve required data in real time , therefore if there is a slowness in the response it will have negative impact on the overall system, It is important that the system is efficient .

Response time – The system will respond within an acceptable time period (2000ms – 3000ms)
Capacity - The application must handle many users simultaneously.
User-interface – The system users with receive a response from the UI within 4000 milliseconds

3.3.2 Usability

The features of the system were planned to ensure the look and feel satisfies the end user. Usability is an important factor as it gives the user the option weather to use the system or not. It is vital that every user who is an end user of the system acknowledges this product. Therefore, the system should have immense clarity and an easy navigational process that is user friendly.

3.3.3 Security

Confidentiality, integrity and availability was the main three components considered when it comes to the aspect of security. In today's world computer, security is very important, thus, every user is protected with a password and only the permissions applicable to their roles are visible to them.

3.3.4 Recovery

90% of requests that are made to the application should respond in less than 7 seconds to the user. There should be a backup taken daily as system deals with important information of the school, which supports easy retrieval of data in case of any loss.

3.3.5 Reliability

The system should present 100% reliable and correct data and information to which the end users are able to acknowledge integrity of the information. Confidential data such as usernames and passwords personal information should be stored in a form that user can rely on the provided data. While designing the system the security of the data was carefully considered.

3.3.6 Availability

Availability is one core aspect, as in order for a system user to perform any tasks at a user desired time the system should be available 24*7.

3.4 Database design

A database design serves the purpose of retrieval of data for the operations and functionalities of the system, after an extensive study on database design the table structure was designed in a way that encompasses well-organized storage, recovery and manipulation of the data correlated. As an exemplar all the information with regards to a record should be stored in a specific table.

The relevant users should be able to query to the database and retrieve required information effortlessly. Confidentiality has being regarded highly in the design of the database therefore only authorized users can access relevant details.

Firebase server is used, as it is a real-time database that allows store and sync data between the users in real time. It also provides data security and a high storage capacity.

3.5 UI Design

It is the expectation of any end user of a software, that the entire product is user friendly and well usable. The system should also have strong security measures undertaken throughout the entire workflow. It is essential that the main administrator of the system is ensured with privacy. Most users accessing this VLE are novices to web applications; therefore, each page that the user navigates to should be implemented in an easy to use style and be simplified.

The system provides up to date and accurate information and is essential that only authorized users have access to the system. The most vital part of UI design is that there should be a good human computer interaction that assists the user in completing tasks, the information presented to the user should be accurate and how it is presented should be user friendly. The use of color, font sizes, font colors and element alignments should be properly coordinated.

3.5.1 Log in screen of the VLE application

The log in page enables students, teachers and parents to log in to the VLE through google-authenticated password protected user accounts. It is displayed in below figure 3.5.
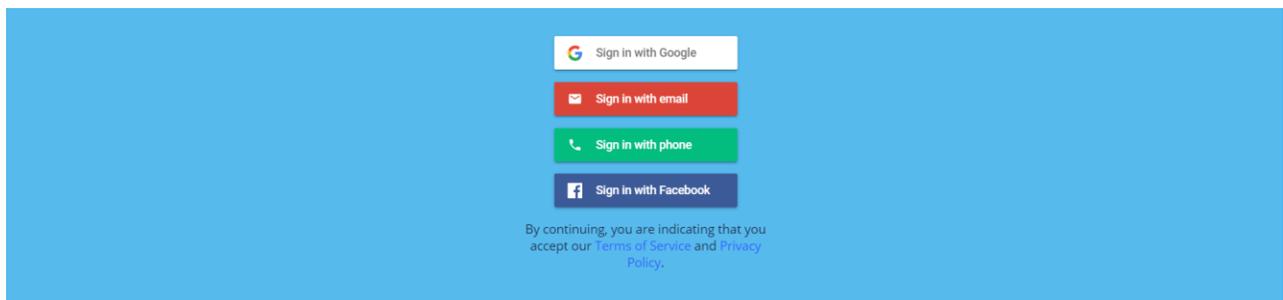
Figure 3.5 Log in screen of the VLE application

3.5.2 Home screen of VLE

Figure 3.6 displays the home screen that will display the available modules on the left hand side; it is an easy navigation for the user to select which module the user wants to work on.
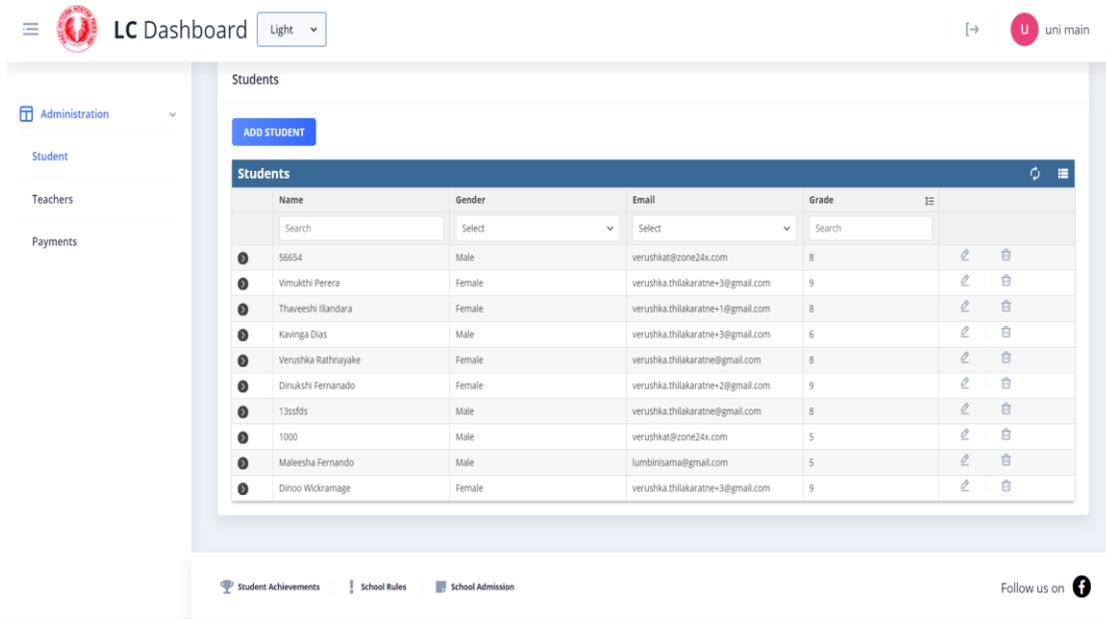
Figure 3.6 Home screen of the VLE application

3.5.3 Add student and parent details

Figure 3.7 displays the add student and parent details screen, through this screen the user is able to a student and the respective and give their details. Then the system will categorize the students according to their respective sections.

Figure 3.7 Add student and parent details screen of the VLE application

3.5.4 Teachers detailed view

Figure 3.8 displays the screen that will display the summary of all teachers in a detailed grid. The table consists of their name, email, phone number, subject and address.
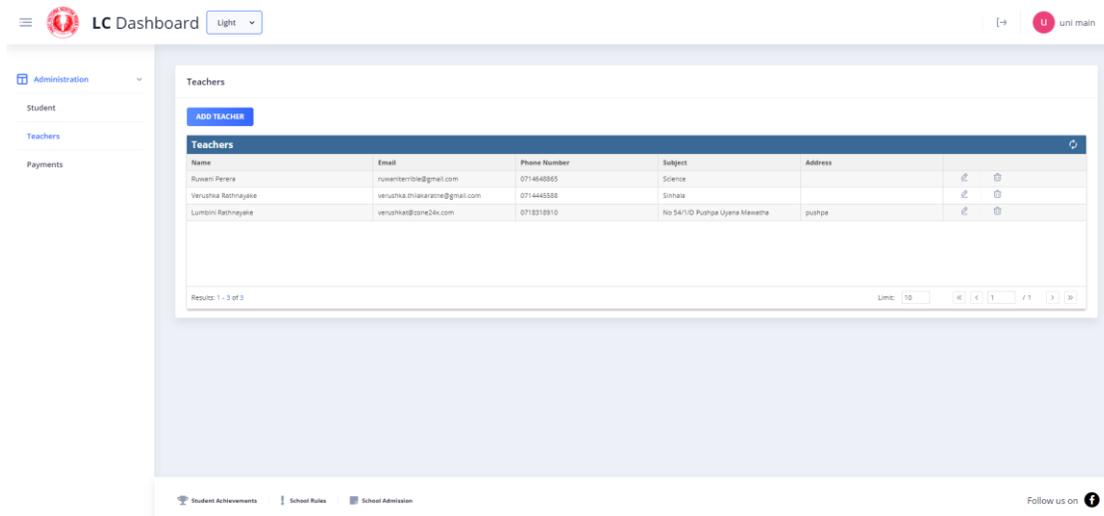
Figure 3.8 Teachers Detail view screen of the VLE application

3.5.5 Add teachers to the VLE

Figure 3.9 displays the screen that will enable the user to add a teacher to the system by filling a form. Upon successful addition, the user will be added to the above detailed view.

Figure 3.9 Add teachers view screen of the VLE application

3.5.6 Add / update payment information

Figure 3.10 displays the payment screen that will display the available sections of the school and their respective school fees amount. The admin user can add and update the fees as per requirement.
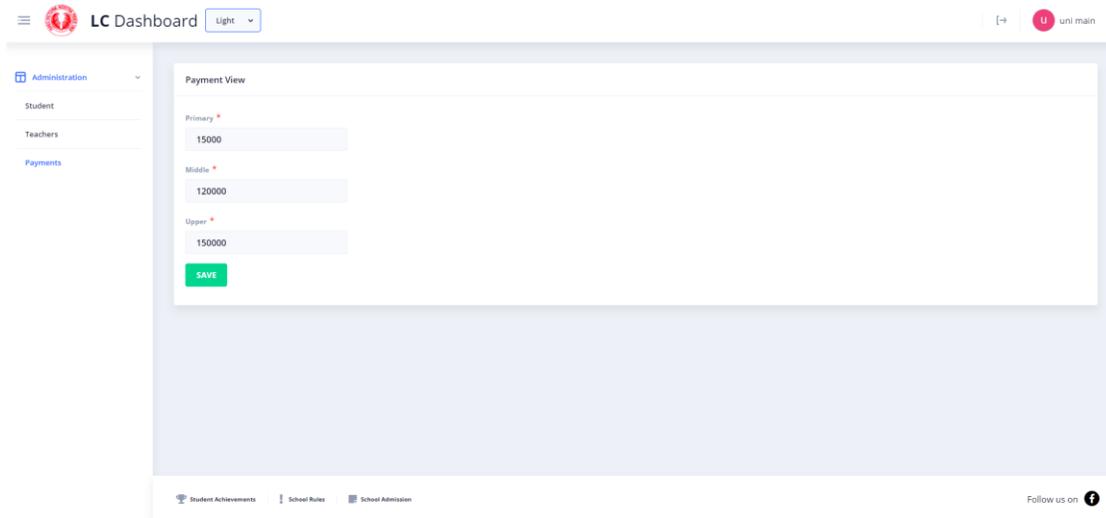
Figure 3.10 Add / update payment screen of the VLE application

3.5.7 View payment details screen

Figure 3.11 displays the screen that is enable for payments to view their respective school fees, that is belonging to their children's sections.
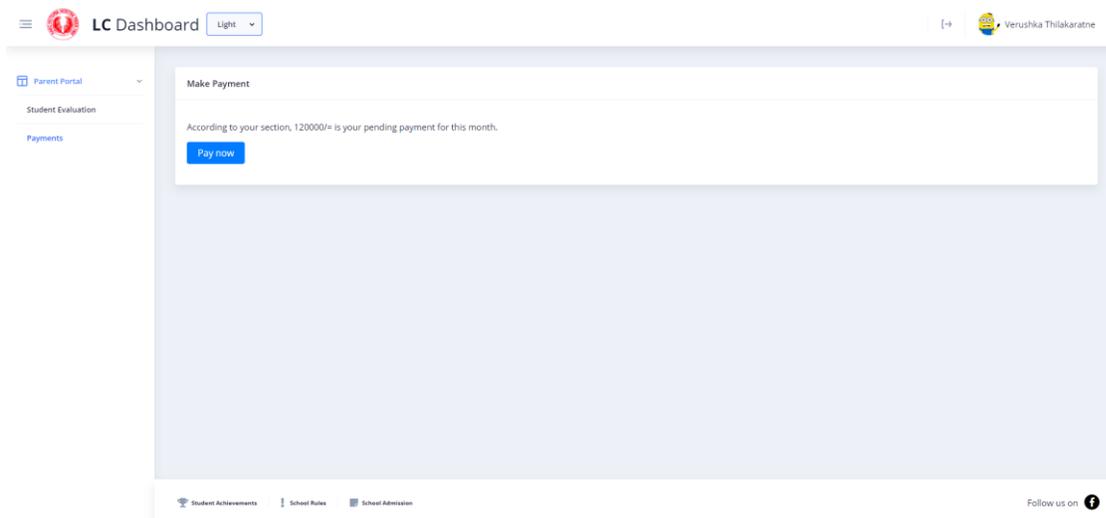
Figure 3.11 View payment details screen of the VLE application

3.5.8 Study materials grid

Figure 3.12 displays the screen that has the study materials uploaded by the teachers.
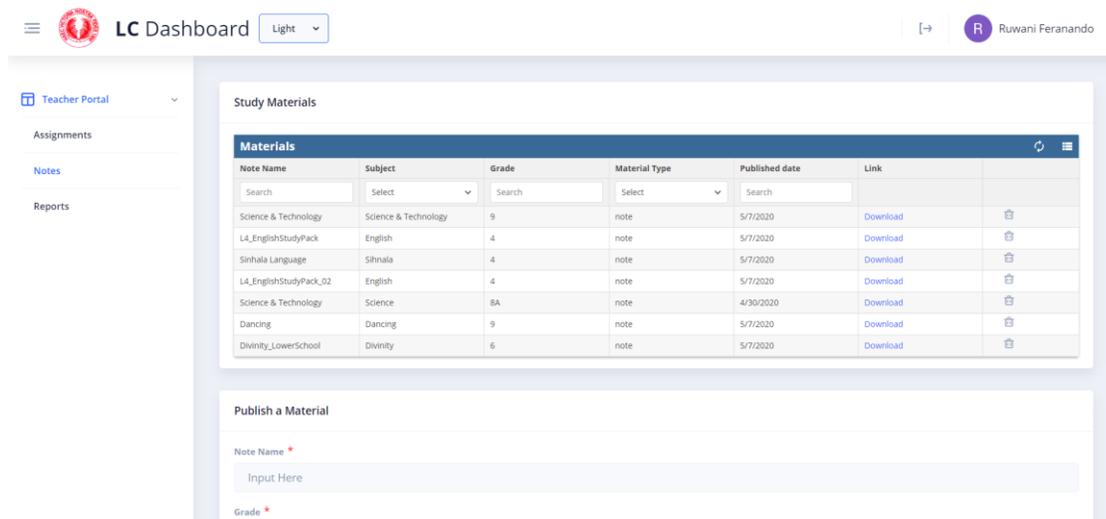
Figure 3.12 Study material screen of the VLE application

3.5.9 Publish study material

Figure 3.13 displays the screen that enables teaches to publish study material, in this screen the user has to fill a form with the name of the study material, subject, grade and type of the material. Study materials can fall under three categories they are notes, past papers and voice recordings.
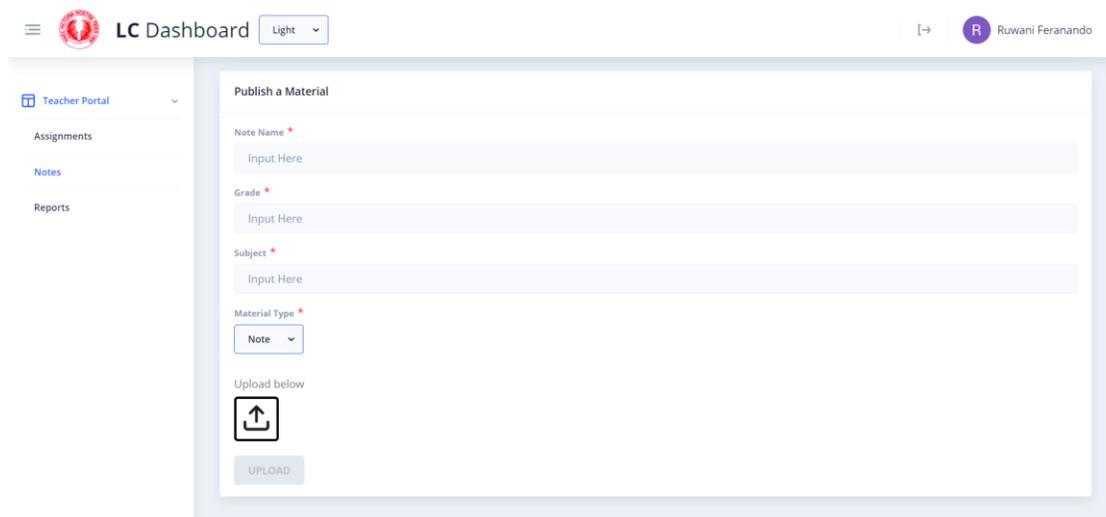
Figure 3.13 Publish study material screen of the VLE application

3.5.9 Reports – selection of a student screen

Figure 3.14 displays the screen that will display to the teacher to select the students she wants to generate a report. In this screen, the teacher is enabled with a check box to select students.
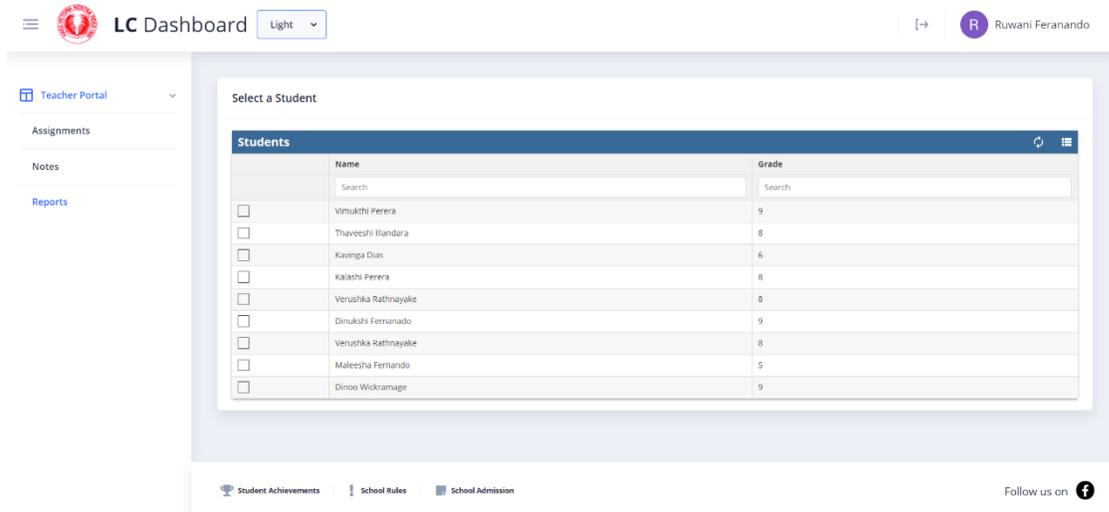
Figure 3.14 Reports – selection of a student screen of the VLE application

3.5.10 Auto generation of students report

Figure 3.15 displays the screen that will display to the teacher to enter the subjects and marks after selection the respective student from the previous screen. In this screen the when user clicks on the generate report user can view the report and amend it if he wishes to and then it will automatically be sent to parent.
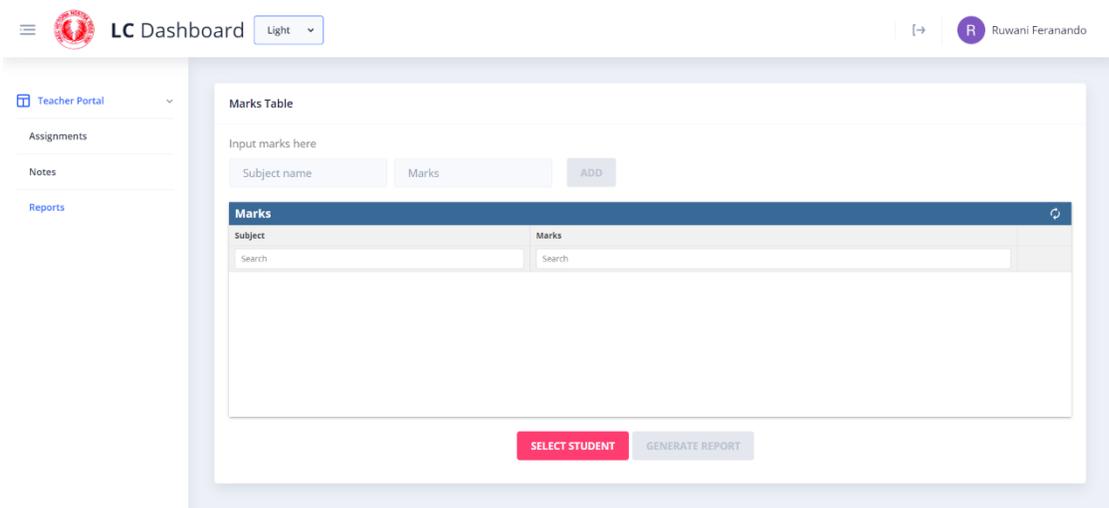
Figure 3.15 The marks table screen of the VLE application

3.5.11 Assignments – pairing with smart board

Figure 3.16 displays the screen that will display to the teacher to enter the pairing code displayed in the smart board launched in the respective classroom.
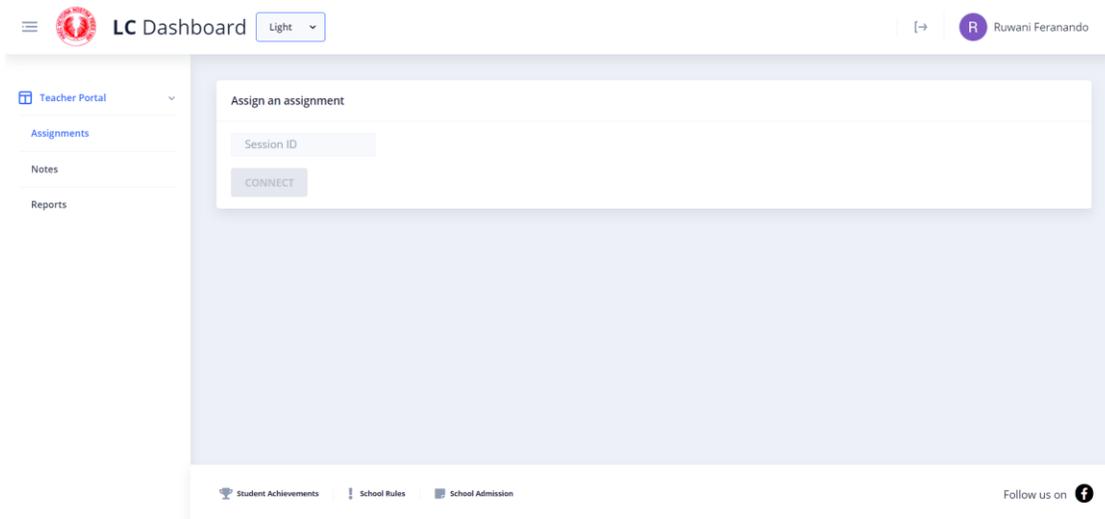
Figure 3.16 Screen to pair with the smart board of the VLE application

3.5.12 Creating assignments

Figure 3.17 displays the screen that will display to the teacher to enter the assignment details there are two types of assignments, MCQ and Drawings.
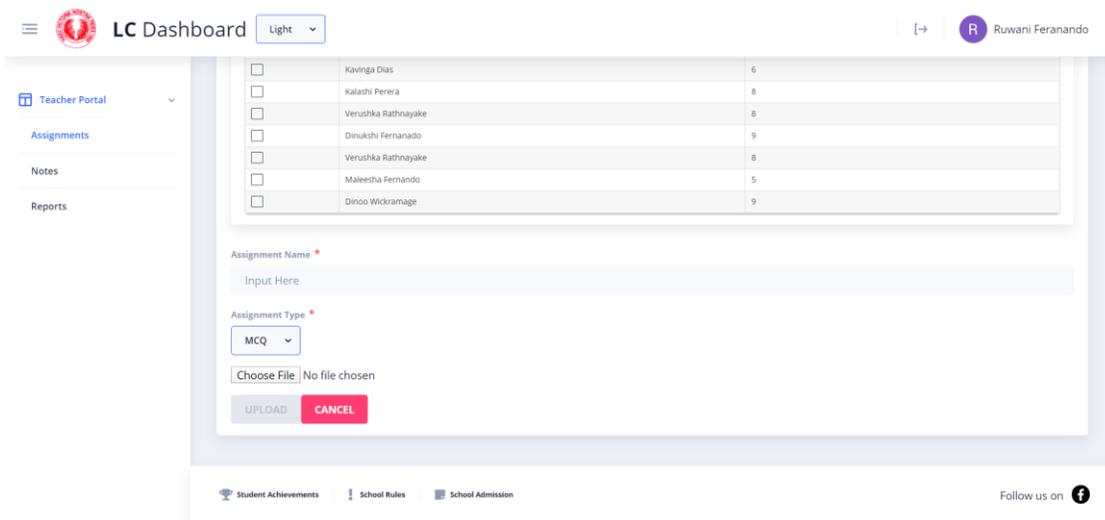
Figure 3.17 Creating assignments details screen of the VLE application

3.5.13 Responsive to the mobile view – VLE application

Below figure 3.18 shows that the customer website is also responsive to a mobile view. The pages are also responding to a mobile view, the toggle device toolbar in the browsers menu was used to take the below screen shots.
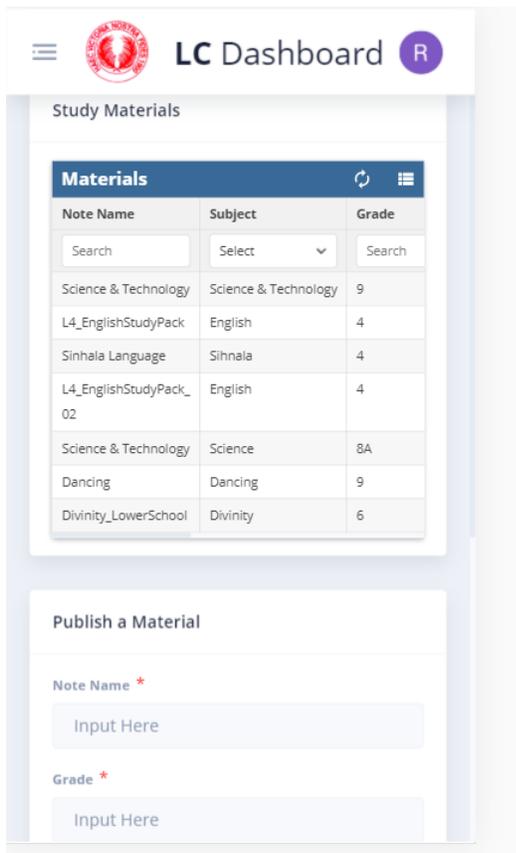
Figure 3.18 Mobile view of the VLE Application

3.6 Summary

The methodology chapter was dedicated towards examining and design of the project. The application is a web-based application and it supplies a fully functional learning environment to intensify a student's education exposure by including computers and the internet in the learning process. The design of the system is highly considered since young children use the system.

Additionally, the methodology elaborated about the database structure of the VLE using images. Further, the UI design of the VLE has been expressed spotlighting some main points, which were contemplated while designing the application and the above said, has been shown using the images of the VLE.

IMPLEMENTATION

4.1 Introduction

This chapter describes about the developing tools and techniques used in implementing this system and the details of the implementation part of this system. The implementation can be categorized into two main sections as the implementation of the VLE and live interactive learning. This chapter presents the implementation particulars of each section of this system with their processes after discussing the tools and techniques adapted.

4.2 Developing tools and techniques

The aim of this project is to implement a web-based application targeting the students and teachers in order to assist the teaching and learning process. However, without a successful implementation, many goals and benefits are unachieved. Consequently, a well-designed strategy to follow is vital to the success of an effective implementation. In order to achieve this purpose a collection of the latest technologies is being used. Following is the list of technologies used in this project. Each of these technologies are described with reference in this chapter.

Technologies used for the front end:

- Angular - Frontend UI framework.
- SCSS - Style UI components.
- Gulp - Build frontend application.
- Rxjs - Compose asynchronous or callback-based code using observables.
- HttpClient - Make REST API calls to backend.

Technologies used for the back end:

- Npm - Npm Repository Management
- Node JS - Backend Framework
- Winston - Logging Library
- Firebase Auth - Authentication Provider
- Firebase Storage - Multimedia Storage Provider
- Firebase Realtime Database - Database
- Node mail - Email Sender
- Body Parser - Request Parcer

For the development of the web-based application, the proposed solution needs to be efficient and reliable. Since students are going to use the application, the urge to provide a more user-friendly application becomes a major objective of the system. A web-based application is targeted because of the encouragement of providing accessibility of the software from anywhere. In addition, it comes with a simple interface and can be easily used by students and teachers.

4.3 Implementation of the system

Implementation of the system can be categorized into three main sections. Client end comprises of an Angular 8 project that interacts with the user and makes API calls. The server end consists of a spring boot +JPA (Hibernate) app Firebase as database. The three main sections are listed below:

1. Virtual learning web application – Front-end application.
2. Interactive board – Front-end application.
3. Back end server.

4.3.1 Virtual learning web application – Front-end application

Virtual learning web application is one of the main components of the developed system. It was implemented using single page application using Angular 8 as front-end technology. This Angular 8 application consumes CRUD Restful APIs developed and exposed by the backend server.

4.3.2 Smart board web application

The Smart board web application, which is the live interactive learning unit, is the application that enables students and teachers to interact in lessons while also enabling parents to view results and activities the student has given. It was implemented using single page application using Angular 8 as front-end technology. This Angular 8 application consumes CRUD Restful APIs developed and exposed by the backend server.

4.3.3 Back end server

The back end server was developed using NPM repository management, Node JS - Backend Framework, Winston logging library and Firebase as a database. The Restful APIs exposed by the backend server consumed by both the front-end applications.

4.3.4 Technology

- **Java 1.8**

Java web development platform is among the most required web development services. Java is an object-oriented language with a thoroughly worked through object model. It can be used to develop both standalone and web applications and suits both purposes equally well [19].

- **Gulp - Build frontend application.**

Gulp is a toolkit that helps you automate painful or time-consuming tasks in your development workflow. Integrations are built into all major IDEs and people are using gulp with PHP, .NET, Node.js, Java, and other platforms [20].

- **Nodejs**

Node.js is an open-source, cross-platform JavaScript run-time environment that executes JavaScript code outside of a browser. Node.js lets developers use JavaScript to write command line tools and for server-side scripting—running scripts server-side to produce dynamic web page content before the page is sent to the user's web browser. [21].

- **Angular/ Angular CLI**

The Angular CLI is a command-line interface tool that you use to initialize, develop, scaffold, and maintain Angular applications. You can use the tool directly in a command shell, or indirectly through an interactive UI such as Angular Console [22].

- **Rxjs**

RxJS is a library for reactive programming using Observables, to make it easier to compose asynchronous or callback-based code. This project is a rewrite of Reactive-Extensions/RxJS with better performance, better modularity, better debuggable call stacks, while staying mostly backwards compatible, with some breaking changes that reduce the API surface [23].

- **Firebase real-time database**

The Firebase Realtime Database is a cloud-hosted database. Data is stored as JSON and synchronized in realtime to every connected client. When you build cross-platform apps with our iOS, Android, and JavaScript SDKs, all of your clients share one Realtime Database instance and automatically receive updates with the newest data [24].

- **Winston Logging library**

Winston is designed to be a simple and universal logging library with support for multiple transports. A transport is essentially a storage device for your logs. Each winston logger can have multiple transports (see: Transports) configured at different levels (see: Logging levels). [25].

4.4 Summary

This chapter discussed about the transition of the application technical package into a fabricated, integrated and evaluated web application, which is ready for a user acceptance test, the next chapter is dedicated in the discussion of the evaluation process conducted in order to ensure this project results in a workable software.

EVALUATION

5.1 Introduction

The ultimate goal of the project is to supply a superior workflow for the academic operations of Ladies' College in an environment that students and teachers of the school can process evenly and precisely on a day-to-day basis.

The comprehensive objective is achieved to build an efficient and reliable VLE system; with the enhancements of web applications and the evolution of computer technology, the VLE is implemented promoting to a new stage.

This chapter is organized to consider on the assessment of the project with regards to the goals as well as the data that is being utilized as assistance to the project.

5.2 Evaluation at different levels

In order to assist the education system technologically and to make learning inspirational data and information along with the validations of it need to be provided correctly. The project was evaluated periodically within the life cycle. A Gantt chart was prepared to manage the timeliness of the life cycle of the project and frequent meetings were conducted with the supervisor. Since the software methodology used was Agile development there was designs done for the requirements that were added during implementation activities, they to needed evaluation and review.

The testing plan of the implemented project was conducted thoroughly. The test plan covers all the stages of the implementation process. All important tasks were listed and the key decisions were taken considering the entire implementation. As the first stage drafting a written proposal, requirement analysis, the problem under consideration, suitable technologies and sufficient resources were identified.

The core evaluation of the application begins at the first phase of the project with the start of gathering data that related to the domain. At the initial stage creating profiles, targeted as the test data so that the evaluation of the system was focused on considering only that particular targeted sub domain. Since there can be huge amount of reservations to be considered, the domain was reduced to a targeted set of data where the identification can be easily managed. Providing a set of test data that used as the example models. For the initial implementation of the project, those test data was used since we can provide a better outcome with the given thousand sets of data.

Creating students, teachers and parent user profiles, uploading study materials such as notes, past papers and voice recordings, making school fees payments and auto generation of student reports through the system are most important sections considered with the application side.

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5.3 Types of evaluation

The testing process of a system includes several types of evaluations; the evaluation methods considered vary from one system to another. The academic process of the school was carefully monitored, and while doing that a user-based evaluation was conducted to get an understanding of the system, In order to assure the quality of the system the evaluation can be conducted for both training and test datasets.

- What is evaluated?

The accuracy of the information provided to a system user needs evaluation in query based scenarios and how the drawbacks of the prevailing manual process has enhanced and benefited the lives of the students, teachers and school administrators.

- What is the purpose of the evaluation?

The main reason for conducting an evaluation is to reach the objectives set at the beginning of the project. The end users are able to use a system that has overcome drawbacks of the manual process; therefore, a careful evaluation is important to assure all objectives are achieved.

- Who is interested in the evaluation?

The end users are satisfied with the system if it is a well usable and accurate system; therefore, the interested group is the end users utilizing the system.

- How will they use the findings?

The end users such as students of the school, teachers and school administrators can utilize the findings gained from the evaluation in order to verify the process and also the amount of data and information they can retrieve and how productive the new application is.

What questions should be addressed?

- What are the areas that can be catered through the application?
- Are the times regarding payments, assignments and quizzes correct?
- Has the educational activities become more efficient and effective?
- Is the application user friendly?
- What kinds of enhancements should be applied and what are the strategies that should be taken?

5.4 System testing

There were a sequence of system verifications and validations done in order make certain the quality of the entire system. There were the sub modules tested separately as unit tests to evaluate each module separately. Once the unit tests were completed the entire system was tested as a whole.

User interface testing, exception handling testing, and performance and security testing were done constantly. The test results of one testing phase was used as the base for the next testing phase. These testing helped to find out issues and defects in the functionality of the system and to develop the system. The developed application is also focused on various types of people of all ages, backgrounds etc. all system testing is done accordance to that scenario.

5.4.1 Compatibility testing

Implemented system has been tested in below various operating system browser combination. The system can be installed into both windows and Linux machines all the devices have the ability to install the developed application. Following table 4.1 displays the tested operating systems and browser combinations.

Operating System	Browser Versions
Windows 7,8,10	Google Chrome -Version 80.0.3987.149 (64-bit)
	Mozilla Firefox - Version 67.0.1 (64-bit)
	Microsoft Edge 44.17763.771.0
Linux	Google Chrome -Version 80.0.3987.149 (64-bit)
	Mozilla Firefox - Version 67.0.1 (64-bit)

Table 5.1 Tested operating system and browser combinations

5.4.2 Functional testing - Test cases and test results

Below tables 5.2 – 5.9 consists of the test cases and test results of the VLE Front end application.

Login page - Test cases	Passed? (Yes/No)
Verify the admin user can login to the application.	Yes
Verify whether the student can login to the application.	Yes
Verify the teacher can login to the system.	Yes
Verify the parent can login to the system.	Yes
Verify the alignments and consistency of the UI elements in the login page.	Yes
Verify whether the field validations are available for username field and password field.	Yes

` *Table 5.2 Test cases for the login page of the Frontend of the VLE application*

Home page - Test cases	Passed? (Yes/No)
Verify the admin user can see the home page details.	Yes
Verify the admin user have access to left navigation panel.	Yes
Verify UI elements are properly aligned in Home page.	Yes
Verify whether the Ladie's College logo is displayed in home page.	Yes
Verify whether the user profile image displayed with the user name.	Yes
Verify whether the user can logout or access to "My profile" page via user profile setting icon.	Yes

Table 5.3 Test cases for the home page of the VLE application

Manage user profiles - Test cases	Passed? (Yes/No)
Verify the admin user can view the student grid view in the 'Add Student'.	Yes
Verify the admin user can successfully add a student and respective parent?	Yes
Verify whether the user can search any record using below fields. Student name, student email ID, grade, address.	Yes
Verify whether user can update the information of students and parents.	Yes
Verify whether user is able to delete a created student or teacher profile and is prompted with a message of confirmation?	Yes
Verify whether the user can logout while in user profile setting page ?	Yes

Table 5.4 Test cases for the manage user profiles

Add / Update school fees details - Test cases	Passed? (Yes/No)
Verify whether the School fees details page is displayed to user?	Yes
Verify whether the user can enter school fees payments for the primary school section	Yes
Verify whether the user can enter school fees payments for the middle school section	Yes
Verify whether the user can enter school fees payments for the upper school section	Yes
Verify the user can change any of the fees entered before saving?.	Yes
Verify whether the user is able to click on save button and save the entered school fees details	Yes
Verify whether the user is prompted with a successful message stating 'Payment information recorded successfully'	Yes
Verify whether the user can click on cancel button while entering school fees details and cancel the process at any time	Yes
Verify whether a parent user can view the correct school fees details entered by the admin user?	Yes

Table 5.5 Test cases for the add / update school fees details of the VLE application

Uploading study material - Test cases	Passed? (Yes/No)
Verify log in from a teacher user and check If the study material page is accessible to user	Yes
Verify user can view the study material grid view.	Yes
Verify whether user can upload new study material by providing the name , grade subject and type of study material	Yes
Verify whether user can select desired type of study material type which is notes, past papers and voice recordings ?	Yes
Verify whether the filtering field and pagination available in the study material grid	Yes
Verify whether the user can search any record using below fields. Grade, Subject, Name, Study material type.	Yes
Verify weather user can edit the below fields of an uploaded study material. Grade , Subject , Name	Yes
Verify weather user can delete an uploaded study material	Yes
Verify the UI elements and alignments of the Add study material form	Yes

Table 5.6 Test cases for uploading study materials of the VLE application

Pairing with smart board - Test cases	Passed? (Yes/No)
Verify whether the user can access the assignments page	Yes
Verify whether teacher can enter the pairing code of the smart board and the field is active.	Yes
Verify the connection between the smart board application and front end application	Yes
Verify whether the teacher can select both drawings and MCQ question assignments.	Yes

Pairing with smart board - Test cases	Passed? (Yes/No)
Verify whether the smart board displays the MCQ questions correctly	Yes
Verify whether students can interact with the smart board and provide the answers.	Yes
Verify whether those drawings can be done and submitted successfully.	Yes
Verify whether the teacher can provide marks to the drawings and submit successfully.	Yes
Verify whether the parent user can view the marks submitted by the teacher for the respective students.	Yes

Table 5.7 Test cases for pairing smart board with VLE application

Student report card auto generator – Test cases	Passed? (Yes/No)
Verify whether the teacher is able to select a student whom she wants to generate a report to.	Yes
Verify whether the teacher is able to enter the subject and marks for each student	Yes
Verify whether the teacher can view the report card.	Yes
Verify whether the average is accurately calculated.	Yes
Verify whether the report is sent to respective parent when teacher clicks on generate report.	Yes

Table 5.8 Test cases for the student report card generator of the VLE application

Interactive board web application

Below table 5.9 consists of the test cases and test results of the interactive board web application.

Interactive board web application – Test cases	Passed? (Yes/No)
Verify whether the smart board application can be successfully launched.	Yes
Verify UI elements of the smart board application initial loading.	Yes
Verify when the application is launched a pairing code for the teacher is loaded.	Yes
Verify whether the students can complete drawings and use all the colors loaded.	yes
Verify whether the drawing can be saved successfully	Yes
Verify whether the teacher is able to successfully see the drawing and provide marks to it.	Yes
Verify whether the marks entered shows accurately to respective parent.	Yes
Verify whether the smart board application is able to display all the questions of the MCQ aligned properly	Yes
Verify the user is able to select an answer from the MCQ questions.	Yes
Verify the user is able to upload content to the smart board application.	Yes
Verify whether the uploaded content is displayed in the smart board application.	Yes

Table 5.9 Test cases for the interactive board web application

5.5 User Acceptance testing

User acceptance testing is a vital step in testing of a software application. The user acceptance testing on this application was conducted on condition that some users are provided with a prototype of the application in order to get their responses.

The developed application selects a particular user group. It is an application for the students, teachers and parents who are a vital part of the school community. The significance of this kind of an application is comprehensible at once for a person with marginal computer knowledge. Therefore, for this user acceptance test, a target group with some computer knowledge background about using systems were selected. Since it is difficult to find a user base that are all non-technical and competent with web applications, application was evaluated between both types of people who are technically expertise as well has people who are on not technical.

A questionnaire was prepared in order to evaluate the implemented system. Following characteristics were targeted in the given questionnaire.

- Usability of the system – The limit of the system that the end users can utilize it effectively without any critical or major issues.

- Reliability of the system – The scale to which the system behaves as expected, in all its functionalities.

- Accuracy of the system – The outputs retrieved from the system should all be accurate.

- Effectiveness of the system - Time taking to provide a result to the end users and how efficient and effective the system it. Less waiting time or had to wait more than they expected.

- Importance of the system to the society – How the system has being a benefit to the society.

- Final evaluation of the system as a whole – How the entire workflow has affected the users and the general idea of the users.

There are general questions at the end of the questionnaire to collect general comments on the system from users. Feedback collected using the above-mentioned questionnaire is analyzed and finally summarized into a table. The questionnaire is displayed in Appendix A. Results of this evaluation is shown in following chart figure 5.1.
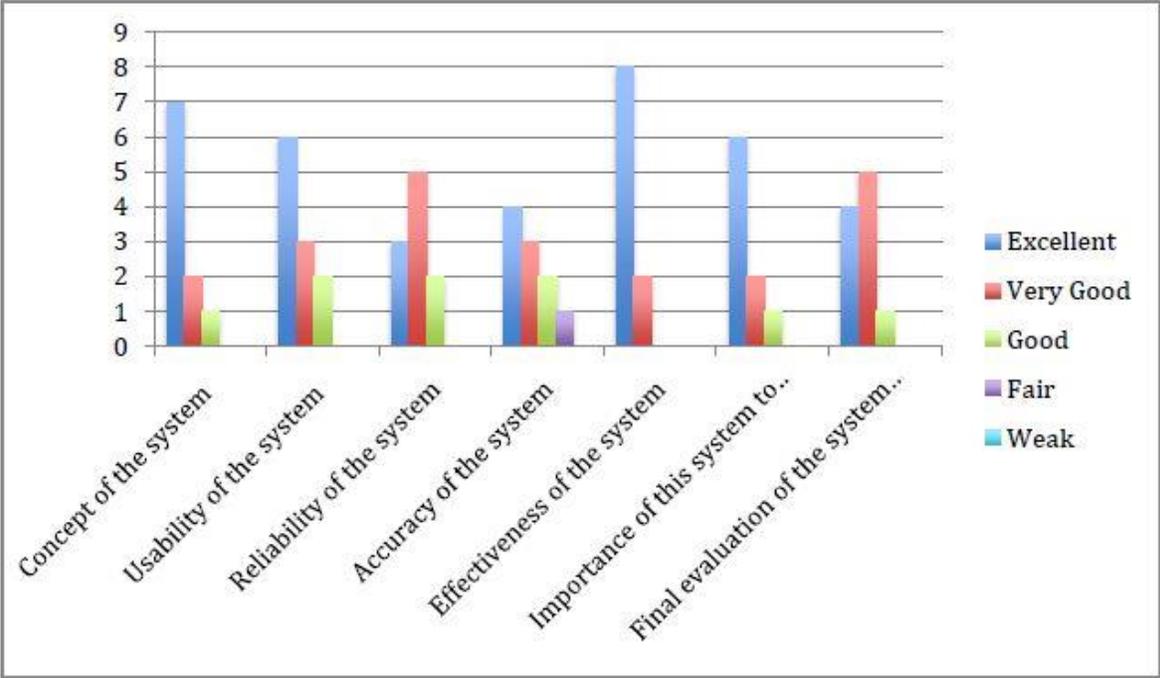
Figure 5.1 Evaluation of the system

As per to the results of evaluation, it was possible to identify functionalities where enhancements are needed. Results indicate that accuracy of the system and reliability has to be improved. In addition, it is noticeable that many users have decided that the web-based application is an important application and such a system is important to the society.

5.6 Summary

This chapter mainly focused on the testing scope and the how the test results was evaluated thoroughly to get an idea about the quality of the system. The response from the questionnaire was displayed as a graph; additionally it explains the improvements needed based on the results.

Next chapter focuses on conclusion of the system based on the objectives achieved, challenges faced and limitations of the system including future enhancements of the system.

CONCLUSION

6.1 Introduction

The principal intention of the project is to supply Ladies' College a VLE in order to carry out their educational activities. Diverse details of the project were being discussed throughout the whole dissertation. The problem that led to the implementation of the project was elaborated at first , later an overview of such prevailing systems and the methodologies used to provide a solution was discussed, the dissertation continues with the tools and technologies used to achieve the final objective and also how the final project was evaluated.

This chapter will conclude the dissertation and is aimed at providing details on the significance of what has being achieved. It also includes descriptions of the objectives attained and further discussing the problems that came up during the implementation of the project. This chapter is concluded by depicting the further extendibility of the project depending on any prevailing limitations.

6.2 Achieving the objectives of the project

To accomplish the goals of a triumphant VLE application, it is necessary to meet the basic requirements that is defined while analyzing and to have a smooth process running.

The below objectives were achieved from Ladies' College

Benefits to students

- Ability of downloading school notes, pass papers and voice recordings uploaded by teachers.

- Ability to interact on assignments and drawings through the live interactive module.

- Be updated about the notices and extracurricular activities.

Benefits to teachers

- Trail & inspect academic performance – for every term, subject and grade.

- Ease of calculating final group and options personalization.

- A dashboard of the student performance.

- Accurate, reliable and hassle free payments to be made from home.

- Time management is easy due to most tasks being done online.

- Report generation for data of the school.

Benefits to parents

- Be updated about latest announcements of the school and the school calendar.

- Accurate, reliable and hassle free payments to be made from home.

- Ability to download notes and past papers for the children.

6.3 Problems encountered in the project

As the project was moving towards achieving its objectives, diversified issues came about due to many causes. They had to be solved immediately in the process of the implementation of the application. Requirements analysis from the beginning of the manual workflow at the school was hard, there were various age groups of students and classes and various subjects that needed to identified.

Additionally a critical problem came about in the correctness of the system. In this system, accurate information has to be given as the output since school students depend on that information. That was one of the core challenges which immediate attention was required as the development of the application processed.

Below are some technological problems that took place

1) The communication between dashboard and smart board real time.

2) The creation of a white board on smartboard application that the student does drawings.

3) Sending generated report via email through the backend.

4) A csv files has to be converted to a JSON object to be read among the application.

Challenges faced on the application aspect:

The application had to be very user friendly so that a large customer base could be targeted, this took some time and was a challenge. I had a goal to develop a chatbot for the school so that the students could retrieve updates through an artificial intelligence assistance, but due to time, constraints I was unable to do it.

6.4 Limitations of the currently developed solution

Ladies' College is greatly benefited by this virtual learning environment; however, there are some limitations, which need to be addressed. That is this system is not implemented to serve as a mobile application. One of the key advantages of responsive e-Learning applications is the mobility and this trend is called Mobile e Learning or m-learning. A mobile application of the VLE will increase the chances to make the VLE platform even more attractive for more users. Therefore, a mobile application not been available is a main limitation of the developed system.

Another limitation is that the system does not support live video lessons or webinars. Virtual classroom software for live interactive online classes is a great benefit in today's world; a virtual classroom is a digital replica of a traditional classroom or training room. The instructors teach, and the participants learn in real-time, face-to-face but via internet-enabled technology devices, therefore a face-to-face interaction not being there is a limitation of the currently developed solution.

6.5 Further extendibility of the system

As the future enhancements of the application. It is vital to mitigate the issues depicted above. There were two major limitations discussed in there and those addressed one by one to provide a better system by further developing it. A mobile application being implemented for this project will achieve:

1. User satisfaction
2. Mobility of the VLE to retrieve study material
3. Efficiency in payment makings

Below listed are some elaborated further extendibility of the system

- High-definition video conferencing: A personalized and collaborative video conferencing tool to be integrated in to the system. The goal of it is to conduct a virtual classroom with audio, video facilities. The students will learn real time, face to face through the internet.

- Advanced interactive whiteboard: The virtual classroom will have an interactive whiteboard that demonstrates circuit diagrams, graphs and also other learning content for physics and chemistry. There will be maps demonstrated which will assist students get a good insight to geography. The teacher can interpret while illustrating or commenting on the files, with options to choose colors from the color palette.

6.6 Summary

It is a great achievement that the completion of a triumphant projects leads to another innovation. As it was mentioned in this chapter that this application is a success of which it is supplied to Ladies College. The application was able to make Ladies College a better place in terms of efficiency and also reaching expected standard. The software has been developed to the expected standards to output the expected results by achieving the objectives frequently. A particular project always carries problems when reaching its goals, challenges in implementation, limitations, and its further evolution. Even though some problems were encountered in the development phases, the project was lead to the final destination of illumination. However, the application of the concept that was addressed by the project is bit challengeable and the ultimate goal was achieved by the extreme effort. The currently developed system also comprises few limitations when implementing it in the real world. However, the further extensibilities of the system have been identified and those can be involved to provide better solutions in the future.

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GLOSSARY

- Database – A storage of items that is electronically retrieved.

- Objects Oriented Development - is a standard approach to software development based on objects and its instances.

- Internet - is a global network of interconnected computer networks.

- Java - Java is a programming language that serves many purposes and created to have fewer dependencies.

- Graphical User Interface – It is an interface that sits in between humans and computers for the communication of them to receive input and provide output.

- Unified Modeling Language (UML) - is a general-purpose modeling language in the field of object-oriented development. This includes a set of graphic notation techniques to create visual models of object-oriented software-intensive systems [26].

- A Chabot - is an artificial intelligence (AI) application that can reproduce a communication with a user in natural language through messaging applications, websites or through the telephone [27].

- Interactive board – It takes the form of a whit board and has a large interactive display; it is also known as smart boards. It is used to display lessons, or perform tasks and operations. The interactive board is displayed as a standalone touchscreen computer, or connected to manipulate as a computer.

- Agile Methodology- It is a type of software development in which the requirements and solutions evolve through the collaborative effort of cross-functional teams, and it gives room for change requirements done throughout the development cycle.

APPENDICES

Appendix – A client response sheet

Designation:

……………………………………………………………………………………..

Rankings:

1 – Highly Dissatisfied   2 – Dissatisfied   3 –Available

4 – Satisfied   5 – Fully Satisfied

Please rate the below conditions as per the rankings provided.

	Feature	Rank
1.	The application is usable in a realistic environment	
2.	The entire application process has a constant satisfactory feel to the user.	
3.	The application provides human readable directions to user.	
4.	The entire application is well demonstrative and friendly	
5.	Validations are comprehensive	
6.	There are agreeing forms, items and navigation bars	
7.	The entire application has an instinctive direction process.	
8.	Relevant information can be input into pages at ease	
9.	Required data along the process of the workflow is well available	
10.	Proceedings such as dashboard, analytics and graphs are well visible	
11.	Dashboard, analytics and graphs have sufficient data	
12.	The application covers all high-level features.	
13.	The developed application solves all issues of the prevailing method	
14.	This developed application brings an advantage to the school	

Appendix – B Acceptance from client

Ladies' College

Colombo 7

2020/06/10

Final Thesis Committee,

University of Colombo School of Computing,

Dear Sir/ Madam,

ACCEPTANCE CONFIRMATION

We hereby state Miss. W.M.V.K Thilakaratne has productively implemented a VLE application for

as her postgraduate project. She collected relevant requirements from our school due to the

implementation for the said application.

The board of Ladies' College concluded to utilize this VLE system, since it is flourishing our

process.

Regards,

Yours Faithfully,

……………………………….

Mrs. Isha Spelderwine

Principal

Ladies' College