

# **Certificate Management Application**

Antonio Flores Marquez<sup>(D)</sup> University of La Verne, USA

Jozef Goetz 匝 University of La Verne, USA

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# **Certificate Management Application**

#### Antonio Flores Marquez, Jozef Goetz

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.

# 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 usergenerated 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, 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.

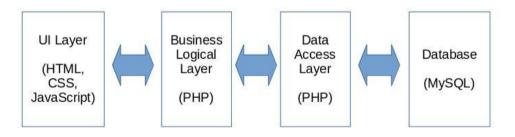


Figure 1. Framework Logical Layers (FLL)

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 <del>created</del> 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).

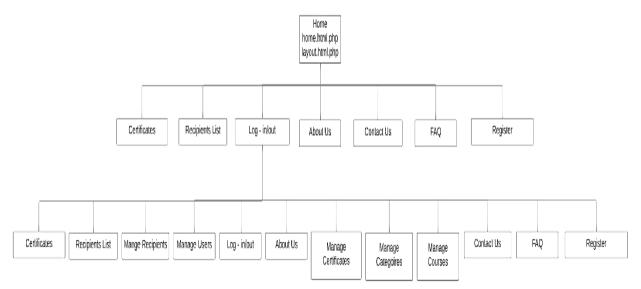
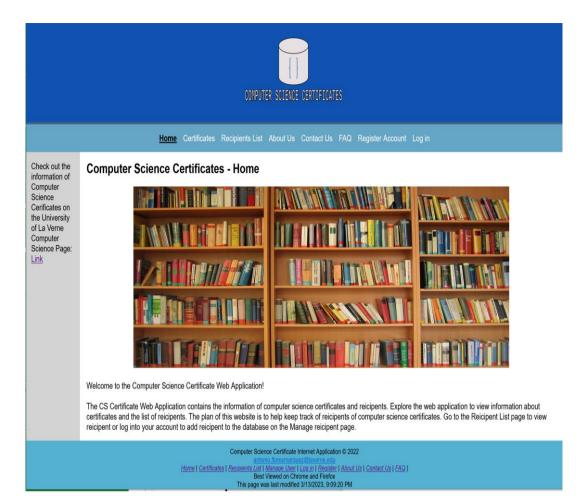


Figure 1. Website Map

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).





	COMPUTER SCIENCE CERTIFICATES
	Home Certificates Recipients List About Us Contact Us FAQ Register Account Log in
Check out the information of information of meco control of the second control of the second verse Computer Verse Computer Verse Computer Science Page: Link	Computer Science Certificates - Certificates         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):         • CMPS 280- Internet Apps Development:         • CMPS 378- C# Programming:         • CMPS 480- Distributed Internet Computing:         • CMPS 372- Introduction to Python Programming:         • CMPS 378- Java:
	CMPS 385- Data Structures:
	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): CMPS 260- Introduction to Linux:
	CMPS 327- Discrete Mathematics:
	CMPS 368- Principles of Computer Networks:
	CMPS 369- Local Area Networks

Figure 3. The Public Component of the Certificate Page

COMPUTER SCIENCE CERTIFICATES														
Home Centrificates <u>Recipients List</u> About Us Contact Us FAQ Register Account Log in														
ck out the mation of puter Science	Computer Science Certificates - Recipients List													
icates on the ersity of La e Computer nce Page: Link	Concentration 18 recipients have been submitted to the CS Certificate Database. Artificial													
nos i ago. <u>Lun</u>	Intelligence Engineering	Functions	Student First Name	Student Last Name	Major	Concentration	Certificate Name	Date of Completion	User					
	Information Science		Antonio	Flores	Computer Science	Internet Programming	Certificate in Website and Internet Applications Development	05-26-22	by Antonio Flores Marquez on 5th December 2022					
	Internet Programming		Dave	House	Computer Science	Artificial Intelligence	Certificate in Website and Internet Applications Development	05-26-22	by Antonio Flores Marquez on 4th December 2022					
	Software Certificates		Jayce	Donny	Computer Science	Engineering	Certificate in Systems Engineering	05-28-22	by Antonio Flores Marquez on 4th December 2022					
	Certificate in Computer Coding		Kason	Penny	Computer Science	Engineering	Certificate in Systems Engineering	05-26-22	by Antonio Flores Marquez on 4th December 2022					
	Certificate in Systems		Theodora	нш	Computer Science	Engineering	Certificate in Systems Engineering	05-26-22	by Antonio Flores Marquez on 4th December 2022					
	Engineering Certificate in Cybersecurity		Jake	Hall	Computer Science	Artificial Intelligence	Certificate in Computer Coding	05-26-22	by Antonio Flores Marquez on 4th December 2022					
	Certificate in Website and		Mariana	Riveros	Computer Science	Internet Programming	Certificate in Computer Coding	05-26-22	by Antonio Flores Marquez on 4th December 2022					
	Internet Applications Development		Hank	South	Computer Science	Internet Programming	Certificate in Website and Internet Applications Development	05-26-22	by Antonio Flores Marquez on 4th December 2022					
	Clear Filter		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					
	4	Select page:	[1] 2											
						antonio flore smaros								
	Computer Sciences Centribute Internet Application © 2002 Atoms   Centributes   Research Line  / Anones Line  ( Anones Line  ( Anone Line) ( A													

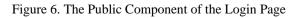
Figure 4. The Public Component of the Recipients List Page

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

					COMPU	TER SCIENC	E CERTIFICA	TES		
			Home	Certificates	Recipients List	About Us	Contact Us	FAQ	Register Account	Log in
Check out the information of Computer Science Certificates on the University of La Verne Computer Science Page: Link	Computer Science Your email address Your first name Your last name Password Register account	Certificates	- Reg	ister For	'n					

Figure 5. The Public Component of the Register Page

	CONPUTER SCIENCE CERTIFICATES
	Home Certificates Recipients List About Us Contact Us FAQ Register Account Log in
Check out the information of Computer Science Cerificates on the University of La Verne Computer Science Page: Link	Computer Science Certificates - Login Form         Your email address         Your password         Log in



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).

out the ation of	Computer Sci	Computer Science Certificates - Manage Recipients													
uter ce cates on the rsity of La Computer ce Page:	Concentration Artificial Intelligence	18 recipien	18 recipients have been submitted to the CS Certificate Database.												
	Engineering Information Science	Functions	Student First Name	Student Last Name	Major	Concentration	Certificate Name	Date of Completion	User						
	Internet Programming		Antonio	Flores	Computer Science	Internet Programming	Certificate in Website and Internet Applications Development	05-26-22	by <u>Antonio Flores</u> <u>Marquez</u> on 5th December 2022						
	Software Certificates		Dave	House	Computer Science	Artificial Intelligence	Certificate in Website and Internet Applications Development	05-26-22	by <u>Antonio Flores</u> <u>Marquez</u> on 4th December 2022						
	Certificate in Computer Coding		Jayce	Donny	Computer Science	Engineering	Certificate in Systems Engineering	05-28-22	by <u>Antonio Flores</u> <u>Marquez</u> on 4th December 2022						
	Certificate in Systems Engineering		Kason	Penny	Computer Science	Engineering	Certificate in Systems Engineering	05-26-22	by <u>Antonio Flores</u> <u>Marquez</u> on 4th December 2022						
	Certificate in Cybersecurity		Theodora	Hill	Computer Science	Engineering	Certificate in Systems Engineering	05-26-22	by <u>Antonio Flores</u> <u>Marquez</u> on 4th December 2022						
	Certificate in Website and Internet Applications		Jake	Hall	Computer Science	Artificial Intelligence	Certificate in Computer Coding	05-26-22	by <u>Antonio Flores</u> <u>Marquez</u> on 4th December 2022						
	Development		Mariana	Riveros	Computer Science	Internet Programming	Certificate in Computer Coding	05-26-22	by <u>Antonio Flores</u> <u>Marquez</u> on 4th December 2022						
	Clear Filter		Hank	South	Computer Science	Internet Programming	Certificate in Website and Internet Applications Development	05-26-22	by <u>Antonio Flores</u> <u>Marquez</u> on 4th December 2022						
			Josh	Deforest	Computer Science	Internet Programming	Certificate in Website and Internet Applications Development	05-28-22	by <u>Antonio Flores</u> <u>Marquez</u> on 4th December 2022						
			Nick	Ball	Computer Science	Internet Programming	Certificate in Website and Internet Applications Development	05-28-22	by <u>Antonio Flores</u> <u>Marquez</u> on 4th December 2022						
		Select page:	[1] 2												

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

		Но	ome Certifica	ates Recipio	ents List Ab	out Us Contact	Us FAQ Register Accor	unt Log out							
				ies <u>Manage</u>	e Recipients										
Check out the information of Computer	Computer Science Certificates - Manage Recipients														
Science Cerificates on the	Concentration	Concentration 19 recipients have been submitted to the CS Certificate Database.													
University of La Verne Computer Science Page: Link	Artificial Intelligence Engineering	Add													
	Information Science	Functions	Student First Name	Student Last Name	Major	Concentration	Certificate Name	Date of Completion	User						
	Internet Programming Software	Edit	Joe	Goe	Computer Science	Internet Programming	Certificate in Website and Internet Applications Development	12-16-22	by Jozef Goetz on 14th March 2023						
	Certificates Certificate in Computer Coding		Antonio	Flores	Computer Science	Internet Programming	Certificate in Website and Internet Applications Development	05-26-22	by Antonio Flores Marguez on 5th December 2022						
	Certificate in Systems Engineering		Dave	House	Computer Science	Artificial Intelligence	Certificate in Website and Internet Applications Development	05-26-22	by <u>Antonio Flores</u> <u>Marquez</u> on 4th December 2022						
	Certificate in Cybersecurity		Jayce	Donny	Computer Science	Engineering	Certificate in Systems Engineering	05-28-22	by Antonio Flores Marquez on 4th December 2022						
	Certificate in Website and Internet Applications		Kason	Penny	Computer Science	Engineering	Certificate in Systems Engineering	05-26-22	becember 2022 by Antonio Flores Marquez on 4th December 2022						
	Development		Theodora	нш	Computer	Engineering	Certificate in Systems		by Antonio Flores						

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.

	ce Certifi	e Certificates - Recipients List											
Concentration Artificial Intelligence													
Engineering Information Science	Functions	Student First Name	Student Last Name	Major	Concentration	Certificate Name	Date of Completion	User					
Internet Programming Software	Edit Delete	Antonio	Flores	Computer Science	Internet Programming	Certificate in Website and Internet Applications Development	05-26-22	by <u>Antonio Flores Marquez</u> on 5th December 2022					
Certificates Certificate in Computer Coding Certificate in Systems	Edit Delete	Dave	House	Computer Science	Artificial Intelligence	Certificate in Website and Internet Applications Development	05-26-22	by <u>Antonio Flores Marquez</u> on 4th December 2022					
Engineering Certificate in Cybersecurity Certificate in Website and Internet Applications	Edit	Jayce	Donny	Computer Science	Engineering	Certificate in Systems Engineering	05-28-22	by <u>Antonio Flores Marquez</u> on 4th December 2022					
Clear Filter	Edit Delete	Kason	Penny	Computer Science	Engineering	Certificate in Systems Engineering	05-26-22	by <u>Antonio Flores Marquez</u> on 4th December 2022					
	Edit Delete	Theodora	HII	Computer Science	Engineering	Certificate in Systems Engineering	05-26-22	by <u>Antonio Flores Marquez</u> on 4th December 2022					
	Edit Delete	Jake	Hall	Computer Science	Artificial Intelligence	Certificate in Computer Coding	05-26-22	by <u>Antonia Flores Marquez</u> on 4th December 2022					
	Edit Delete	Mariana	Riveros	Computer Science	Internet Programming	Certificate in Computer Coding	05-26-22	by <u>Antonio Flores Marquez</u> on 4th December 2022					
	Edit Delete	Hank	South	Computer Science	Internet Programming	Certificate in Websile and Internet Applications Development	05-26-22	by <u>Antonio Flores Marquez</u> on 4th December 2022					
	Edit	Josh	Deforest	Computer Science	Internet Programming	Certificate in Websile and Internet Applications Development	05-28-22	by <u>Antonia Flores Marquez</u> on 4th December 2022					
	Edit Delete	Nick	Ball	Computer Science	Internet Programming	Certificate in Websile and Internet Applications Development	05-28-22	by <u>Antonio Flores Marquez</u> on 4th December 2022					
	elect page: [1 Top	]2	1	1		1		<u>.</u>					

Figure 9. The Manage Recipients Page in the Desktop

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

			Manago Catogorios	Manago Docinionte	Manago Cortificatos		likor					
			Manage Categories	Manage Recipients	manage Centilicates	Manage Courses Manage	0361					
Check out the information of Computer	Manage Recipients > Edit Re	ecipient										
Science Cerificates on the University of La Verne Computer Science	Type recipient's first name here:	Antonio										
Page: Link												
	Type recipient's last name here:	Flores										
		11.										
	Select the major for this recipie	nt										
	<ul> <li>Computer Science</li> </ul>											
	Enter date of completion:	05 / 26 / 2022 📋										
	Select the concentration for this recipient:											
	<ul> <li>Artificial Intelligence</li> </ul>											
	<ul> <li>Engineering</li> </ul>											
	<ul> <li>Information Science</li> </ul>											
	Internet Programming											
	<ul> <li>Software</li> </ul>											
	Select the certificate received to	by the recipient:										
	<ul> <li>Certificate in Computer Coding</li> </ul>	9										
	<ul> <li>Certificate in Systems Engineering</li> <li>Certificate in Cybersecurity</li> </ul>											
	<ul> <li>Certificate in Website and Internet Applications Development</li> </ul>											
	Save											
				Computer Science	Certificate Internet Applicat	tion © 2022						
	E	tome   Certificates   Recipients List   M	lanage User   Log.out   Ma	Best Vie	Recipients   Manage Certi wed on Chrome and Firefor ast modified 3/14/2023, 6:2	x	User   Register   About Us   Contact Us   FAQ					

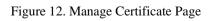
Figure 10. Edit Recipient Page

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

	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 - Manage Categories
Computer Science Cerificates on the	Add
University of La Verne Computer Science Page: Link	Edit Delete Artificial Intelligence
	Edit Delete Engineering
	Edit Delete Information Science
	Edit Delete Internet Programming
	Edit Delete Software

Figure 11. Manage Categories Page

		Home Certificates Recipients List About Us Contact Us FAQ: Register Account Log out
0		Manage Categories Manage Recipients Manage Certificates Manage Counces Manage User
Check out the information of Computer Science Cerificates on the University of La Verne Computer Science Page: Link	Computer Science Certificates - Ma	nage Certificates
	Add	
	Edit Delete	Certificate in Computer Coding
		Description: Five of the most in-demand programming Languages: C++, OH, Java, PHP, and Python are the right tools that can be used to build anything are introduced.
		Required Courses (Complete):
		CMPS 280- Introduction to Linux:
		CMPS 320- Internet Apps Development:
		CMPS 378-C# Programming:
		CMPS 480- Distributed Internet Computing:
		CMPS 372- Introduction to Python Programming:
		+ CMPS 378-Java:
		CMPS 385- Data Structures:
		Certificate in Cybersecurity
	Edit Delete	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):
		CMPS 280-Introduction to Linux:
		CMPS 327- Discrete Mathematics:
		CMPS 368- Principles of Computer Networks:
		CMPS 389- Local Area Networks:
		CMPS 366- Programming in C:
		CMPS 371-Assembly Language:
		CMPS 420- Cyber Security:
	Edit Delete	Certificate in Systems Engineering
		Description: The Systems Engineering Certificate Program provides the key stills and knowledge essential for successful systems engineering in today's rapidly changing environment.
		Required Courses (Complete):
		CMPS 392- Project Management:
		+ CMPS 370- Seminar:
		CMPS 376- Systems Analysis and Design:
		CMPS 410- Management Information Systems:
		CMPS 491- Systems Architecture:
	Edit Delete	Certificate in Website and Internet Applications Development
		Description: This Program in Website and Internet Applications Development prepares students to design, greate and administer interactive websites and applications that utilize client and server side
		programming technologies.
		Required Courses (Complete):  CMP5 218-Publishing on the Web 1:
		CMPS 319- Publishing on the Web II:
		CMPS 320- Internet Apps Development:
		CMPS 378- C# Programming:
		CMPS 480-Distributed Internet Computing:
		CMPS 481- Mobile Applications Development:
	Select page: [1]	
	Тор	



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

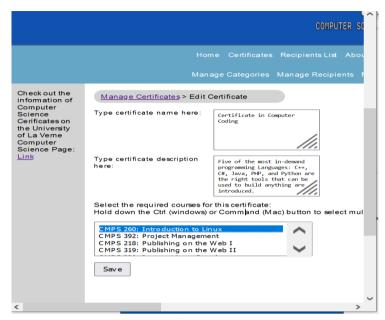


Figure 13. Edit Certificate Page

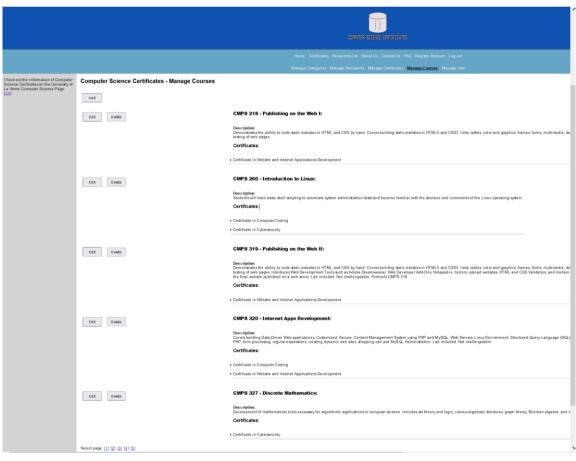


Figure 14. Manage Courses Page

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

		COMPUTER SCIENCE CE					
		Home Certificates RecipientsList About Us Co					
		Manage Categories Manage Recipients Manage C					
Check out the information of	Manage Courses > Edit Cour	se la					
Computer Science Cerificates on the	Type course code here:	CMPS 218					
University of La Verne Computer Science Page: <u>Link</u>	Type course name here:	Publishing on the Web I					
	Type course description here:	Demonstrates the ability to code static websites in HTML and CSS by hand. Covers building static websites in					
	Select the certificates that required to the certificates that required to the Ctrl (windows) of the certificates the certifi						
	Hold down the Ctrl (windows) or Command (Mac) button to select multiple options. Certificate in Computer Coding Certificate in Systems Engineering Certificate in Cybersecurity Certificate in Website and Internet Applications Development Save						

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).

			COMPUTER SCIENCE CERTIFICATES		
			es Recipients List About Us Contact Us FAC s Manage Recipients Manage Certificates Ma		
Check out the information of Computer Science	Computer Sci	ence Certificates - Ma	anage Users		
Cerificates on the	First Name	Last Name	Email	Edit	
University of La Verne Computer	Antonio	Flores	afloresm@gmail.com	Edit Permissions	
Science Page: Link	Joe	Smith	jsmith@gmail.com	Edit Permissions	
	Ela	Mcclain	emacclain@gmail.com	Edit Permissions	
	Oliver	Meadows	omeadows@gmail.com	Edit Permissions	
	Travis	Conley	tconley@gmail.com	Edit Permissions	
	Antonio	Flores Marquez	aflores@gmail.com	Edit Permissions	
	Earl	Cruz	ecruz@gmail.com	Edit Permissions	
	Carrie	Lester	clester@gmail.com	Edit Permissions	
	Home   Certificates	s   Recipients List   Manage User   Log.out	Computer Science Certificate Internet Application © antonio foresmarcuez@iaveme.edu Manage Category Manage Receptonts   Manage Certificates Best Viewed on Chrome and Firefox This page was last modified 3/16/2023, 12:15:12 /	Nanage Courses   Manage User   Register   About Us   Contact U	<u>/s   FAQ  </u>

Figure 16. Manage User Page

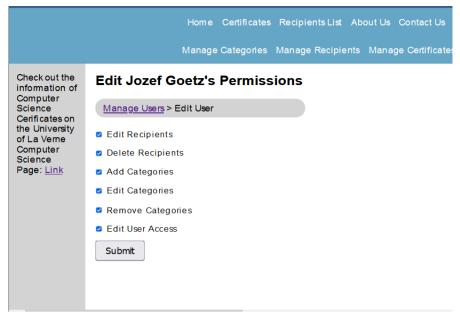


Figure 17. Edit User Page - Grant Permission

#### **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 Name	Table Columns	Description	Related Manage
			Menu Item
category	id, name	Store category names.	Manage Category
certificatecategor	certificateId,	Link certificates with	
У	categoryId	categories.	
certificate	id, userId,	Holds information of	Manage Recipients
	certificatedetailsId,	recipients of	
	studfname,	certificates.	
	studlname, major,		
	concentration,		
	certificatecomplete,		
	certificatedate,		
		Halda information	Managa
user	id, firstname,	Holds information	Manage User
	lastname, email,	about the user.	
	password,		
	permissions		
certificatedetails	id, certificatename,	Holds information of	Manage Certificate
	certificatedescription	certificates.	
requiredcourses	id, coursename,	Holds information	Manage Courses
	coursenumber,	about courses.	
	coursedescription		
certificaterequire	certificatedetailsId,	Link courses with	
dcourses	requriedcoursesId	certificates.	

 Table 1. Application Data Table

 (Primary Keys are in hold Foreign Keys are in italics)

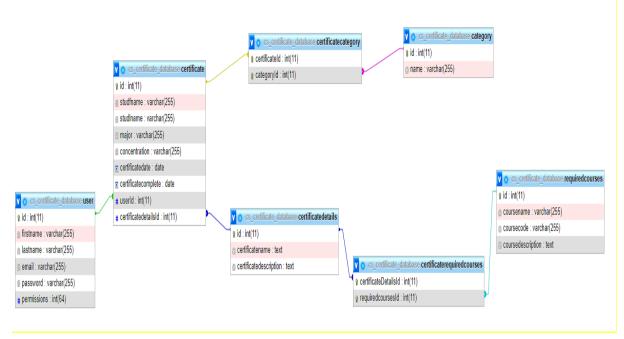


Figure 18. Visual Database Table Relationship

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

Recent Favorites										
œ	Showing rows 0	- 4 (5 total, Query	took 0.0013 se	conds.)						
	SELECT * FROM `c	ertificate`								
ture books ture	Profiling [ Edit inl	ne][Edit][Expl	ain SQL ] [ Crea	ate PHP code ]	[Refresh]					
🗄 🗐 chapter09										
- cs_certificate_database	Show all	Number of rows:	25 🗸	Filter rows:	Search this table	Sort by key:	None	~		
- Rew	+ Options									
• A category	+T→	⊽ id	studfname	studIname	major	concentration	certificatedate	certificatecomplete	userld	certificatedetailsId
• Certificate	🗌 🥜 Edit 👫 Cr	py 😂 Delete 1	Antonio	Flores	Computer Science	Internet Programming	2022-09-07	2022-05-26	1	1
certificatecategory     certificatedetails	🗌 🥜 Edit 👫 Co	py 🥥 Delete 2	Antonio	Flores	Computer Science	Internet Programming	2022-09-07	2022-05-26	1	4
			-						2	4
⊕ ✓ requiredcourses	🛛 🗌 🥜 Edit 👫 Co	py 🤤 Delete 3	Sammy	Davis	Computer Science	Software	2022-09-07	2022-05-26	2	1
+		py 🤤 Delete 3 py 😄 Delete 4		Davis Williams	Computer Science		2022-09-07 2022-09-07	2022-05-26 2022-05-28	2	1
T · ·	🗌 🥜 Edit 👫 Co		Clara		Computer Science	Software				1 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 [Flores Marquez, A. (2023)].

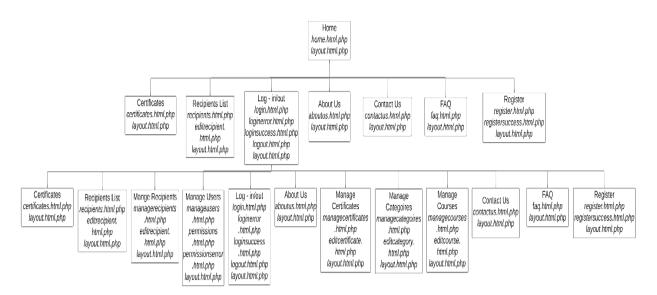


Figure 20. Website Map with Corresponding File Names

## **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.

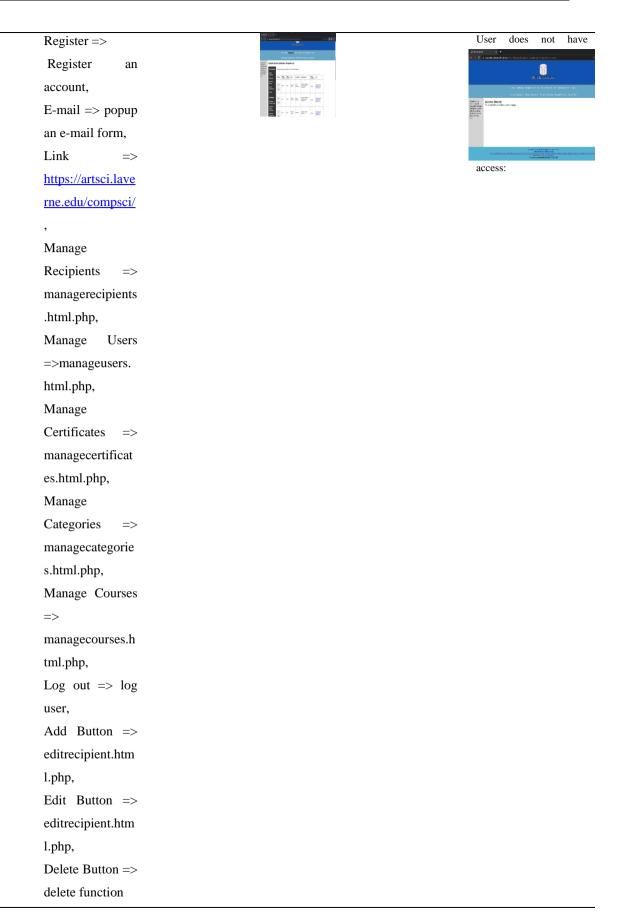
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Cerificates on the University of La Verne Computer Science Page: Link	Form cannot be submitted, please First name cannot be blank Last Name cannot be blank	check the following:					
	Type recipient's first name here:						
	Type recipient's last name here:						
	Select the major for this recipient:						
	Computer Science						
	Enter date of completion:	3d/yyyy 🗖					

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.

1. Page       2. Test item       3. Validation       4. Outcome       5. Outcome in       6. Outcome in         #/name       - list hyperlinks,       each web page       in Mobile       - tablet.       - desktop.         list       all       fields,       buttons,       using       Phone       Resolution       Resolution         pages       in videos,       http://validator.w       Resolution       1920x1080       1440*900.         order       GUI       controls,       http://validator.w       Resolution       1920x1080       1440*900.         order       GUI       controls,       http://validator.w.3o       reaction       - Good display in       - Good display in <td< th=""><th></th><th>Table 2. Test P</th><th>lan and Results - Ver</th><th>rification Matrix fo</th><th>r the Certificate Web</th><th>Page</th></td<>		Table 2. Test P	lan and Results - Ver	rification Matrix fo	r the Certificate Web	Page
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Table 2. Test Plan and Results - Verification Matrix for the Certificate Web Page



# 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 computingbased 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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Author Information				
Antonio Flores Marquez	Jozef Goetz			
b https://orcid.org/0009-0000-1615-1266	b https://orcid.org/0009-0004-7751-3653			
University of La Verne	University of La Verne			
1950 Third Street, La Verne, CA 91750	1950 Third Street, La Verne, CA 91750			
USA	USA			
Contact e-mail: antonio.floresmarquez@laverne.edu				