

## Certificate Management Application



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## Certificate Management Application

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### Abstract

The purpose of the paper is to show how to expand the low code interactive framework in order to develop a web app for the broad needs of different fields. The goal of this work is to give a chance to computer science senior project students to work on a broad spectrum of projects using Apache, HTML, CSS, JavaScript, PHP, and MySQL. In this paper, the web app keeps track of recipients of computer science certificates. The web application is interactive, responsive, secured, password and database driven app. The web app uses a MYSQL database on the web server-side to record concentration, courses, and certificates. Admins and users with proper permissions can add, delete, view, and edit recipients, categories, certificates, and courses based on a level of permission. Admins with full permissions can edit permissions for other registered accounts. They have access to the Manage Categories, Manage Certificates, Manage Courses, Manage Recipients, and Manage Users pages depending on their permissions. The web app is accessible on all devices and is designed to be mobile as well. In conclusion, the project has been successfully designed and implemented according to best practices and finally tested on a web hosting server provider.

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### Introduction

Keeping track of different entities are important problems and can be very useful for monitoring events. The project [Miranda-Hill, W., Goetz, J. (2019, June 30 – July 4)] aims to prototype the functionality of a user-generated geospatial meteorology map (for keeping track of temperature and pressure) based on low code interactive framework [Butler, T., & Yank, K. (2017)]. This includes the design and implementation of a database driven website with a public and a password protected admin component, in addition to a database, web server and hardware component. Another project Patient Care Reporting App [Guarrera, A., Goetz, J. (2022, May 10)] is based on low code interactive framework [Butler, T., & Yank, K. (2017)] as well. The purpose of the app was to provide a platform to simulate an electronic patient care reporting system for the students to interact with. The goal of this project was to develop a web application that allows the students in the Emergency Medical Technician (EMT) course at Pasadena City College (PCC) to be able to create, edit, and submit simulated calls to the database. A relational database was used to create tables, such as users, calls, categories, user roles and a token to verify instructors. There were five different admin roles in total: admin (the highest privilege), primary instructor, adjunct instructor, lab instructor, and student (the lowest privilege) and the “superuser” with all privileges accessible. An additional project [Grime, C., Goetz, J. (2023)] based on low code interactive framework [Butler, T., & Yank, K.

(2017)] is Course and Faculty Management System (CFMS) allowing educational organizations efficiently organize and manage their courses and faculty. The basic goal of CFMS was to keep track of courses and faculty by Managing (i.e., viewing, adding, editing and deleting) Courses, Instructors, Subjects, Departments, Timeslot, Course Attributes with given constraints for each entity.

Keeping track of certificates is an important task for many different types of industries. myComply [myComply.net (2022)] is a software company that offers software to keep track of certificates and certifications relating to construction work. They claim that public worker profiles make it possible to view certifications on any smart device, that their software allows the user to organize and filter their workers by title, training, and certification status, and that their software saves time and money [myComply.net (2022)]. Keeping track of important documents like certificates is not a new idea. myComply certification management software and other similar types of software show the benefits of having a tracking system. Expiration and Renewal Tracking Software for the employees is available at [SkyXoft Technologies. (2023)]. However, keeping track of academic certificates have different requirements.

Each department of the university needs a Certificate Management Application (CMA) that can be tailored to their department certificates. At the University of La Verne, the computer science department offers four different types of certificates to students who are majoring in computer science. Those four certificates are Certificate in Computer Coding, Certificate in Cybersecurity, Certificate in Systems Engineering, and Certificate in Website and Internet Applications Development. However, there isn't a public system to keep track of recipients of those certificates. The purpose of this project is to solve this problem by making a public website where recipients of these certificates can be managed and tracked. This will make easier for the faculty in the computer science department to manage and track recipients and have space where students can also view information about the certificates like the description of each certificate and the courses that are required to earn a certificate.

### **Problem Statement**

The information for the certificates can be found on the University of La Verne Computer Science page. The problem statement is that certificates at time can be difficult to manage and can be difficult to track the recipients of those certificates. It would be easier to build a website to keep track of certificates and the requirements for those certificates.-To achieve this, the project needs to have a management system that allows users to filter needed information and depending on their permissions, to add, edit, and delete certificates, courses, and recipients.

The purpose of the paper is to show how to expand the low code interactive framework [Kevin Yank, Tom Butler 2017] in order to develop a web app for the broad needs of different fields. The low code framework (LCF) is to expand a framework based on PHP and MySQL for creating low cost, customized, and integrated Web based certificate management applications. Moreover, the framework should host many users which can have access from different clients the same time. The goal of this project is to develop a web application that keeps track of recipients of computer science certificates by Managing (i.e. viewing, adding, editing, deleting) Certificates, Recipients, Courses, Categories and setting the Users permissions.

A relational database consists of certificates, courses, categories, recipients, and user tables. The web application includes administration capabilities, which allows admins to set permissions for users and edit, delete, and insert certificates, courses, categories, or recipients. The website consists of multiple web pages that limits accessibility depending on the permissions set to the user by the admin. Super admins with all permissions have access to all pages including Manage Certificates, Courses, Categories, Recipients, and Users. There is need for a project like this because it is important to keep track of recipients to encourage students to have a more active participation in the certification process and provides transparency between the faculty and professors and their students. This project is contributes to the body of knowledge by providing a tool for students to view information about the certificates and encourage them to seek and earn the certificates.

## System Design

### Design Overview

The Certificate Management Application is a full-stack web based application consisting of three main components. The three components are the user interface, the server, and the database. The technology stack currently used by Certificate Management Application is HTML, CSS, JavaScript, PHP, and MySQL.

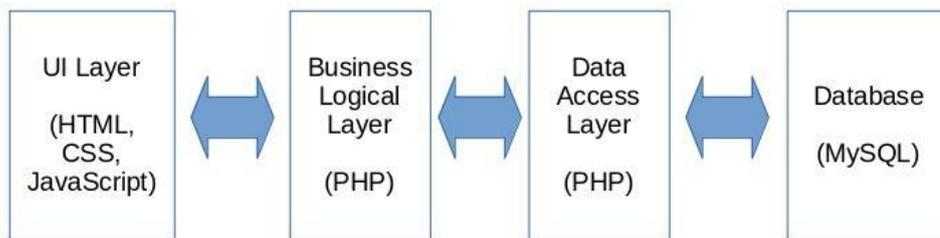


Figure 1. Framework Logical Layers (FLL)

The framework logical layer (LCF) architecture consists of three functional layers (see Figure 1):

- *User Interface (UI) Presentation Layer,*
- *Business Logical Layer (BLL), and*
- *Data Access Layer (DAL).*

The front-end, user interface (UI) layer of this application is ~~created~~ to present web pages on the client side using HTML, CSS, and JavaScript generated on the server side. The user interface allows users to view, add, update, and delete data relating to Certificates, Recipients, Courses and Categories. The components of the web application interface are dynamically created using the template engine provided by the PHP framework. The application also includes a permissions-based access system. The permissions system is used to generate and display only the relevant user interface elements required by the active user [Grime, C., Goetz, J. (2023)].

The back-end, server components (BLL and DAL) of the application is coded in PHP. The server application is built on a PHP framework. This framework provides methods to connect to a MySQL database and perform queries on the connected database. The server application perform calculation on data and also adds, deletes or

modifies data in the database. The system prevents malicious users from performing SQL injection to run undesired code in the web application. The PHP framework provides a PHP routing system that allows the server to handle GET, POST, and PUT requests. The framework is robust and flexible allowing a large variety of web applications to be built with it [Grime, C., Goetz, J. (2023)]. The last component is a MySQL Server as its Relational Database Management System (RDBMS) but it's considered a third party application and not a logical layer [Azma, H., Goetz, J. 2007]. RDBMS is used to store data. The web application's back-end connects to the database and interacts with it using SQL queries. The foundation for this functionality is provided by the framework and expanded in the Certificate Management Application.

### User Interface Layer

The graphical user interface (GUI) is designed to **interact with graphical controls through direct manipulation** to view, add, delete or edit **information about** Certificate Management Application. The website conforms to the [Web Design Best Practices Checklist (2023)].

### Sitemap

The following Figure 1 describes the hierarchy of the website. The first level depicts the web pages that are available to users who are not logged in, while the second level depicts the pages that are available to logged in users, although some features are locked depending on the user's privileges (only admins can access the manage categories, certificates, courses, recipients, and users' pages).

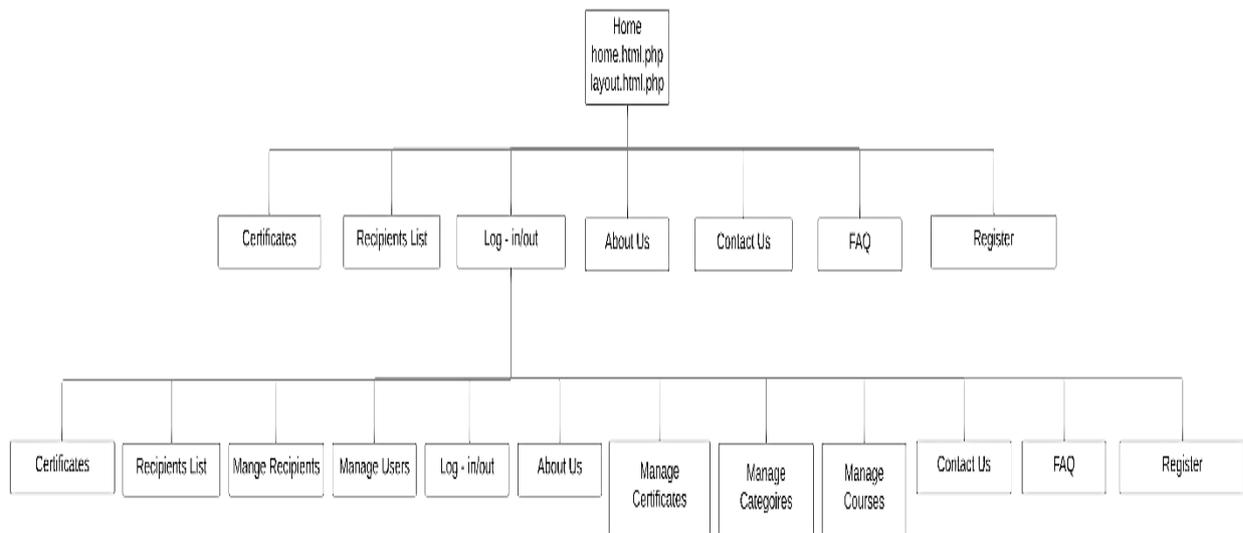


Figure 1. Website Map

Certificate Management Application (CMA) has two main components, the public and admin components. The public functionality and the menu are shown in Figure 2. The public user interface of CMA consists of the following sections: header, menu, aside, main content area, and footer. All public entities such as Certificates and Recipients list are available to view only and they don't have interactions buttons such as add, edit or delete (see Figure 3 - 4).

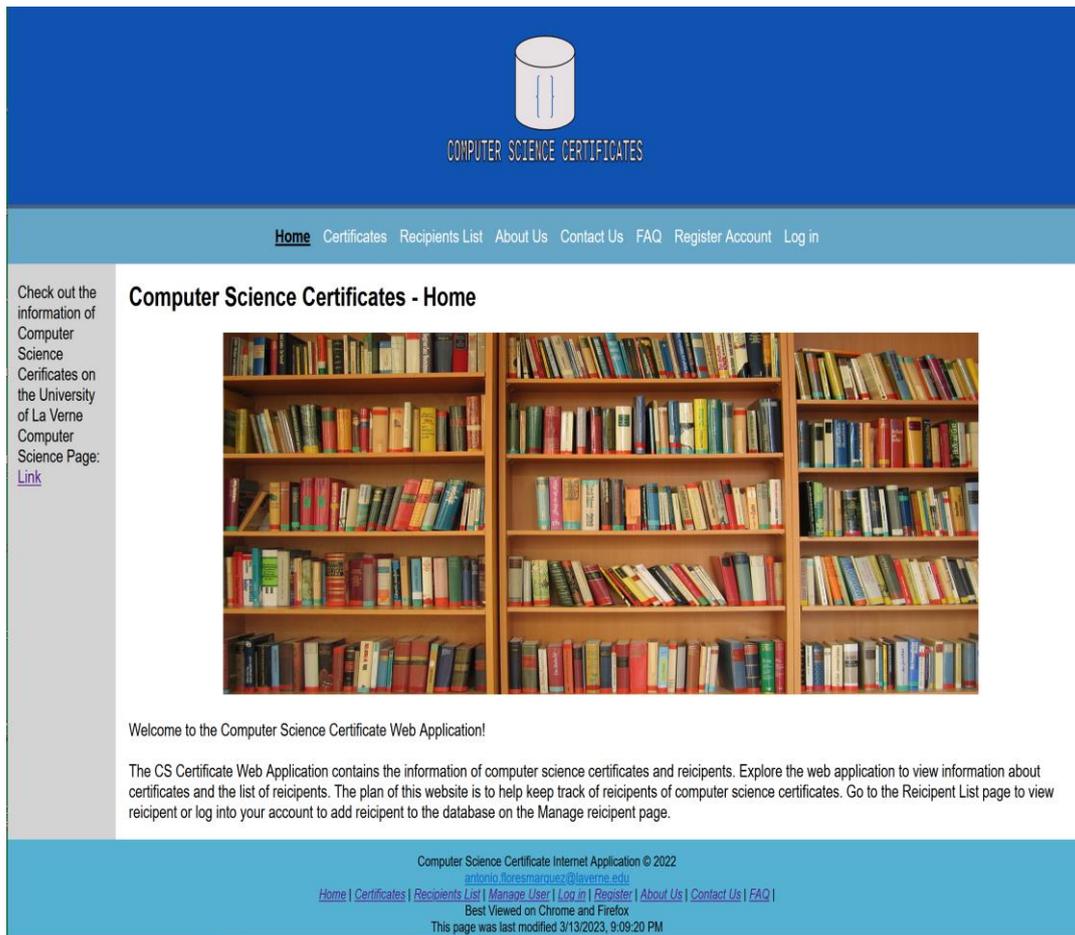


Figure 2. Public Component - Home Page

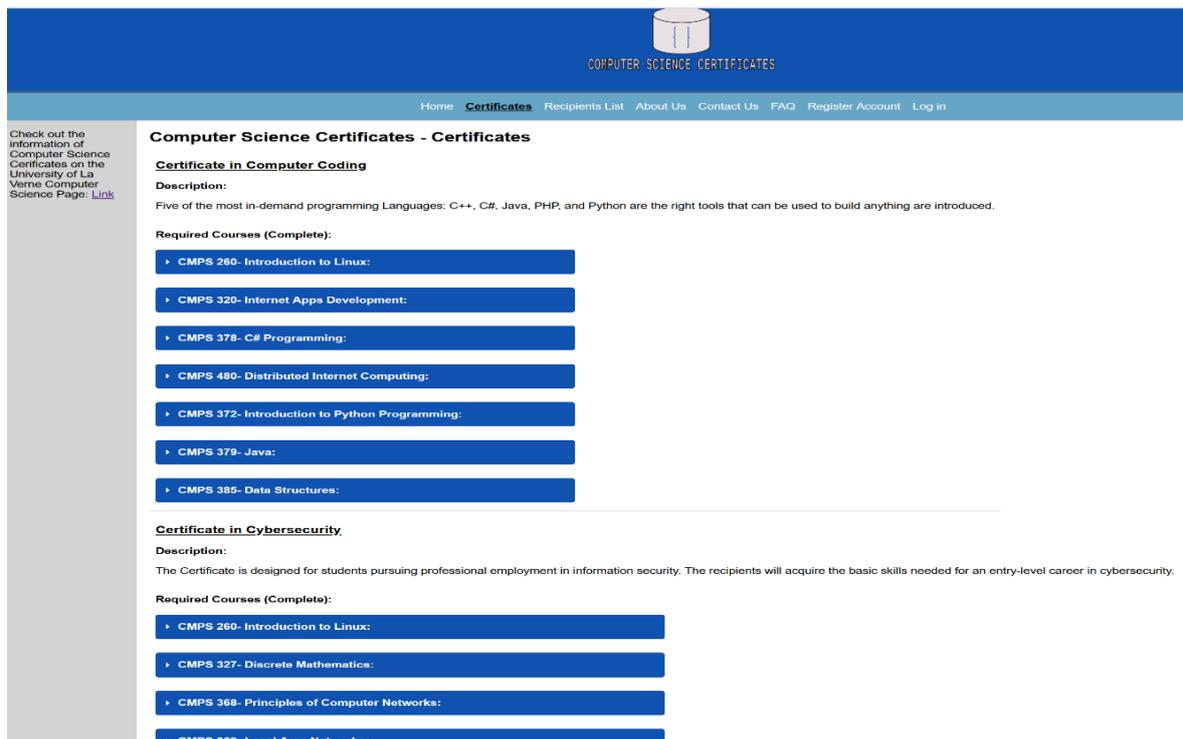


Figure 3. The Public Component of the Certificate Page

Check out the information of Computer Science Certificates on the University of La Verne Computer Science Page: [Link](#)

**Computer Science Certificates - Recipients List**

18 recipients have been submitted to the CS Certificate Database.

Functions	Student First Name	Student Last Name	Major	Concentration	Certificate Name	Date of Completion	User
	Antonio	Flores	Computer Science	Internet Programming	Certificate in Website and Internet Applications Development	05-26-22	by Antonio Flores Marquez on 5th December 2022
	Dave	House	Computer Science	Artificial Intelligence	Certificate in Website and Internet Applications Development	05-26-22	by Antonio Flores Marquez on 4th December 2022
	Jayce	Donny	Computer Science	Engineering	Certificate in Systems Engineering	05-28-22	by Antonio Flores Marquez on 4th December 2022
	Kason	Penny	Computer Science	Engineering	Certificate in Systems Engineering	05-26-22	by Antonio Flores Marquez on 4th December 2022
	Theodora	Hill	Computer Science	Engineering	Certificate in Systems Engineering	05-26-22	by Antonio Flores Marquez on 4th December 2022
	Jake	Hall	Computer Science	Artificial Intelligence	Certificate in Computer Coding	05-26-22	by Antonio Flores Marquez on 4th December 2022
	Mariana	Riveros	Computer Science	Internet Programming	Certificate in Computer Coding	05-26-22	by Antonio Flores Marquez on 4th December 2022
	Hank	South	Computer Science	Internet Programming	Certificate in Website and Internet Applications Development	05-26-22	by Antonio Flores Marquez on 4th December 2022
	Josh	Deforest	Computer Science	Internet Programming	Certificate in Website and Internet Applications Development	05-28-22	by Antonio Flores Marquez on 4th December 2022
	Nick	Ball	Computer Science	Internet Programming	Certificate in Website and Internet Applications Development	05-28-22	by Antonio Flores Marquez on 4th December 2022

Select page: [1](#) | [2](#)

[Top](#)

Computer Science Certificate Internet Application © 2022  
 Home | Certificates | Recipients List | About Us | Contact Us | FAQ | Register Account | Log in  
 Best Viewed on Chrome and Firefox  
 This page was last modified on 12/20/22, 9:35:24 PM

Figure 4. The Public Component of the Recipients List Page

In order to have admin privileges the user needs to be registered (see Figure 5) and then login (see Figure 6).

Check out the information of Computer Science Certificates on the University of La Verne Computer Science Page: [Link](#)

**Computer Science Certificates - Register Form**

Your email address

Your first name

Your last name

Password

Home | Certificates | Recipients List | About Us | Contact Us | FAQ | [Register Account](#) | Log in

Figure 5. The Public Component of the Register Page

Check out the information of Computer Science Certificates on the University of La Verne Computer Science Page: [Link](#)

**Computer Science Certificates - Login Form**

Your email address

Your password

Home | Certificates | Recipients List | About Us | Contact Us | FAQ | Register Account | [Log in](#)

Figure 6. The Public Component of the Login Page

After the user is authenticated for the first time, the user has the lowest admin permission and have access to Manage Certificate menu (see Figure 7) and can add certificate records as Figure 8 shows. Manage Certificate has pagination at the bottom to improve performance by reducing the amount of data displayed on the single screen (see Figure 7).

Home Certificates Recipients List About Us Contact Us FAQ Register Account Log out

Manage Categories **Manage Recipients** Manage Certificates Manage Courses Manage User

Check out the information of Computer Science Certificates on the University of La Verne Computer Science Page: [Link](#)

**Concentration**

- Artificial Intelligence
- Engineering
- Information Science
- Internet Programming
- Software

**Certificates**

- Certificate in Computer Coding
- Certificate in Systems Engineering
- Certificate in Cybersecurity
- Certificate in Website and Internet Applications Development

Clear Filter

18 recipients have been submitted to the CS Certificate Database.

Add

Functions	Student First Name	Student Last Name	Major	Concentration	Certificate Name	Date of Completion	User
	Antonio	Flores	Computer Science	Internet Programming	Certificate in Website and Internet Applications Development	05-26-22	by Antonio Flores Marquez on 5th December 2022
	Dave	House	Computer Science	Artificial Intelligence	Certificate in Website and Internet Applications Development	05-26-22	by Antonio Flores Marquez on 4th December 2022
	Jayce	Donny	Computer Science	Engineering	Certificate in Systems Engineering	05-28-22	by Antonio Flores Marquez on 4th December 2022
	Kason	Penny	Computer Science	Engineering	Certificate in Systems Engineering	05-26-22	by Antonio Flores Marquez on 4th December 2022
	Theodora	Hill	Computer Science	Engineering	Certificate in Systems Engineering	05-26-22	by Antonio Flores Marquez on 4th December 2022
	Jake	Hall	Computer Science	Artificial Intelligence	Certificate in Computer Coding	05-26-22	by Antonio Flores Marquez on 4th December 2022
	Mariana	Riveros	Computer Science	Internet Programming	Certificate in Computer Coding	05-26-22	by Antonio Flores Marquez on 4th December 2022
	Hank	South	Computer Science	Internet Programming	Certificate in Website and Internet Applications Development	05-26-22	by Antonio Flores Marquez on 4th December 2022
	Josh	Deforest	Computer Science	Internet Programming	Certificate in Website and Internet Applications Development	05-28-22	by Antonio Flores Marquez on 4th December 2022
	Nick	Ball	Computer Science	Internet Programming	Certificate in Website and Internet Applications Development	05-28-22	by Antonio Flores Marquez on 4th December 2022

Select page: [1](#) | [2](#)

Top

Computer Science Certificate Internet Application © 2022  
antonio.floresmarquez@laverne.edu  
Home | Certificates | Recipients List | Manage User | Log out | Manage Category | Manage Recipients | Manage Certificates | Manage Courses | Manage User | Register | About Us | Contact Us | FAQ |  
This page was last modified 3/13/2023, 10:35:28 PM

Figure 7. Manage Recipients Page After the User is Authenticated for the First Time

Home Certificates Recipients List About Us Contact Us FAQ Register Account Log out

Manage Categories **Manage Recipients** Manage Certificates Manage Courses Manage User

Check out the information of Computer Science Certificates on the University of La Verne Computer Science Page: [Link](#)

**Concentration**

- Artificial Intelligence
- Engineering
- Information Science
- Internet Programming
- Software

**Certificates**

- Certificate in Computer Coding
- Certificate in Systems Engineering
- Certificate in Cybersecurity
- Certificate in Website and Internet Applications Development

19 recipients have been submitted to the CS Certificate Database.

Add

Functions	Student First Name	Student Last Name	Major	Concentration	Certificate Name	Date of Completion	User
Edit Delete	Joe	Goe	Computer Science	Internet Programming	Certificate in Website and Internet Applications Development	12-16-22	by Jozef Goetz on 14th March 2023
	Antonio	Flores	Computer Science	Internet Programming	Certificate in Website and Internet Applications Development	05-26-22	by Antonio Flores Marquez on 5th December 2022
	Dave	House	Computer Science	Artificial Intelligence	Certificate in Website and Internet Applications Development	05-26-22	by Antonio Flores Marquez on 4th December 2022
	Jayce	Donny	Computer Science	Engineering	Certificate in Systems Engineering	05-28-22	by Antonio Flores Marquez on 4th December 2022
	Kason	Penny	Computer Science	Engineering	Certificate in Systems Engineering	05-26-22	by Antonio Flores Marquez on 4th December 2022
	Theodora	Hill	Computer Science	Engineering	Certificate in Systems Engineering	05-26-22	by Antonio Flores Marquez on 4th December 2022

Figure 8. Manage Recipients Page After the User Added the Certificate

The main part of a page, after the user is authenticated, has Edit and Delete buttons and one Add button for each of the main entities: Manage Categories, Manage Recipients, Manage Certifications and Manage Courses. The admin user interface of CMA consists of the following sections: header, menu, aside, main content area with buttons (and filters for the Manage Recipients), and footer.

The main menu navigates the user to a certain entity. The functionality of each of the page changes based on the permissions of the logged in user. The just logged in user for the first time has ability to add, edit or delete any record for the Manage Recipients page (see Figure 7 - 8). The super admin users who has Edit User Access permissions can change any registered user to have selectively access to Manage Recipients and Manage Categories (see Figure 17). Figure 9 – 17 show all adding, editing and deleting permissions. All pages are responsive to the display size of a smart phone, tablet and desktop.

Home Certificates **Recipients List** About Us Contact Us FAQ Register Account Log out

Manage Categories Manage Recipients Manage Certificates Manage Courses Manage User

Check out the information of Computer Science Certificates on the University of La Verne Computer Science Page [Link](#)

### Computer Science Certificates - Recipients List

18 recipients have been submitted to the CS Certificate Database.

Functions	Student First Name	Student Last Name	Major	Concentration	Certificate Name	Date of Completion	User
<a href="#">Edit</a> <a href="#">Delete</a>	Antonio	Flores	Computer Science	Internet Programming	Certificate in Website and Internet Applications Development	05-26-22	by <a href="#">Antonio Flores Marquez</a> on 5th December 2022
<a href="#">Edit</a> <a href="#">Delete</a>	Dave	House	Computer Science	Artificial Intelligence	Certificate in Website and Internet Applications Development	05-26-22	by <a href="#">Antonio Flores Marquez</a> on 4th December 2022
<a href="#">Edit</a> <a href="#">Delete</a>	Jayce	Donny	Computer Science	Engineering	Certificate in Systems Engineering	05-28-22	by <a href="#">Antonio Flores Marquez</a> on 4th December 2022
<a href="#">Edit</a> <a href="#">Delete</a>	Kason	Penny	Computer Science	Engineering	Certificate in Systems Engineering	05-26-22	by <a href="#">Antonio Flores Marquez</a> on 4th December 2022
<a href="#">Edit</a> <a href="#">Delete</a>	Theodora	Hill	Computer Science	Engineering	Certificate in Systems Engineering	05-26-22	by <a href="#">Antonio Flores Marquez</a> on 4th December 2022
<a href="#">Edit</a> <a href="#">Delete</a>	Jake	Hall	Computer Science	Artificial Intelligence	Certificate in Computer Coding	05-26-22	by <a href="#">Antonio Flores Marquez</a> on 4th December 2022
<a href="#">Edit</a> <a href="#">Delete</a>	Mariana	Riveros	Computer Science	Internet Programming	Certificate in Computer Coding	05-26-22	by <a href="#">Antonio Flores Marquez</a> on 4th December 2022
<a href="#">Edit</a> <a href="#">Delete</a>	Hank	South	Computer Science	Internet Programming	Certificate in Website and Internet Applications Development	05-26-22	by <a href="#">Antonio Flores Marquez</a> on 4th December 2022
<a href="#">Edit</a> <a href="#">Delete</a>	Josh	Deforest	Computer Science	Internet Programming	Certificate in Website and Internet Applications Development	05-28-22	by <a href="#">Antonio Flores Marquez</a> on 4th December 2022
<a href="#">Edit</a> <a href="#">Delete</a>	Nick	Ball	Computer Science	Internet Programming	Certificate in Website and Internet Applications Development	05-28-22	by <a href="#">Antonio Flores Marquez</a> on 4th December 2022

Select page: [1](#) [2](#)

[Top](#)

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[Home](#) | [Certificates](#) | [Recipients List](#) | [Manage User](#) | [Log out](#) | [Manage Categories](#) | [Manage Recipients](#) | [Manage Certificates](#) | [Manage Courses](#) | [Manage User](#) | [Register](#) | [About Us](#) | [Contact Us](#) | [FAQ](#) | [Best Viewed on Chrome and Firefox](#)

Figure 9. The Manage Recipients Page in the Desktop

The edit button allows editing of the selected recipient (see Figure 10).

Figure 10. Edit Recipient Page

The Manage Categories, Manage Recipients, Manage Certifications and Manage Courses are editable after selecting editing or deleting buttons (see Figure 11 – 17 respectively).

Figure 11. Manage Categories Page

[Home](#) | [Certificates](#) | [Recipients List](#) | [About Us](#) | [Contact Us](#) | [FAQ](#) | [Register Account](#) | [Log out](#)  
[Manage Categories](#) | [Manage Recipients](#) | **[Manage Certificates](#)** | [Manage Courses](#) | [Manage User](#)

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**Computer Science Certificates - Manage Certificates**

Check out the information of Computer Science Certificates on the University of La Verne Computer Science Page: [Link](#)

**Certificate in Computer Coding**

**Description:**  
Five of the most in-demand programming Languages: C++, C#, Java, PHP, and Python are the right tools that can be used to build anything are introduced.

**Required Courses (Complete):**

- Certificate in Cybersecurity**

**Description:**  
The Certificate is designed for students pursuing professional employment in information security. The recipients will acquire the basic skills needed for an entry-level career in cybersecurity

**Required Courses (Complete):**

  - Certificate in Systems Engineering**

**Description:**  
The Systems Engineering Certificate Program provides the key skills and knowledge essential for successful systems engineering in today's rapidly changing environment.

**Required Courses (Complete):**

    - Certificate in Website and Internet Applications Development**

**Description:**  
This Program in Website and Internet Applications Development prepares students to design, create and administer interactive websites and applications that utilize client and server side programming technologies.

**Required Courses (Complete):**

      -

Figure 12. Manage Certificate Page

The Manage Certifications is editable after selecting Edit button (see Figure 13).

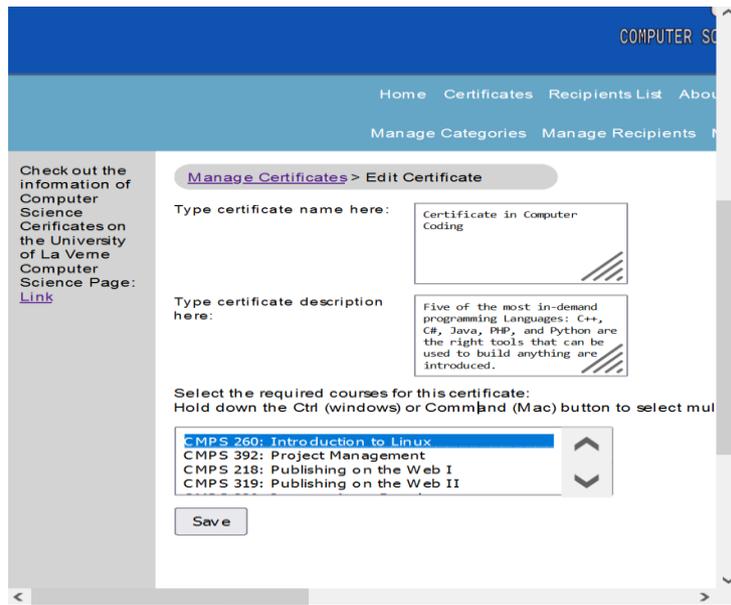


Figure 13. Edit Certificate Page

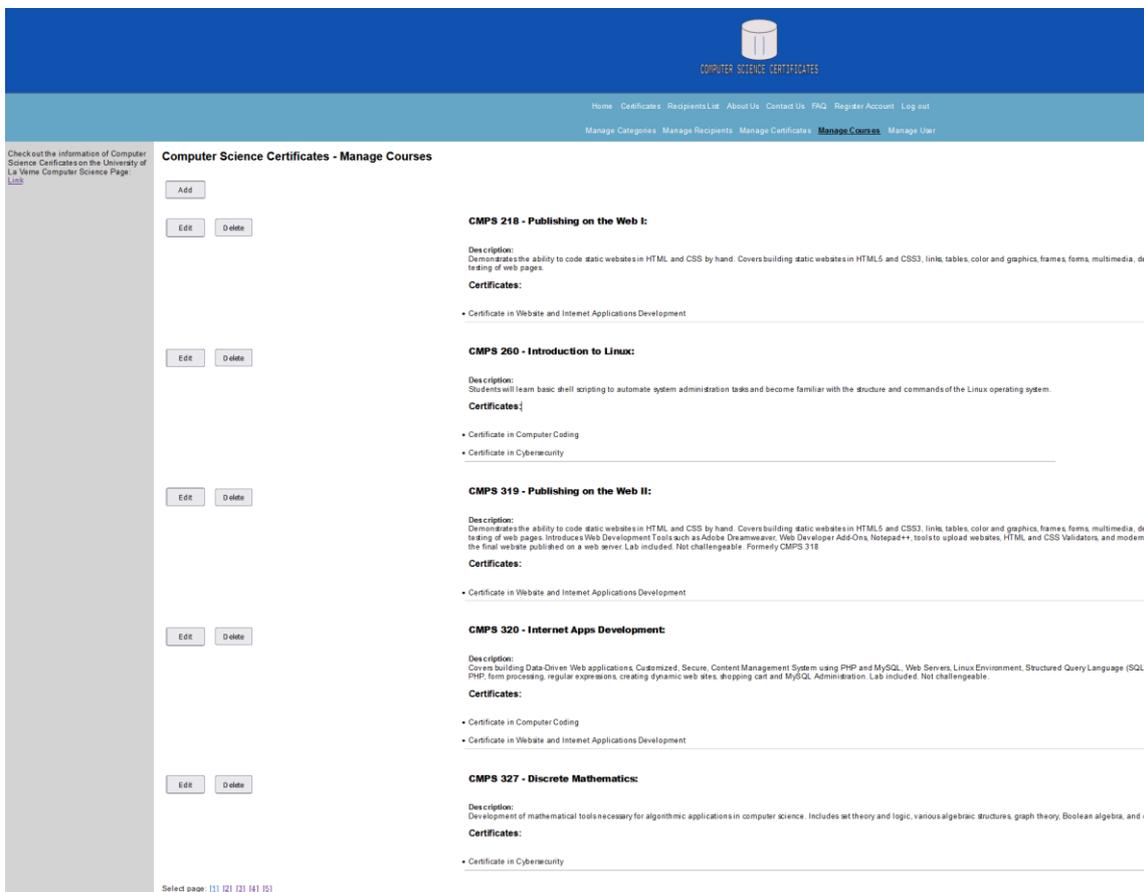


Figure 14. Manage Courses Page

The Manage Course is editable after selecting Edit button (see Figure 15).

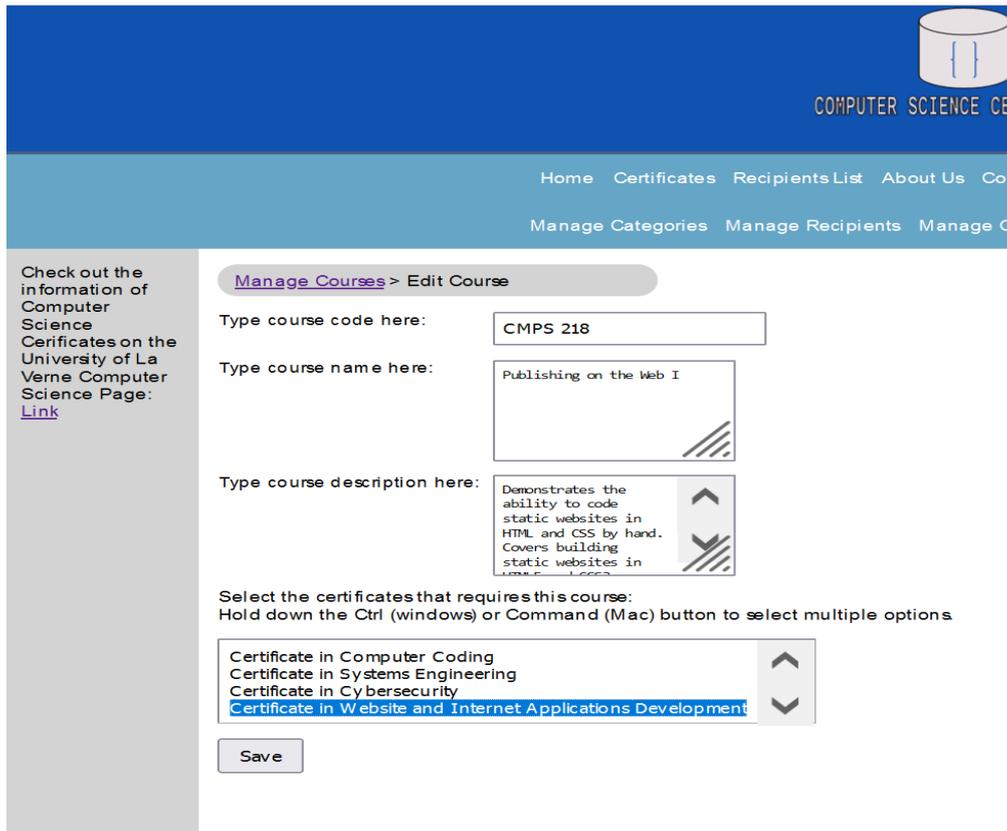


Figure 15. Edit Course Page

The admin user who has access to Menu User page can edit permission for others or yourself (see Figure 16 - 17).

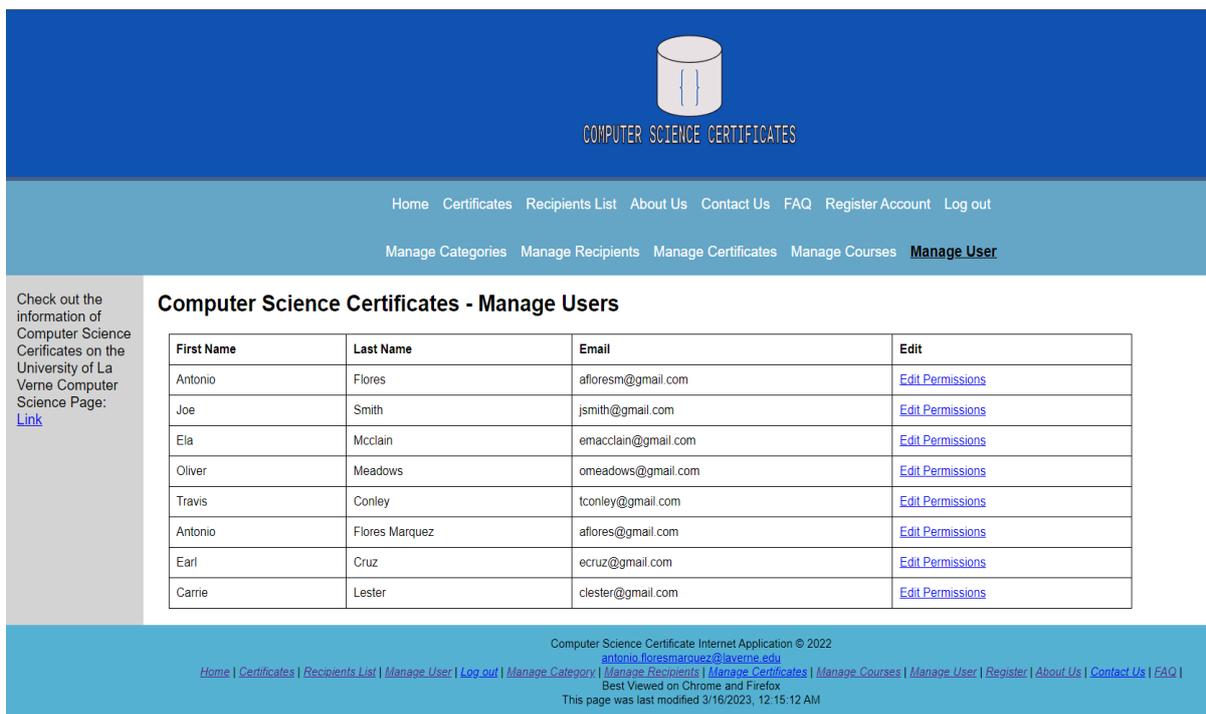


Figure 16. Manage User Page

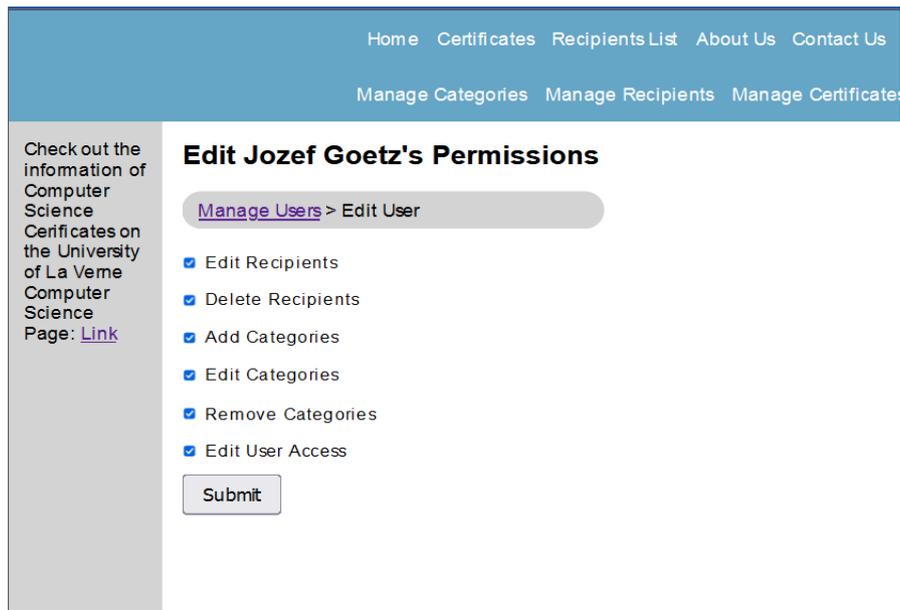


Figure 17. Edit User Page - Grant Permission

### Business Logical Layer

The Business Logical Layer (BLL) consists of PHP generic and project specific classes where data are processed. A specific connection PHP class facilitates the communication with the Data Access Layer (DAL). The BLL hides the SQL statements calls from the UI Layer (see Figure 1). The low code framework provides methods in PHP generic classes to get and send SQL commands to the database. The application also uses GET, POST and PUT requests via a PHP routing system for accessing numerous elements.

A user that is logged into the website can have multiple permissions given to them. The permissions system allows for the admin of the site to grant only the necessary permissions to the users (see Figure 17). The following are permissions that are currently available to be assigned to any user.

- *Edit Recipients* – Allows users to edit recipients' information.
- *Delete Recipients* – Allows user to delete recipients from the database.
- *Add Categories* – Allows user to add categories.
- *Edit Categories* – Allow user to edit categories.
- *Remove Categories* – Allow user to remove categories.
- *Edit User Permissions* – Allows user to edit other user permissions.

### Data Access Layer and Database

The low code framework (LCF) uses MySQL as a relational database management system (RDBMS). The database is normalized to improve performance and disk space utilization. The UI objects use the Business Logical Layer (BLL) to communicate with the Data Access Layer (DAL). The DAL connects to RDBMS and request the content that belongs in the web page. The RDBMS responds by sending the requested content to the DAL. The

DAL stores the content into one or more PHP variables of Business Logical Layer (BLL). UI layer outputs the content in the browser as part of the web page using the HTML and CSS code.

The database consists of the database tables with its primary and foreign keys. Primary, foreign keys of the tables and the admin permission determine business logic. Adding, editing and deleting table records are limited by business logic. The database structure is designed around the certification and recipient models. Application data table (see Table 1) stores user specific information about categories, certificates, courses, recipients, and users. The last column of Table 1 shows admin menu items in a relationship to the database table names in the first column. Figure 18 shows graphically the Database Table Relationship based on primary and foreign keys. Adjacent endpoints of each edge in those tables in Figure 18 are represented by the point and the bullet point and they are connected to primary and foreign keys respectively.

Table 1. Application Data Table  
(Primary Keys are in bold, Foreign Keys are in italics)

Table Name	Table Columns	Description	Related Manage Menu Item
<b>category</b>	<b>id</b> , name	Store category names.	Manage Category
<b>certificatecategory</b>	<i>certificateId</i> , <i>categoryId</i>	Link certificates with categories.	
<b>certificate</b>	<b>id</b> , <i>userId</i> , <i>certificatedetailsId</i> , studfname, studlname, major, concentration, certificatecomplete, certificatedate,	Holds information of recipients of certificates.	Manage Recipients
<b>user</b>	<b>id</b> , firstname, lastname, email, password, permissions	Holds information about the user.	Manage User
<b>certificatedetails</b>	<b>id</b> , certificatename, certificatedescription	Holds information of certificates.	Manage Certificate
<b>requiredcourses</b>	<b>id</b> , coursename, coursenumber, coursedescription	Holds information about courses.	Manage Courses
<b>certificaterequiredcourses</b>	<i>certificatedetailsId</i> , <i>requiredcoursesId</i>	Link courses with certificates.	

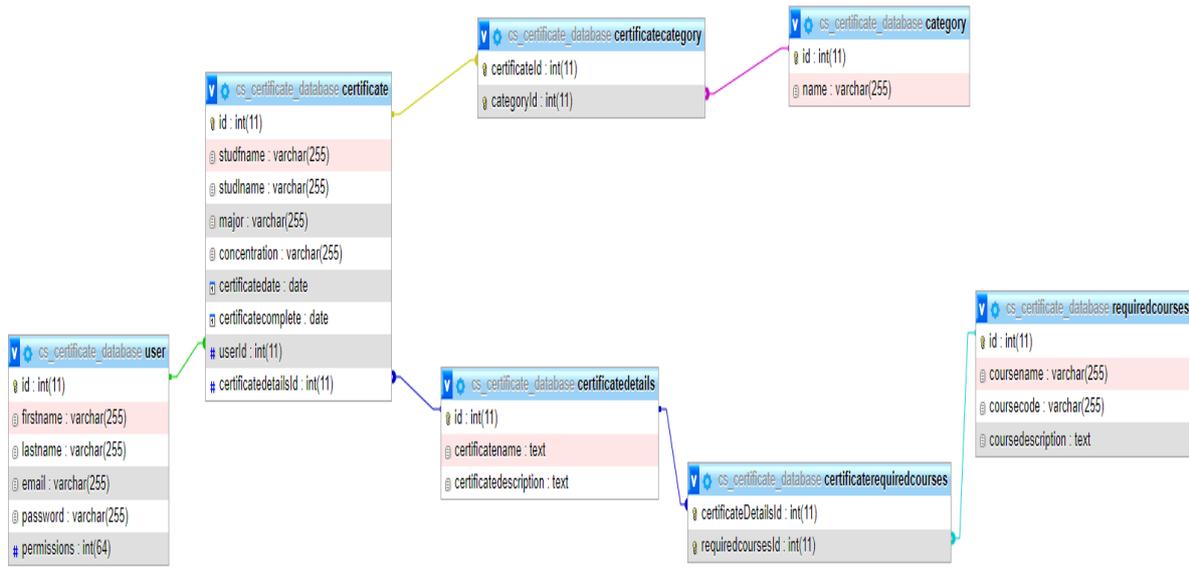


Figure 18. Visual Database Table Relationship

The certificate table database implementation in phpMyAdmin with five records of certificate recipients is shown in Figure 19.

	id	studname	studName	major	concentration	certificatedate	certificatecomplete	userID	certificatedetailsId
<input type="checkbox"/>	1	Antonio	Flores	Computer Science	Internet Programming	2022-09-07	2022-05-26	1	1
<input type="checkbox"/>	2	Antonio	Flores	Computer Science	Internet Programming	2022-09-07	2022-05-26	1	4
<input type="checkbox"/>	3	Sammy	Davis	Computer Science	Software	2022-09-07	2022-05-26	2	1
<input type="checkbox"/>	4	Clara	Williams	Computer Science	Software	2022-09-07	2022-05-28	2	1
<input type="checkbox"/>	5	Chloe	Smith	Computer Science	Information Science	2022-09-07	2022-05-28	4	3

Figure 19. Certificate Database Table with Data Examples

## Implementation

The project files in the relationship to the website map is shown in Figure 20. Certificate Management Application with all files is available at [github.com](https://github.com) [Flores Marquez, A. (2023)].

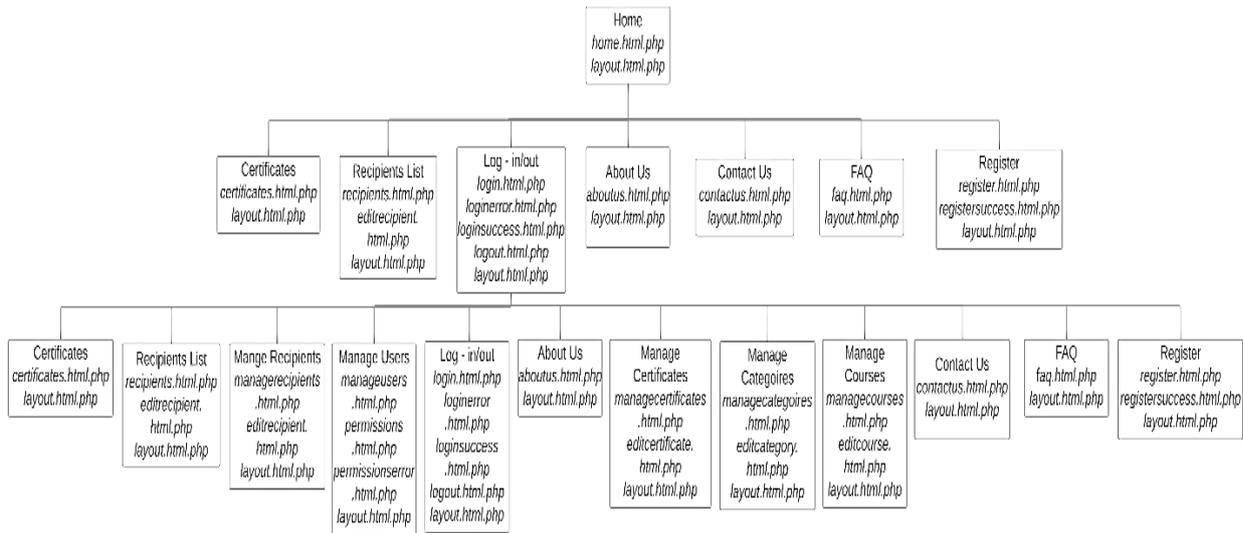


Figure 20. Website Map with Corresponding File Names

## Test and Results

Testing for the website is a very important step in the project. An example of a test case would be testing the register system (see Fig. 8). The system expects four inputs: a first name, a last name, an email address in the correct format, and password. The software has to check if the email is in the correct format and if all the fields in the form are filled. If one of these checks are not true and the software doesn't allow the user to register and doesn't let the incomplete data to be sent to the database. An example of a use case for the register system is that the user is able to visit the register page and fill out the form to register in the system. If the entered data is correct i.e. satisfied the requirements, then the data is sent to the database and the user is able to log in.

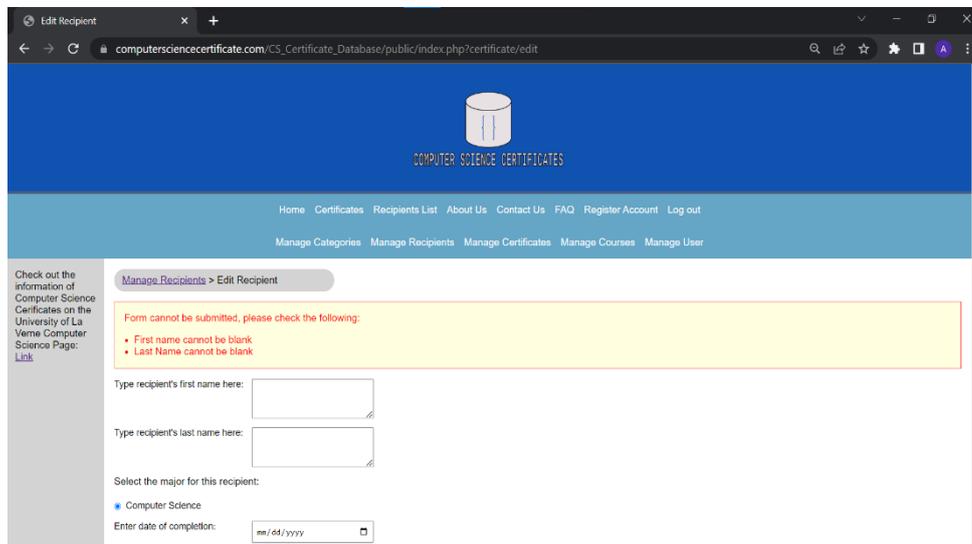
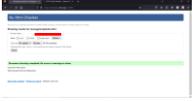
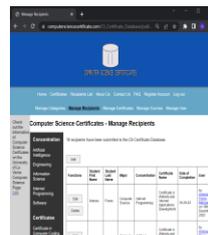
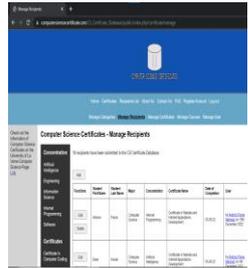
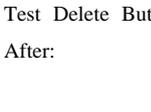


Figure 21. Registration Web Page

Testing for the website application is performed on all web pages. Responsive design principles are implemented for mobile phones, tablets and desktops (see Table 2 the last three columns). The example of Verification Matrix for the Certificate web page is shown in Table 2. All links are tested and they work. Test cases for all possible inputs are performed for any input fields on the site. HTML, CSS [Felke-Morris, T. (2021), Deitel, P. J., Deitel, H. M., & Deitel, A. (2012), PHP Butler, T., & Yank, K. (2017)] errors are tested for using validation websites [W3C Markup Validation Service (2023), W3C CSS Validation Service (2023), **PHP** Code Checker (2023)]. Testing ensures that no improper data is entered into the database.

Table 2. Test Plan and Results - Verification Matrix for the Certificate Web Page

1. Page #/name	2. Test item	3. Validation each web page using	4. Outcome in Mobile Phone Resolution 1920x1080	5. Outcome in - tablet. Resolution 1920x1080	6. Outcome in - desktop. Resolution 1440*900.
managere cipients.ht ml.php	LOGGED IN: Home=>home.ht ml.php, Certificates => certificates.html. php, Recipients List => recipientlist.html .php, About Us=>aboutus.ht ml.php, Contact Us => contactus.html.p hp, FAQ => faq.html.php,	Correct using <a href="http://validator.w3.org/">http://validator.w3.org/</a> Validate PHP code using: <a href="http://phpcodechecker.com/">http://phpcodechecker.com/</a> :	- Good display in chrome.	- Good display in chrome.	- Good display in chrome.
					
			Test Edit Button:		
					
			Test Delete Button Before:		
					
			Test Delete Button After:		
					
				Test Add Button:	
					
				User is not logged in:	
					

Register =>

Register an account,

E-mail => popup an e-mail form,

Link =>

<https://artsci.lave.rne.edu/compsci/>

,

Manage

Recipients =>

managerecipients

.html.php,

Manage Users

=>manageusers.

html.php,

Manage

Certificates =>

managecertificat

es.html.php,

Manage

Categories =>

managecategor

ies.html.php,

Manage Courses

=>

managecourses.h

tml.php,

Log out => log

user,

Add Button =>

editrecipient.htm

l.php,

Edit Button =>

editrecipient.htm

l.php,

Delete Button =>

delete function



User does not have



access:

## **Discussion**

This project has been a great exercise to show how expandable the low code interactive framework is. This is because the project involved creating a website that was able to read and write user inputs from a database. This is a complex task that requires a lot of functionality, and the fact that the project was able to be completed using a low code interactive framework demonstrates the flexibility and scalability of these frameworks. Many new additions to the various PHP, CSS and HTML files were needed in order to achieve a full functionality of Certificate Management Application. One addition was creating Manage Categories, Manage Certificates, Manage Courses, Manage Recipients, and Manage User. Another addition implementing a secondary level of the navigation which only displays if the user is logged in. Software like Notepad++ [Notepad++ (2023)], Visual Studio Code [Visual Studio Code (2023)] and phpMyAdmin which is bundled with XAMPP [XAMPP (2023)] were used as the core software when constructing the web application. The results of the project show that a web application for keeping track of certificates and recipients is necessary to make the process of tracking and sharing information more efficient than using Excel spreadsheet. The project was successfully designed and implemented.

## **Limitations and Future Expansion**

Certificate Management Application is an emerging application therefore, it is limited in features. The current version allows privileged users to perform create, read, write, and delete operations on the connected MySQL database. One limitation in the current version of the website is that changes in permissions are not notified to user whose permissions have been changed. Another limitation is that the user can only filter recipients using the certificate name and concentration of the recipient.

To solve these limitations there will have to be future expansion to the current version of the web application. Potential expansion can fit into data navigation. In the data navigation all columns for the course page can be expanding by adding ascending and descending order feature. Additional development is to introduce a two-factor authentication security subsystem. One future enhancement will be introducing a filter system where users can enter the names of recipients to filter results. Another search functionality for entities such as the recipients should be implemented for any attributes that entity may have. The database should be expanded to include the information of managers of the certificates and build a notifying system around the managers.

## **Conclusion**

The goal of this work is achieved within the computer science senior project by studying, learning and expanding coding of the low code interactive, secure framework for the purpose of designing, implementing and testing Certificate Management Application. The main goal of the senior project course (CMPS 499) is to provide a capstone experience in which the student combines knowledge, skills and topics that the student already learned with some new learned topics during the course. In addition, students need to have a senior project presentation

and write a final project report. All computer science undergraduates are required to take a capstone course senior project at the La Verne University and many other universities [Computer Science Curricula (2013)].

Moreover, the senior project course (CMPS 499) satisfies the following Program Criteria for Computer Science student outcomes [Accreditation Board for Engineering and Technology – ABET (2022-2023)] as follows:

- Ability to analyze a complex computing problem and to apply principles of computing and other relevant disciplines to identify solutions.
- Ability to design, implement, and evaluate a computing-based solution to meet a given set of computing requirements in the context of the program's discipline.
- Ability to communicate effectively in a variety of professional contexts.
- Ability to apply computer science theory and software development fundamentals to produce computing-based solutions.

Before starting work on a senior project, in another class (CMPS 320 - Internet Apps Development), students learn how to construct dynamic, data-driven web applications, and secure, customized content management systems using PHP and MySQL. Students develop skills in many aspects of the software development and deployment process. Students develop basic and intermediate skills in structured Query Language (SQL), MySQL, development using PHP, form processing, and regular expressions. Therefore, many new additions to the various PHP and HTML framework files were successfully added or modified to achieve the well-structured, full functionality of Certificate Management Application. The design, implementation and testing of Certificate Management Application with a wide spectrum of functionality is an excellent proof of a senior project achievement beyond regular CMPS 499 requirements.

The current version of Certificate Management Application provides an excellent base for expansion with low code framework it uses. The web application provides the ability to create, read, update, and delete entries in the connected database built using PhpMyAdmin. The connected database itself and the admin component of Certificate Management Application provides a strong foundation for expanding the functions of the website.

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