

# **An Enhanced E-Learning Application for Tertiary Institutions**

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## **ABSTRACT**

An enhanced E-learning platform took into consideration vital concerns of its target population (teachers and the learners). Also, it provided a conducive environment for teachers to carry out their teaching effectively and efficiently. It does also provide the same atmosphere for students (learners) to enjoy quality education. The main objective of this study is to design an enhanced E-learning application for a tertiary institution. To achieve this aim, existing E-learning applications were evaluated based on identified performance indicators (communicativeness of interface, security and system upgrade). Based on the limitations of the existing E-learning applications (Module, Blackboard and Edmodo E-Learning applications) a logical and physical system for the proposed system was designed, and the unique system was also evaluated based on identified performance indicators. The analysis of the proposed system was carried out using the Object-Oriented Analysis and Design Methodology (OOADM). This study also presented the model, system design and formal description of the e-learning system. Subsequently, the architectural design was implemented using the Apache Wamp Server, MySQL and PHP web technology tools on the backend. In contrast, HTML, CSS, and JavaScript technologies were used on the front end. The result of the design was a prototype system that was developed which has a better communication interface, security and system upgrade capabilities. To enjoy a better feel of security, a firewall system was integrated into E-learning platforms to filter out the activities of unsolicited traffic to the web platform.

## **Keywords**

E-Learning, Security, Upgrade, Communication Interface, Enhanced.

## **1. INTRODUCTION**

Each time the word Education is spoken of, the classroom system is envisaged by many. The thought of people receiving lessons from teachers in an enclosed space called classroom comes to mind. However, the advent of technology and the internet is gradually overturning such thoughts or impression about education. E-learning is a concept that emerged from technological and internet advancement of this present era and is gradually being integrated into many tertiary educational programs, thus resulting in a paradigm shift from the traditional method of education to an electronic method in which students can have access to instructional resources irrespective of time and location. [1] defines E-learning as using electronic media such as the internet, DVD, CD-ROM, videotape, television, cell phones, etc. for teaching and learning at a distance. Why adopt this concept of learning at the tertiary level of education? The reason being that E-learning enables learners to broaden their knowledge horizon

since learning is self-paced and results in the improvement of learner's level of confidence and independence [14]. The Nigerian government has made a promise to improve the Information and Communications Technology (ICT) skills of its people and to bridge the digital divide by targeting Nigerian higher institution [2]. The Federal Republic of Nigeria (2004:53)[3] earlier stated that "the government shall provide facilities and necessary infrastructure for the promotion of ICT and e-learning." These commitments are in line with that of the New Partnership for Africa's Development to attain sustainable development in the 21st century. Hence, e-learning, as a component of ICT, has suffered some setbacks. The existing e-learning platforms (Moodle, Blackboard and Edmodo E-Learning applications) have limitations in areas such as security, system upgrade, and communicativeness of interface. These problems have made it very difficult for many students both at home and abroad to enjoy learning programmes from this innovative platform. The enhanced e-learning platform will improve on the existing e-learning system, which is in line with the Nigerian government's objective to bridge the digital divide through e-learning platforms to achieve sustainable development in the economy. The enhanced e-learning system will provide better security, system upgradeability, and communicativeness of interface. This paper is organized as follows: section two presents a review of related works. Section three describes the proposed system, its architecture, implementation, and test, Section four presents the result and discussion, and finally, section five concludes the work.

## **2. LITERATURE REVIEW**

### **2.1 Review of Empirical Framework**

In recent years, different needs of versatile e-learning have pulled in consideration of numerous scientists in computer sciences and information fields. Subsequently, various works have been done toward versatile e-learning frameworks, which are displayed beneath.[4] Designed an extended e-learning platform called i-coverage which incorporates social networking approach to improve the learning experience in Universities. It also has a comprehensive learning platform that allows for the exchange of information between stakeholders in the University in a simplified and consistent manner. [5] Focused on providing comprehensive guide on designing and implementing e-learning courses for trainers and instructional designers who are new to e-learning design. It also provides basic concepts and information on the processes and resources involved in e-learning development, which might be of interest to capacity-development managers. [6] Investigated the application of e-teaching and e-learning in Nigerian educational system. Result of their research shows that Nigeria has been slow when it comes to implementing ICT infrastructures in most of the Universities in the country

due to poor policy making, poor information infrastructure, poor implementation strategies, and lack of steady electrical power supply and this has affected the adoption of e-teaching and e-learning in most tertiary institutions across the country. [7] Developed a customized web-based virtual classroom system (webVCS) model, which is a substitute teaching or learning system to the traditional approach. However, for the smooth functioning of the system, factors such as internet facilities and availability of computers even at remote locations need to be addressed. [8] Designed and implemented a robust system that integrated both intranet-based communication and e-learning together. The synergized platform provides institution-wide communication and remote learning with the aid of local intranet networks already available in most of the Nigerian Universities at a little cost. [9] Presents the adoption of cloud computing in tertiary institutions intending to make higher educational processes seamless. [10] Used component-based software to design a computer-based testing system. The concept of reuse in object programming is evident in this work. Multiple components of the software were achieved by reusing single-core components again and again. However, it should be noted that each reused single component differs from the other, though having the same template format. [11] Presents an overview of e-learning and the conditions required for individuals to benefit from it maximally. The work also highlighted the status quo and challenges of implementing e-learning in developing countries. The work further proffers solutions to the challenges of implementing e-learning in developing countries.

## 2.2 E-Learning Equipment and Materials in Nigeria’s Tertiary Institutions

Tertiary institutions in Nigeria recognized the fact those with physical disabilities in the country should be given special educational consideration. With that viewpoint in mind, e-learning is seriously encouraged to achieve this purpose. The government supports these physically challenged individuals by providing learning equipment such as overhead projectors, slides, smart boards, circuit television (CCTV), transparencies, magnifiers, and computers with special devices for operating complex functions. However, these e-learning equipment are not enough when compared to the number of individuals that needs it, and learning resources such as e-books, special reading devices, television conferencing infrastructure lack in most Nigerian tertiary institutions [12].

## 3.SYSTEM ARCHITECTURE AND IMPLEMENTATION

### 3.1 System Architecture

The e-Learning system makes use of a relational database, Web Services and Web Pages. This connects all other modules of the application. User interactions are being passed to these modules, and then results are generated and passed back to the user-end. Within this system has some set of middleware that filters interactions and applies security measures as integrated into the system. Figure 1 shows the architectural system design.

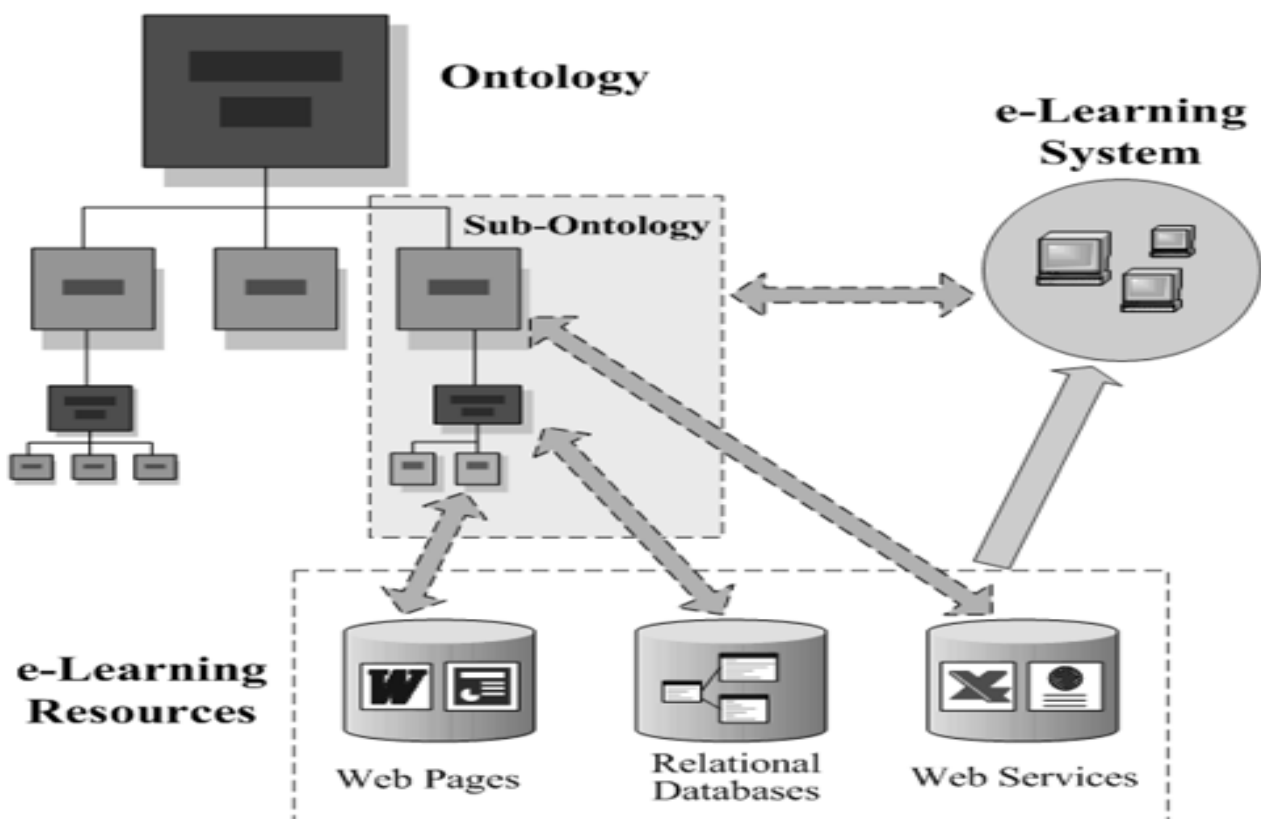


Figure 1: System Architectural Design

### 3.2 Physical System Design

The screenshot of the input/output design is shown in this section.

#### 3.1.1 Input Design Screenshot

(a) **Login Form:** The login form (figure 2) presents the user with options for entering the username, which serves as the user I.D. and the password which will authenticate the user.



Figure 2: Login Form

(b) Admin Area and New User Page: The admin area page, as shown in figure 3, is an overview of the various administrative tasks that the admin can perform. The screenshot below displays the admin area page in figure 3 and the new user page in figure 4.

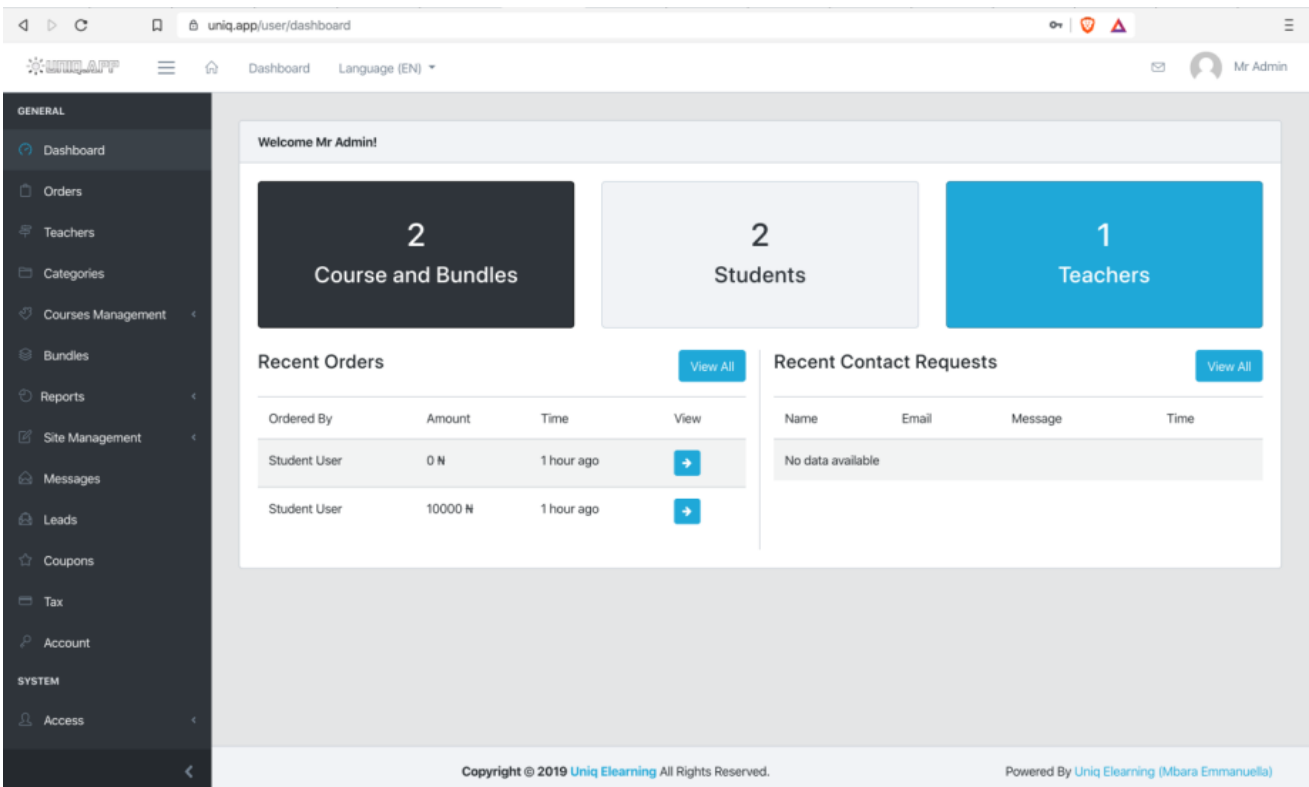


Figure 3:Admin Area Page

**User Management Create User**

First Name:

Last Name:

E-mail Address:

Password:

Password Confirmation:

Active:  YES

Confirmed:  YES

Send Confirmation E-mail (If confirmed is off):  YES

Abilities:

Roles	Permissions
<input type="checkbox"/> OFF Administrator	<input type="checkbox"/> OFF User_management_access
<a href="#">All Permissions</a>	<input type="checkbox"/> OFF User_management_create
	<input type="checkbox"/> OFF User_management_edit
	<input type="checkbox"/> OFF User_management_view
	<input type="checkbox"/> OFF User_management_delete

Figure 4: New user Page

(c) **Change Password Page:** The change password page, as shown in figure 5, allows the admin to change the user password of any login account.

**My Account**

Profile | Update Information | **Change Password**

Old Password:

Password:

Password Confirmation:

Figure 5: Change Password Page

(d) **User Profile Search Page:** The User profile page, as shown in figure 6, allows the admin to search for a user profile of the e-learning system. The user clicks on the user profile link to view a user record.

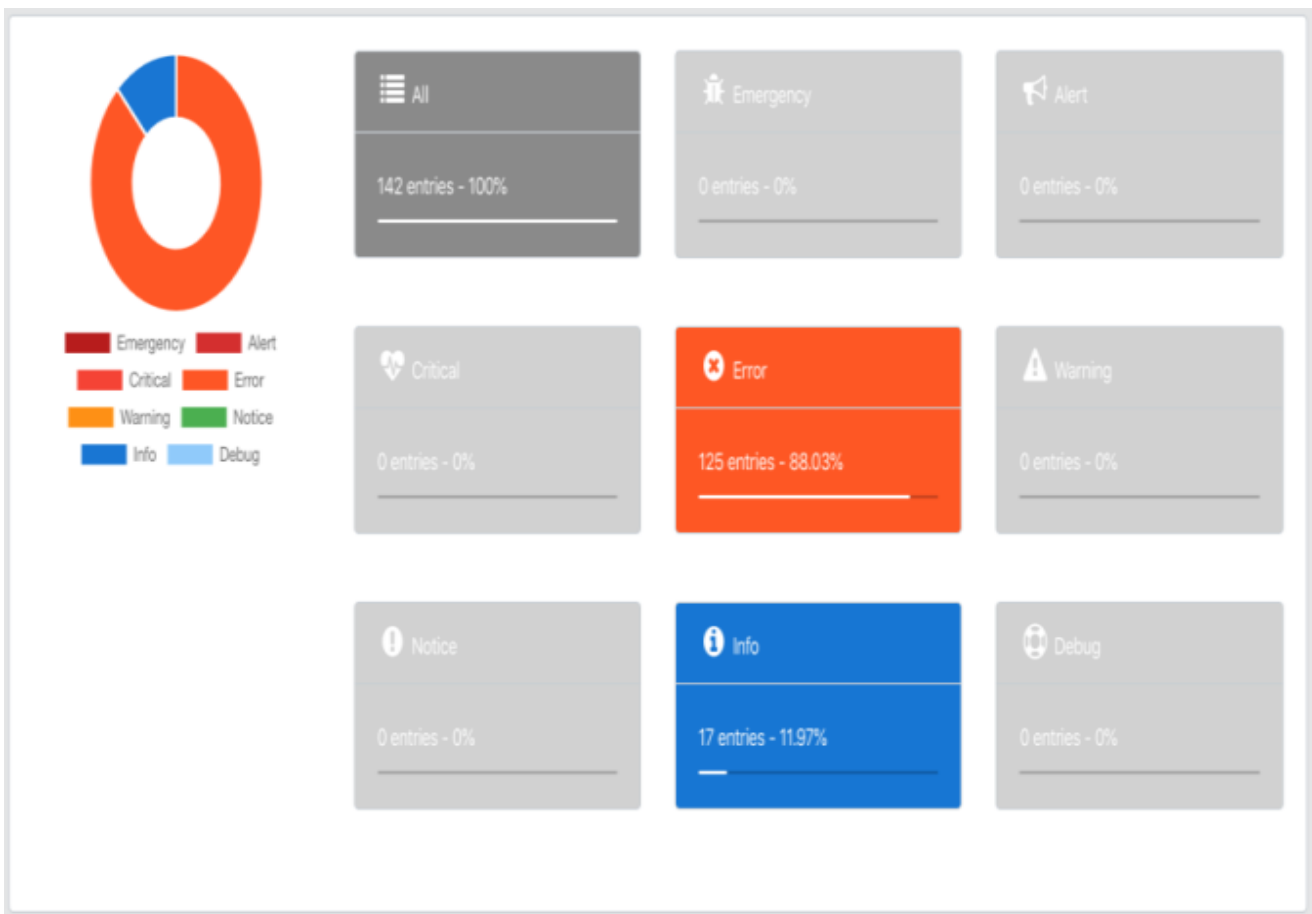
**User Management** Active Users +

Last Name	First Name	E-mail	Confirmed	Roles	Other Permissions	Social	Last Updated	Actions
Admin	Mr	admin@uniq.app	Yes	Administrator	N/A	None	8 minutes ago	<span>👁</span> <span>✎</span> <span>More ▾</span>
User	Teacher	teacher@uniq.app	Yes	Teacher	N/A	None	4 hours ago	<span>👁</span> <span>✎</span> <span>More ▾</span>
User	Student	student@uniq.app	Yes	Student	N/A	None	4 hours ago	<span>👁</span> <span>✎</span> <span>More ▾</span>
User	Normal	user@uniq.app	Yes	Student	N/A	None	4 hours ago	<span>👁</span> <span>✎</span> <span>More ▾</span>

4 users total

**Figure 6: User Profile Search Page**

(e) **Site Debug Dashboard:** The site debugs dashboard, as shown in figure 7, allows the admin to view all logs made by the application while it is running. This will hence assist the admin in debugging the app and effect necessary applications updates.



**Figure 7: Site Debug Dashboard**

(f) **Subscribe Page:** The subscribe page, as shown in figure 8, allows the users to subscribe to the e-learning platform’s newsletter; all necessary updates will be communicated via this medium.

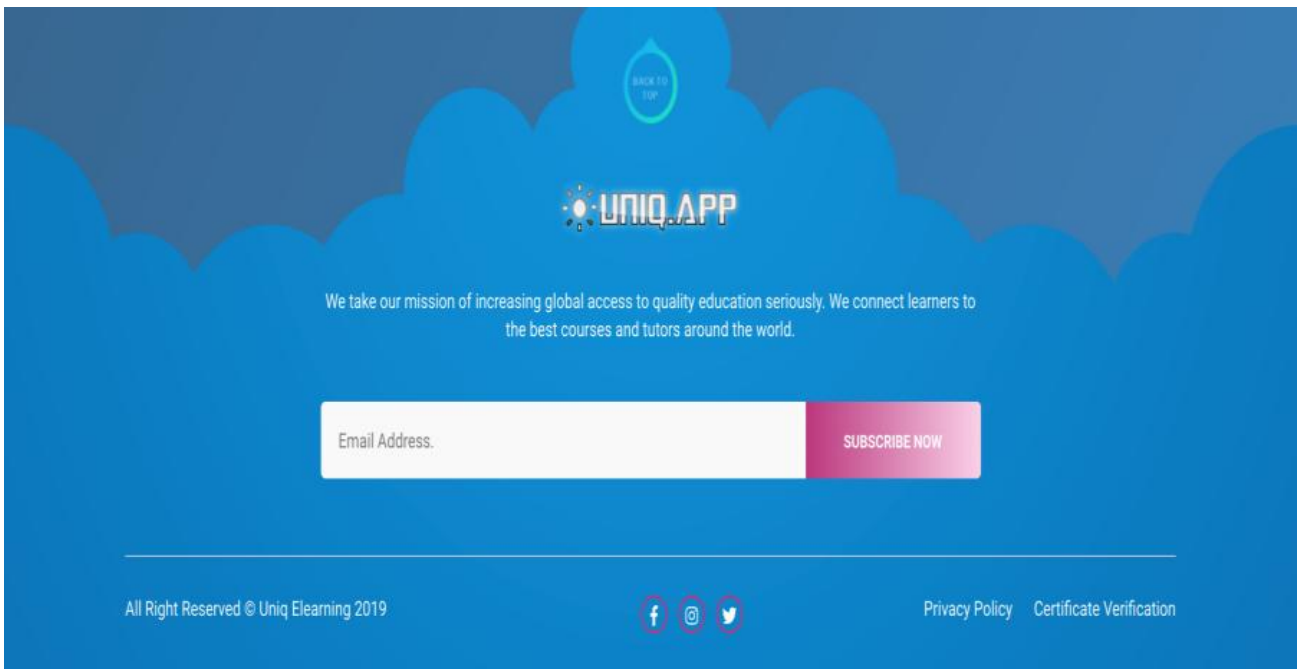








Figure 8: Subscribe Page

(g) **New Course Page:** The new course page, as shown in figure 9, allows the admin to add courses to the e-learning system.

Figure 9: New Course Page

(h) **User's Role Management Page:** The role management page, as shown in figure 10, allows the admin to manage each user's roles and permissions on the e-learning system.

### Role Management

Role	Permissions	Number of Users	Actions
Administrator	All	1	N/A
Teacher	User_management_access Course_access Course_create Course_edit Course_view Course_delete Lesson_access Lesson_create Lesson_edit Lesson_view Lesson_delete Question_access Question_create Question_edit Question_view Question_delete Questions_option_access Questions_option_create Questions_option_edit Questions_option_view Questions_option_delete Test_access Test_create Test_edit Test_view Test_delete View Backend Category_access Category_create Category_view Bundle_access Bundle_create Bundle_edit Bundle_view Bundle_delete	1	 
Student	User_management_access Course_access Course_view Lesson_access Lesson_view Question_access Question_view Questions_option_access Questions_option_create Questions_option_edit Questions_option_view Questions_option_delete Test_access Test_view View Backend Bundle_access Bundle_view	2	 
User	None	0	 

4 roles total

Figure 10: User's Role Management Page

(I) **Generate Certificate Page:** The Generate Certificate page, as shown in figure 11, allows the admin to generate attendance certificates for students.

### Certificates

Show  entries

Search:

[CSV](#) [PDF](#) [Column Visibility](#)

Sr No.	Course Name	Progress	Action
1	Cloud Computing	100%	<a href="#">View</a> <a href="#">Download</a>
2	Learning Cryptography	100%	<a href="#">View</a> <a href="#">Download</a>

Showing 1 to 2 of 2 entries

Previous  Next

Figure 11: Generate Certificate Page

(j) **Course Page:** The Course page, as shown in figure 12, allows the admin to view and manage courses currently registered on the e-learning system.

The screenshot shows a web interface for managing courses. At the top, there is a header 'Courses' and an 'Add new' button. Below the header, there are filters for 'All' and 'Trash', a 'Show 10 entries' dropdown, a search box, and buttons for 'CSV', 'PDF', and 'Column Visibility'. The main content is a table with the following data:

<input type="checkbox"/>	Sr No.	Teachers	Title	Category	Price (in ₹)	Status	Lessons	Actions
<input type="checkbox"/>	1	Teacher User	Cloud Computing	Technology	10000.00	Published Trending		
<input type="checkbox"/>	2	Teacher User	Learning Cryptography	Computer Science	Free	Published Featured Popular		

At the bottom of the table, it says 'Showing 1 to 2 of 2 entries' and 'Previous 1 Next'.

Figure 12: Course Page

(k) **Implementation of the Message Page:** The message page, as shown in figure 13, 14, 15 and 16, allows the student to view and send messages in the e-learning management system.

The screenshot shows a web interface for managing messages. At the top, there is a header 'Messages'. Below the header, there is a search bar with the text 'Search User' and a magnifying glass icon. To the right of the search bar is a 'Select Recipients:' dropdown menu. Below the search bar, there is a message from 'Teacher User' with the text 'Send the Report.' and a timestamp '8 seconds ago'. To the right of the message, there is a 'Start a conversation' button.

Figure 13: Message Page (1)



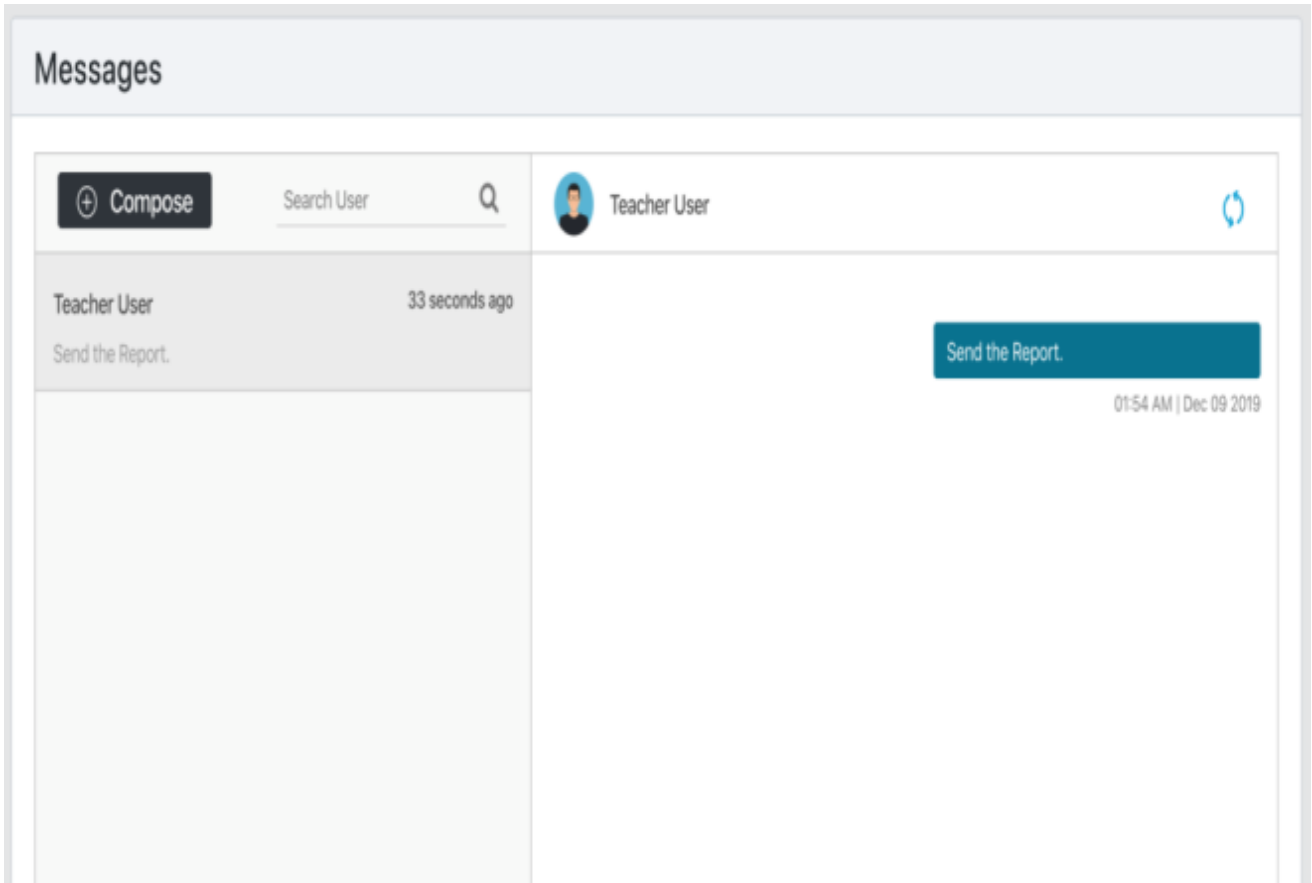


Figure 14: Message Page (2)

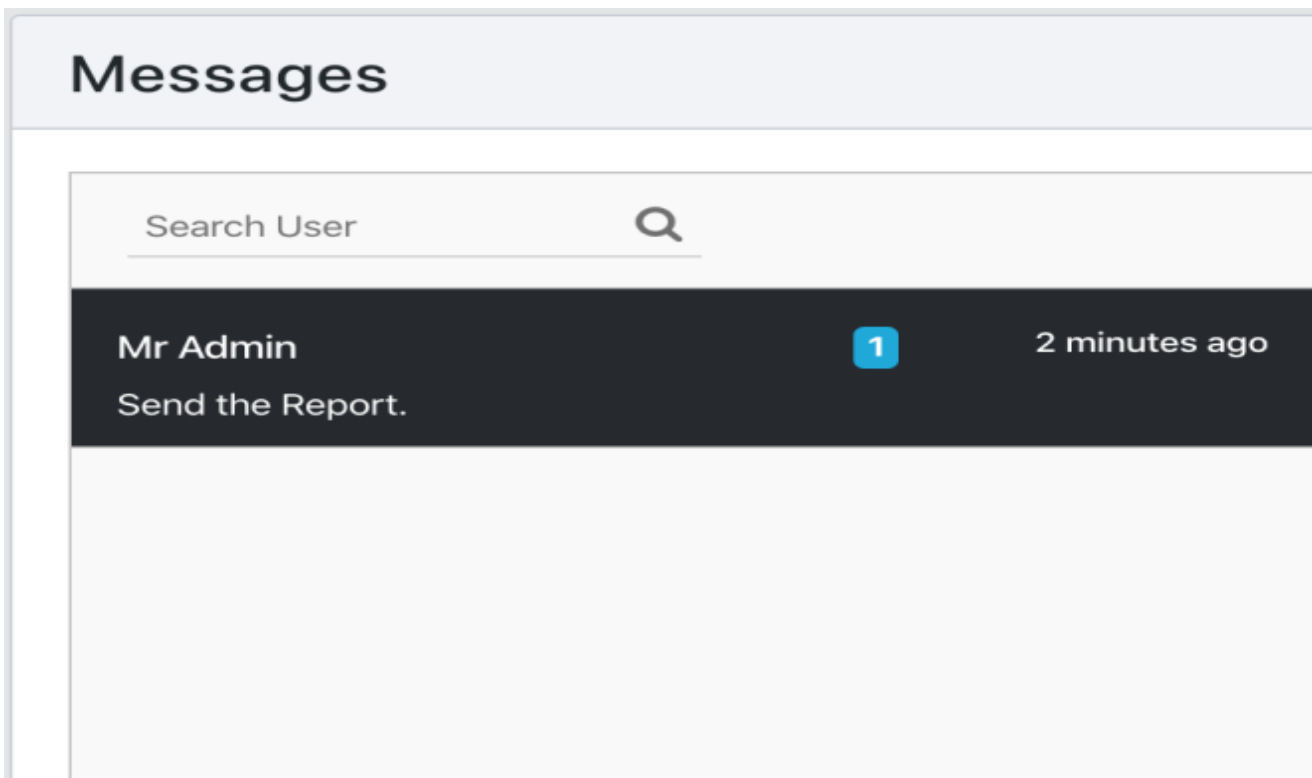


Figure 15: Message Page (3)

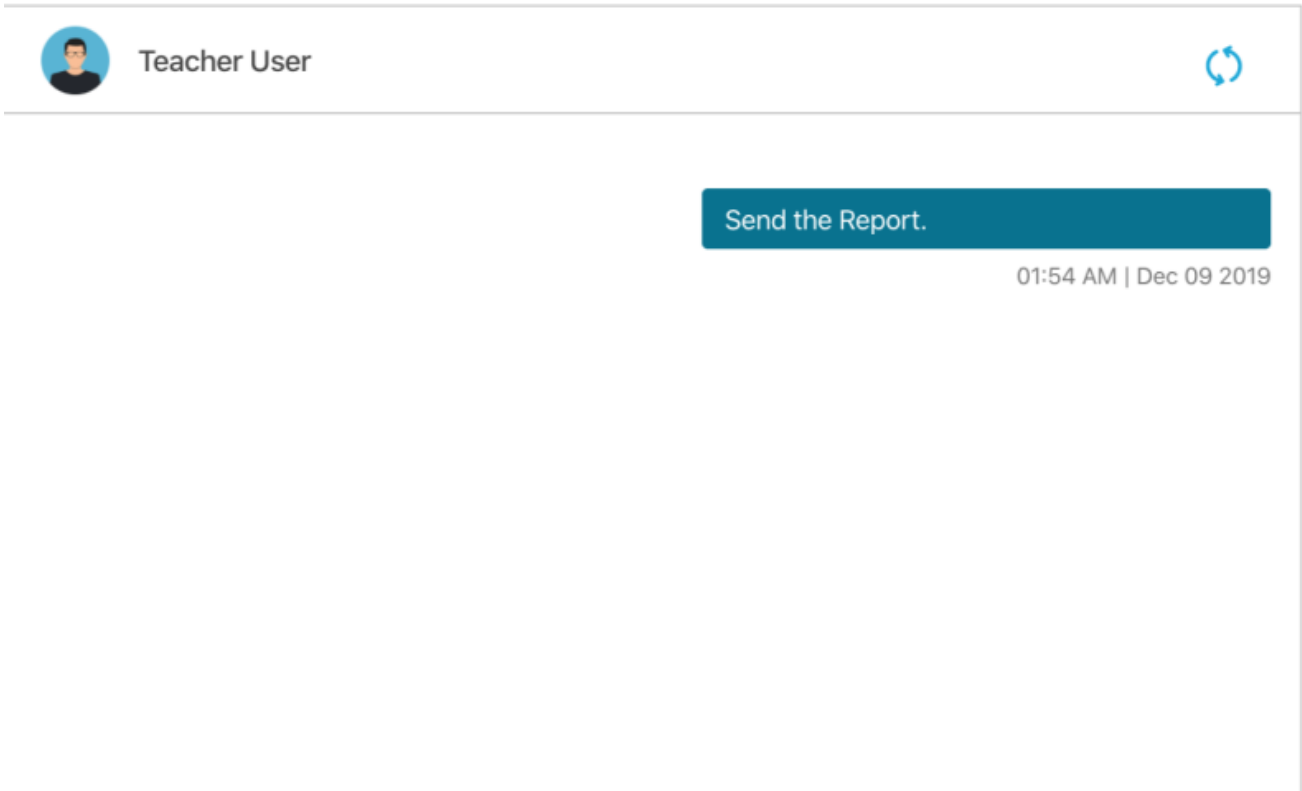


Figure 16: Message Page (4)

(l) **Course Category:** The Course Category page, as shown in figure 17, allows the admin to add locations of courses in the e-learning management system.

The screenshot shows the 'Categories' page. At the top right, there is an 'Add new' button. Below the header, there are tabs for 'All' and 'Trash'. A 'Show 10 entries' dropdown and a search box are present. On the right, there are buttons for 'CSV', 'PDF', and 'Column Visibility'. The main content is a table with the following data:

Sr No.	Name	Slug	Icon	Courses	Actions
1	Statistics	statistics		0	<a href="#">Courses</a>
2	Photoshop	photoshop		0	<a href="#">Courses</a>
3	Entertainment	entertainment		0	<a href="#">Courses</a>
4	Computer Science	computer-science		1	<a href="#">Courses</a>
5	Marketing	marketing		0	<a href="#">Courses</a>
6	Arts	arts		0	<a href="#">Courses</a>
7	Technology	technology		1	<a href="#">Courses</a>
8	Business	business		0	<a href="#">Courses</a>

At the bottom left, it says 'Showing 1 to 8 of 8 entries'. At the bottom right, there are 'Previous', '1', and 'Next' navigation buttons.

Figure 17: Course Category Page

(m) **New Page/Create New Page:** The New Page/Create New Page, as shown in figure 18, allows the admin to add and view pages in the e-learning management system.

The 'Create Page' form is structured as follows:

- Title:** A text input field with a placeholder 'Title'.
- Slug:** A text input field with a placeholder 'Input slug or it will be generated automatically'.
- Featured image (max file size 10MB):** A section containing a 'Choose file' button and the text 'No file chosen'.
- Content:** A rich text editor with a toolbar containing various icons for text formatting (bold, italic, underline, link, unlink, list, list-group, link, unlink, source, print, save, undo, redo, help) and dropdown menus for 'Format', 'Font', and 'Size'.
- Meta Title:** A text input field with a placeholder 'Meta Title'.
- Meta Description:** A text input field with a placeholder 'Meta Description'.

Figure 18: Create New Page

(n) **Menu Management Page:** The Menu Management Page, as shown in figure 19, provides a means to manage the menu system that is displayed to both students and teachers when they logon to the e-learning management system.

The 'Menu Manager' interface includes the following components:

- Selection:** A dropdown menu showing 'nav-menu' with a 'Choose' button and a link to 'Create new menu'.
- Name:** A text input field containing 'nav-menu' and a blue 'Save Menu' button.
- Menu Structure:** A section with the instruction 'Place each item in the order you prefer. Click on the arrow to the right of the item to display more configuration options.' It contains a list of items: 'Blog', 'Courses', 'Bundles', 'Forums', 'Contact', and 'About Us', each with a dropdown arrow.
- Menu Settings:** A section with a 'Display' label and a checked checkbox for 'Top Menu'.
- Custom Link:** A section with a 'URL' input field containing 'http://', a 'Label' input field containing 'Label menu', and an 'Add to Menu' button.
- Pages:** A section with a 'Search Pages' input field and checkboxes for 'About Us', 'Privacy Policy', and 'Select All', along with an 'Add to Menu' button.

Figure 19: Menu Management Page

(o) **User Dashboard:** When the user inputs the correct login credentials, he is taken to the user dashboard, as shown in figure 20. The dashboard is the command and control centre where the admin can add e-learning resources.

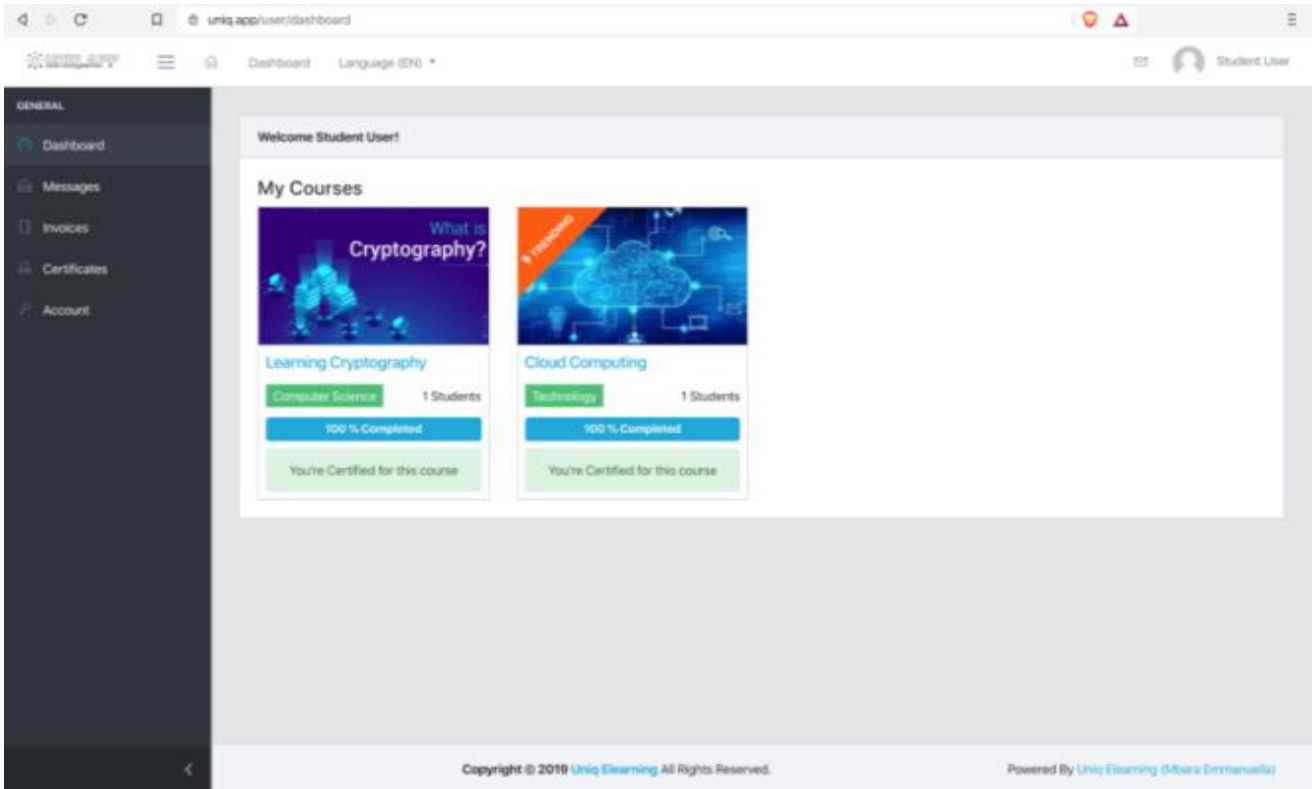


Figure 20: User Dashboard

### 3.2.2 Output Design

The E-learning system uses this module to convey information to the users. The output design screenshots include:

- (a) **Message pages:** The messagepage, as shown in figure 21, 22, 23, and 24, allows the student to view and send messages in the e-learning management system.

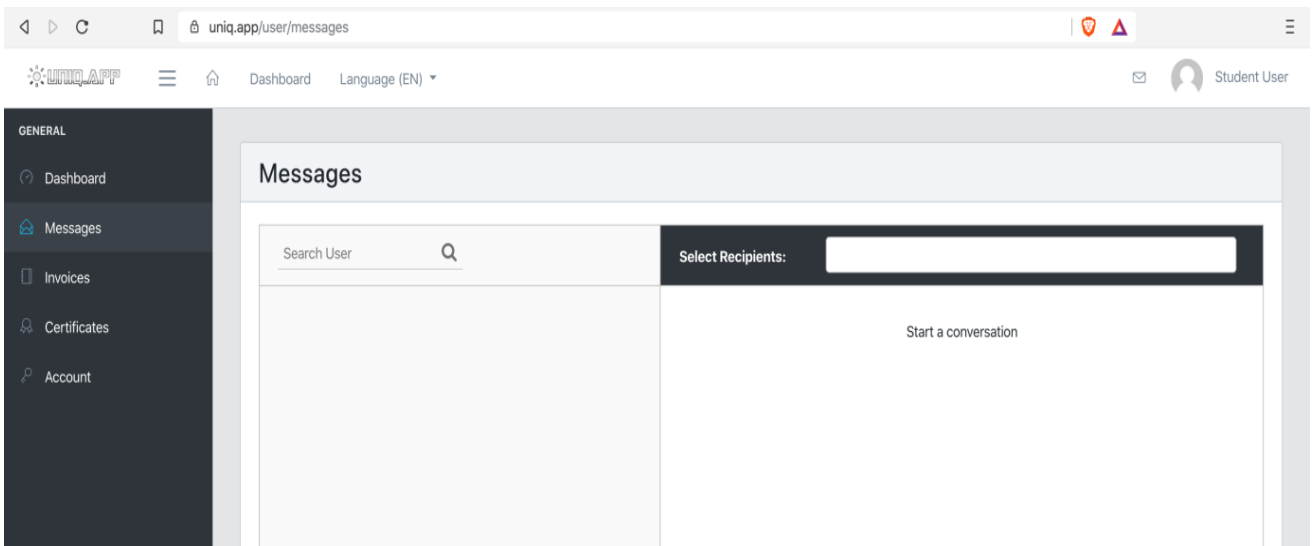


Figure 21: Message Page (1)

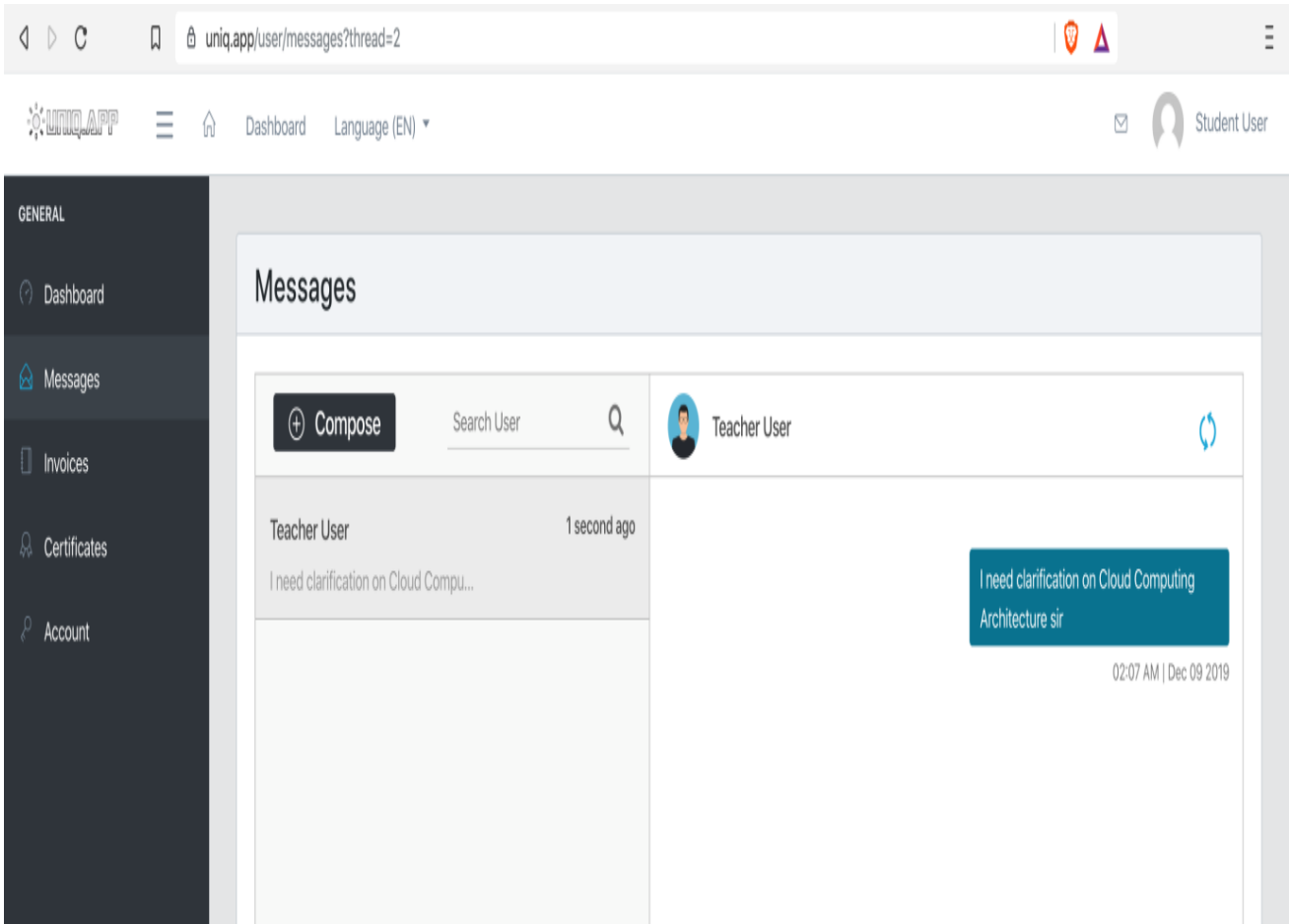


Figure 22: Message Page (2)

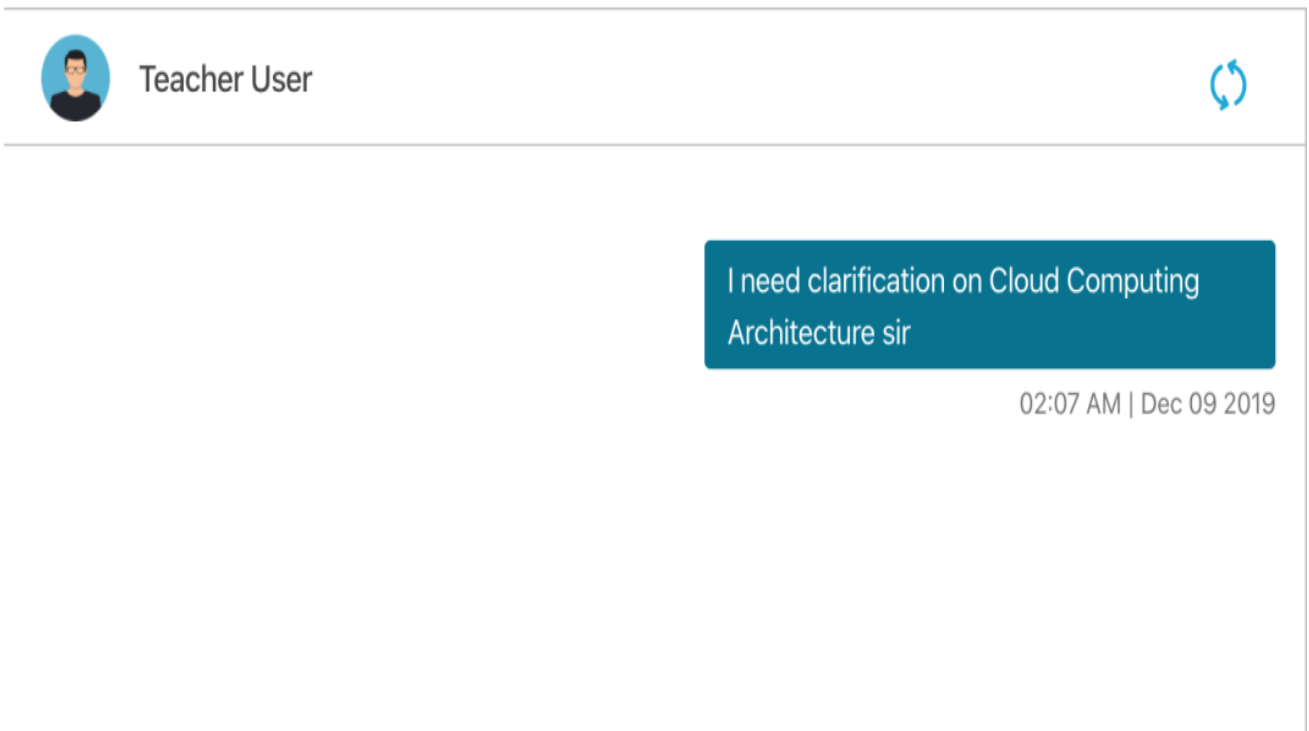


Figure 23: Message Page (3)

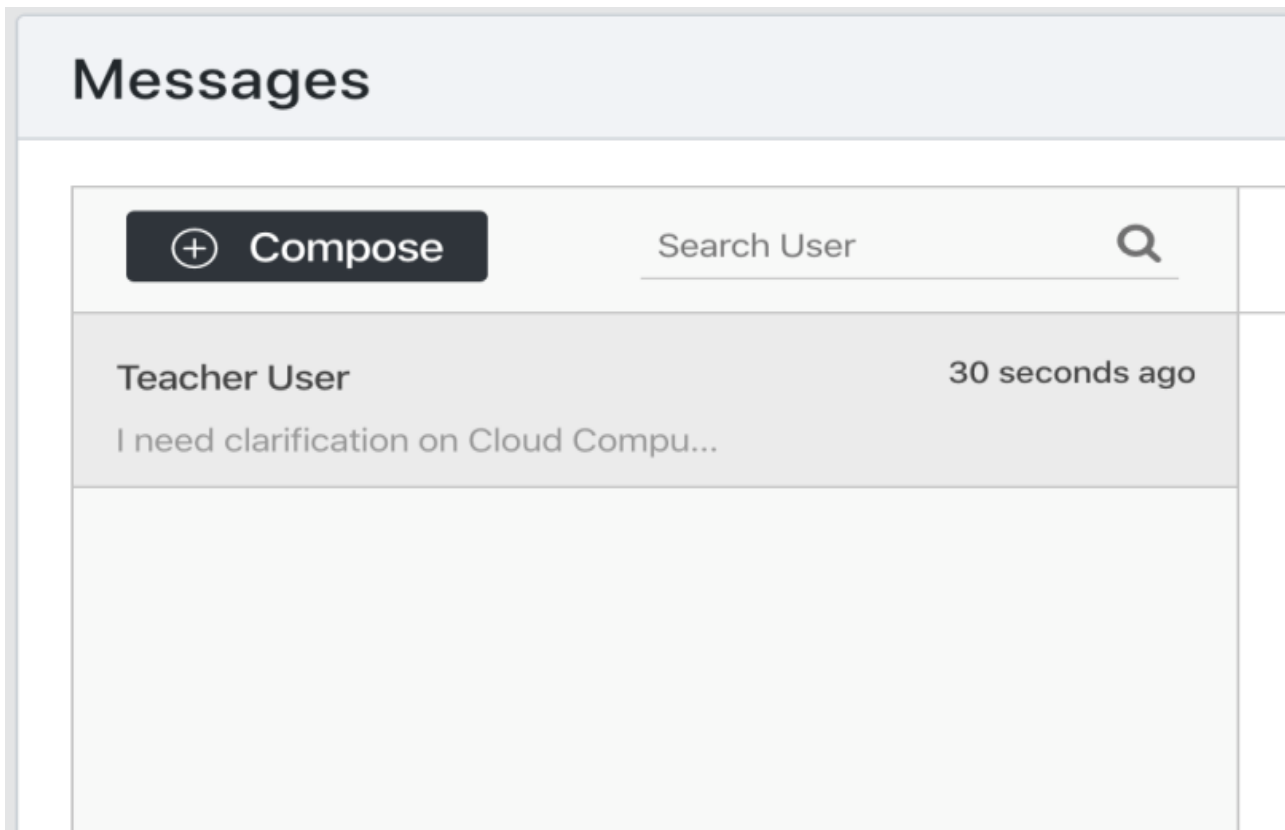


Figure 24: Message Page (4)

(b) **User Profile Display Page:** The user profile display page (figure 25) shows a user's profile information.

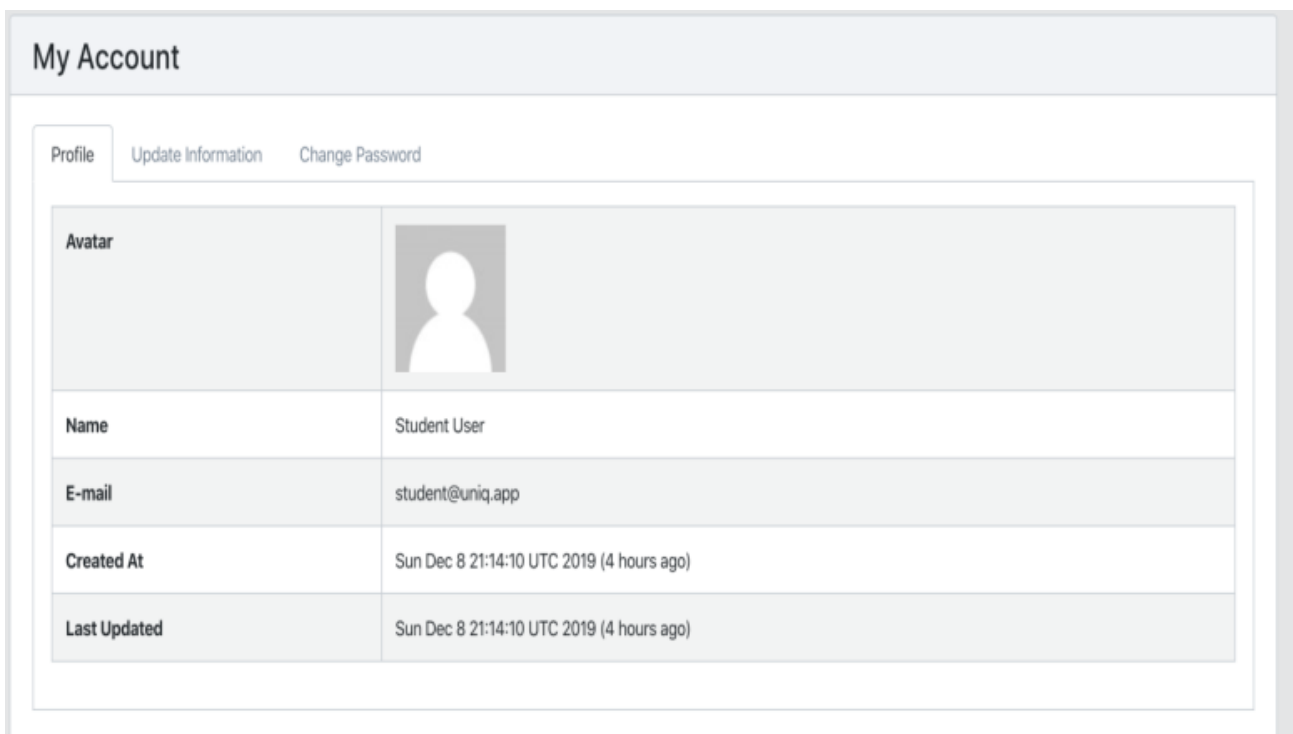


Figure 25: User Profile Display Page

(c) **Student's Forum Page:** This page (figure 26) allows the student to participate in the interactive forum of the e-learning platform.

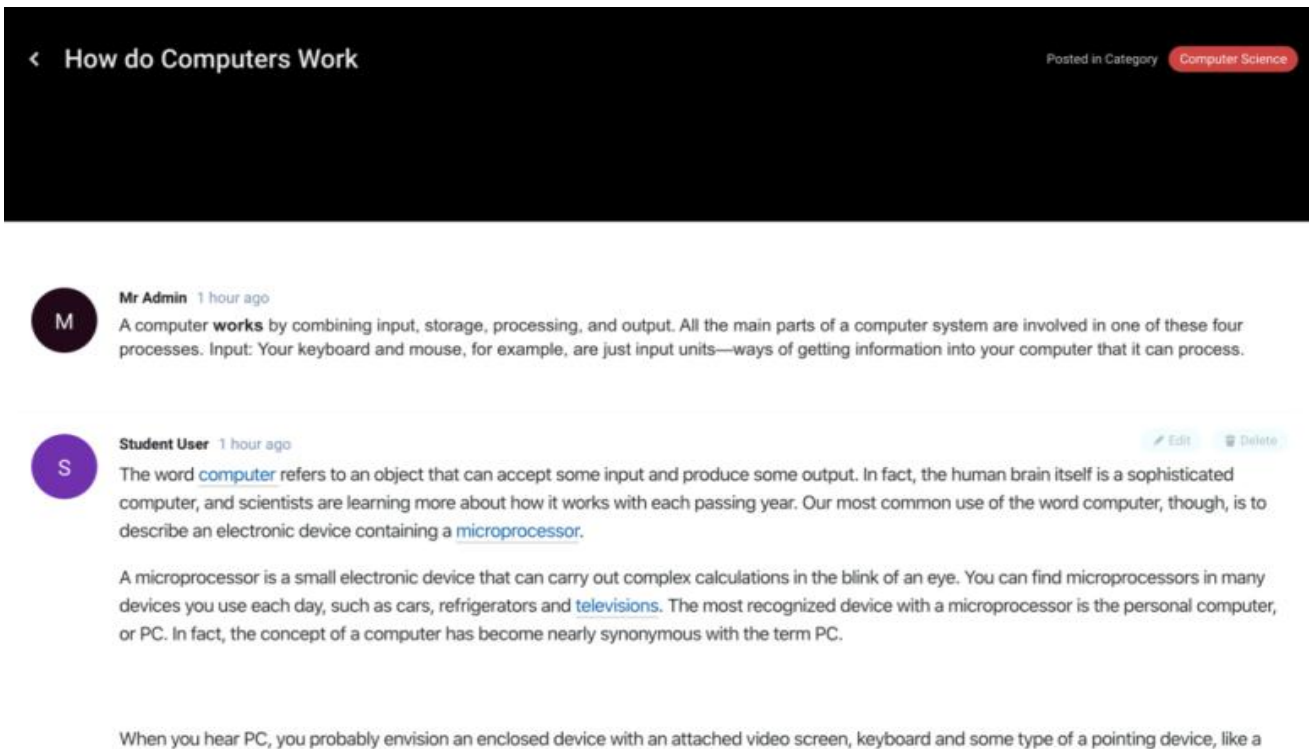


Figure 26: Student's Forum Page

(d) **Invoice Page:** The invoice page, as shown in figure 27, allows the student to view the invoices of the purchased courses.

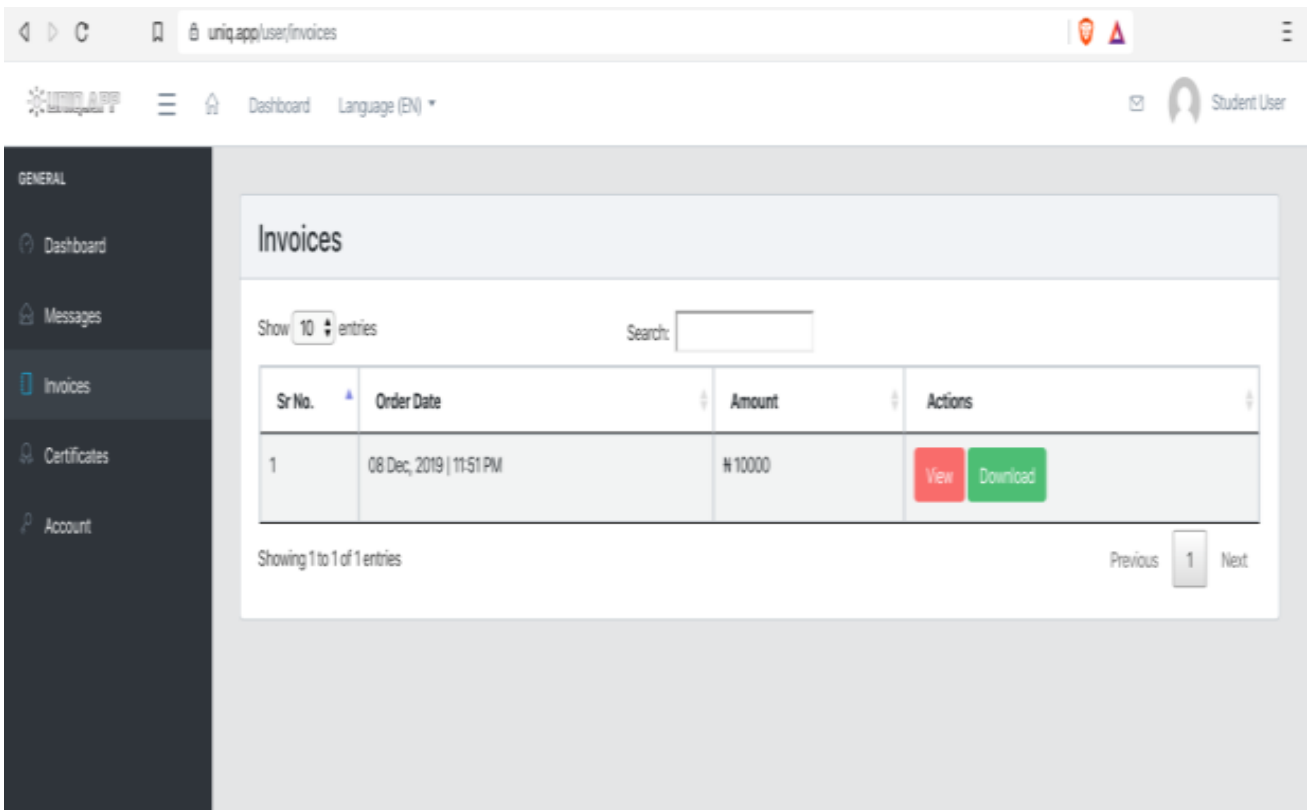


Figure 27: Student's Invoice Page

(e) **Student's Generated Invoice Page:** The generated invoice page, as shown in figure 28 and 29, allows the student to view generated invoice in the e-learning management system.

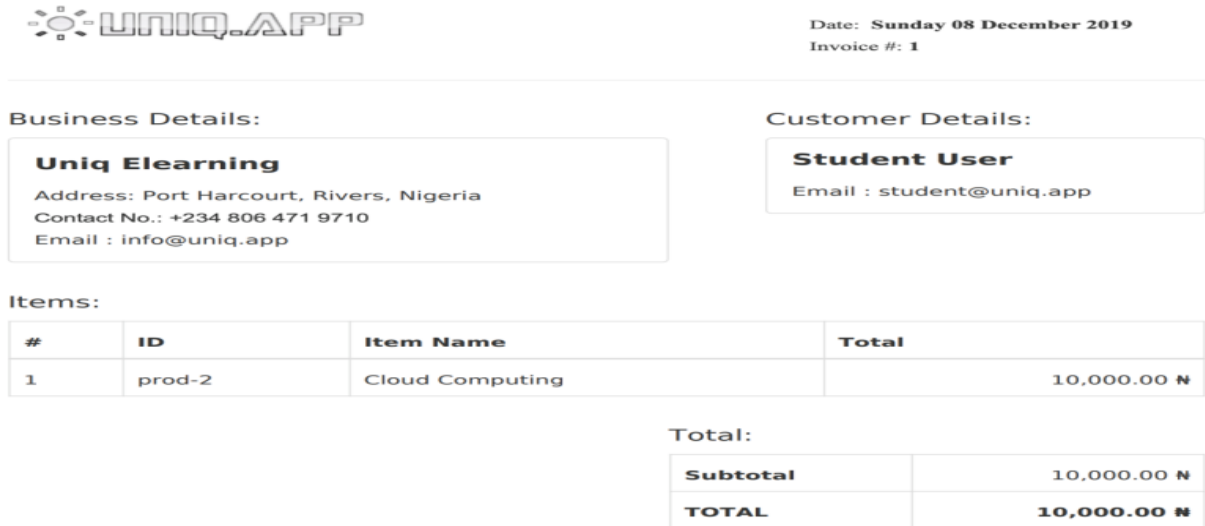


Figure 28: Student's Generated Invoice Page

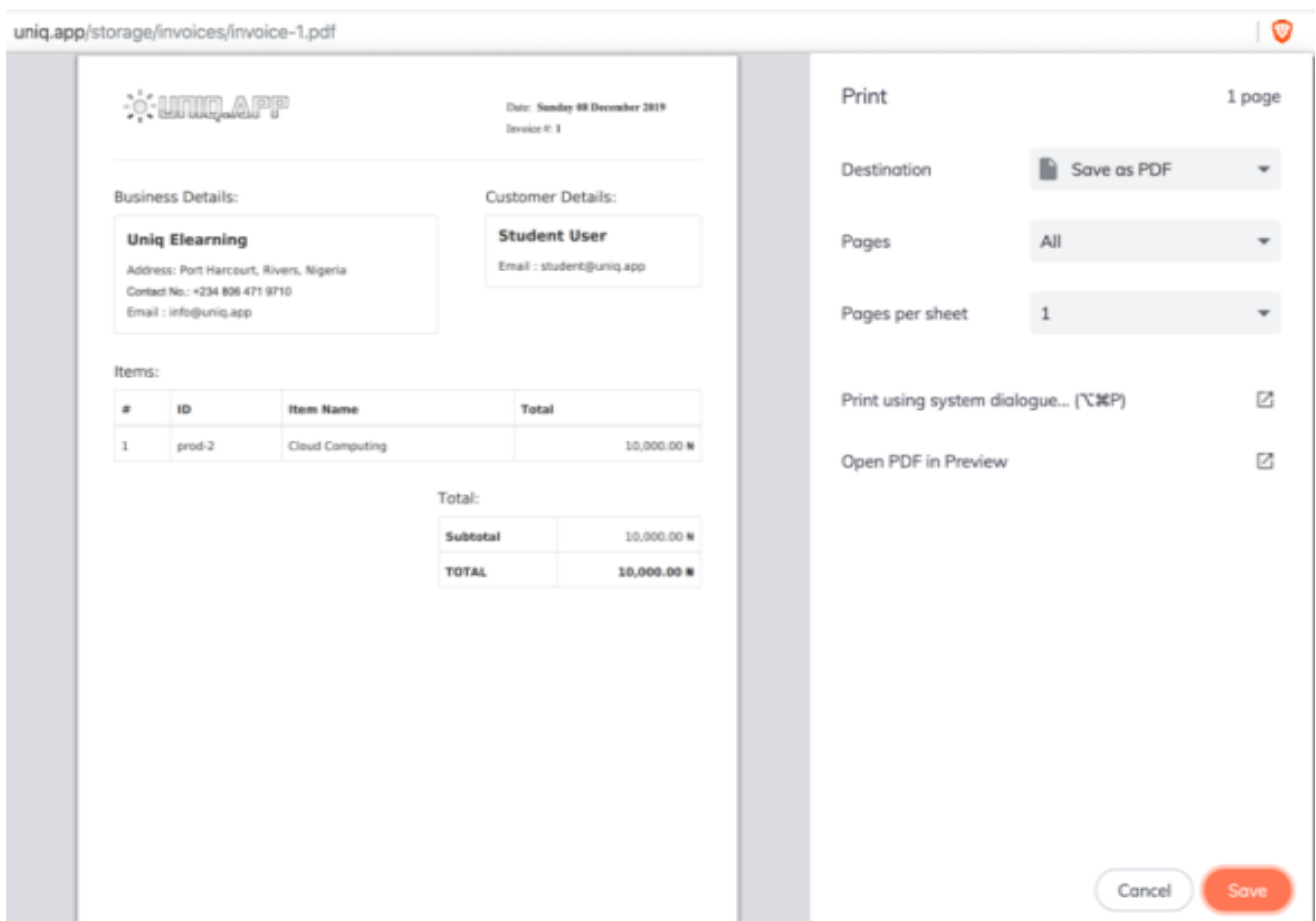


Figure 29: Student's Print Generated Invoice Page

(f) **Student's Profile Page:** The profile page, as shown in figure 30, allows the student to view profile details.



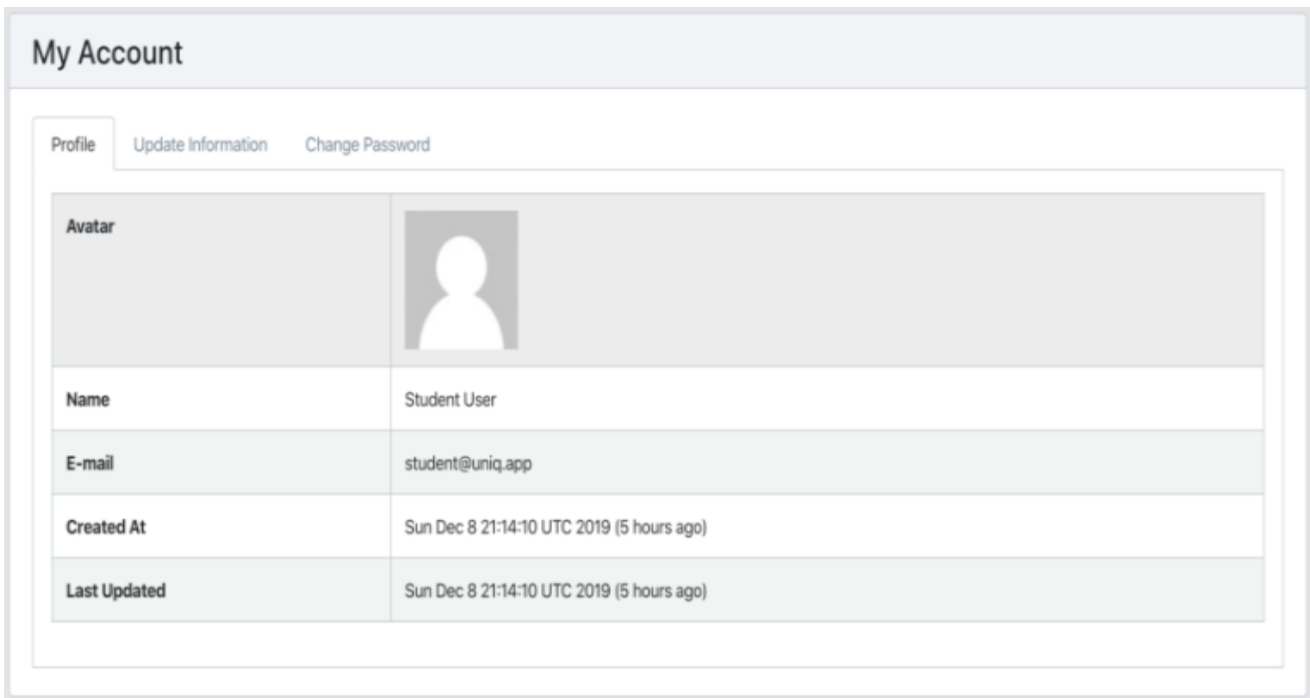


Figure 30: Student's Content Library Page

(g) **Student's E-Learning Page:** The e-learning page, as shown in figure 31, allows the student to view the courses that he/she was subscribed to.



Figure 31: Student's E-learning Page

### 3.3 Implementation and Testing

The proposed system was implemented using HTML, CSS and J.S. as front end to display its content; PHP for the middle-end and MySQL Database Server was used as its back end and used for storing data saved by the user. The E-learning application software for this study passed through the

unit and system test procedure, a standard testing procedure for software development. The test script can be executed via the command line using "vendor/bin/phpunitTestCaseName". Table 1 shows the test scripts for the various modules of the proposed system.

**Table 1: Test Script**

<i>Functional Area</i>	<i>Test Name</i>	<i>Test Steps</i>	<i>Expected Results</i>
<b>Homepage</b>	Home page success	Open your browser and goto the app link (e.g https://uniq.app)	Show the landing page, courses, blog posts, forums etc
<b>Login</b>	Login Success	1. Enter valid username & password 2. Click Login Now	User login successful and access dashboard
<b>Login</b>	Login Failed	1. Enter invalid username and password 2. Click Login Now	User login failed and redirect to login page
<b>Sign-up</b>	Create Account	1. Fill the form (all fields required) 2. Click <b>Register Now</b>	On successful registration, redirect to the Login page and show the registration success message
<b>Sign-up</b>	Account Creation Failed	1. Partially fill the form or enter the mismatched password or enter an email already in use. 2. Click <b>Register Now</b>	Show error messages.
<b>Course Creation</b>	Course Creation Success	1. Login with valid I.D. (as admin or tutor) 2. Goto Course Management > Courses (fill all required field) 3. Click <b>Create</b>	Course Creation Successful, show Course list
<b>Course Creation</b>	Course Creation Failed	1. Login with valid I.D. (as admin or tutor), 2. Goto Course Management > Courses (leave required fields empty) 3. Click <b>Create</b>	Course Creation Failed, show errors
<b>Course Category Creation</b>	Course Category Creation Success	1. Login with valid I.D. (as admin) 2. Goto Create Category (fill all required field) 3. Click <b>Create</b>	Course Category Creation Successful, show Course Categorieslist
<b>Course Category Creation</b>	Course Category Creation Failed	1. Login with valid I.D. (as admin) 2. Goto Create Category (leave required fields empty) 3. Click <b>Create</b>	Course Creation Failed, show errors
<b>Lesson Creation</b>	Lesson Creation Success	1. Login with valid I.D. (as admin or tutor) 2. Goto Course Management > Lesson (fill all required field)	Lesson Creation Successful, show Lessons list

		3. Click <b>Create</b>	
<b>Lesson Creation</b>	Lesson Creation Failed	1. Login with valid I.D. (as admin or tutor) 2. Goto Course Management > Lesson (leave required fields empty) 3. Click <b>Create</b>	Lesson Creation Failed, show errors
<b>Tests Creation</b>	Tests of Creation Success	1. Login with valid I.D. (as admin or tutor) 2. Goto Course Management > Tests (fill all required fields) 3. Click <b>Create</b>	Tests Creation Successful, show Tests list
<b>Tests Creation</b>	Test Creation Failed	1. Login with valid I.D. (as admin or tutor) 2. Goto Course Management > Tests (leave required fields empty) 3. Click <b>Create</b>	Test Creation Failed, show errors
<b>Questions Creation</b>	Questions Creation Success	1. Login with valid I.D. (as admin or tutor) 2. Goto Course Management > Questions (fill all required field) 3. Click <b>Create</b>	Questions Creation Successful, show Questions list
<b>Question Creation</b>	Question Creation Failed	1. Login with valid I.D. (as admin or tutor) 2. Goto Course Management > Questions (leave required fields empty) 3. Click <b>Create</b>	Questions Creation Failed, show errors
<b>Tutors List</b>	Tutors List	1. Login with valid I.D. (as admin) 2. Goto Teachers	View List of Created Tutors
<b>Orders List</b>	Orders List	1. Login with valid I.D. (as admin) 2. Goto Orders	Show List of Course Orders
<b>Coupon Creation</b>	Coupon Creation Success	1. Login with valid I.D. (as admin) 2. Goto Coupon > Create Coupon (fill all required field) 3. Click <b>Create</b>	Coupon Creation Successful, show Coupon list
<b>Coupon Creation</b>	Coupon Creation Failed	1. Login with valid I.D. (as admin) 2. Goto Coupon > Create Coupon (leave required fields empty)	Coupon Creation Failed, show errors

		3. Click <b>Create</b>	
<b>Reports List</b>	Reports	1. Login with valid I.D. (as admin) 2. Goto Reports	Show List of Students and Sales Records
<b>Role and Permission Management</b>	Role and Permission Test	1. Login with valid I.D. (as admin) 2. Goto Access > Role Management	Show Roles and Permissions attached to the roles
<b>Roles and Permission Management</b>	Role Attachment	1. Login with valid I.D. (as admin) 2. Goto Access > Role Management 3. Edit or Add 4. Create or Update	Show Creation Form or the Edit form, on success, redirect to Roles List Page
<b>Order Course</b>	Course Ordering	1. Login with valid I.D. (as a student) 2. Select Course 3. Click 'Buy Now' 4. Make Payment 5. Access Course	Course Purchase Success, Access Course
<b>Course Access</b>	Course Access	1. Login with valid I.D. (as a student) 2. From the dashboard, access the course you wish 3. Start Learning	Show Course Details and All Learning Materials Associated with the course.
<b>Take Test</b>	Take Test	1. Login with valid I.D. (as a student) 2. SelectCourse 3. Finish course outline and Write test 4. Click Submit	Show Course Assessment and report
<b>Forum Access</b>	Forum Test	1. Login with valid I.D. (as a student) 2. Select Select a Fora discussion 3. Participate by commenting and submitting comments	Show Forum room and all messages in the forum
<b>Certificate</b>	Certificate	1. Login with valid I.D. (as a student) 2. Goto Certificates 3. Select a Certificate to View or Download	Show Certificate List, View Certificate Details and Print Certificate
<b>Message</b>	Message	1. Login with valid I.D. (as a student) 2. Goto Messages 3. Compose Message, select recipient & Send	Show Message Inbox, create and view a list of all in-out messages

## 4.RESULTS AND DISCUSSION

### 4.1 Result Presentation

The control matrix of the result from the evaluation of the existing system and the proposed method is shown in Table 2, Table 3, Table 4 and Table 5, respectively.

**Table 1:Control Matrix for Information Consumers (Existing system)**

Performance Indicator	Extremely Low	Low	Neutral	High	Very High	Rank	Judgment
Likert scale Grade	1	2	3	4	5		
Security	47	66	29	18	13	2	weak
System Upgrade	35	61	32	26	19	2	weak
Communicativeness of Interface	39	42	35	30	27	2	weak

**Table 3: Control Matrix for Independent Experts (Existing System)**

Performance Indicator	Extremely Low	Low	Neutral	High	Very High	Rank	Judgment
Likert scale Grade	1	2	3	4	5		
Security	47	66	29	18	13	2	weak
System Upgrade	35	61	32	26	19	2	weak
Communicativeness of Interface	39	42	35	30	27	2	weak

The gap analysis shows that the existing system has limitations in the key performance indicators (security, system upgrade, and communicativeness of interface)

**Table 4: Control Matrix for Independent Experts (Evaluation of the Unique System)**

Performance indicator	Extremely Low	Low	Neutral	High	Very High	Rank	Judgment
Likert Scale Grade	1	2	3	4	5		
Security	0	0	2	3	20	5	Strong
System Upgrade	0	0	0	7	18	5	Strong
Communicativeness of Interface	0	0	2	2	23	5	Strong

**Table 5: Control Matrix for Information Consumers (Evaluation of the Proposed System)**

Likert Scale Grade	1	2	3	4	5		
Security	0	0	2	2	21	5	Strong
System Upgrade	0	0	4	6	15	5	Strong
Communicativeness of Interface	0	0	0	1	24	5	Strong

From the evaluation made by the Independent Experts (IEs) and Information Consumers (I.C.s), the unique system has succeeded in overcoming the bottlenecks posed by the existing system, namely its weak performance indicators.

## 4.2 Discussion

In this section, we answered the raised research questions.

### 1) To what extent do the weaknesses of the existing E-learning system for tertiary institution affect learning in tertiary institutions?

From the analysis carried out on the current E-learning system using Delphi method [13], it shows that the existing E-learning system has some weaknesses in terms of security, system upgrade, and communicativeness of interface. This has made online learning not conducive for the users of the existing E-learning system.

### 2) To what extent does the existing system as a whole differ from the enhanced E-learning application?

The proposed method has a wiki forum, upload video courses, create an assignment and live chat features. These features create a conducive learning environment for users of the proposed E-learning application software. However, these features are deficient in the existing E-learning system.

### 3) To what extent does the enhanced e-learning system improve over the current e-learning system?

The enhanced e-learning system has successfully addressed the limitations of the existing e-learning system. The results of the independent experts and information consumers from the analysis carried out shows that the enhanced e-learning system has improved security features, improved system upgradeability, and improved communicativeness of interface when compared to the existing e-learning system

## 5. CONCLUSION

The computerized automated enhanced e-learning system for tertiary institutions will provide better services for the students. Priority was on problem elimination of existing system and quality improvement of teaching in tertiary institutions. The software model used is the Structured System Analysis and Design Methodology. An improved security feature of the computerized system was also employed to avoid an unauthorized person or persons having access to data. The communicativeness of the interface of the proposed method was improved as well as the system upgrade feature. With the unique enhanced E-learning system, administrators would be able to control and streamline operations significantly. The enhanced system would also enable them to improve their response time to the demands of students because it automates the entire learning process.

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