

A Secured Cloud-Based Mobile Learning Management System

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ABSTRACT

Mobile learning systems are designated learning systems that are easily accessible via a mobile device. The challenges faced by mobile learning systems are: speed of connection, processing power, adaptability (been available for every mobile device regardless of the size of the device screen) and difficulty in achieving security. In this work, a secured cloud-based mobile learning management system (CLOUD-MOLEMAS) was designed and implemented. The system comprises of three main modules namely; the client model, mobile network and the cloud model. The client model allows users such as students and lecturers to access the cloud infrastructures through the mobile application on their mobile devices via a mobile network. The cloud model consists of the business logic layer, data access layer, authentication server and database. The authentication server helps in verifying the identity of each user trying to access the system. CLOUD-MOLEMAS was implemented using Java programming language, android API and .NET framework while MySQL was used as the database. The system was tested using android mobile phone and the performance shows that it makes educational content and materials available to the students when and where they need it; it provides easy interaction of the user with the content because of the different modes of using audio, graphics, video with feedback features. It is also effective in assessment process. CLOUD-MOLEMAS is well-structured, efficient, adaptive and secured.

Keywords: Mobile Learning System, Database, Educational Content, Cloud, Security

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I. INTRODUCTION

Learning is the acquisition of knowledge or skills through study (self-study), experience or being taught (through a teacher-student mode of instruction). It is a lifetime activity therefore knowledge should be easily accessible as required by students at any time without the constraints of a classroom or library building. With the increasing use of personal computers and modern information systems,

learning materials are managed and distributed electronically using e-books and the likes. However, electronic learning just translates old learning materials into new formats but does not improve the learning process by making it an on demand, dynamic mobile service. Students need these electronic learning materials to acquire knowledge without the constraint of specified location before they can utilize these materials. Devices that support e-learning are bulky and not mobile therefore

constraints the learning process to a particular location and building at a time.

The use and adoption of mobile devices is increasing rapidly as a report says that mobile device users are over 5.6 billion as at 2015. Furthermore, by 2018, mobile device users are projected to increase to 6.2 billion, which translates to “84% of the world population using mobile device technology” [11]. Mobile devices provide a mobile platform for dynamic extension of learning. Mobile learning projects are blooming all over the world and they range from the use of personal digital assistants (PDAs) and tablet computers in classroom, through mobile phones to support learning between schools and museums, to context-aware technology for field trips and tourist visits [8].

Mobile learning makes use of handheld technologies with wireless and mobile phone networks to facilitate, support, enhance and extend the reach of teaching and learning [12].

The educational systems has failed to recognize this and therefore failed to adapt learning processes and resources to be consumed on mobile devices a term known as Mobile Learning shortened as M-learning. M-learning is highly situated, personal, collaborative and long term, in other words, truly learner-centered learning because it makes educational content and materials available to students when and where they need it [12]. Mobile learning systems are designated learning systems that are easily accessible via a mobile device. The challenges faced by mobile learning systems are speed of connection, processing power, adaptability (been available for every mobile device regardless of the size of the device screen) and difficulty in achieving security.

However, this system needs to be available at all times to the student who consume the learning materials, lecturers who create these materials and upload to the system regardless of the device used whether phones, tablets, laptops or operating system of the device used, android, IOS, etc.

Advancement in IT has made these possible through cloud computing; a new style of computing which is dynamically scalable and often virtualize resources are provided as a services over the internet. Cloud computing combined with mobile devices create a powerful system as the processing and data storage associated with the applications is moved off the mobile device to powerful centralized computing platforms located in the cloud

which are then accessed over mobile internet using a thin native client or web browser on the mobile device [10]. However, there are challenges to cloud computing which include performance, reliability issues, bandwidth costs, but the biggest challenge to users is security and privacy as the cloud is vulnerable to attacks, when information and critical IT resources are outside the firewall in the hands of end users. The main objective of this study is to develop a secured cloud based mobile learning management system.

II. LITERATURE REVIEW

[2] in their approach of e-learning using cloud computing highlights the drawbacks of using traditional e-learning network computing that makes use of internal networks or Local Area Networks to provide a connected e-learning experience. The authors actually failed to propose a strategy for integration or implementation of the proposed architecture.

[5], proposed a mobile based collaborative learning system called “myVote” which aims to improve collaboration in the learning process among students. They created a system that allows all students in a class to contribute to a lecture. The system allows collaboration of all students in a lecture hall. It also improve social interaction of students which allows them to participate fully in the lecture through the use of their mobile devices. The system is designed to be used in a lecture environment which makes it not fully portable and available for use anywhere and anytime. The system is on a server that is not cloud enabled which means that all students need to be physically present in the classroom before they can utilize the system.

[1], proposed a mobile based learning system in form of a mobile optimized website that allows students to read, compose and comment on educational articles. It also allows users to upload and download educational resources. It does not allow for communication between students and lecturer therefore there is no assessment of student understanding and learning pace. It also inhibits collaborative learning as users cannot truly communicate on the system.

[3], proposed a mobile web environment that enables users to access shared resources at anytime and anywhere as long as they are connected to the system. Users can read resources after they register and login into their accounts. The system does not allow for interactive and collaborative learning and does not include a lecturer

module that enables assessment of students to further identify and improve student's weaknesses.

[6], proposed an android based mobile learning system which comprises of a system management module through which a manager usually a lecturer carries out application management. It also includes a mobile client which is the android app that the students use to connect to the app server in the cloud to complete relevant learning operations.

[7] design a mobile learning management system which improves learner's knowledge, performance, achievements, problem solving skills and individual learning system. The design consists of a content module, learning module and evaluation module with learner, teacher and knowledge interface. It supports online, offline, in campus and out campus learning activities. The mobile learning management systems allow learners to collaborate through an online or offline interaction with teachers and other learners. The system helps the learners to increase their performance through the learning and evaluation module.

[9] develop a mobile-learning management system for overcoming the difficulties of outdoor learning activities. Using the theory of 5e learning cycle, this study was conducted based on learning experiment on marine education in an elementary school for investigating its impact on the learners' learning achievement and attitudes, and evaluating the suitability of system. Through short-term learning experiment on marine education, the outdoor mobile learning model can significantly improve the achievement of experiment group as compared to those of control group under traditional teaching pedagogy. Nevertheless, the learning attitude towards marine education is not promoted divergently after learning experiment.

[8] designed a web-based platform for mobile learning management system. The author addressed the problems facing traditional and formal way of teaching adopted in most institution. The subsystem provides the administrator with web-based services to manage the information of the mlearning system and other services provided by the system. It also provides the lecturer with web-based tools to manage the information required. The mLearning system is majorly intended for students. The students can download and view learning materials and they can also send feedback to the lecturer on a particular course for evaluation. The system was not hosted on the

mobile cloud so the mobile devices cannot work perfectly with little memory space.

[4], explored the suitability of handheld devices for mobile learning. They tried to evaluate the various types of handheld devices and deduces the most suitable device for mobile learning. They developed a mobile application and then analyzed learners' experiences based on their handheld devices. There is no means of communication between students and lecturer in this system. The system also inhibits collaborative learning as users cannot truly communicate on the system

Table 1 and Table 2 in the Appendix show the summary of the review papers and the justification for the new architecture.

III. DESIGN METHODOLOGY

3.1 Design Consideration

- (i) Cloud-based Management System: the databases and files are stored in the clouds to ease and reduce cost of accessibility.
- (ii) Authentication/authorization: Security is supported through the use of access control mechanism. This mechanism determines the users who have the right to access the system.
- (iii) Secure Sockets Layer (SSL): Maintains the integrity of information on the system. When information is being sent/received to/from the cloud the sender/recipient know that the information cannot be tampered with during transit.
- (iv) Adaptation: the system has the ability to know the characteristics and specification of the ubiquitous device including the environment and deliver the learning material base on that. It is accessible to all students regardless of device OS.
- (v) Auditing: allows the system administrator to know the system state and check whether the data has been compromised.
- (vi) Communication/Collaboration: this allows the students to communicate directly with their lecturer by sending a text message to make comment on the learning materials, assignment and tutorials provided by the lecturer. It also allows students to interact with their colleagues
- (vii) Assessment mechanism: It allows lecturer to assess/evaluate students learning performance.

3.2 Architecture of a Secured Cloud- Based Mobile Learning Management System

The architecture of a secured cloud-based mobile learning management system is presented in Figure 1. The system comprises of three main modules namely; the client model, mobile network and cloud model. The system allow users to access the cloud by logging in or registering through the mobile application on their mobile devices which is connected to the internet via internet service provider or Wi-Fi.

The user's sends a request for a resource to the cloud server, the business logic layer gets this request, processes it and sends a request message to the data /file access layer to return the requested resource. The data access layer checks if the user is authorized to use the resource he is requesting, if he is, access is granted and the requested resource is fetched from the database through a data query/search engine and then sends it to the user mobile device for viewing through the business layer. Meanwhile, if the user is not authorized to access this resource, the data access layer sends an error code to the business layer which in turn relays the appropriate error message to the user.

3.3 Component of the Cloud-Molemas

(a) Client model:

The client model is an interactive interface between users and the system. Its responsibility is to deal with the dialog between users and system. The client model provides separate interfaces for the users i.e. students/learners, lecturers/instructors, and administrators. It also contains the following functional modules: users, mobile device, mobile application and adaptation.

(i) Users :

The Cloud-Molemas allows three different types of users to interact with the system according to given privileges. They are the administrator, lecturer and student. Each of them can login into the system with a related identity, possessing different operating authority and functions.

Algorithm for Registration and Logging in of a User.

Suppose in the database D_n , there exists U_i for $1 \leq i \leq m$ for m number of users.

To register a user U_i ;

Step 1: Start

Step 2: Input user details in registration form.

Step 3: Check if E of $U_i \in D_n$ where E is email of user

Step 4: if $E \in D_n$, goto 1

Else goto 5

Step 5: Add user U_i record in database D_n

Step 6: End

To login a user U_i ;

Step 1: Start

Step 2: Input user details in login form

Step 3: Check if email and password of $U_i \in D_n$

Step 4: If Email and Password of $U_i \in D_n$

Goto 5

Else display "Invalid email / password" and goto 1

Step 5: Log user U_i into the system

Step 6: Create user session and set role.

Step 7: end

(ii) Mobile Devices:

The client device could be in the form of smart mobile phones, tablets or a PDA. The mobile device include the mobile application and the adaptation.

Mobile Application: The client software on the smart device is mainly client application programs. Users visit the mobile learning management system (MLMS) server through the mobile application on their various devices. The mobile application has been compiled to run only on android mobile operating system using web technologies such as Java and android API.

Adaptation : One of the challenges associated with the use of mobile devices for learning is the size of the screen. Content management must be carefully considered to be suitable for different types of devices. To facilitate this type of management, the delivery of learning material is adaptive to better suit the learner and the mobile device used. Adaptability can be performed in multiple ways and for this purpose various techniques can be used to get all needed data. In this system the profile of the user is retrieved and the mobile device specifications are sensed at each new session. The specification of the mobile device used is also gathered and accordingly, the contents are displayed on the user's mobile screen. For instance, the size of a picture will be chosen according to the dimensions of the mobile device's screen. This will ensure that the information delivered to the learner is properly displayed. The adaptation gathers information about the learner profile and the mobile specifications which are the key elements for content adaptation and delivery, and it also offers the learner a personalized experience of learning. The presentation adaptation can include

adaptation of the structure, adaptation of the media format, quality or even type, etc.

(b) Mobile Network Services

The mobile network services refer to the choice of network or service provider preferable by the user for internet provision. Also among mobile network services is the Wi-Fi service and which is virtually owned by every tertiary institution these days.

(c) Cloud model

Cloud computing presented in the architecture is an efficient component by which students, lecturers and users can access, store learning data, communicate with each other in the cloud at anytime and anywhere through the use of their mobile devices connected to the internet. The cloud offer pay-as-you-go service because internal datacenters and application are delivered as a service over the internet to the public use making it a Public Cloud. Thus, the hardware and system software component in the cloud are the Business Logic Layer, Data Access Layer, Authentication server and Database.

(i) Business Logic layer

The business logic layer receive request from the client model through the mobile network, process it and pass it down to the data access layer and to the database server. The result is sent back to the client model. The business logic layer consist of two modules namely Mobile Learning Management System (MLMS) and Communication Module. These two modules interact within the cloud-based mobile learning system.

Mobile Learning Management System (MLS): consists of functions that allow users to view learning materials through a guided curriculum. It allows special users to upload courses and course materials, allows student to view and download this course material.

It also consists of an assignment module that enables lecturer to create assignment, which will be downloaded by students and answers would later be uploaded and then graded by lecturers. This enhances the evaluation of the user whether he is truly learning therefore measuring the efficiency of the system.

Algorithm for Uploading of Learning materials

Step 1: Start

Step 2: If user level= special, goto step 3

Else print “Access is denied.

Please contact admin”. Goto step 8

Step 3: select file for upload

Step 4: input full details of file e.g. name, type, course code, department, etc.

Step 5: submit form for upload

Step 6: If file is valid go to step 7

Else print” Invalid file” go to step 3

Step 7: Store file details in database and move file to cloud storage.

Step 8: Stop

Algorithm for viewing and downloading learning materials

Step 1: Start

Step 2: if user login is successful goto 3

Else goto 1

Step 3: Get all course materials from the cloud and display them, grouped by department and course code.

Step 4: Select file for download

Step 5: Get file from cloud storage and save to user device

Step 6: Stop

Algorithm for uploading assignment

Step 1: start

Step 2: If user level = special, goto 3

Else print “Access is denied. Please contact admin”. Goto 7

Step 3: select assignment file for upload

Step 4: Fill details e.g. deadline, course, etc. and submit form

Step 5: if file is valid goto 6

Else print “invalid file” goto 3

Step 6: Store assignment details in database and upload file to cloud storage.

Step 7: stop.

Algorithm for Assignment Answer Upload

Step 1: start

Step 2: if user login is successful goto 3 Else goto 6

Step 3: Show a prompt displaying assignment details and options to download and upload answer.

Step 4: if user select download, save assignment file to user device.

Step 5: if user select upload answer goto 6

Step 6: display upload form

Step 7: On form submit, if file is valid goto 8

Else goto 6

Step 8: save answer details in database and upload file to cloud storage.

Step 9: stop

Communication Module: provides a functionality for users in the system to be able to communicate with one another through messages anytime and anywhere. Every user has an inbox that contains messages received and he can also send message to other users. This functionality is important as it enables constant communication in learning. For example, two students can discuss a course or assignment through their mobile device. All messages are stored securely in the cloud database for longevity and easy retrieval

(ii) Data Access Layer

It contains the search engine and links. Its main task is to receive requesting information from the business logic layer, then complete the function of querying, refreshing and changing data in the database. Thereafter, it returns the results to the business logic layer server. Data layer provides data sources for the application of the m-learning system through the search engine and links.

(iii) Authentication Server

This is the part of the system that handles authentication and authorization. It verifies if a user has the right to access the system and also the right to perform an intended action (such as updating, retrieving, transferring, deleting, etc.) on data. The authentication server grant access to authorized users and denies unauthorized users to use resources on the system. This is achieved through the generation of passwords for users with special privileges such as admin, lecturers, etc. while normal users such as students simply need to register to access the system.

Algorithm for Authorization of Special Users.

Suppose UL is the access level of a user

At start up, $UL = normal$

Step 1: Start

Step 2: User input details in login form.

Step 3: Search details in database records.

Step 4: If email and password exist in the database and user type = lecturer or admin change $UL = special$ goto 5
Else
Print “INVALID USERNAME / PASSWORD”,
goto 2

Step 5: log user in with special privileges.

Step6: stop.

(iv) Database Server

Files such as learning documents, assignment, videos and audios are stored in this system and they need to be accessible at all times. The cloud provides a file storage system to help maintain and serve file easily. All files are organized sequentially and their details stored in the database. The database is responsible for storing all data used throughout the system. Therefore, it is important that it runs at all times as data can be needed at anytime and anywhere, also the information is stored securely and backed up regularly. The cloud makes all this easy as cloud service providers provide functionalities to automatically carry out maintenance on the database as it is the backbone of the whole system.

IV. IMPLEMENTATION/RESULTS

4.1 Implementation

CLOUD-MOLEMAS was implemented using java programming language, android API and MySql was used as the database system. The reasons for using Android API and Java are:

- (i) Android is the largest shareholder of the smartphone market, so to target the largest mobile client possible Android platform is the best to use.
- (ii) The Android API is created and maintained by Google which provide quality assurance stability in its engineering.
- (iii) Android studio provide an easy graphical interface to create screen designs combined with a full-fledged IDE for coding, a debugger, an inbuilt Android Virtual Machine for easy testing during development under different simulated devices environment and screen sizes.
- (iv) Java is a simple and powerful object oriented programming language

Microsoft MySQL

This is the relational database management server that is used to stores data in form of tables. It is made up of the following tables: lecturer, course materials and student.

Figures 2, 3 and 4 are the screen shots of the database and contents. Figures 5 and 6 are the screen shots of the database schema

Flow of the System

Figure 7 shows the flowchart of the system. There are different logins for the student and the lecturer. The students register themselves in the system for further

process. The non-registered user cannot access any of the feature of the system.

After login, the students will be able to perform the tasks like viewing/downloading of course materials and assignment, submitting assignment, making comment and communicating with other students and lecturers.

After the Lecturer login to his profile, he can upload course material and assignement for the students, view/download submitted assignment, assess/grade the assignment and also make comment.

At the end, after performing the respective tasks in their respective profiles, user needs to logout from the system for security purpose.

4.2 Results

The front-end user interface of CLOUD-MOLEMAS is a graphical representation of the design. The graphical user interface components are used to provide good navigation and easy access to frequently used data. The splash screen allows login and signup for users. It consists of four sections namely: Registration Screen, Login Screen, Lecturer session and Student Session.

The application allows the user to login as a lecturer or student. The lecturer fills the form displayed in Figure 8 to log in with his details.

After logging in, the lecturer home page will pop-up as shown in figure 9. This home page consists of the following button: upload materials, edit profile, start chat, send message and logout.

Figures 10 and 11 show the UPLOAD material page and the status respectively. To UPLOAD material, the title of the material to be uploaded is entered, the level is selected and the file to be uploaded is chosen and the upload button is pressed. After which a message “material uploaded” is display. This material is now available on the cloud for view and download.

Figure 12 and 13 shows the registration and login page for student. Figure 12 is the page that is displayed when the student clicks on the registration button. This enables him or her to register as a user. Every new user has to register first to get login id as well as password.

Figure 13 is the page that is displayed when the student clicks on the login button. The registered user can directly login. The user validation will be done based on the id

given to the user so that unauthorized user won't be able to gain assess.

This page enables the authorized student to be able to login and view/download the uploaded materials or assignments.

A logged in student is welcomed with the uploaded materials by the lecturer and has the option to save for offline viewing. Figure 14 shows the Student Home Page displaying the available materials and figure 15 shows the saved material. From the student's perspective, he or she is able to view, download and also save the materials.

4.3 Discussion

This work aimed at developing a secured cloud based mobile learning management system for students at Ondo State University of Science and Technology, Okitipupa. The work is expected to overcome the problems faced by users with the current system used. The expected outcomes of using the developed cloud based mLearning management system include:

- (i) The system enables accurate registration of students and lecturers
- (ii) It facilitates authentication, so as to ensure that only authorized users gain access to services
- (iii) It provides functions and features such as validation and user friendliness
- (iv) It provides a mobile learning system enabled by the cloud.
- (iv) The system provides seamless communication between students and lecturers
- (v) The system was designed to support collaborative learning.
- (vi) The system can be adapted to a number of different environment.

V. CONCLUSION

The mobile learning has been made easy with cloud computing which enables building of technology eco systems without having to purchase physical devices. Cloud computing coupled with mobile devices enable the possibility of building system that are accessible at any time on any platform.

In this work, a secured cloud-based mobile learning management system (CLOUD-MOLEMAS) was designed. The system is made up of the client model, mobile network and the cloud model. The CLOUD-MOLEMAS provides the user such as the student or

lecturer with the means to access e-learning functionalities on their mobile devices. This application was developed using Android Studio and can be downloaded and installed by android phone users. In future, apps could be developed for other platforms. e.g. IOS, Blackberry. The communication could be extended to support audio and video live streaming features to enable easy communication between users on the platform.

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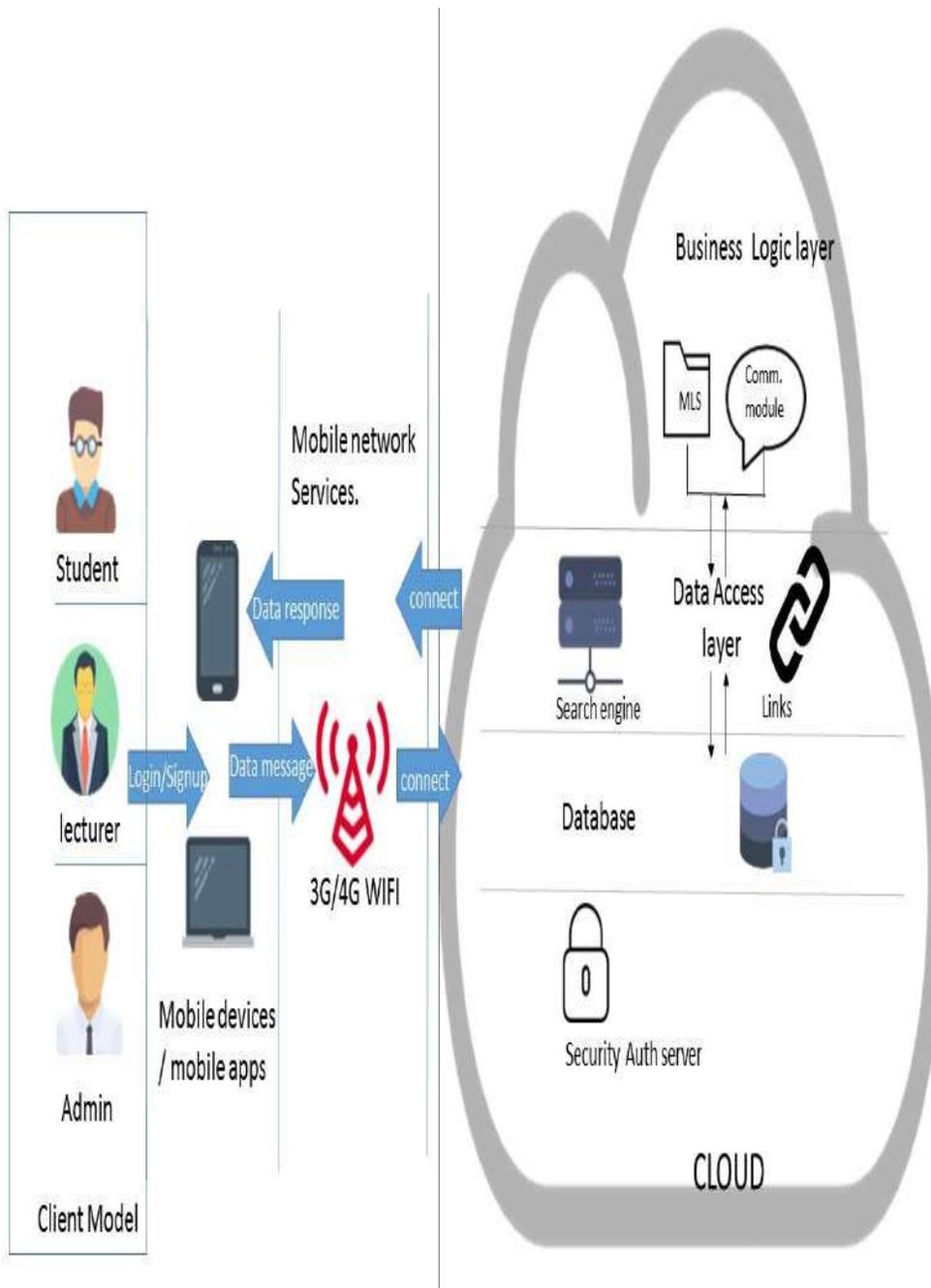


Figure 1: Architecture Design of a Secured Cloud-Based Mobile Learning Management System (CLOUD-MOLEMAS)

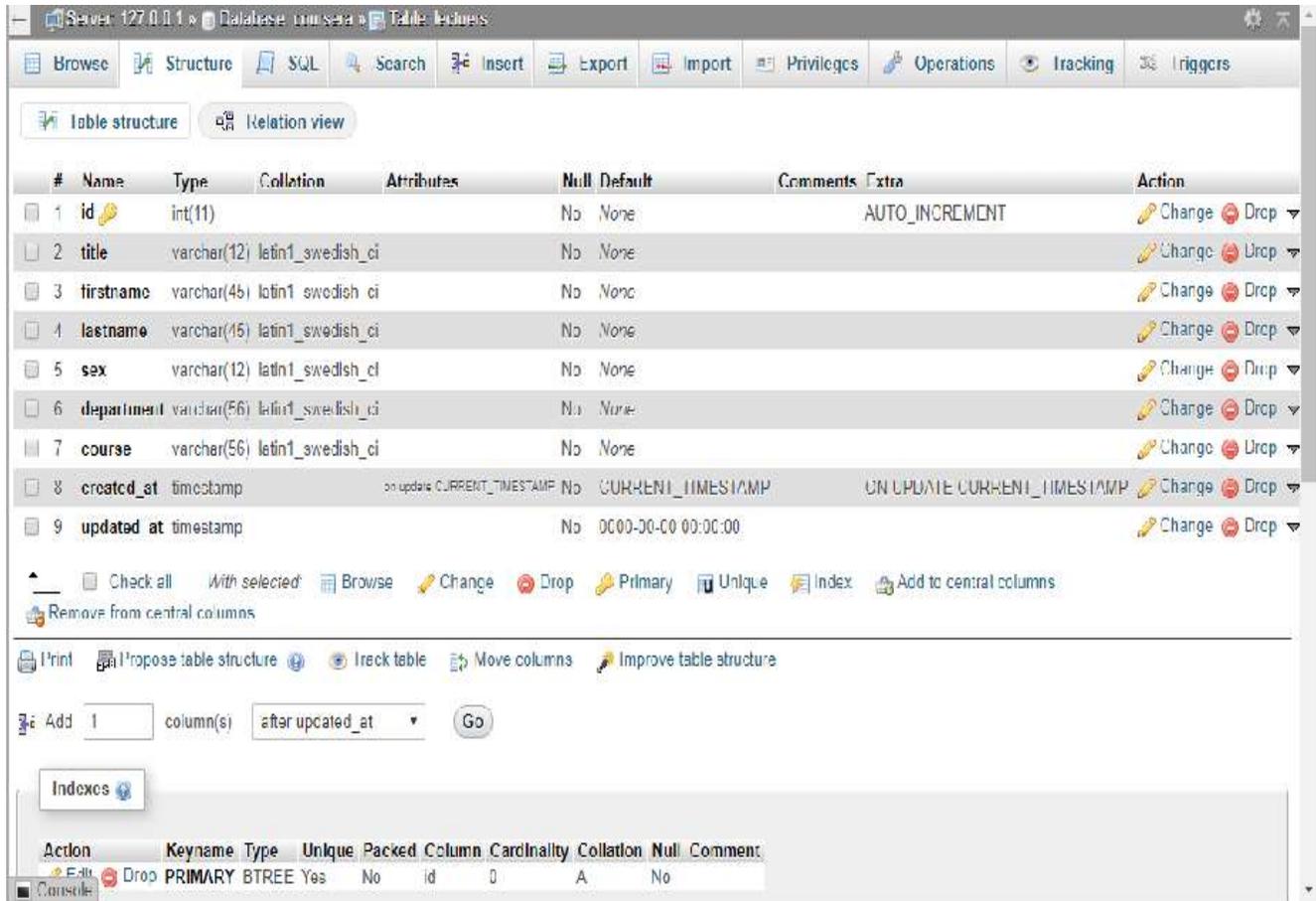


Figure 2 : Screenshot displaying the database application of the lecturer

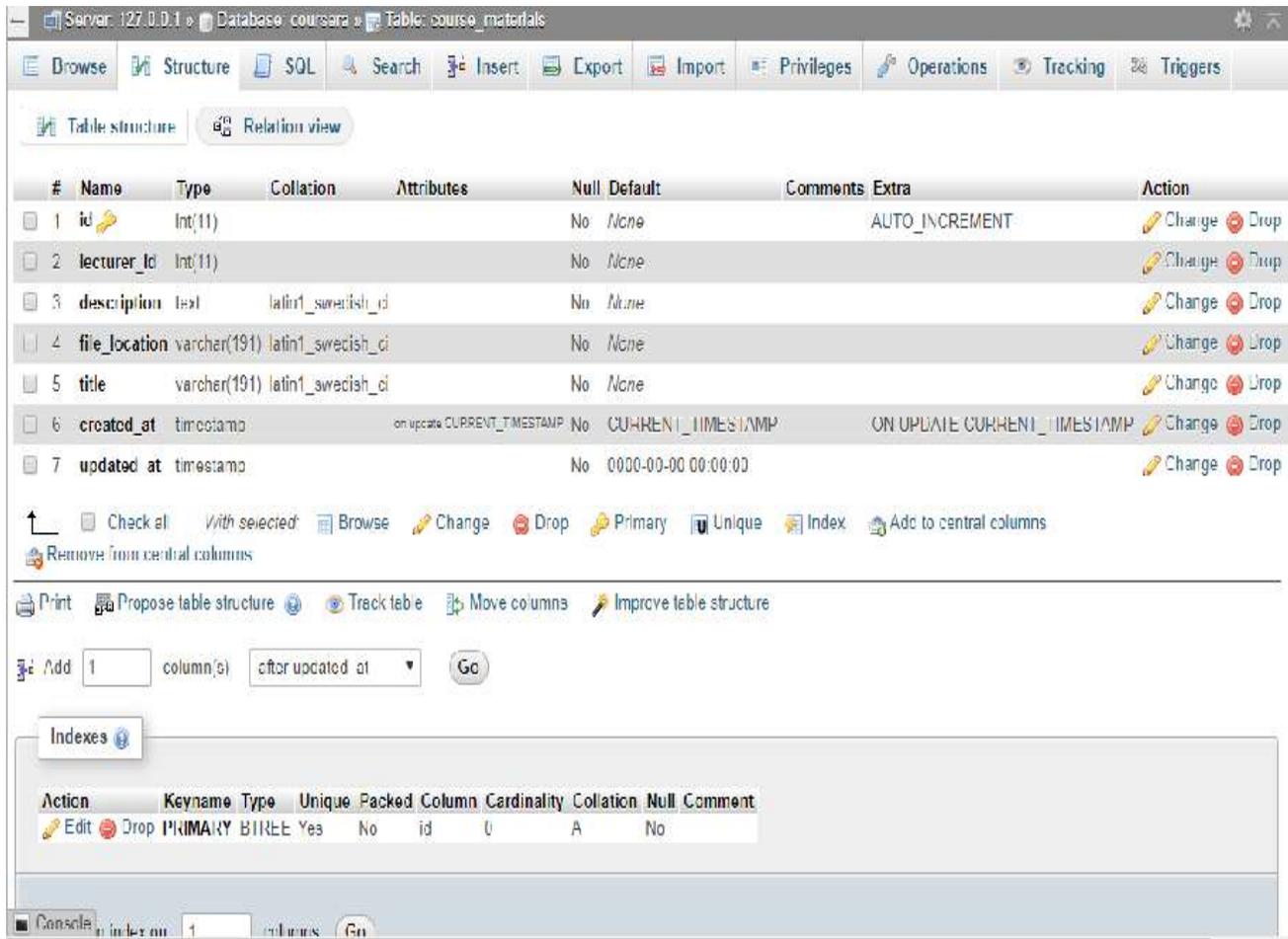


Figure 3: Screenshot displaying the database application of the course materials

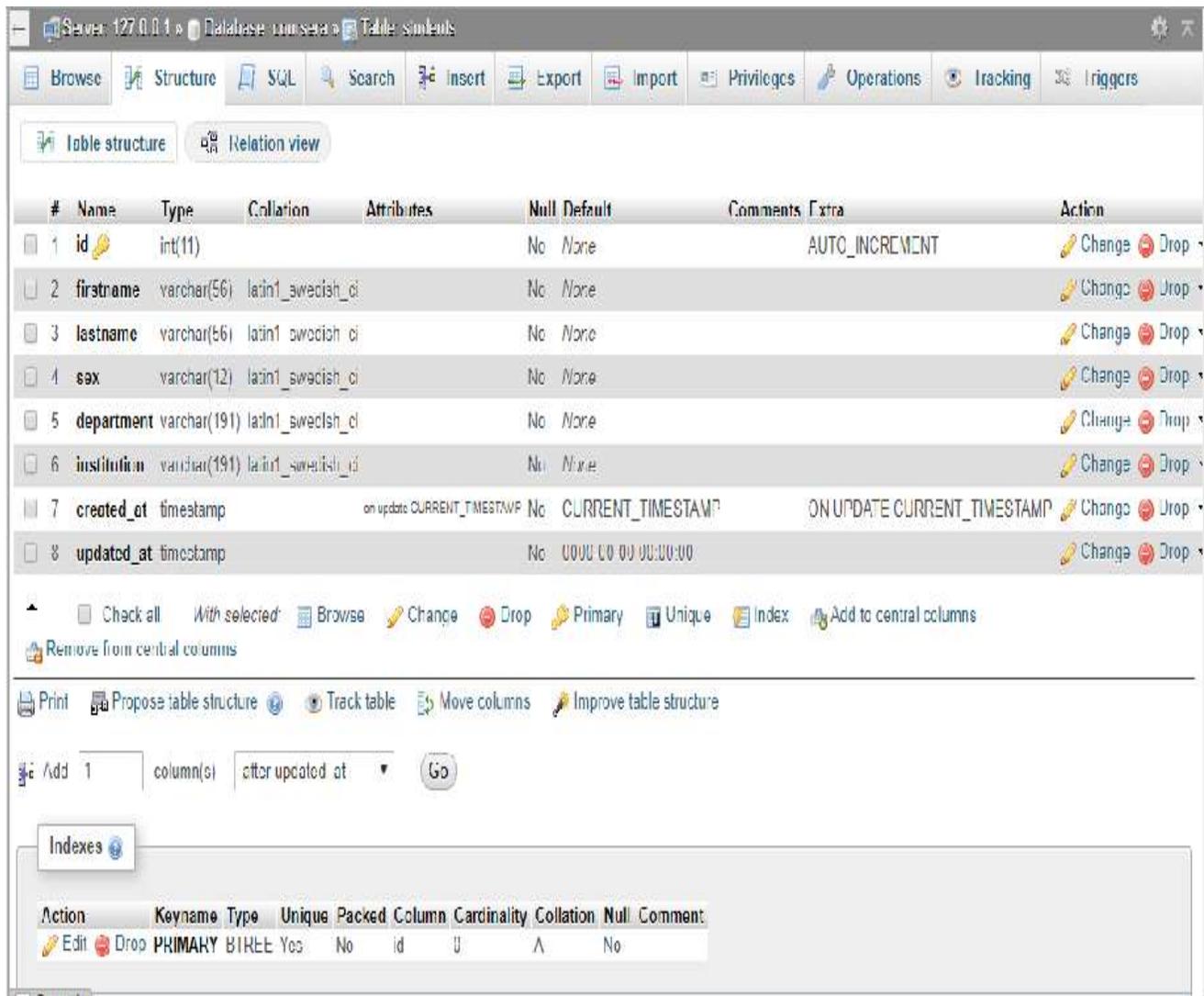


Figure 4: Screenshot displaying the database application of the Student

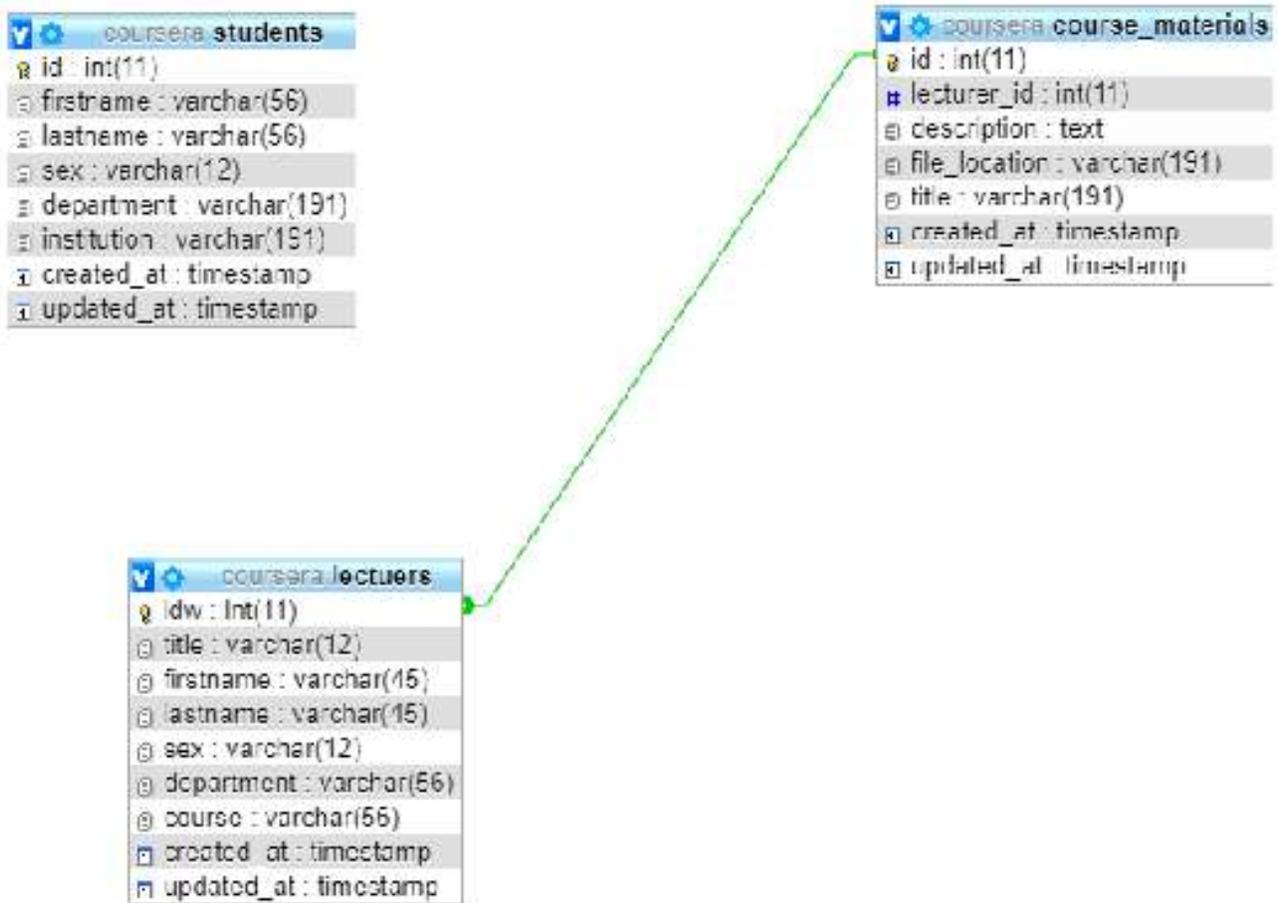


Figure 5: Screenshot displaying the Relation

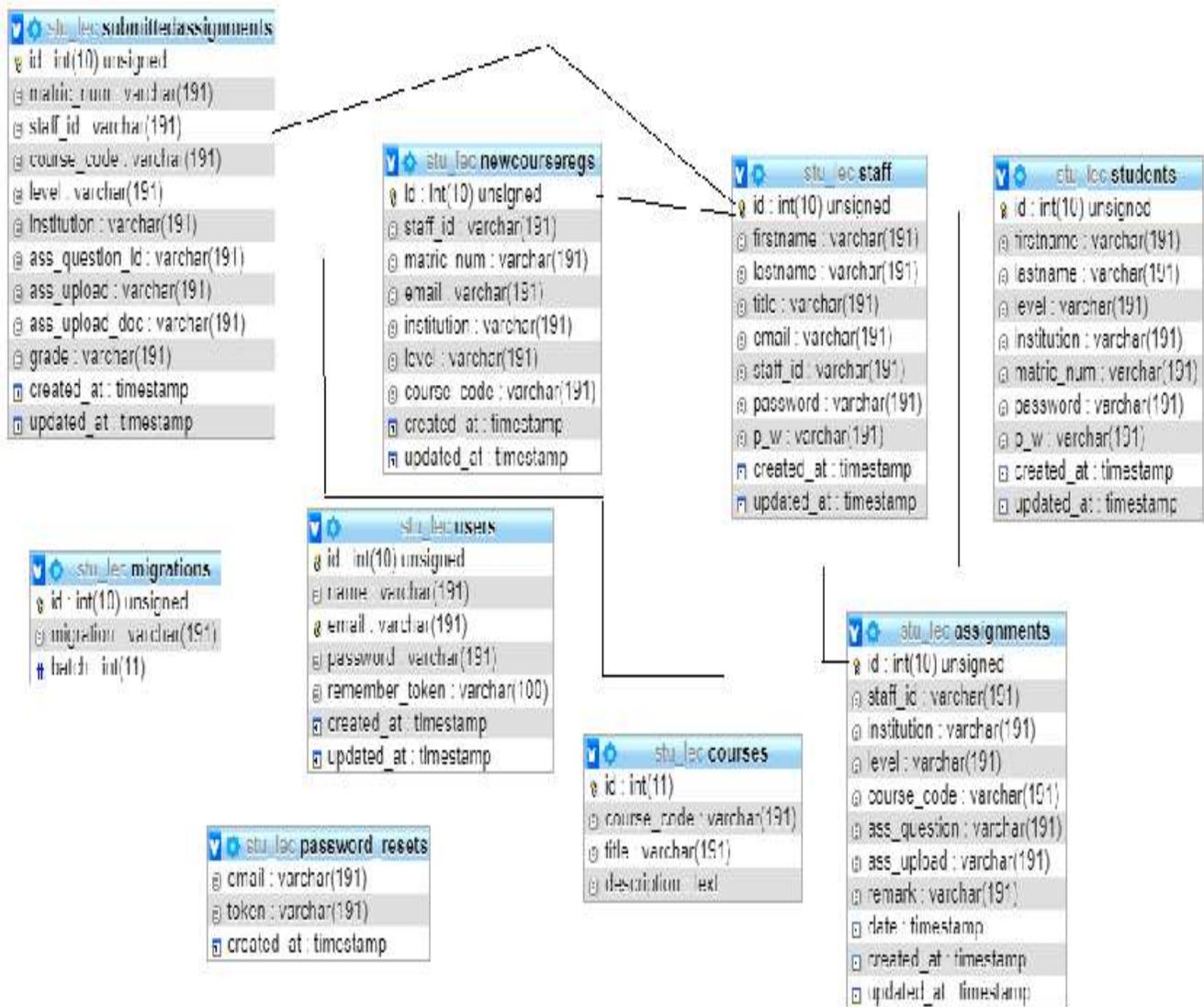


Figure 6: Screenshot displaying the Assignment files

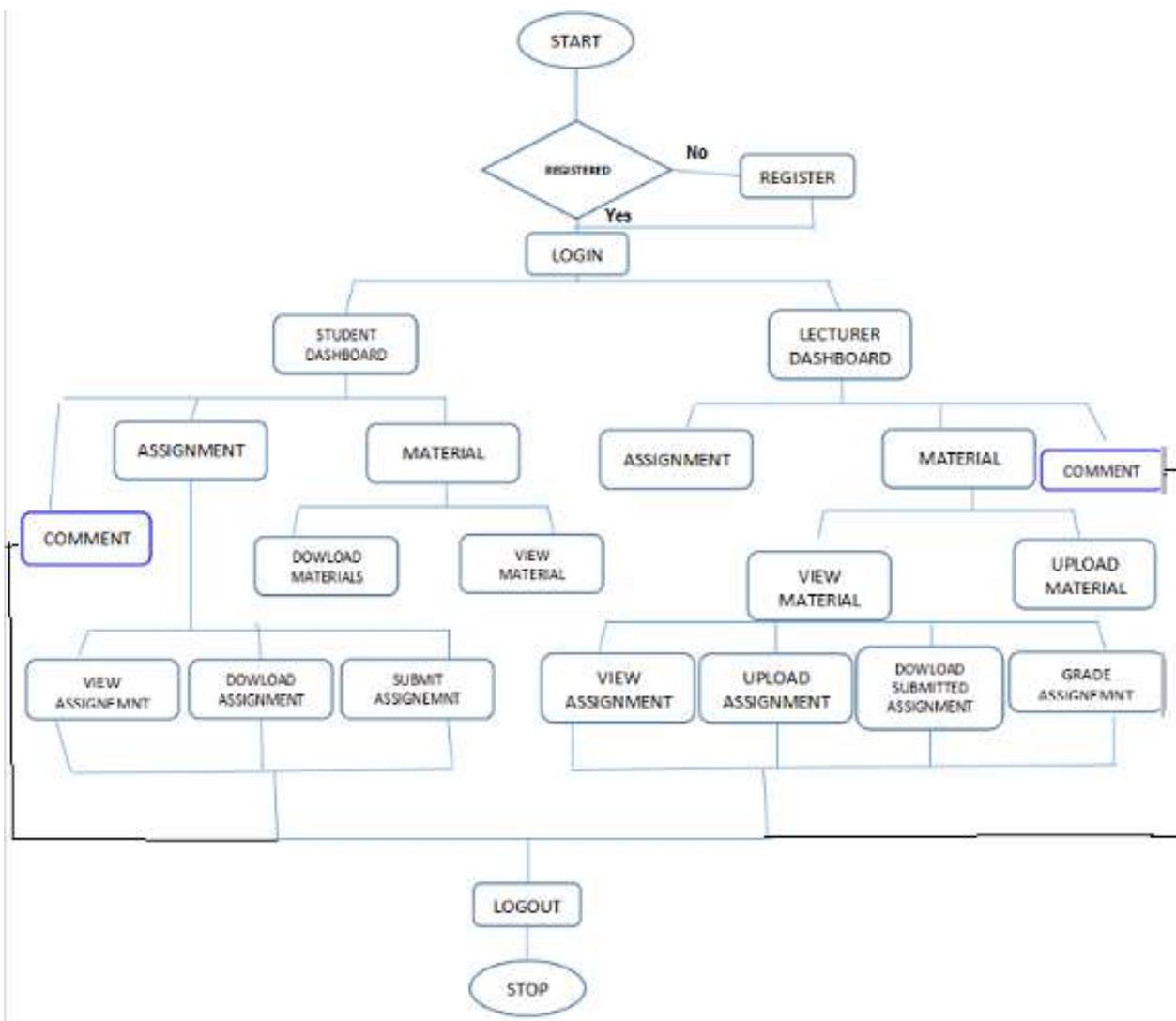


Figure 7: Flowchart of a Secured Cloud-Based Mobile Learning Management System

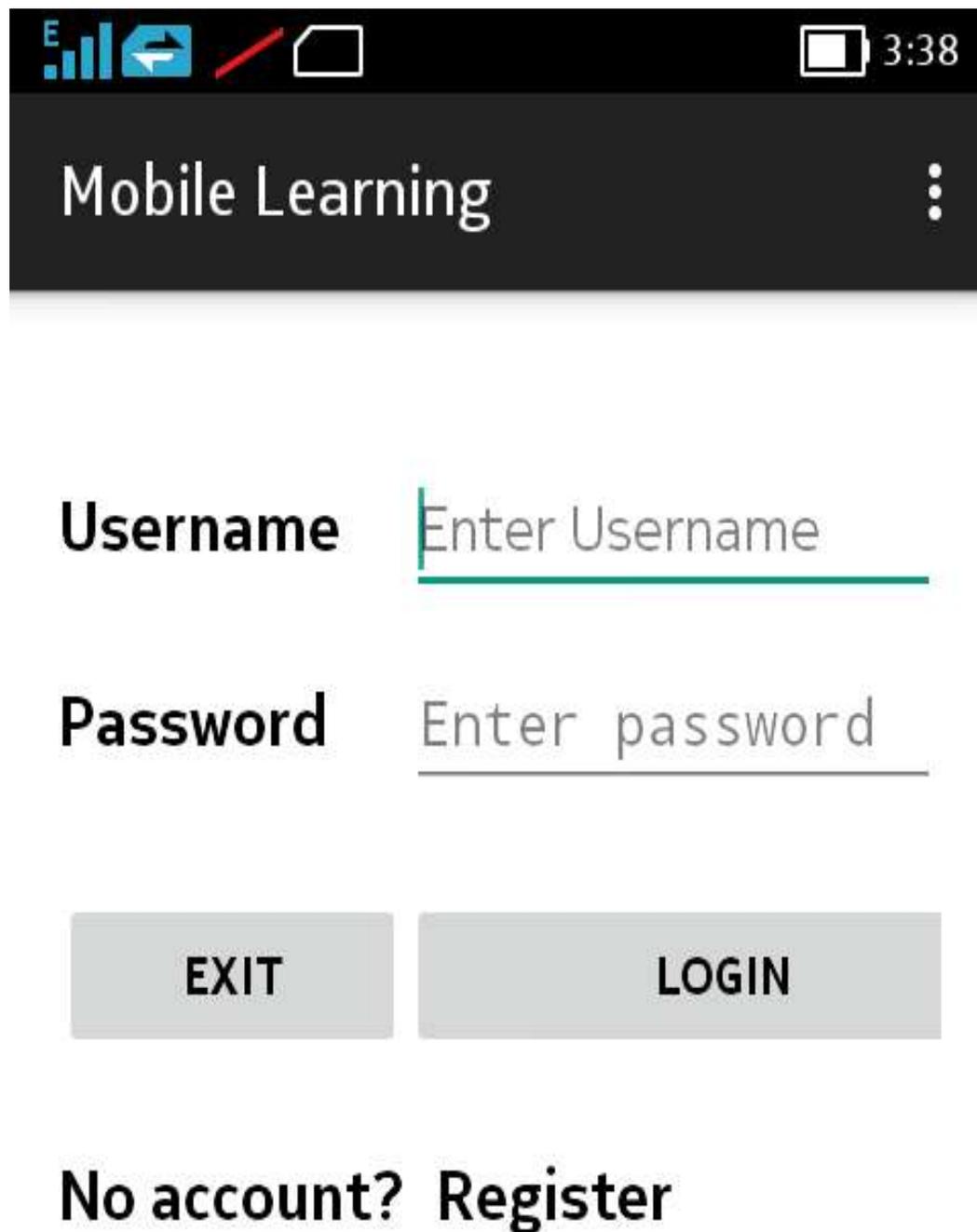


Figure 8: The Lecturer login screen into the Mobile Learning Platform

Figure 9: Lecturer Home Page

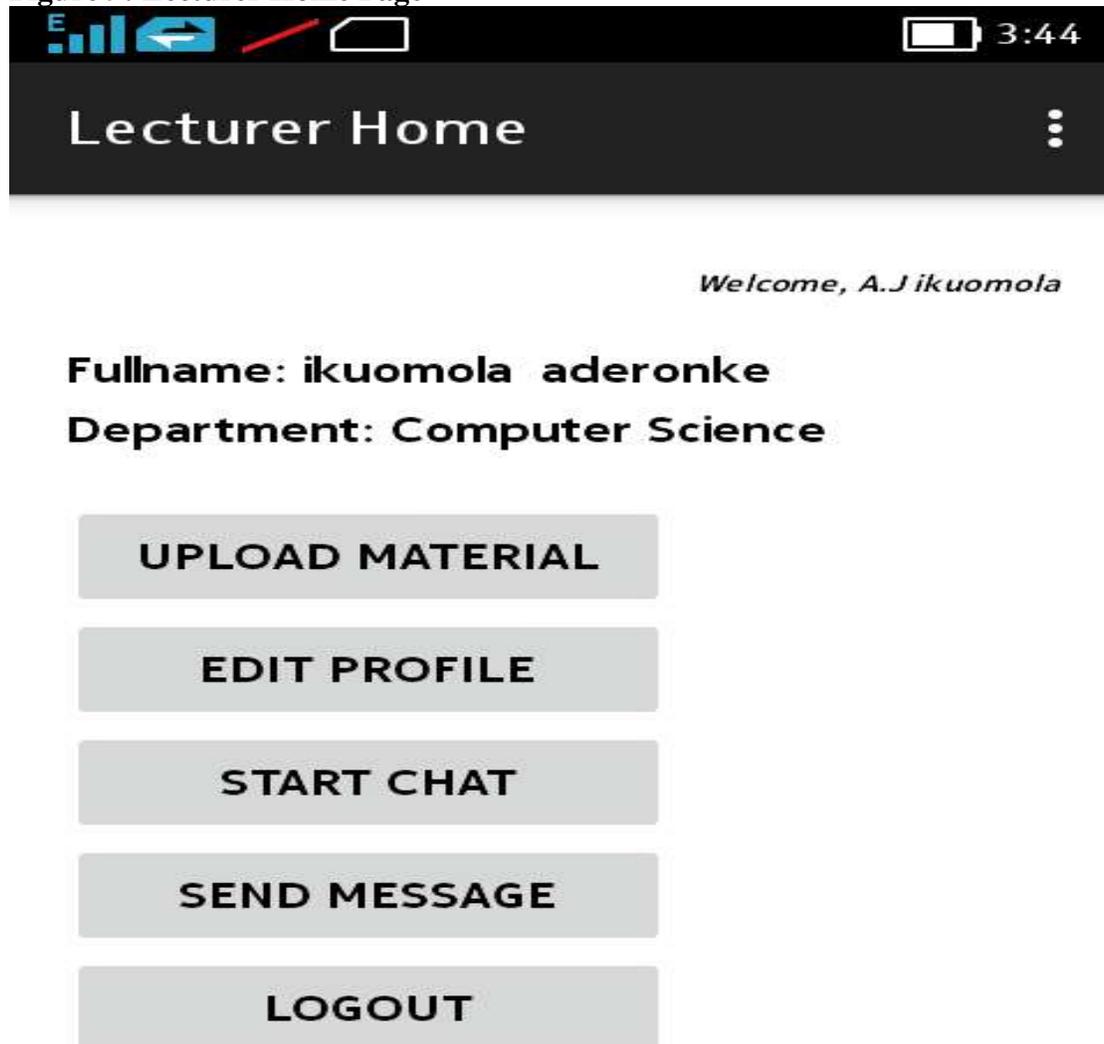


Figure 9: Lecturer Home Page

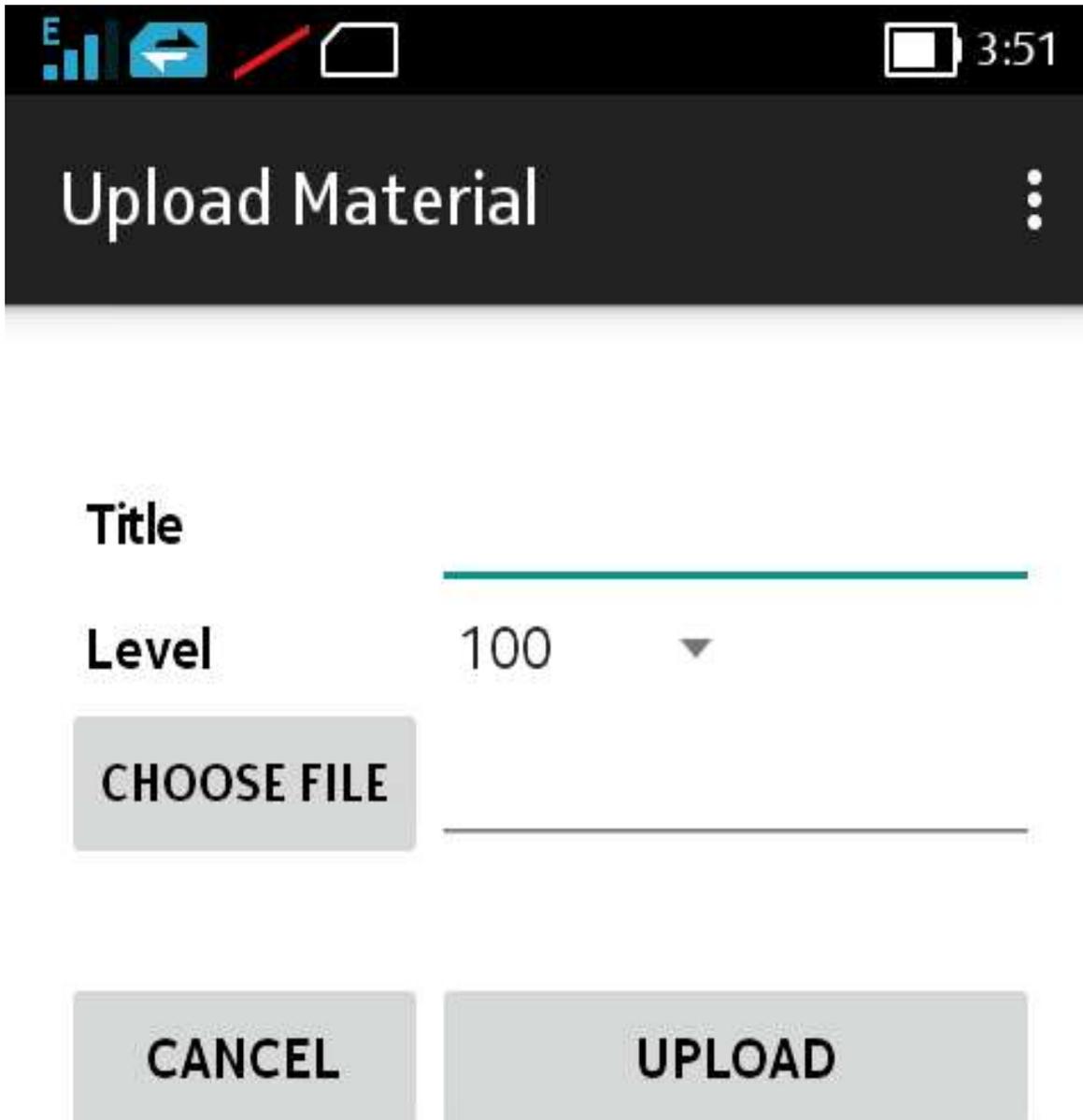


Figure 10: Upload Page

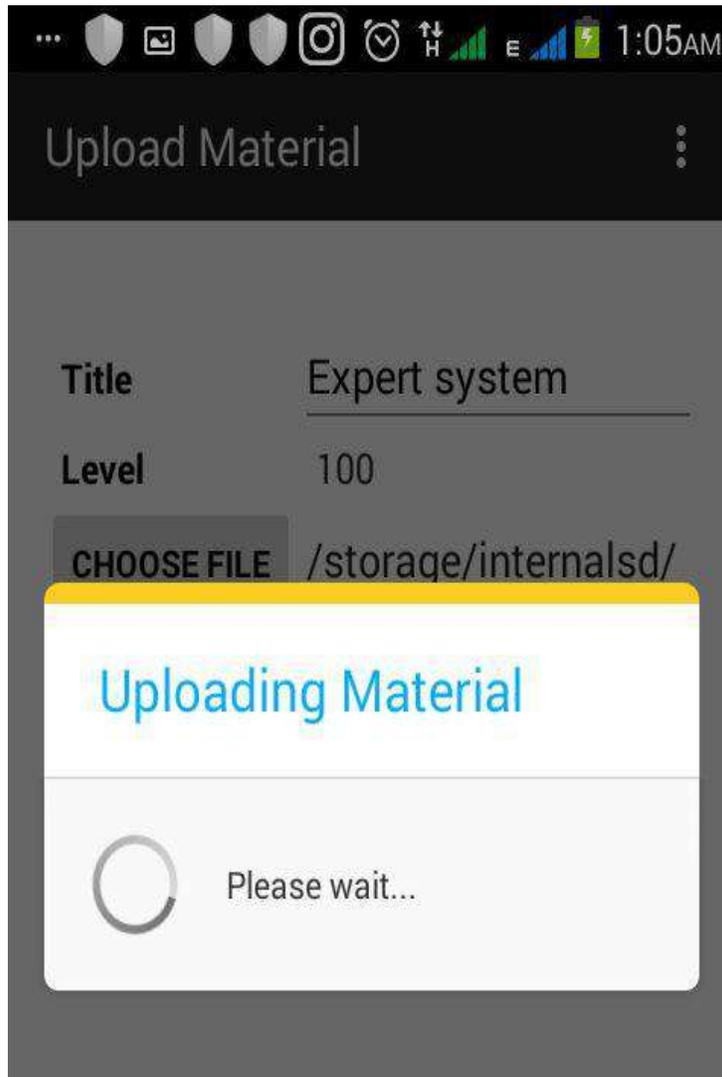


Figure 11: Uploading in action

The image shows a mobile application interface for a registration form. At the top, there is a status bar with various icons and the time 4:46AM. Below the status bar is a dark header with the text "learning Platform". The main form area is light gray and contains the following fields and controls:

- Username**: A text input field with a green underline.
- Surname**: A text input field.
- Firstname**: A text input field.
- Department**: A dropdown menu with "Mathematics" selected.
- Level**: A dropdown menu with "100" selected.
- Role**: A dropdown menu with "Student" selected.
- Password**: A text input field.
- Confirm Password**: A text input field.
- CANCEL**: A button on the left.
- SUBMIT**: A button on the right.

Figure 12: Register Form for Students



Figure 13: Login Form for Students

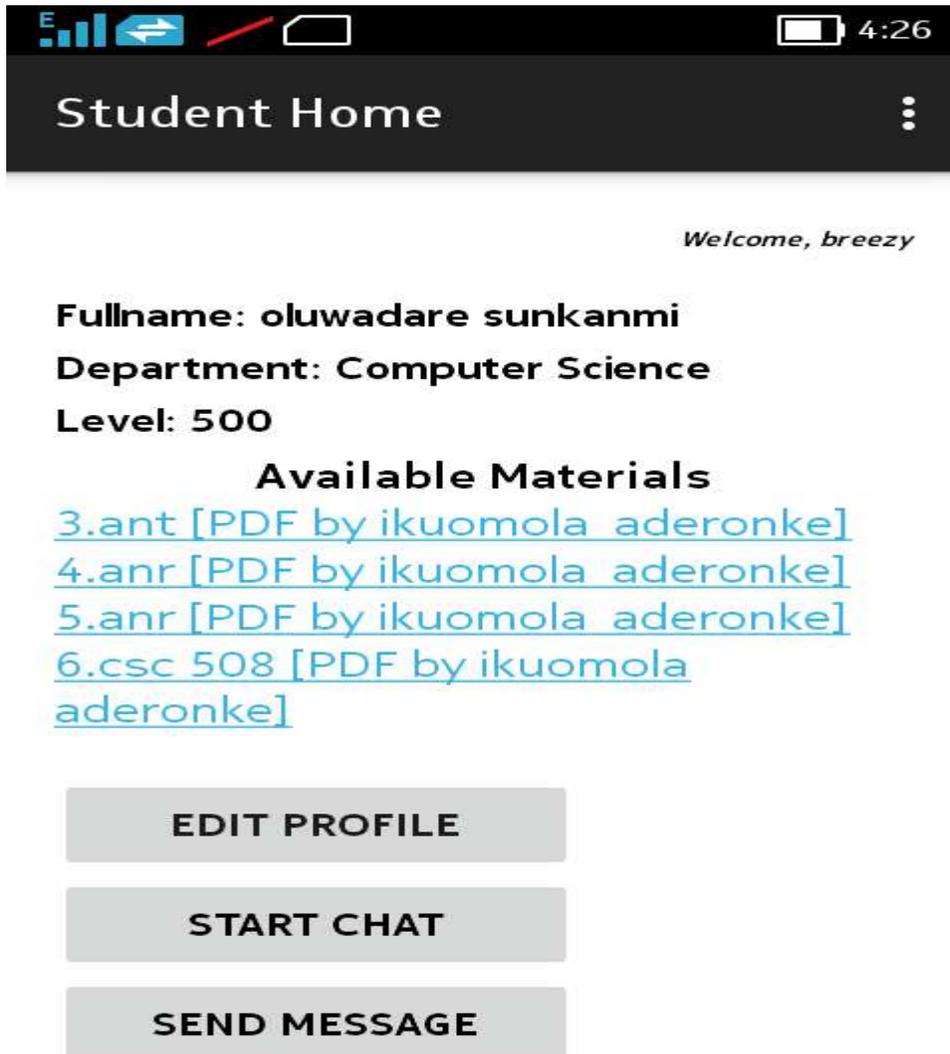


Figure 14: Home Screen for Students

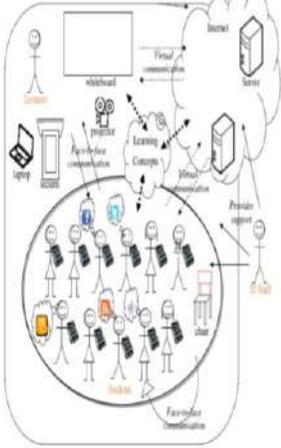
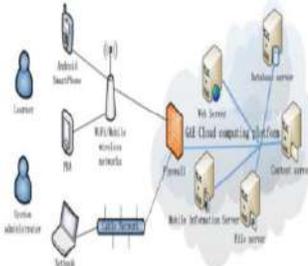


Figure 15: The student screen displaying saved material

APPENDIX

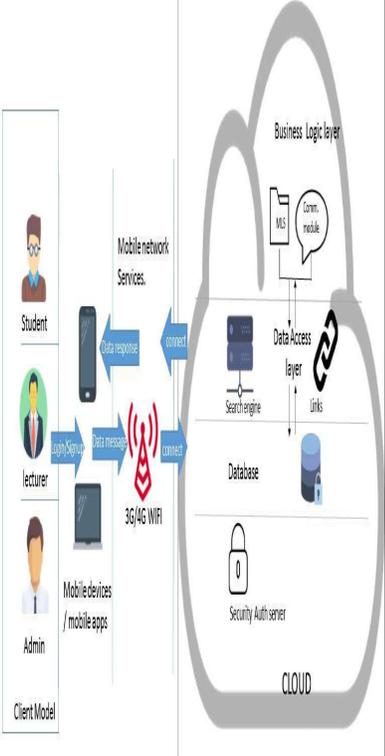
Table 1: Summary of the Review papers

Ref No	Literature Review	Name of Author(s)	Architecture	Limitation
1	On Mobile Cloud Computing in a Mobile Learning System	Afolabi A.O. (2014)		The system does not allow for communication between students and lecturer. Hence, students understanding and learning pace cannot be assessed. It also inhibits collaborative learning as users cannot truly communicate on the system
2	An E-learning System Architecture based on Cloud Computing	Anwar M.D. Masud H. and Huang X. (2012)		The authors actually failed to propose a strategy for integration or implementation of the proposed architecture.
3	A Cloud Based Mobile Learning Interface	Boyinbode O. and Akintade F. (2015)		There is no interactive and collaborative learning. There is no lecturer module that allows assessment of students to further identify and improve student's weaknesses.

4	Exploring the Suitability of Handheld Devices for Mobile Learning.	Boyinbode O and Ogundipe T. (2017).	Nil	There is no means of communication between students and lecturer. It also inhibits collaborative learning as users cannot truly communicate on the system
5	Designing a Mobile-app-based Collaborative Learning System	Cheong C. Bruno V. and Cheong F. (2012)		The system is designed to be used in a lecture environment which makes it not fully portable and available for use at anywhere and at any time. The system is based on a server which is not cloud enabled which requires that all students need to be physically present in the classroom before they can utilize the system.
6	Design and Research of Android Mobile Learning system.	Han J., Yin H., Liu J., and Dong J. (2010)		It can only be access by a mobile client with android OS. It is important that access is provided for all students regardless of device OS.
7	The Frame Work Design of Mobile Learning Management System,	Hemabala J. and Suresh E.S.M. (2012).		The system was not hosted on the mobile cloud

8	A Web-based platform for Mobile Learning Management System	Ikuomola A. J and Nureni O. N, (2013)		The system was not hosted on the mobile cloud so the mobile devices cannot work perfectly with little memory space.
9	Developing a Mobile Learning Management System for Outdoors Nature Science Activities Based on 5e Learning Cycle.	Lai A., Lai H., Chuang W and Wu Z (2015).	Nil	The learning attitude towards marine education is not promoted divergently after learning experiment. It was not launch on a long term learning experiment and cannot be apply on different learning domain.

Table 2: Justification for the new architecture

Title	Name of Author(S)	New Architecture	Strength/Justification for the new Architecture
<p>A Secured Cloud-Based Mobile Learning Management System</p>	<p>Ikuomola A. J. (2018)</p>	 <p>The diagram illustrates the system architecture. On the left, a 'Client Model' includes a Student, a lecturer, an Admin, and Mobile devices/mobile apps. These clients connect to 'Mobile network Services' (3G/4G/WiFi). The data then flows into a 'Cloud' environment. The Cloud is divided into several layers: a 'Business Logic layer' at the top, a 'Data Access layer' containing a 'Search engine' and 'Links', a 'Database', and a 'Security Auth server' at the bottom. A 'Comm. mobile' icon is also shown within the cloud layer.</p>	<p>The system is hosted on the mobile cloud. Security is enabled through the use of access control mechanism. It is portable and available for use at anywhere and at any time.</p> <p>Adaptation: the system has the ability to know the characteristics and specification of the ubiquitous device including the environment and deliver the learning material base on that.</p> <p>It is accessible to all students regardless of device OS.</p> <p>It allows the students to communicate directly with their lecturer by sending text messages so as to make comment on the learning materials, assignment and tutorials provided by the lecturer. It also allows students to interact with their colleagues</p> <p>Assessment mechanism: It allows lecturer to assess/evaluate students learning performance.</p>

			It allows the system administrator to know the system state and check whether the data has been compromised
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