

EDUCATION FOR ALL
CONCEPT AND IMPLEMENTATION OF AN EDUCATIONAL MOBILE
APPLICATION

by

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CSE497 / CSE498 Engineering Project report submitted to Faculty of Engineering
in partial fulfillment of the requirements for the degree of

BACHELOR OF SCIENCE

Supervised by:
Ali Haydar ÖZER

Marmara University, Faculty of Engineering

Computer Engineering Department

2021

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ABSTRACT

In our developed community, online learning is considered as a significant methodology that can conquer the restrictions of on-campus learning, and it is widely accepted. Acceptance of learning technologies is generally based on beliefs about technology and perceived usability. E-learning is an innovative approach to providing e-learning environments designed and well-mediated and focused on the learner through the use of the Internet and digital technologies with regard to the principles of interactive instructional design. Our project provides application software development techniques in the development of an e-learning system that facilitates mobile learning in the learning environment. An advanced application offering a student can, after registration, access to the various functions that can improve the learning process. A portal exists for teachers to transfer learning substance and understudies assessment results. The application was tried and assessed with acceptable outcomes.

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1. INTRODUCTION

1.1 Problem Description and Motivation

The topic was chosen after exploring the importance of distance learning and its impact on the education community before the Corona epidemic spread worldwide. Since we have to, we use computer and mobile applications for educational purposes.

Distance Education can be as effective as traditional education when methods and technologies are used properly. In today's world, education is given only to people who can pass a certain examination system, but the problem is that even these people have difficulty following the education system and there is a difference in skills among these students. Working in the traditional way is good but can be slow, tiring, and unfair to the new fast world. Online learning has gained wide acceptance and is recognized as an important approach that can overcome the limitations of on-campus learning. Thus, we start to see this as an opportunity and as a problem.

1.2 Aims of the Project

The adoption of learning technologies often depends on technology-related beliefs and perceived ease of use. E-learning is an innovative approach to provide electronically mediated, well-designed, student-centered interactive learning environments using the internet and digital technologies in terms of instructional design principles. This project presents the application of Software Development techniques in the development of a Mobile-Based E-learning system that facilitates learning in a learning environment. The developed application provides a system where a student can access various functions that can improve the learning process after enrollment. A portal is available for lecturers to upload learning content and student exam results. The system has been tested and evaluated with satisfactory results. The main objectives of this project can be listed as follows;

- Eliminating discrimination in education
- To establish a common platform where obstacles are withdrawn.
- Allowing the use of different techniques in problem-solving

- Establishing better tools for instructors to teach.
- To reduce paper usage.
- Minimizing the tuition fee.
- To show what education can achieve in a proper environment

2. DEFINITION OF THE PROJECT

2.1 Scope of the Project

Online learning application is a broad platform to help students get more educated. With e-learning, the concept of learning has differed from ancient times. This e-learning platform has been massively increased as everyone has a smartphone with high-speed internet through which they can access the training courses on websites in minutes. Some KPMG report engines such as their research released that, by 2021, the number of people who were using the e-learning platform can reach 9.6 million. This is a huge number in terms of number. In order to help learners gain more knowledge, the Ministry of Human Resource Development (MHRD) is working to create more interest for users through training courses, certificates, new practical applications, etc. This e-learning platform is to create its kind of awareness that is available in villages and all cities.

2.2 Success Factors and Benefits

Through our researches, we were able to formulate and test many Success Factors of e-learning. It was considered that the following five factors positively affected the results in our platform:

- Humanitarian issues: The teacher should be skilled in motivating students online and creating an enthusiastic environment online.
- Technical Skills: Both the instructor and students need to acquire the necessary skills to work efficiently with the online environment.
- Attitude: The teacher and the student need to take a positive approach towards online learning.

- Interface: the actual design of the application pages and the content of the navigation system must be easy to access and use.
- Evaluation system: include assessment of students' learning process, evaluation of e-learning programs and evaluate the development of e-learning content.

2.3 Professional Considerations

2.3.1 Methodological considerations/engineering standards:

Figma: Figma is a cloud-based design and prototyping tool for digital projects. It is made so that the team can collaborate on projects and work anywhere. We used it to design our application pages and the other diagrams related to the application.

React Native: React Native is a JavaScript framework for writing real, natively rendering mobile applications for iOS and Android. We choose it because most of the code you write can be shared between platforms; React Native makes it easy to simultaneously develop for both Android and iOS.

Firebase: Firebase Real-time Database is a cloud-hosted database. Stores data in JSON format. When you build cross-platform apps with our iOS, Android, and JavaScript, all of your clients share one Real-time Database instance and automatically receive updates with the newest data. We planned to use it because it allows us to set up and provision a back-end database as a service more easily and in offline situations.

Expo: Expo is a tool chain built around React Native to help you quickly start an app. We used Expo because It provides a set of tools that simplify the development and testing of React Native apps and arms us with the components of user interface and services that are usually available in third-party native React Native components.

Discord: The team leader chose discord as a main communication tool because it provides a sharing screen feature which helped us in sharing our results from our homes.

GitHub: GitHub is a source control system that allows you to track versions of your work in project containers called repositories. We created our repository to share the codes among the team members.

UML diagrams: In creating software systems, using UML diagrams leading to visual system representation. In addition, the main actors, action, roles and classes will be clear for the developer.

NPM: NPM is the package manager for the Node JavaScript platform. We used it because It puts modules in place so that nodes can find them, and manages dependency conflicts intelligently.

Yarn: In JavaScript programming, yarn is one of the most important package managers. The feature of using yarn is the high-speed performance while installing the dependencies compared with other package managers.

Android studio: Android Studio is the official integrated development environment (IDE) for Android application development. In our project, it is used to implement our application on android operating system

Xcode: Xcode is Apple's integrated development environment for macOS, we used it to test our application performance in the IOS.

Google products: We planned to use Google products like Google Docs, Google Drawing and Google Sheets because it provides the multi-access for each file which make the work easier for the team members

Visual Studio Code: Visual Studio Code is a free source-code editor that can be used in all operating systems. Highlighting and debugging is the most important feature that leads us to use it in our project. It also allows us to work together in the same code for debugging and publishing our work.

2.3.2 Societal/ethical considerations:

In terms of Societal/ethical considerations, our application keeps you informed about technology and improving the personal technological skills. In addition, the other advantage of the e-learning application in society is creating an innovative way to collaborate among the society. From the economical perspective, our application and E-learning in general creates a technology-immersed society with job skills in the twenty-first century, which in turn creates economic returns for a country that invests in e-learning. The other aspect that our platform impacts positively is health. Using the e-learning application to study for children will lead to improved mentality and thinking skills, which will lead to smarter workforce. From the environmental aspect, we clarified that the negative environmental impacts of manufacturing and transportation has reduced thanks to E-learning. Dramatically cut back on materials needed for traditional educational institutions (textbooks, offices, electricity, buildings). This reduces waste and conserves natural resources.

2.4 Literature Survey

Among the various papers that were discussed, many of them focus heavily on the effectiveness and impact of learning created by electronic sources in the minds of the current generation. While some papers even discuss additional factors such as what interests people to study something digitally. [1] According to Mudesir Khan (Khan, 2016), e-learning techniques seek to promote the goal of educational outcomes using e-learning technology tools in a comprehensive way and to enable innovative learning. E-learning is an effective part of a student's technical, design and development skills in the current era of computer science. [2] From Froilan and Gesswein(2019) point of view, the e-learning system is designed to help students gain an understanding of their respected academic topics, enhance and participate in their learning experience. Through research that they did regard the scope of e-learning, suggesting that it would be better to thrive as a learning system as such all over the world, which can only happen when everyone knows access to the resources provided. [3] According to Roohinder Kaur(2012), today, with various technological developments, learning is not limited to

lecture classes as the only way to impart knowledge, but rather the electronic learning method continues to evolve. E-learning, which provides training through communication networks, has made online learning, large networks or local networks available from anywhere at any time.

3. SYSTEM DESIGN AND SOFTWARE ARCHITECTURE

3.1 Project Requirements

3.1.1 Functional Requirements

- **Registration System:**

The management system of registration must include a full range of functions to manage and configure system parameters and attributes, data and user type. The system works with authentication protocols to identify the users and check their information with the database.

- **Course Management:**

This function should provide tools for synchronous and asynchronous e-learning application, create, edit, provide and delete courses, encourage student participation in the learning process and ensure better interaction within the teaching process.

- **Content Management:**

In this function, content for all users should be stored and managed on the learning platform in order to facilitate work with educational materials.

- **Evaluation system:**

Possibility to evaluate the contribution of the student's personality (individual mark) and provide feedback to each member of the group

3.1.2 Nonfunctional Requirements

- Usability

We designed an application with high efficiency of use that helps the student to complete many tasks without any help or transaction errors. In addition, we designed a colorful interface, buttons and headings to make the application simple to understand and use.

- Security

The access permeation of the user database in our application can be only changed and modified by the system data administration because we used a high authorization and authentication roles.

- Reliability

In our project we worked with the coding languages and simulators that led our software to work for a given time period without failure.

- Scalability

The scalability can be described by how the system performance should not be influenced negatively while processing more data or serving more users. We used Firebase which can work with an enormous number of users without affecting the application.

3.2 System Design

3.2.1 UML Use case Diagram(s) for the main use cases

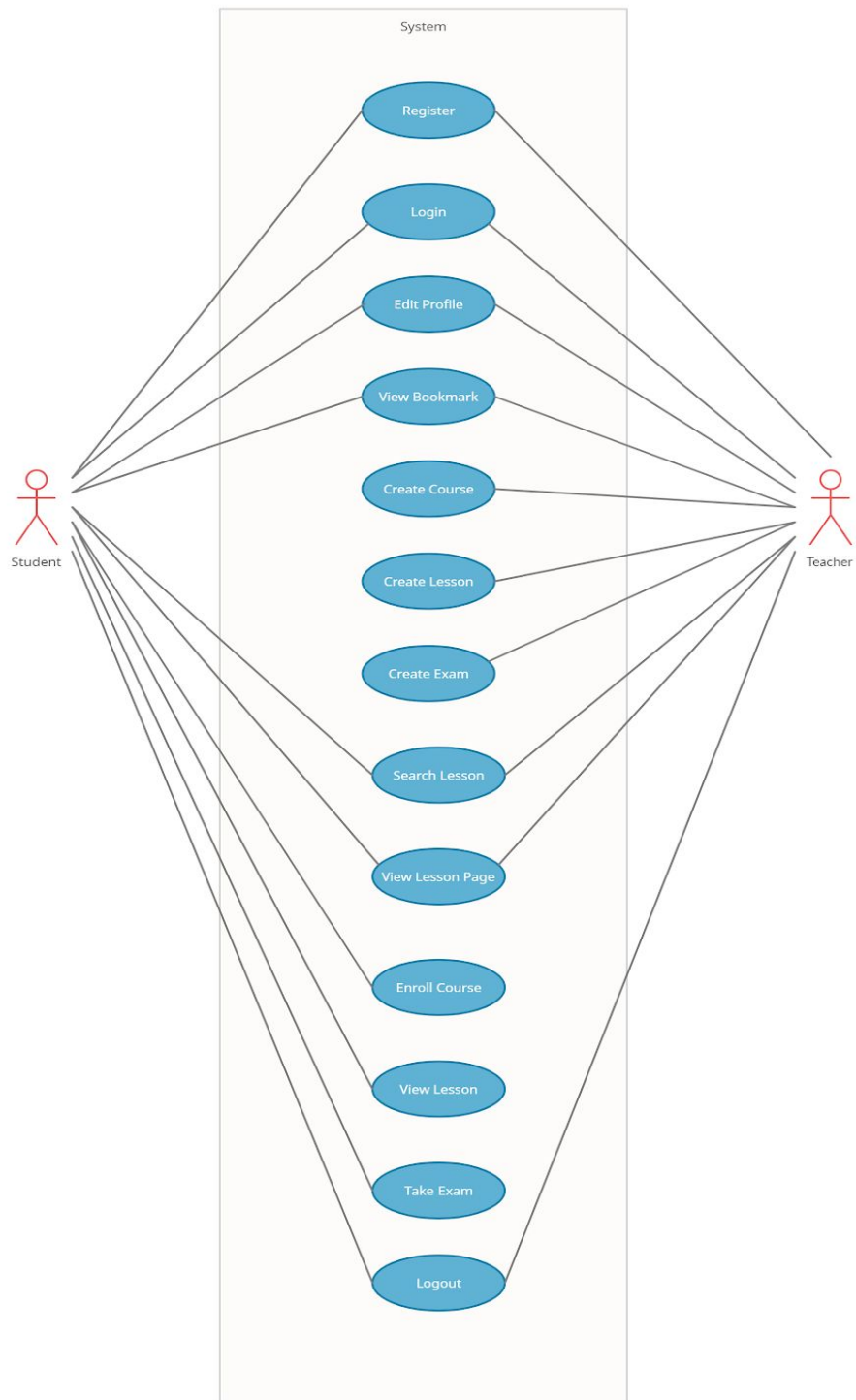


Figure 3.1: Use Case Diagram

3.2.2 UML Class and Database ER diagram

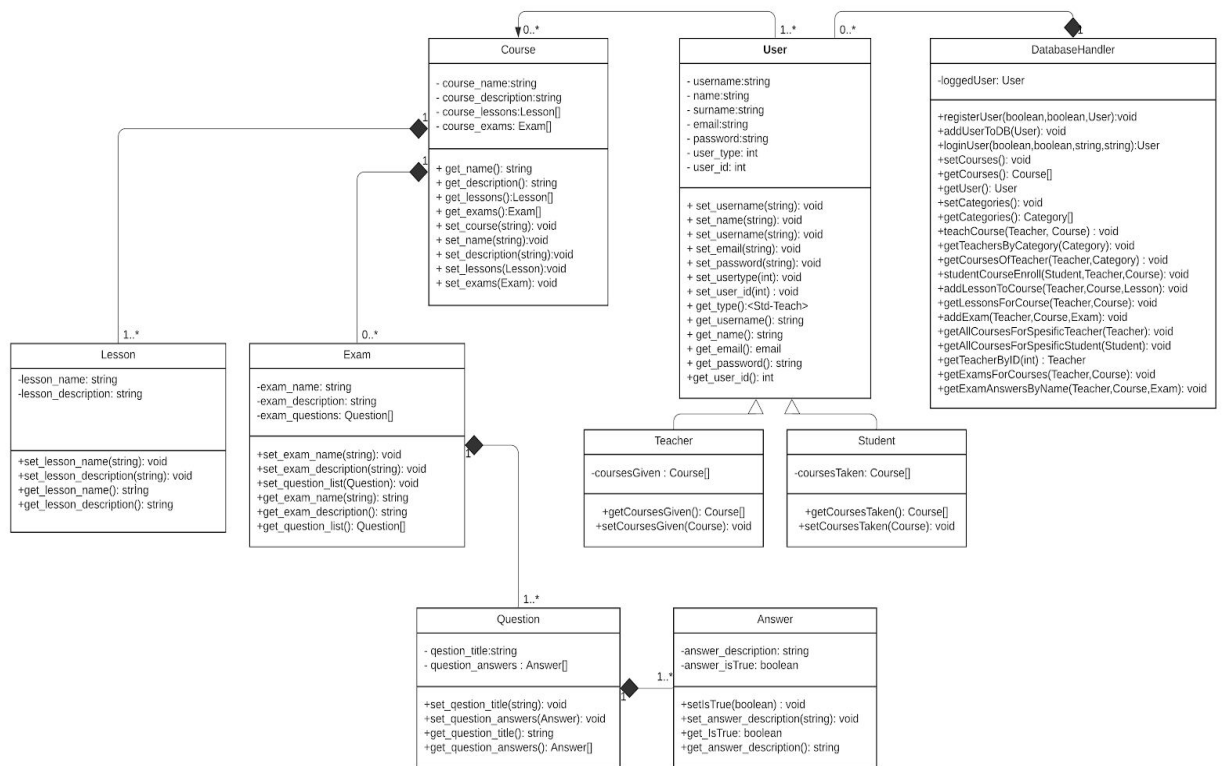


Figure 3.2: UML Class Diagram

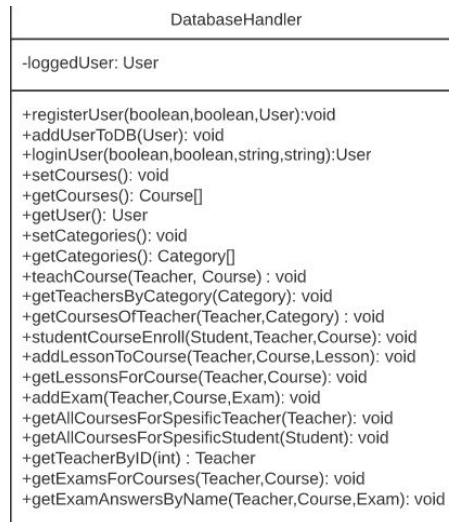


Figure 3.3: Database Handler

DatabaseHandler Class: This class we use provides communication between all our tables and particles. It plays the main factor in the transmission and updating of changes on a user's own accounts from input and output data.

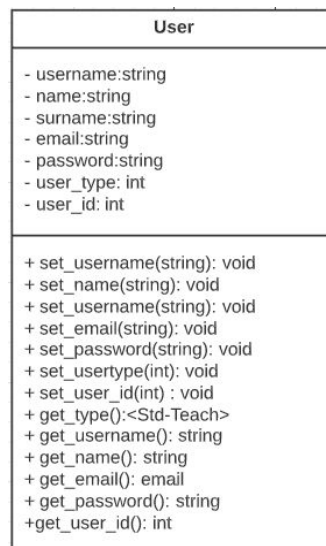


Figure 3.4: User

User Class: Another main factor that determines the main scheme of our program is the users. Therefore, we created a main object for our users, and this main object facilitated all the changes we made by keeping all the sample variables that users should have. When we complete these main parts, there are 2 options, Student and Teacher.

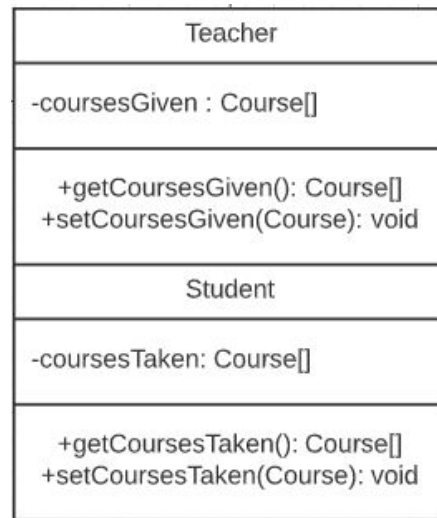


Figure 3.5: Teacher & Student Classes

Teacher & Student Classes: Teacher and student constitute the main template in the logic and physical structure of our program. It also keeps the data of the lesson they have taken or given externally from the main scheme.

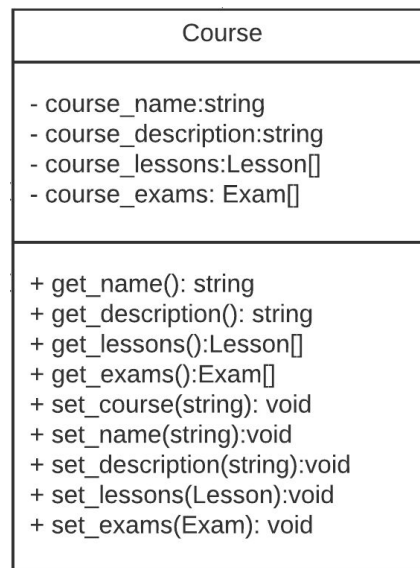


Figure 3.6: Course Class

Course Class: Another component that we designed a Course, we created the whole main scheme for the courses and exams to be given or taken.

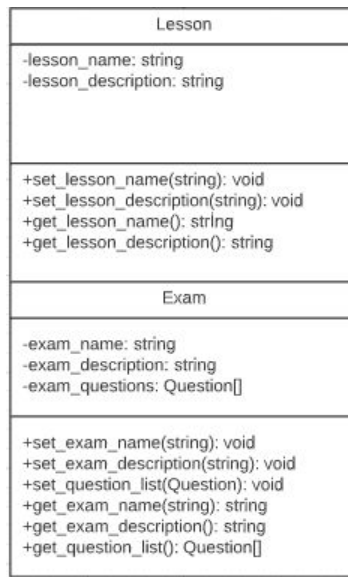


Figure 3.7 : Lesson & Exam Classes

Lesson & Exam Classes: The Course and Exam specify what an instructor can currently create and what a student can take, and with only these 2 structures, the instructor and the student can easily

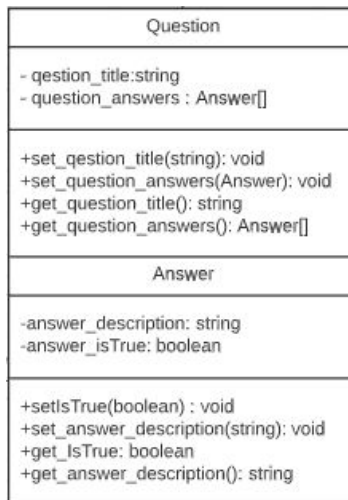


Figure 3.8 : Question & Answer Classes

Question & Answer Classes: The question and answer part is one of the last but most important parts of our program, this part forms the heart of the exam system and keeps all the necessary components in it.

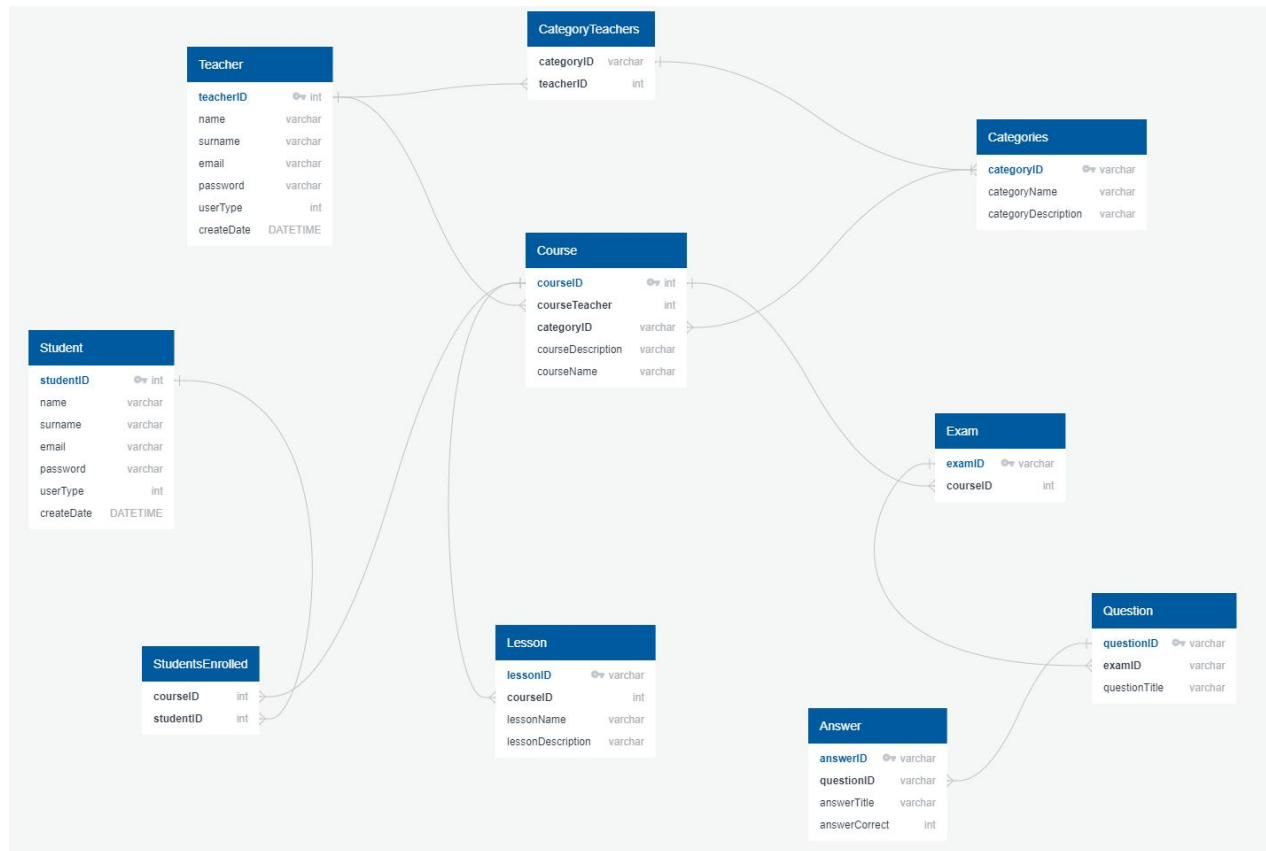


Figure 3.9: Database ER Diagram

3.2.3 User Interface

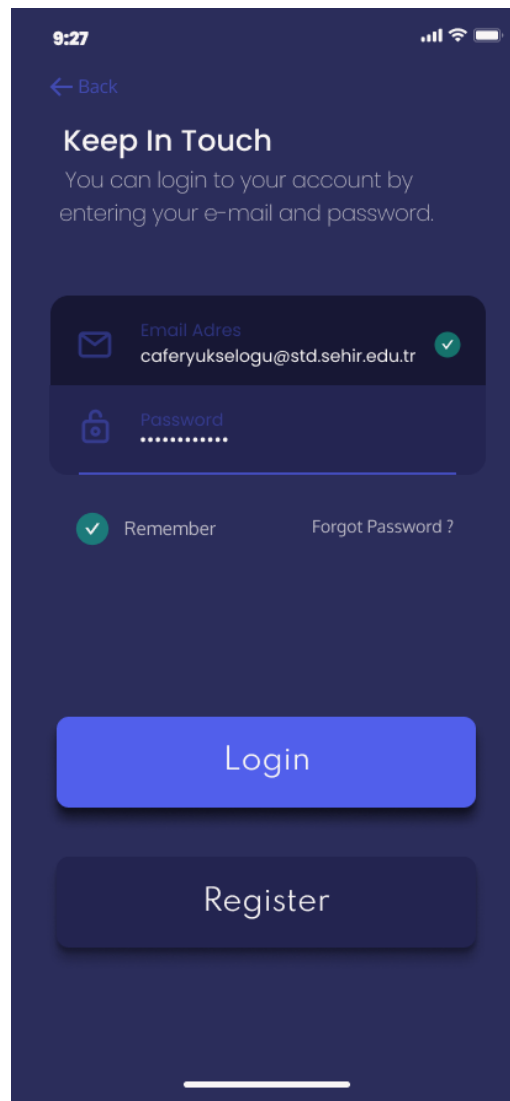


Figure 3.10: User Interface Login

Login Page: In the Login page, there are sections for users to enter email and password correctly. Also, navigation to other pages such as Forgot Password and Register can be made from this page. Login button is calling methods to establish a connection with the database to check the correctness of password and email.

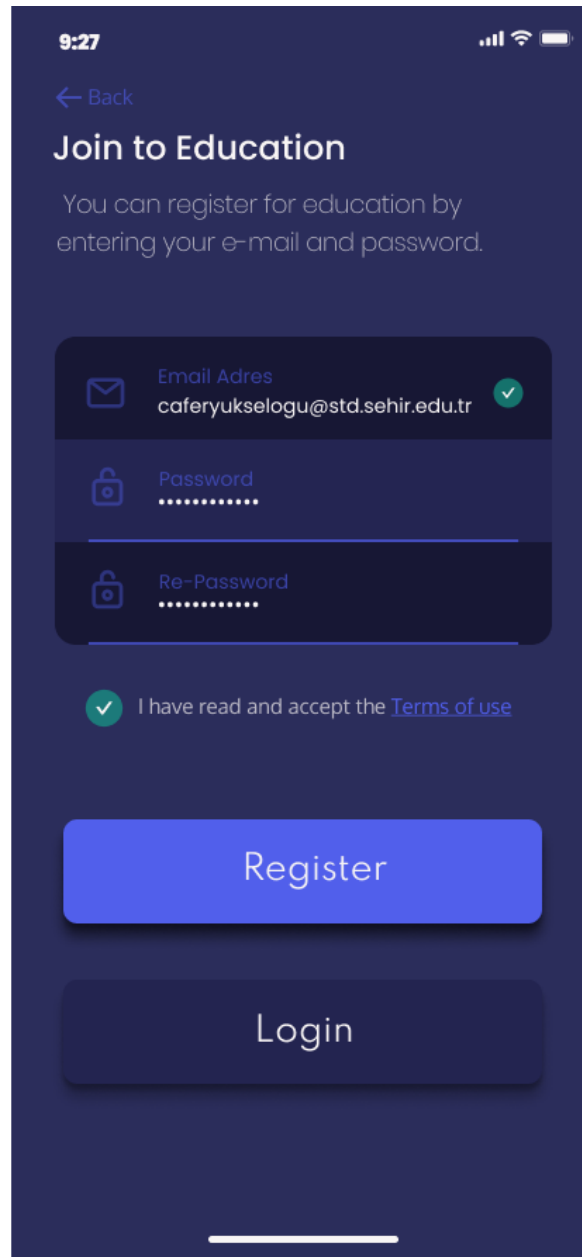


Figure 3.11: User Interface Register

Register Page: The Register page is designed to create a new user by asking for an email address and password. It also connects to the database when the credentials are valid to add new users to the database.



Figure 3.12: User Interface Selection

Selection Page: In the registration process, the user is expected to choose the user type by selecting one of the user types.

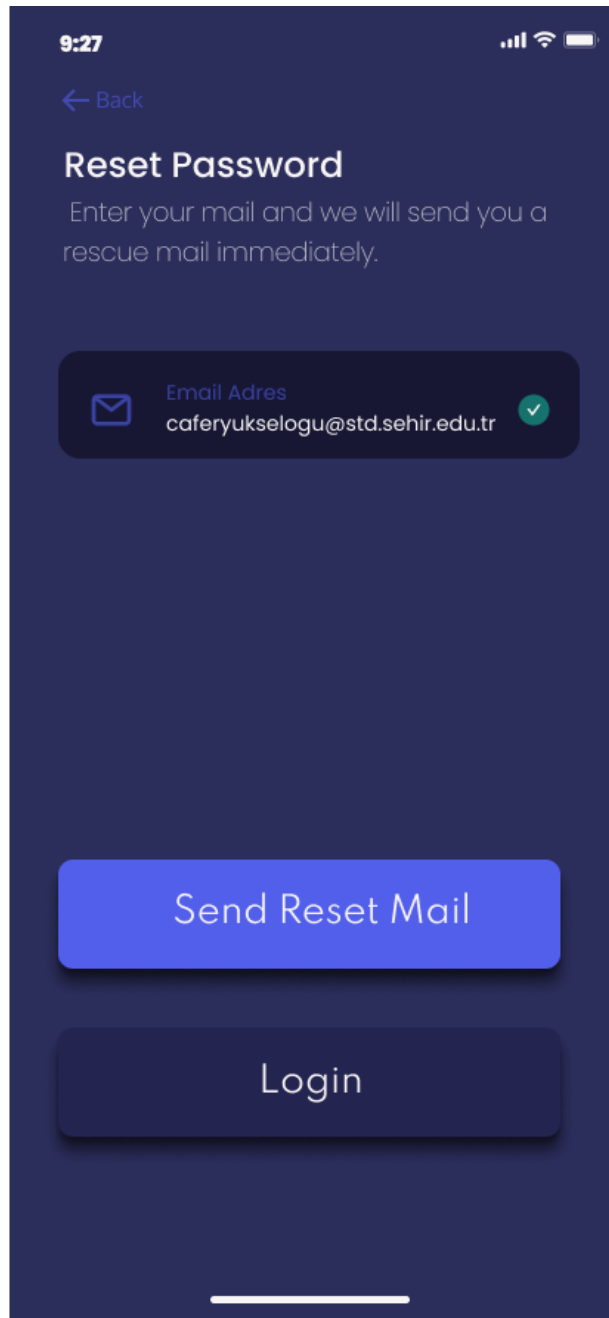


Figure 3.13: User Interface Forgot Password

Forgot Password Page: When a user is not able to sign in because the password is forgotten, this page sends a reset password mail to the given e-mail.

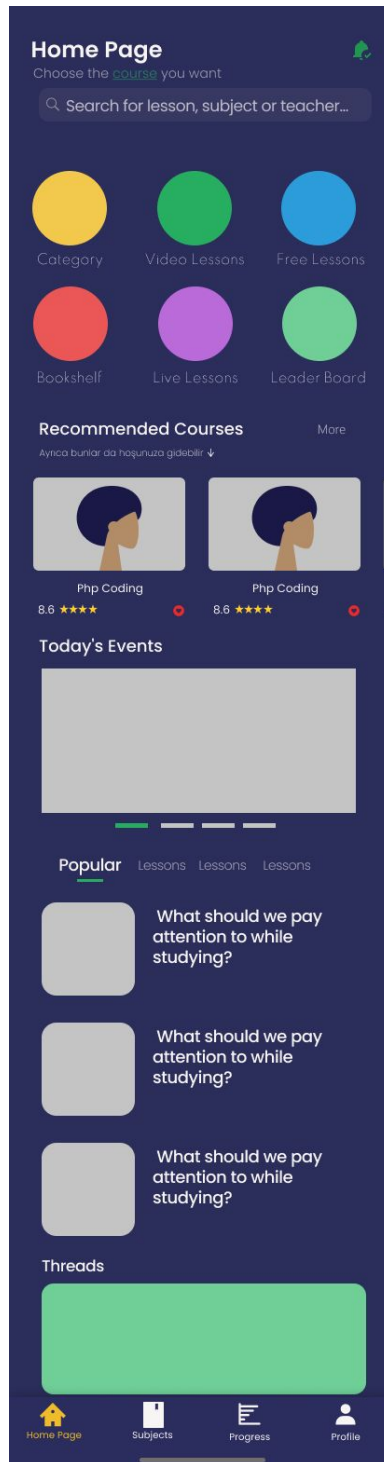


Figure 3.14: User Interface Home

Home Page: Categories, recommended courses and the navigation to other pages such as Profile, Bookmarks is available in this page.

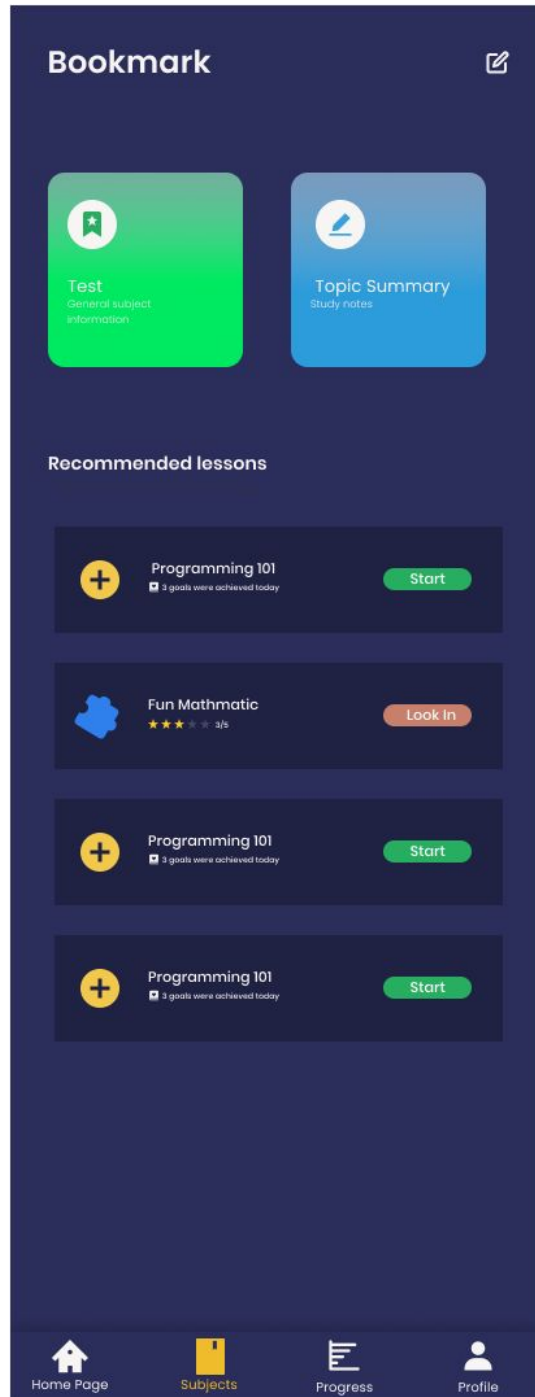


Figure 3.15: User Interface Bookmark

Bookmark Page: In Bookmark page, courses listed for both teachers and students. If this account is a teacher, the Bookmark page is listing the courses that the teacher is giving. On the other hand, if this account is a student, this page lists the courses that students take.

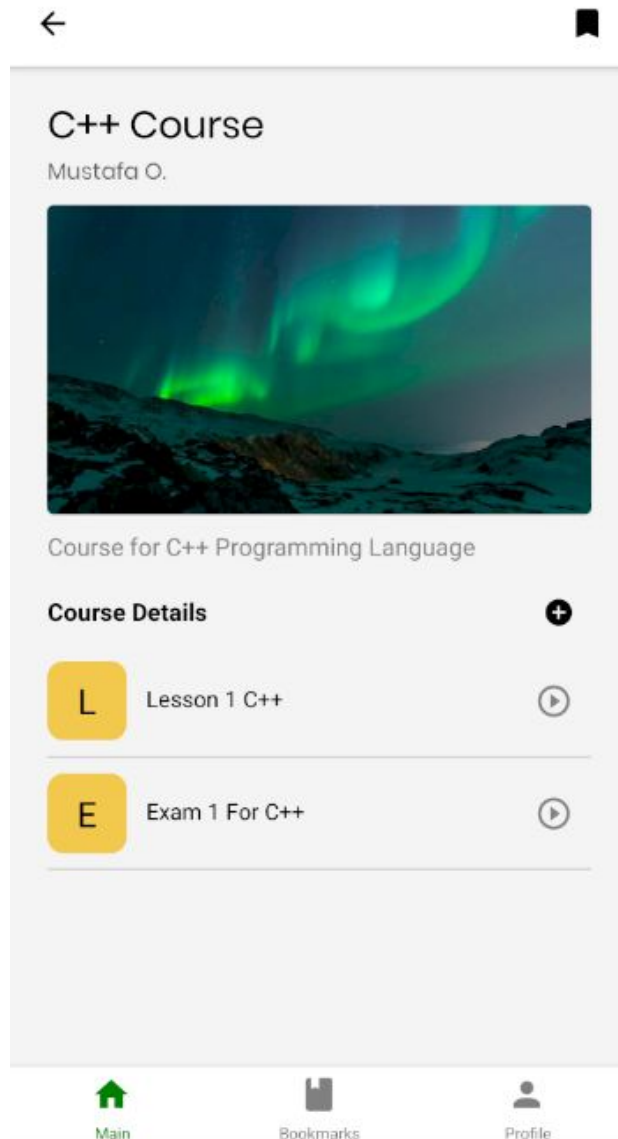


Figure 3.16: User Interface Course

Course Page: In Course page, details of the selected course, lessons and exams are listed for students to navigate. Also, for teachers, the Course page is the main page to create lessons, exams by clicking plus sign.

×

Create A Lesson

Lesson Name

Lesson Description

Lesson

Lesson

Enter Lesson Text...

SUBMIT

Figure 3.17: User Interface Create Lesson

Create Lesson Page: Teachers are allowed to create lessons by providing lesson name, lesson description and the lesson content. After submission, the lesson is immediately listed in the course page.

Create A Exam

Exam

▼

Exam

Question

×

Enter Question...

Answers

×

Enter Answer...

○

ADD ANSWER

+

Figure 3.18: User Interface Create Exam

Create Exam Page: In the Create Exam page, teachers are expected to provide exam name, exam description. Additionally, teachers can create unlimited amounts of questions by clicking the plus icon and answers by clicking the Add Answer button.

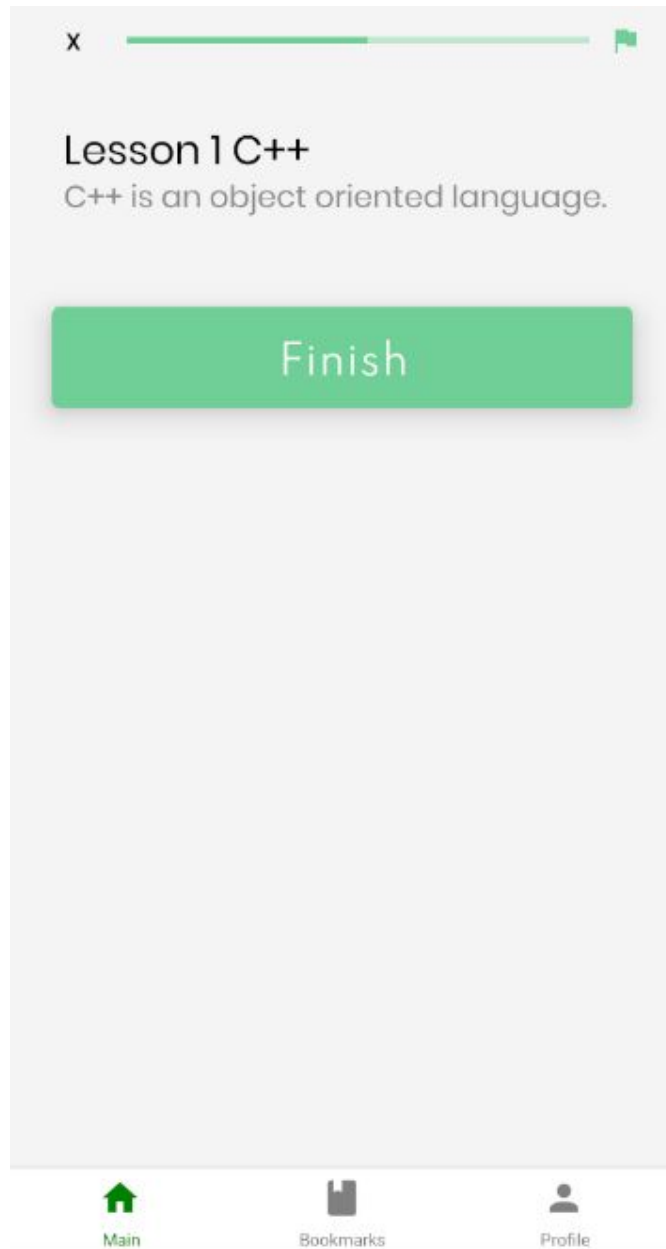


Figure 3.19: User Interface Lesson

Lesson Page: Lesson content is available for students who are enrolled to the course.

The screenshot shows a mobile application interface for an exam. At the top, there is a status bar with a green progress indicator and a close button (X). Below this, the title "Exam 1 For C++" is displayed, followed by the subtitle "Exam 1 For C++ for Beginners". The first question is "Do C++ use semicolon", with two options: "Yes" and "No", each accompanied by an unchecked checkbox. The second question is "Is C++ object oriented", also with "Yes" and "No" options and unchecked checkboxes. A large green button labeled "Finish" is positioned below the questions. At the bottom, there is a navigation bar with three icons: a house icon labeled "Main", a bookmark icon labeled "Bookmarks", and a person icon labeled "Profile".

X

Exam 1 For C++

Exam 1 For C++ for Beginners

Do C++ use semicolon

Yes ☐

No ☐

Is C++ object oriented

Yes ☐

No ☐

Finish

Main Bookmarks Profile

Figure 3.20: User Interface Exam

Exam Page: Exam page presents all questions and answers for a selected exam. Also the name of the exam and description is presented in the Exam page.



Figure 3.21: User Interface Result

Result Page: After clicking Finish button in Exam page, the result of taken exam is presented in Result page.

3.2.4 Test Plan

In this section, we will describe how to test our system. We have divided our system into subsystems. Each subsystem should be tested individually. So, the tests will be applied in various times during the development cycle.

The following subsystems will be tested:

- Teacher Testing
 - Test Register For Teacher
 - Test Login For Teacher
 - Test Creating Class For Teacher
 - Test Creating Lesson and Exam For Teacher
- Student Testing
 - Test Login For Student
 - Test Enrolling Class For Student
 - Test Lecture & Exam & Evaluation System For Student
- Global Testing
 - Test Forgot Password

3.2.4.1 Teacher Testing

Test Case #1

Test Case Name	Test Register For Teacher
Requirement	System shall allow user to sign up through teacher page with credentials
Procedure	Adding new teacher email and password
Expected Result	The System should accept the user for registering and send the user to the dashboard

Table 3.1: Teacher Test Case 1

Test Case #2

Test Case Name	Test Login For Teacher
Requirement	System shall allow user to login through teacher page with credentials
Procedure	Entering pre-created email and password
Expected Result	The System should accept the user for login and send the user to the dashboard

Table 3.2: Teacher Test Case 2

Test Case #3

Test Case Name	Test Creating Class For Teacher
Requirement	The System shall allow the teacher to create a new class and pass to the class page
Procedure	Clicking the button of creation and giving new Class Name and Description
Expected Result	System should accept information and register it to the database

Table 3.3: Teacher Test Case 3

Test Case #4

Test Case Name	Test Creating Lesson and Exam For Teacher
Requirement	The System shall allow the teacher to create a new Lesson or an Exam
Procedure	Giving the type of register for this class Exam or Lesson
Expected Result	System should accept information and register it to the database as (Exam or Lesson)

Table 3.4: Teacher Test Case 4

3.2.4.2 Student Testing**Test Case #1**

Test Case Name	Test Login For Student
Requirement	System shall allow user to login through Student page with credentials
Procedure	Entering pre-created email and password
Expected Result	The System should accept the user for login and send the user to the dashboard

Table 3.5: Student Test Case 1

Test Case #2

Test Case Name	Test Enrolling Class For Student
Requirement	System shall let the student to enroll to a new class
Procedure	Clicking the bookmark icon in course page
Expected Result	System enrolls a student to a specified course and adds the course to bookmark page

Table 3.6: Student Test Case 2

Test Case #3

Test Case Name	Test Lesson & Exam & Evaluation System For Student
Requirement	System shows the correctness of answers
Procedure	After finishing the exam or lesson, the finish button will show the results
Expected Result	Program should present all answer status or lesson information

Table 3.7: Student Test Case 3

3.2.4.3 Global Testing**Test Case #1**

Test Case Name	Test Forgot Password
Requirement	System shall send reset password confirmation to the email of the user
Procedure	Give an email which registered before
Expected Result	Program should send an email to the user

Table 3.8: Global Test Case 1

3.3 Software Architecture

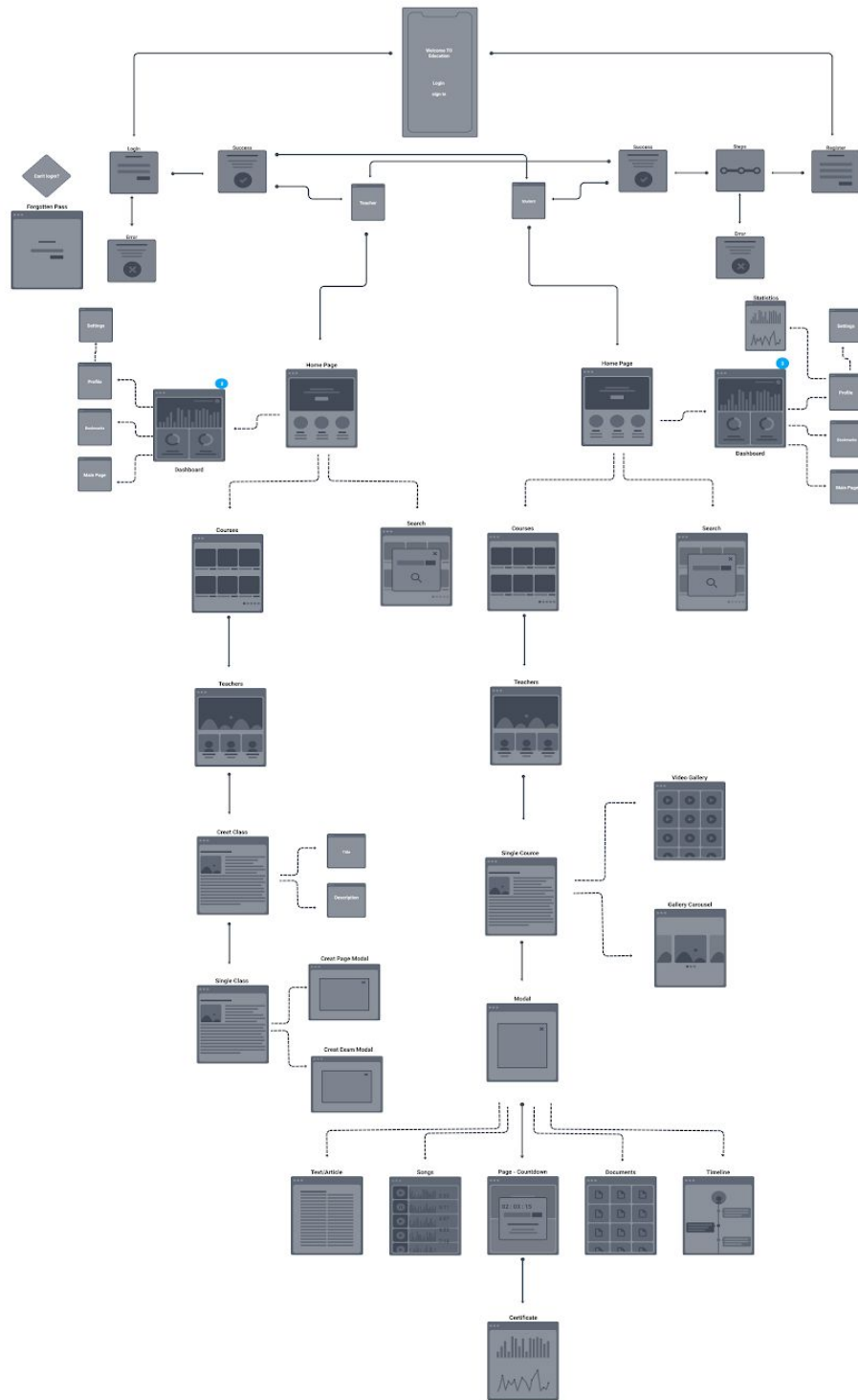


Figure 3.22: User Flow Diagram

3.3.1 Login Part

The main part which allows users to login their designated account by using the login algorithm if it is succeeded it send us to the Dashboard.

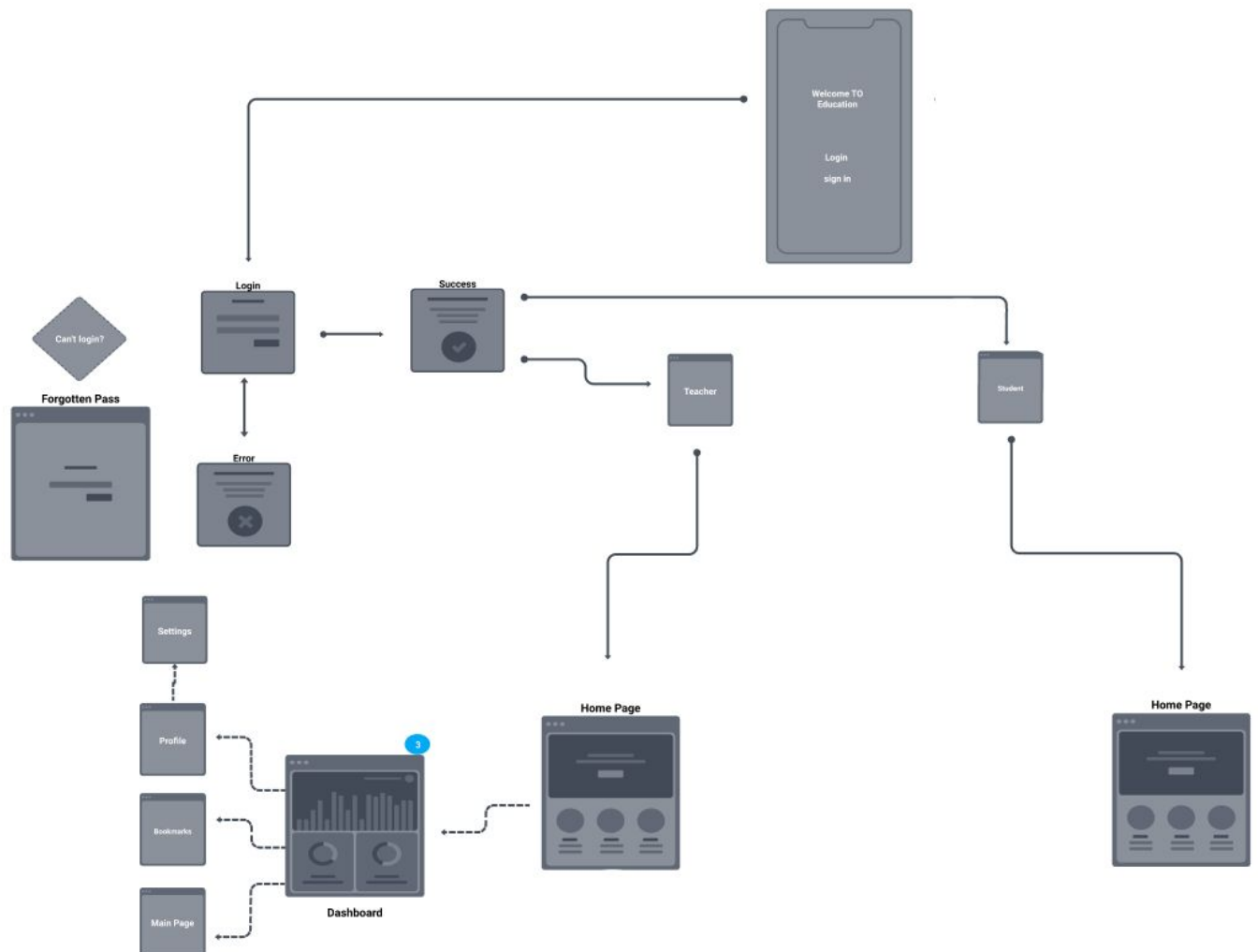


Figure 3.23: User Flow Diagram Login

3.3.2 Register Part

The main part which allows users to register their designated account by using login algorithm if it is succeeded it send us to the Dashboard.

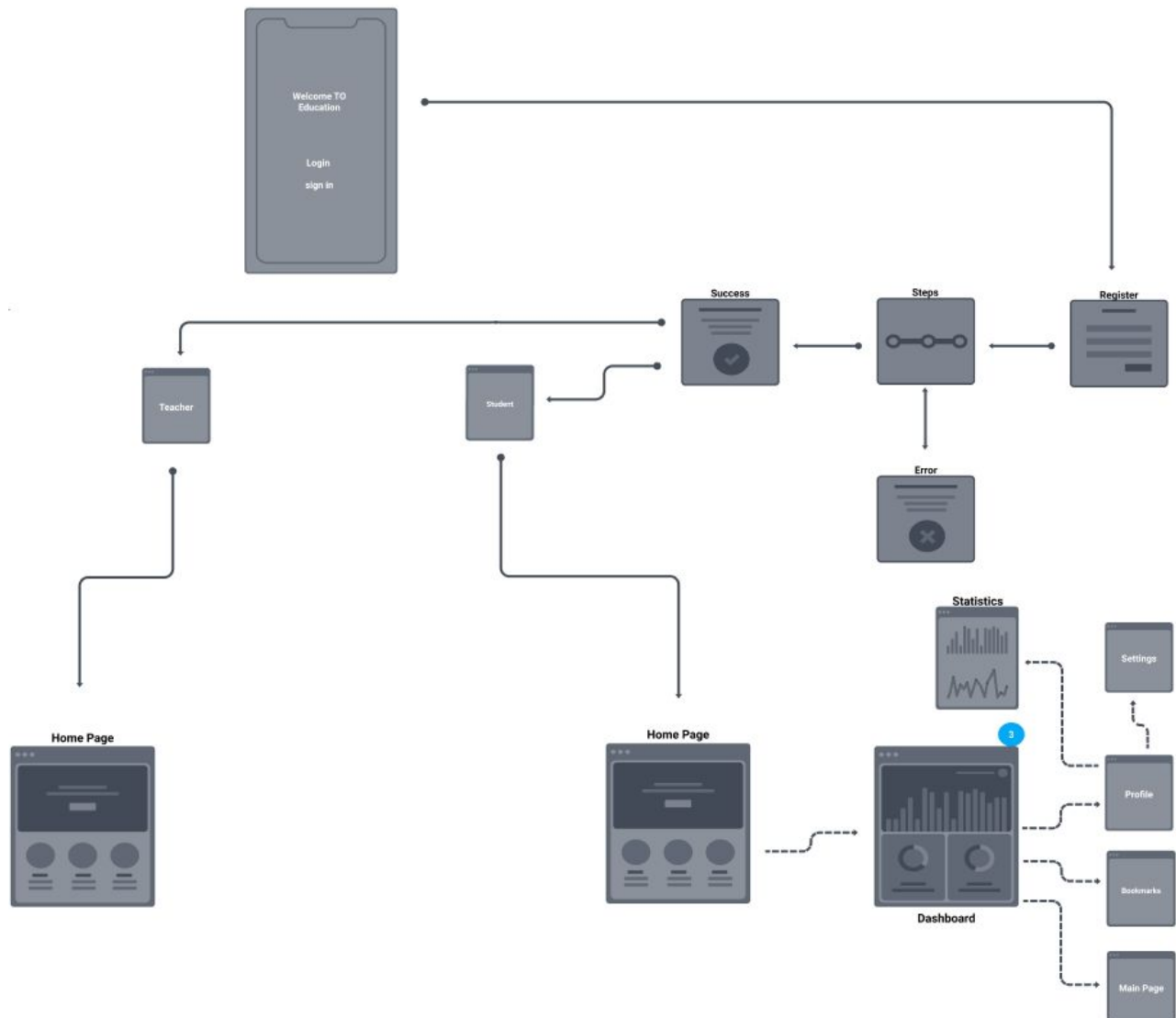


Figure 3.24: User Flow Diagram Register

3.3.3 Menu Student Part

The main part which allows the user to surf between the content of our system. There is a Courses page which allows students to search and find their desired education. Inside that we have a teacher page which also lets the student to select the lecturer by their comments and likes.

After then that student can view the class content and he / she can take the Exam or Lesson right away.

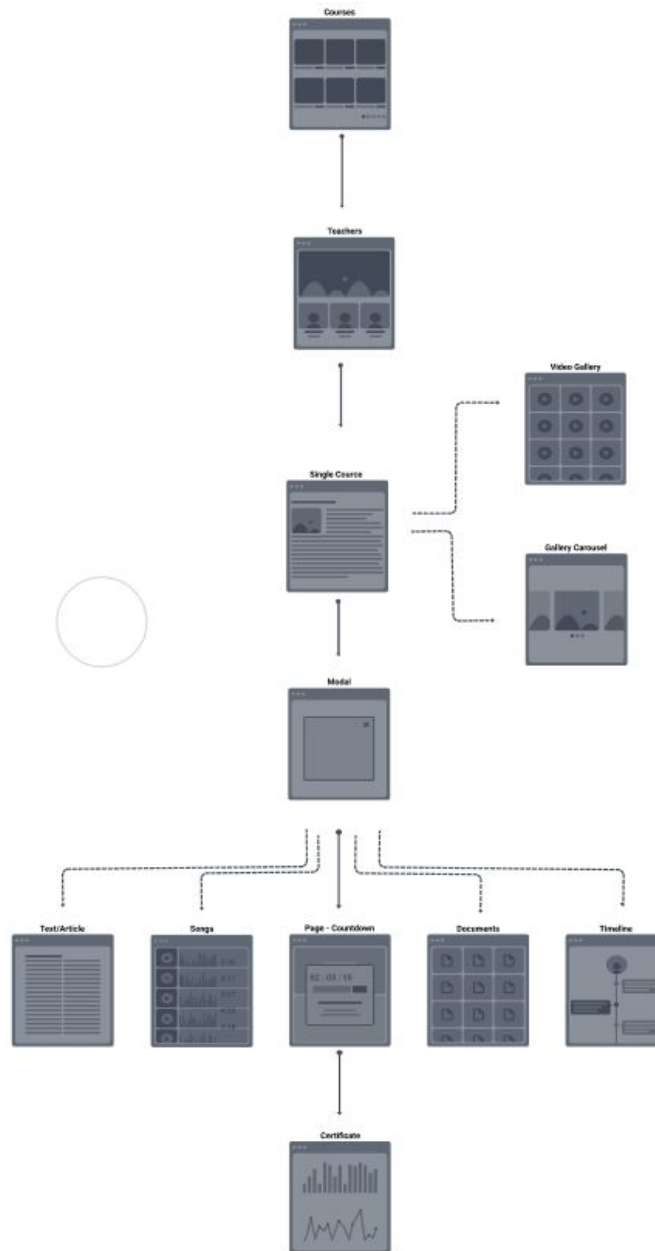


Figure 3.25: User Flow Diagram Student Menu

3.3.4 Menu Teacher Part

The main part which allows the user to surf between the content of our system. There are Courses pages which allows teachers to search and find their desired lesson to give. Inside that we have a teacher page which also lets the teacher to see other instructors and their lecture.

After then that teacher can create the class content and he / she can create a Lesson or an Exam right away.

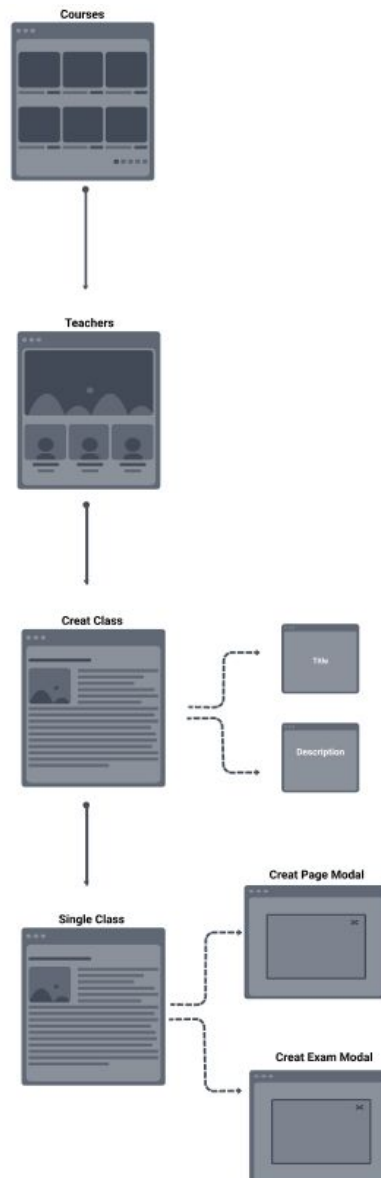


Figure 3.26: User Flow Diagram Teacher Menu

4. TECHNICAL APPROACH AND IMPLEMENTATION DETAILS

4.1 Software Tools

The software design of the system mainly focused on JavaScript, TypeScript and React Native framework. In addition to programming languages and frameworks, this system uses Firebase Realtime Database, which is a cloud-hosted database to store and gather data in realtime.

4.1.1 JavaScript

JavaScript is a programming language used on client-side and also server-side, allows developers to create contents for users to interact. The main usage of JavaScript is for web development, creates and controls contents within the pages.

4.1.2 TypeScript

TypeScript is a programming language built on JavaScript, and the compiler of TypeScript transforms TypeScript code to JavaScript code. The Main usage of TypeScript is to detect errors and debug the written code in the compiling phase.

4.1.3 React Native

React Native is a mobile application framework to build mobile applications for various types of devices, especially works both on iOS and Android platforms. React Native framework uses HTML, CSS and JavaScript to build applications. Furthermore, React Native allows developers to create reusable components.

4.1.4 HTML

HTML is a declarative programming language, meaning it does not have functionality that programming languages have. Programming languages allow developers to create functions to execute. On the other hand, HTML creates and describes the structure of a text, responsible for visuals of a page.

4.1.5 CSS

CSS is a declarative programming language and responsible to style the HTML pages. CSS determines the design of an HTML page with the help of colors, styles, fonts, margins to apply to the shape of a page. React Native closely uses CSS to add style to components along with the HTML.

4.1.6 Firebase Realtime Database

Firebase Realtime Database is a cloud-hosted database system developed by Google. Although the majority of database systems use SQL, Firebase Real-time Database stores data in JSON format. The Database system is designed using Firebase. Furthermore, algorithms used by Firebase to store and encrypt data.

4.2 Data Structures

Data Structures are the ways to organize and control data in a system. In a system, data structures have a huge role to maintain data. In our project, we used Arrays and ArrayLists to maintain and control the data inside the system.

4.2.1 Array

An Array is a data structure to store data of the same type. Holds a fixed number of elements inside it. Every element of an array has an index to reach the element and identify it. The process of searching and sorting is easy for an array to preserve data and use them inside the program efficiently. Furthermore, arrays allow developers to insert, delete and search for an element. In our program, we use arrays when we have the same type of object types and fixed number of elements to store.

4.2.2 Array List

Array Lists are containers that can change size dynamically. Furthermore, lists allow addition and deletion operations to maintain memory and order of data. It is called a resizable array since it can dynamically change its size. Array List comes into our usage when we need a collection, however, we do not know the size.

4.3 Object-Oriented Design Patterns

Design patterns are solution ways prepared by developers to overcome problems faced commonly inside a system. In this way, the process of problem-solving is easier by implementing design patterns into the system.

4.3.1 Creator Design Pattern

Creator design pattern is a way to determine which class is responsible to create other class objects. Thus, assigning responsibility to one class and making responsibility for creation of other class objects solves this main problem of how other objects will be produced. In our program, creation of Student and Teacher objects was a problem, we assigned this responsibility to a class and overcame this problem.

4.3.2 Information Expert Design Pattern

The problem of assigning responsibility to an object is a common problem in each system. Information expert is a pattern to overcome the problem of which objects are responsible for holding information of other objects. The information expert comes to our usage, in our program, when we need to determine which object will hold information by looking at the association between objects. Thus, assigning responsibility for holding data is done by how closely other objects will use the data to process and perform operations.

4.3.3 Polymorphism Design Pattern

Assigning responsibilities by the type of object is a common issue, it is a hard problem to overcome, however, polymorphism design pattern overcomes this problem by assigning different responsibilities for different types of a class. Using polymorphic operations by the different alternatives of a class is the solution for this problem.

4.4 Implemented Algorithms

4.4.1 Sorting Algorithms

One of the most important features of collections is sorting algorithms. Sorting makes the collection and data organized and reachable for further use. It rearranges the given collection and performs comparison among elements.

4.4.2 Searching Algorithms

Searching algorithms has great importance for collections and data structures. Searching allows you to reach a particular element in a given collection. It is a process of retrieving information at the stored location of data.

4.4.3 The Diffing Algorithm

Diffing algorithm is a React Native algorithm that updates the particular page when it needs to be updated. The algorithm works by comparing two trees of HTML codes. Update process has steps to work efficiently. It checks for both trees and updates only the changed parts of the tree. In this case, it becomes more efficient and faster to work.

4.4.4 Authentication Algorithm

In our project, Authentication Algorithms of Firebase are used on Register and Login phases. In register, Firebase encrypts a given password and assigns each user a new user id to differentiate. Therefore, hold these encrypted passwords and user id for further login processes of the user.

4.4.5 Encryption Algorithms

It is very important to encrypt sensitive information such as passwords or encryption crucial data to store. We used encryption algorithms to hide real data from any attack or insecurity in our database.

4.5 Networking Protocols

4.5.1 HTTP Protocol

HTTP protocol allows users to fetch data from resources. Firebase uses HTTP protocol to send and receive requests to servers. It is a process for us to send Firebase Realtime Database servers messages to gather JSON data by using HTTP protocol.

4.5.2 XMPP Protocol

XMPP protocol is the main protocol designed for instant data changes. Since Firebase Realtime Database works in real time, meaning that the changes occurring in the database are shared for all instances, Firebase uses XMPP protocol to gather, encapsulate data.

5. SOFTWARE TESTING

5.1 Implementation

First, we created our main colors, fonts and screen frames based on the drawings of the project. Later, we designed each element of the project one by one and made it into code. In this section, we created a blueprint with help from the paper library to add each element button, input, text and views. We have added features that can be changed for each addition one by one for a fluid structure and to recreate these parts we used the styled component. There are exactly 13 pages, 50 components and 40 colors in our design. Each of these can be modified, edited or completely ignored.

After finishing all these, we created 10 pages and 100 functions for the database, which is the backbone of our system. After finishing all the processes, of course, we have created new functions with Zustand, a global variable, so that all these functions are navigated between pages and all variables and objects remain intact in this navigation. This is how we managed to maintain the endless number of users and the exam course system without any confusion.

We achieved all of these with an average of 4200 lines of code.

5.2 Testing Tools

5.2.1 Android Studio Emulator

Android Studio Emulator is a simulation to use and test written programs on Android devices on computers. It is available via Android Studio. We tested our program by integrating Android Studio to React Native. Emulator has many amount of devices for us to test. We tested on 4 different devices which powered by Android Studio Emulator.

5.2.2 Expo

Expo is a tool to simulate written code on web, iOS devices and Android devices. When we do not have access to Xcode, we tested our program on Expo to mainly test on iOS devices.

5.2.3 Xcode

Xcode is the main tool to develop iOS applications. Besides Expo, we tested our program by connecting our phone via Xcode. In this case, we can see and test the program in our hands, without simulators.

5.3 Test Results

5.31 The Teacher

Test Case #1

Easy registration of the teacher to the system. Actor Teacher, target registration page, task registration. In this part there are some possible endings;

- ❖ User could be existing
 - Tested by existed user received error message shows error
- ❖ Mail format could be wrong
 - Tested by spaces, no dots, no @ received error message shows error
- ❖ Password format could be wrong
 - Tested by spaces, no numbers, no chars received error message shows error
- ❖ Fields can be empty
 - Tested by spaces, empty received error message shows error
- ❖ Server could be offline
 - Tested by offline mode received error message shows error
- ❖ Everything is normal
 - Tested online system with right sent to dashboard successfully

Test Case #2

Easy login of the teacher to the system. Actor Teacher, target login page, task login. In this part there are some possible endings;

- ❖ User could not be existing
 - Tested by not existed user received error message shows error
- ❖ Mail format could be wrong
 - Tested by spaces, no dots, no @ received error message shows error
- ❖ Password format could be wrong
 - Tested by spaces, no numbers, no chars received error message shows error
- ❖ Fields can be empty
 - Tested by spaces, empty received error message shows error
- ❖ Server could be offline
 - Tested by offline mode received error message shows error
- ❖ Everything is normal
 - Tested online system with right sent to dashboard successfully

Test Case #3

Successful creation of class for the teacher to the system. Actor Teacher, target create class button, task create class. In this part there are some possible endings;

- ❖ Class name could be in appropriate
 - Tested by special characters received error message to fix that
- ❖ Class name could be empty
 - Tested by empty input received error message shows error
- ❖ Class description could be empty
 - Tested by empty input received error message shows error
- ❖ Server could be offline
 - Tested by offline mode received error message shows error
- ❖ Everything is normal

- Tested online system with right sent to class page successfully

Test Case #4

Successful creation of Lesson and Exam for the teacher. Actor Teacher, target create lesson & exam button, task create lesson. In this part there are some possible endings;

- ❖ Lesson name could be in appropriate
 - Tested by special characters received error message to fix that
- ❖ Lesson name could be empty
 - Tested by empty input received error message shows error
- ❖ Lesson description could be empty
 - Tested by empty input received error message shows error
- ❖ Exam questions could be empty
 - Tested by empty input received error message shows error
- ❖ Server could be offline
 - Tested by offline mode received error message shows error
- ❖ Everything is normal
 - Tested online system with right return to class page successfully

5.3.2 The Student

Test Case #1

Easy registration of the student to the system. Actor Student, target registration page, task registration. In this part there are some possible endings;

- ❖ User could be existing
 - Tested by existed user received error message shows error
- ❖ Mail format could be wrong
 - Tested by spaces, no dots, no @ received error message shows error
- ❖ Password format could be wrong
 - Tested by spaces, no numbers, no chars received error message shows error
- ❖ Fields can be empty

- Tested by spaces, empty received error message shows error
- ❖ Server could be offline
 - Tested by offline mode received error message shows error
- ❖ Everything is normal
 - Tested online system with right sent to dashboard successfully

Test Case #2

Easy login of the student to the system. Actor Student, target login page, task login. In this part there are some possible endings;

- ❖ User could not be existing
 - Tested by not existed user received error message shows error
- ❖ Mail format could be wrong
 - Tested by spaces, no dots, no @ received error message shows error
- ❖ Password format could be wrong
 - Tested by spaces, no numbers, no chars received error message shows error
- ❖ Fields can be empty
 - Tested by spaces, empty received error message shows error
- ❖ Server could be offline
 - Tested by offline mode received error message shows error
- ❖ Everything is normal
 - Tested online system with right sent to dashboard successfully

Test Case #3

Entering Lesson & Receiving Exam and Evaluation of the student through the system. Actor Student, target course page, task join lesson or exam. In this part there are some possible endings;

- ❖ Exam taken before
 - Tested by existed exam score received chart for evaluation of last try

- ❖ Exit Exam
 - Tested by quit exam before time-end could re-enter the exam
- ❖ Server could be offline
 - Tested by offline mode received error message shows error
- ❖ Everything is normal
 - Tested online system with right conditions sent to evaluation page with correct calculations of true false and blank answers

5.3.3 Global

Test Case #1

Easy reset password of the student and teacher. Actor Student & Teacher, target forgot password page, task reset. In this part there are some possible endings;

- ❖ Email format could be wrong
 - Tested by spaces, no dots, no @ received error message shows error
- ❖ Email could be empty
 - Tested by spaces, empty received error message shows error
- ❖ Email not registered
 - Tested by non registered email received error message
- ❖ Server could be offline
 - Tested by offline mode received error message shows error
- ❖ Everything is normal
 - Tested online system with right conditions sent email to reset password.

6. CONCLUSION AND FUTURE WORK

6.1 Conclusion

E-learning is not just a change of technology. It is part of a redefinition of how we as a species transmit knowledge, skills, and values to younger generations of workers and students. With the above technologies, In This project our objective is to establish a learning application system, where instructors and students participate in learning activities while geographically separated from each other. The Additional objective of this project is to design a system with reusable components, feasibility and provision for system expansion without compromising system performance. The other objective of this project is to design and implement a web-based system that allows interaction between instructors and students.

6.2 Future Work

6.2.1 Podcast

One of the most important features of our future plans is the podcast system. The aim of the podcast system is to keep communication between instructors and students anywhere. It will allow them to attend the lessons by listening directly, even on public transportation vehicles such as Metro, Marmaray and Metrobus.

6.2.2 Video Lessons

The video system is one of the most preferred methods today. While a live broadcast carries the face of traditional education with it, it also eliminates environmental and human error. Online lessons will allow you to listen and watch with the same precision over and over again.

6.2.3 Sound Reply

Voice communication is one of the things we want most. Voice communication enables a student to give appropriate answers to an exam in his / her own voice. Thanks to this system, exams based on telecommunication will also be possible.

6.2.4 Better Color-Blind Options

We have already integrated the color changing system in our program. The next step of this system will be to let students shape our system according to their own eye disorders. We plan to be in a system that comes from every disease in the future.

6.2.5 Drag & Drop Options

Improving the tests in our system has always been our main goal, which is why we do not want a system that only goes over the classical question and answer logic. With Drag-and-Drop tests, it will help students improve their questions by trial and mistake method. Even using only fingertips will bring productive results to increase learning speed.

REFERENCES

[1] Mudassir K., "The Scope of e-learning in the Computer Science & Technology," International Journal of Computer Science Engineering and Information Technology Research (IJCSEITR), vol. 6, no. 6, pp. 1-6, 2016.

[2] Mobo, D., F. and Sabado G., O, "An Assessment of the Effectiveness of E-Learning in AMA Olongapo Campus," Oriental Journal of Computer Science and Technology, vol. 12, no. 3, pp. 99- 105, 2019.

[3] Kaur, R., "E-Learning Portal: Its Development & its Scope," International Journal of Computer Science and Technology, vol. 3, no. 3, pp. 754-755, 2012.

Cook, K. C. & Grant-Davie K. (2017). Online education 2.0: Evolving, adapting, and reinventing online technical communication, London, ; Routledge.

Jayasinghe, U., Dharmaratne, A. and Atukorale A., "Students' performance evaluation in online education system Vs traditional education system", 12th International Conference on Remote Engineering and Virtual Instrumentation, Bangkok, Thailand, 2015.

APPENDICES