Allegheny College
Department of Computer Science

Senior Thesis

ProgMagus LMS, the Python Programming Language Learning Management System

by

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Abstract

The research paper explores ProgMagus LMS, an open-source Learning Management System adapted for instructors in Computer Science, specifically focusing on Python Programming language. ProgMagus LMS focuses on simplicity and ease of use. This research paper investigates how the platform addresses challenges related to complexity, lack of functionalities, and high costs, offering valuable insights into effective course management the field of Computer Science and Python Programming. With the evolution on Learning Management Systems, the aim has been towards the subjects that are getting more popular, like Python Programming Language. Most of the popular Learning Management Systems do not aim to include coding or any support to code in their platform, which does not give the opportunity to those who want to improve their coding skills. The aim of this research paper is to focus on instructors and their ease to manage content about Python Programming Language and provide practice to their students or users and to provide a solution to the problem of Modern Learning Management Systems that face high cost, complexity and lack of functionalities. Evaluation conducted to students to use ProgMagus LMS to determine if it is an efficient software to use for Python programming language and intro courses of Computer Science.

Table of Contents

List of Figures

List of Tables

Appreciation

Words cannot explain the feeling of gratitude towards my professors, assistant professors, associate professors and chair of the Computer Science department. All of those who I just mentioned, have provided me with expertise and knowledge, which has been making this journey of completing my Bachelor of Science in Computer Science and Thesis project more enjoyable. Without those who helped me throughout rough times, I would not be able to accomplish this milestone in my life. I am so grateful for completing my research with the help of the professors in the Computer Science department.

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Furthermore, I must recognize my family's role in my journey. Their infinite support, both emotionally and financially, has been crucial to my academic success. Their belief in my abilities has helped me during moments of doubt, and I am forever grateful to them for their sacrifices and encouragement to accomplish my dreams.

In conclusion, completing my thesis project has been a challenging journey, and I am deeply grateful to all those who have played a crucial part in it and supported me at all times. From my professors to my classmates,

from Allegheny College to my family, and my friends, each of them has contributed in their own way to my academic success, and because of that, I am forever thankful with all of them.

Introduction

The thesis explores ProgMagus LMS, an open-source Learning Management System adapted for instructors in Computer Science, specifically focusing on Python Programming language. ProgMagus LMS focuses on simplicity and ease of use. This study investigates how the platform addresses challenges related to complexity, lack of functionalities, and high costs, offering valuable insights into effective course management the field of Computer Science and Python Programming.

When there is a skill that you want to develop further, practice comes first to mind. When I want to get better at something, I go back and practice it. It is all about learning and making it easy to learn. Education has always present in the development of skills, or anything, and it has been there because technology has been improving substantially. For the introduction of the Senior Thesis of ProgMagus, I have been there myself. Trying to learn a new skill or practicing some old coding techniques that did not remember well enough. I have experienced some lack of usability with software and that comes in hand with lack of functionalities, therefore it made me look for alternatives.

There were not a lot of alternatives that helped improve the Python Programming Skills, and those that were available were not focusing on the easy to manage content. Therefore, the research on which Python Programming Language LMSs were paid and not paid and how much data you can include to it. Of course there were a lot that were free, but the functionality was not as good as a premium service, or did not feel as premium as the other ones.

Over the years, computer science education has been growing, the need for effective and efficient learning management systems (LMS) is more pressing than ever. However, the existing solutions often can come with significant challenges that impact their efficiency and user experience. These challenges primarily involve around three key areas and for this project these are: high

costs, complexity, and limited functionality.

Learning Management Systems have a rich history dating back to the late 20th century. The first-generation LMSs emerged in the 1990s, primarily as tools for managing and tracking training and educational courses. [3] These early systems were rudimentary and focused on basic functionalities such as course administration and documentation.

LMSs evolved with advancements in technology, expanding their capabilities to include features like content delivery, assessment, and collaboration tools. [4] The tool of having the internet further develop and make the development of web-based LMSs, making education more accessible beyond traditional classroom settings.

Despite the progress, contemporary LMSs face significant challenges that make their effectiveness not be as good. The challenges primarily involve around high costs, complexity, and limited functionality, impacting their efficiency and user experience, as discussed earlier.

In response to the limitations of existing LMSs, ProgMagus LMS has been conceptualized as a cost-effective, user-friendly, and feature-rich platform designed explicitly for Python programming language education. This initiative starts from the recognition that current LMSs, though advanced, may not fully aim to the specialized needs of programming education.

The high costs associated with many existing LMSs can be harmful or not available for many educational institutions, particularly those with limited resources. This restricts access to quality education and creates the digital divide from students that want to learn, and instructors that want to teach. The financial cost of implementing and maintaining these systems can significantly be adapted, but not all the time making and creating limitation to their reach and effectiveness.

The complexity of use is another significant challenge. Many LMSs have complex interfaces and complicated features that can be confusing for students and instructors. This complexity can harm learning and make users not to fully utilize the system's capabilities. The steep learning curve associated with these systems can lead to frustration and disengagement, undermining these platforms' very purpose.

The limited functionality offered by many existing LMSs is the third major challenge and key problem that this project faces. Often, these systems need to provide the comprehensive tools and features necessary to facilitate effective learning and teaching. This can result in a contradicting user experience and limit the system's effectiveness. The lack of essential features can

restrict the types of content that can be delivered and the delivery methods, therefor making the learning experience not as good, and making people not want to use the tool.

The ProgMagus LMS aims to address these challenges by providing a cost-effective, user-friendly, and feature-rich platform designed explicitly for Python programming language education. Conceived during a discussion with Professor Luman from Allegheny College, ProgMagus LMS is designed to offer an intuitive platform for students and instructors to show content about Python Programming Language and to study, and practice Python programming language terms and coding.

Powered by a MongoDB database, ProgMagus LMS includes a Python terminal embedded in the lessons and offers features such as User Authentication, User Management, Content Manager/Custom Content, Python terminal, and Quiz. These features aim to overcome the limitations of existing LMSs and enhance the learning experience for students and instructors.

ProgMagus LMS provides students an opportunity to practice with instant answers, prepare for interviews, and engage with more interactive content. For instructors, it streamlines course management, enhances engagement, and provides a structured and interactive learning environment for their students.

The ethical implications of this research are profound. By developing a more accessible and user-friendly LMS, this research aims to democratize education and contribute to a more equitable learning environment. This is particularly important in the current state where the high cost and complexity of existing LMSs can improve education. By addressing these challenges, ProgMagus LMS hopes to contribute significantly to the field of computer science education. It is a step towards making education more inclusive, engaging, and practical, thereby creating a culture of continuous learning and improvement. By doing so, it hopes to contribute to the broader goal of promoting programming literacy and creating a culture of continuous learning and improvement. The success of this endeavor could pave the way for similar initiatives in the future, thereby shaping the future of computer science education.

Motivation

Existing Learning Management Systems (LMS) offer a range of features but often need to provide an interactive and engaging platform for learning programming languages. Moreover, these systems can be expensive and complex, creating additional barriers to students and instructors.

Furthermore, many students desire to improve their programming skills in their own time, outside structured class hours. They seek a flexible learning platform that allows them to learn at their own pace and according to their schedule.

Additionally, there is a growing demand for open-source software in the educational sector. Open-source software reduces costs and provides transparency and flexibility that proprietary software often needs to improve.

Traditional LMSs, like the ones used in many schools and companies, are often broad in scope. They are designed to manage and deliver educational content, from history lessons to math exercises.[9] These systems are often complex and can be hard to use.[6] They are more focused on managing the learning process rather than making it engaging or interactive.[6]

On the other hand, an LMS that focuses on Python programming is different. It is designed with the specific goal of teaching and learning Python programming language. This kind of LMS is often more interactive and engaging.[6] It can include features like code editors, error-checking tools, and even systems for students to run and test their code. This makes learning Python more hands-on and practical for computer science students.

When it comes to learning something, does not matter what it is you want the source to be available when you need it, and it can be available over the internet. There are moments in which it motivates people for having the sources on hand that are always there for them adn it makes people be more engaged and the feeling that they want to improve or learn something new. In this case this inclusivity is faced towards Python programming language, which makes a community that wants to start coding or already knows about coding to keep practicing and make their ability to code better than before.

So, when we talk about an LMS in this context, we are talking about a system designed specifically for Python programming. It is about making learning Python easier, more engaging, and more effective. And because it is open-source, it is also more flexible and adaptable.

Current State of the Art

The computer Science community has been growing a lot throughout the years and has been gaining popularity as the technology improves over the years. Computer Science education has shifted from textbook and in-person classes, to online undergraduate and master programs. There has been a lot of changes throughout the years and how people manage their time to practice their hobbies and complete their education. Some people do online classes as it is a cheaper option sometimes, or they are working most of their time, and they still want to graduate or learn something in their own time.

The development of this project has been focused to help multiple people, those who want to improve their skills in anything they want. In this case it is Python Programming Language, and it has been mostly to aim for instructors, those who want to make sure that their students and them get an easier way to show their content, learn and use it at the same.

There are competitors for online learning, specifically in Python programming language, which share some features with ProgMagus. In this case we are talking about the ability to learn Python online in a platform or documentation website, as Python is the fastest growing programming language. Online Learning is growing as platforms are uploading more and more certificates you can get within the same website that are accredited to some institutions.

Online Learning for the Python Programming Language and programming languages as a whole, is growing exponentially as more people are trying to learn about things over the internet. With this said, as the people interested in online learning is growing the online learning platforms are developing better technology every year. The competitors that are mainly doing some sort of the same idea are Codecademy, Coursera, HackerRank, among others. Some of them are mostly aiming the practice of programming language not only for Python but for a lot more programming languages and not being able to upload courses as an instructor. Either way, this is important to note, as the online learning platforms are growing every year by including more and more lessons into their system.

Program Development

ProgMagus has been developed with multiple programming languages those are HTML, CSS and JavaScript. ProgMagus is a website based software in

which contains a front-end and back-end. The front-end is managed and developed using HTML and CSS, even though there is also the use of Handlebars. Handlebars is just simply a template language, so all the content that is being displayed to each of the users that ProgMagus have the same layout. CSS comes in when the colors and the design of the webpage is.

For the CSS design ProgMagus is using the help of kickstart HTML, which is the CSS library that was chosen to get the All the design of the page, it has a lot of features, and it is a small size component for the project. The back-end of ProgMagus is the most important part of the website as it manages all the data that is needed in ProgMagus, also this is the part of the website that you cannot see. There is a constant communication between the front-end and back-end, in this case receiving and sending information to be displayed on the website.

As data needs to be managed the database server that is being used by ProgMagus is MongoDB, which is used to store all the data that is being processed in ProgMagus. The JavaScript files that are in the back-end are the files that manage all the functions that the website has when a user is on the website, all the requests of the data is being managed by JavaScript sending a request to the database, in this case MongoDB. All of this makes up the back-end of the website, and makes it function the way it should be.

As for now, ProgMagus LMS has been growing in features and stability. The features that are included are powered by a MongoDB database, includes a Python terminal embedded in the lessons, offering features such as User Authentication, User Management, Content Manager/Custom Content, Python terminal, and Quiz. These features were developed with the intention of overcoming the limitations of existing LMSs and enhancing the learning experience for both students and instructors. In other words, ProgMagus LMS has been in exponential development for to succeed of the project and growth of the LMS community.

Interactive Learning

In the fast-paced world of computer science education, interactive learning has become increasingly important. This type of learning goes beyond the usual teaching methods. It gives students a chance to learn by doing, which makes learning more exciting and helps them remember what they have learned. This part discusses how to create interactive learning environments in computer science education. It also shows how ProgMagus LMS is an

excellent example of this kind of learning.

Interactive learning environments are very important for meeting the changing needs of computer science students. The old way of learning, where students listen to lectures, is slowly replaced by interactive methods that encourage students to participate. Studies have shown that students who learn in interactive environments better understand complex ideas and solve problems.[3] This change is part of a more significant trend in education, where the focus is shifting from teacher-led to student-led learning. The goal is to make it easier for students to explore and discover new things and have a system that instructors can use and manage.

ProgMagus LMS is an excellent example of this new way of learning. It was created as a learning platform specifically for Python programming. It represents the new way of learning in computer science. By including features like a Python terminal, instant feedback on answers, and interactive quizzes, ProgMagus turns learning into an active experience with the Python programming language. The platform's focus on practical exercises allows students to use what they have learned in real situations. The focus on practical exercises helps strengthen their understanding and develop their skills.

Customers

Who is the customer for ProgMagus LMS? In the complex idea of learning management systems (LMS), the primary customer for ProgMagus LMS is the instructors. Whether in traditional classroom settings, online courses, or coding boot camps, instructors play a pivotal role in shaping the educational experience for students and users. ProgMagus LMS is accurately designed to help instructors' unique needs and challenges, particularly those engaged in teaching Python programming language.

ProgMagus LMS delivers a simple and easy to use Python LMS. When it comes for the instructor experiencing ProgMagus LMS, it includes adding lessons, classes and editing them. Those options are available for the instructors to play with. All the features that are included in ProgMagus LMS should make the use of the software simple and easy for the instructors to make the use for them effective and worth the time.

ProgMagus LMS delivers a simple and easy-to-use Python LMS to its customers. For an instructor using ProgMagus LMS, the platform offers features including the ability to add lessons, create classes, and edit them as

needed. These options provide instructors with the flexibility to customize their courses according to the learning objectives and the needs of their students or users that they aim to teach to.

All the features included in ProgMagus LMS are designed with the goal of making the software simple and easy for the instructors to use. The interactive user interface, the comprehensive feature set, and the focus on Python programming language contribute to making the use of the software effective for the instructors whenever they want to share content. The goal is to enhance the teaching and learning experience, making programming education more accessible and enjoyable for all. This is the value that ProgMagus LMS brings to its primary customers, instructors.

Implications for Online Learning

Online Learning in LMS have to include many strategies, as an LMS is going to display the information for the instructor. There has to be a linear information display because there has to be a connection between the software and the student, for effective results on learning. [3] Also, LMS has to include different styles of activities throughout the lessons, as it needs to catch the attention of the student or user, so they can get more involved with the information that is being instructed.

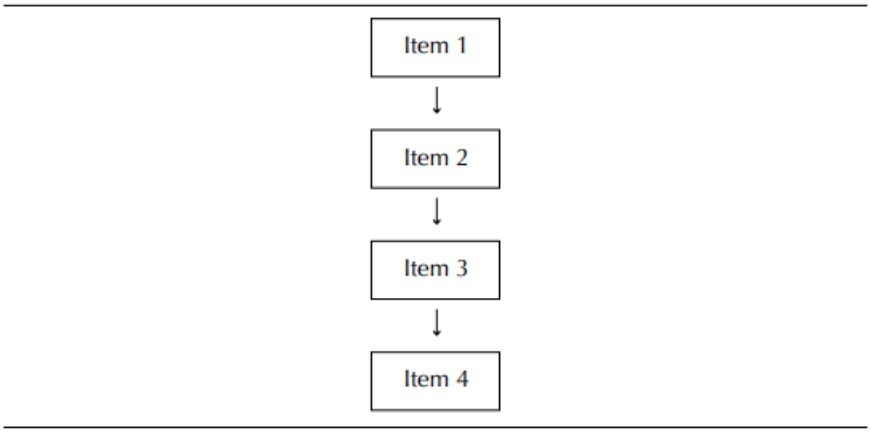

Figure 1: Linear Map

[3]

Goals of the Project

The goal of the project comes down to several key things. To make a system in which students can learn in an easy and simple fashion, and make the students develop better skills using this product. On the other hand, for instructors is to make a simple and easy to manage content about Python and to be able to produce and reproduce their own content on the website with the use of all the functionalities that are included on the website.

Not only that, one of the main goals of this project is to make people understand how simple things, software or anything can help us develop an effective manner. [3] Another main goal for this project is to make people that need help and want to learn something about Python Programming Language, even though this project can be extended to making the use of any other programming languages, the main one for now is Python Programming Language. TO create a product that can be used for several things that can help others and make them learn something about Python Programming language and how Python Programming language can help them in various things in life.

In addition, as a current student in Allegheny I can attest that simplicity for a software can make education and the learning experience more enjoyable, not because it is more effective, because you can do it in your own time too as the tool is built in a website that does not need a powerful computer to use. Which delivers the other goal that is sharing to everyone that is interested in LMSs that the community is growing for Python Programming Language and needs to be included in next LMSs.

As a whole, the main goal was to improve the experience for the instructor as a main costumer, but also the other main point was the student or user of the platform, as those people are the ones that will be using the service that the instructors provide. The primary objective was to enhance the experience for the instructor, who is considered the main customer. This was crucial because the instructors are the ones who deliver the content and interact with the platform on a regular basis which includes managing content, adding or removing lessons, editing lessons and adding classes. Their satisfaction and ease of use directly impact the quality of the service provided, for ProgMagus to be more focused to the instructors as a whole.

However, the focus was not just aimed at the instructors. Equal importance was given to the students or users of the platform as those who are users will be suing the platform on a regular basis too, to make their Python

Programming Language skills improve. After all, they are the end recipients of the service that the instructors provide, after the instructs have added the lessons and classes. Their interaction with the platform, their ability to easily navigate through it, and their overall user experience will all be taken into account.

The students' feedback and user experience are considered valuable in shaping the platform. Their needs and preferences were taken into account during the development process, ensuring that the platform was not only user-friendly but also effective whenever someone wants to learn on it.

In essence, the platform was designed with a dual-focus approach, keeping both the instructors and the students in mind. The aim was to create a balance between the needs of the instructors and the students, therefor creating a platform that is efficient, effective, and user-friendly for all. This approach ensures that the platform serves its purpose effectively while providing a positive experience for all its users.

Ethical Implications

Data security is of paramount importance for any project, particularly those that handle sensitive user data. The ethical implications of data security are vast and multifaceted.

Firstly, there is the principle of confidentiality. Users entrust their personal information to a platform with the expectation that it will be kept confidential. Any breach of this trust not only harms the individual users but also damages the reputation of the platform. It is therefore it is not ethical upon the platform to implement robust security measures to protect this data.

Then, there's the principle of integrity. The data stored by the platform should be accurate and reliable. Any manipulation or misuse of this data could lead to misinformation, which can have serious consequences. As in ProgMagus there is data collection, for whenever the user, student, or instructor is trying to access the website content they have to input their personal information, because it is valuable for ProgMgaus to keep the development and from where people are trying to access the website.

There should not be any data leaks as the data is important for the service of the platform but also the users that are trying to use this website as their daily basis for learning or uploading content that they think is important.

All the data that is included in ProgMagus is considered important as all of it is needed for the functionality of the platform.

As a whole, data security isn't just about protecting information from unauthorized access it is about making the user comfortable of entering their information to ProgMagus.

Several key factors come to the forefront when considering the ethical implications associated with the ProgMagus Learning Management System (LMS). These include Information Privacy, Potential Misuse, Second- or Third-Party Risk, and Data Collection Issues. These issues are not unique to ProgMagus LMS but are present across various online platforms.

Information Privacy is a paramount concern. The system handles sensitive data, and it is crucial to protect this information from unauthorized access or disclosure. Potential Misuse refers to the possibility of the system being used for unethical or illegal activities, such as sharing inappropriate content or using the platform for phishing or other forms of cybercrime.

Second or Third-Party Risk involves the potential for external entities to pose a threat to the system. These entities can invade the user's privacy if these parties gain unauthorized access to the system or its data. Data Collection Issues pertain to the ethical considerations surrounding user data collection, storage, and use.

All these issues could directly impact the success of the LMS, needing a strong focus on security. For instance, there could be implications if instructors demonstrate any form of unethical hacking. Such activities could potentially harm the system and compromise user data.

Personal information is susceptible to invasion of online privacy. While data is collected and stored, measures such as using MongoDB for database management and hashing techniques are employed to enhance security and ensure the data is untraceable.

ProgMagus LMS could face significant harm if information, particularly personal data, is leaked to the public or unethical sources. Therefore, it is essential to have robust security measures in place to protect the integrity of the system and the privacy of its users. The software will include technical measures and foster a culture of ethical use and respect for privacy among all system users.

Related work

Introduction

In designing this LMS, the project will aim previous research on Learning Management Systems (LMS) and the use of LMSs in education for instructors. Specifically, the project will examine how these concepts can be applied to designing an LMS that aims for instructors to upload Python lessons that teaches basic Python programming concepts.

Computer Science education has been growing exponentially. More and more people are trying to learn new skills independently. This has led to developing and evolving Learning Management Systems (LMSs) that aim to meet this growing community.

However, the increasing focus on Computer Science education has shifted from these traditional LMSs to Python or coding LMSs. These LMSs are explicitly designed for coding purposes and aim to enhance the programming skills of learners.

One such LMS is ProgMagus LMS. Designed specifically for Python programming language education, ProgMagus LMS aims to fill the gap in the market. It offers a Python terminal embedded in the lessons, allowing students to practice programming within the context of the lesson. This hands-on approach to learning, combined with features such as user authentication, user management, content manager/custom content, and quizzes, sets ProgMagus LMS apart from existing LMS platforms.

The shift from traditional LMSs to Python or coding LMSs represents learners' evolving needs in Computer Science education. By offering specialized tools and features for teaching and learning programming languages, these LMSs are playing a crucial role in enhancing the programming skills of learners.

However, while these platforms are effective, they often need a dedicated

focus on computer science education, which is what this study focuses on. Most of these systems are designed to focus on specific subjects and disciplines. As a result, other LMSs may not offer the specialized tools and features needed for teaching and learning programming languages. As we are taking feedback on writing code, the terminal embedded in the LMS and the ability for the instructor to set up the code for every student to practice. There are some projects that connect to ProgMagus in some way.

LMS Development and Growth

Abbas, H. and Gupta, S. and Hasib, M. and Raza, A. in their study, "THE ROLE OF CONTINUING PROFESSIONAL DEVELOPMENT AND LEARNING MANAGEMENT SYSTEMS IN THE SUCCESSFUL ROLLOUT OF PYTHON IN THE GULF COOPERATION COUNCIL", [1] discuss the importance of introducing programming languages at an early age and presents a survey-based study focused on primary schools in the Gulf Cooperation Council (GCC) countries. Even though there is presence of programming language instruction in GCC primary schools, the practice is found to be limited and unevenly distributed. Teachers often face mental barriers, and students perceive programming as challenging. Unlike some programming languages, Python requires no specialized training, making it accessible for any teacher to introduce basic computational and logical thinking skills. The study highlights a deficiency in Continuing Professional Development (CPD) related to pedagogical approaches for teaching programming in primary schools. Additionally, the analysis reveals challenges related to the school's learning management system (LMS) and emphasizes the hands-on nature of learning Python, which can be facilitated through online platforms. The integration of Python learning with the school's LMS is recommended for effective student assessment.

The paper discusses the efficiency of having Python embedded on the website to make it more efficient for students to learn those type of assessments. This includes that it is hard of teachers to teach programming as it is often seen as hard or challenging from the student and instructor's perspective. The study also mentions that if the Python Programming language were to be taught in online services, would make it way easier to understand and manage.

Pollari-Malmi, Kerttu in the study, "An integrated practice system for

learning programming in Python: design and evaluation" [13], addresses the challenge of integrating various interactive learning resources for computer science education, particularly in introductory programming. The authors introduce a general-purpose architecture designed to integrate multiple types of smart content into a unified system. As a practical demonstration, they present the Python Grids practice system, which successfully integrates four types of smart content across different servers spanning two continents. The system was implemented in a large-scale introductory programming course, involving over 600 students over a semester. The study reveals that students engaging with multiple types of content within the integrated system exhibited higher course performance compared to those using only one type. Additionally, consistent use of the system throughout the course correlated with improved overall performance, emphasizing the importance of regular practice. The research also explores students' motivational profiles, indicating that system users demonstrated higher motivation levels. The findings highlight the positive impact of integrating diverse smart content on student engagement, performance, and motivation in computer science education.

The paper talks about the challenges that the learning resources for computer science education cause to the students and instructors. And mostly happens with the introductory level computer science programming. The addition to the system that they developed is as large scale programming course, which consists of having 600 students and coding or using the system at the same time.

Cavus, Nadire and Uzunboylu, Huseyin and Ibrahim, Dogan in their study, "The Effectiveness of Using Learning Management Systems and Collaborative Tool in Web-Based Teaching of Programming Languages", [7] discuss about a pilot study conducted at the Near East University during the 2004/5 Fall Semester, utilizing the Moodle Learning Management System (LMS) in conjunction with the GREWPtool collaborative editor. The study involved 36 students enrolled in Java and Pascal programming courses. The findings from the pilot indicate that the efficiency of a Learning Management System can be significantly improved through the integration of a collaborative learning tool. Moreover, the study demonstrates the successful teaching of programming languages such as Pascal and Java in a web-based environment using an LMS system along with a collaborative tool.

The paper talks about a specific LMS that is not aiming to satisfy the needs of computer science courses. Then it mentions the collaboration of a tool that can be used to make it work with computer science courses. Al-

though it is a good idea to integrate a tool to make it work for programming languages courses, but sometimes when it is integrations not all the functionalities from the original program are going to work as expected or as needed, which makes it difficult for the companies that already have their chosen LMS. On the other hand, there can be a solution into making the LMS with the tool already in the system, so that it can handle a lot of workloads while being in use.

Cavus, Nadire and Uzunboylu, Huseyin and Ibrahim, Dogan in their experimental study, "Combining Collaborative Learning with Learning Management Systems in Teaching Programming Language" [8], discuss a collaborative teaching environment for programming languages, specifically Java, was developed using Moodle, a learning management system. The study involved 36 subjects divided into two groups, with each group using a different type of Collaborative Tool (CT): Standard CT and Advanced CT. The primary objective was to investigate student opinions regarding the use of these collaborative tools. The subjects were randomly selected, with Group 1 using the advanced tool, and Group 2 using the standard tool. The system allowed students to engage in highly interactive and collaborative learning experiences from their own locations using personal computers. Data collection involved the use of instruments such as Student Opinions in Relation to the Used Collaborative Tool and The Online Learning Opinion Scale, administered at the end of the experimental study.

This paper explains about the programming language teaching tool that was created for the people that wants to learn Computer Science online, or for institutions. In this case to understand which of the tools works the best, they conducted an experiment with 2 tools, one advanced and one standard to know which one is the best from the two and more effective to the instructors and students.

One of the biggest websites to learn Python was designed, to make people learn Python online. Some of the most prestigious universities use this tool for their Introductory Computer Science classes, which makes it to be pretty popular. It has a Python textbook integrated, and it works like a charm.

Python for learning

Python – The Fastest Growing Programming Language from Srinath, K. R. [16] provides an overview of Python as a versatile language suitable for

both learning and real-world programming. Authored by Guido van Rossum, Python is highlighted for its powerful, high-level, and object-oriented features. The paper introduces the characteristics and attributes of Python, emphasizing its rapid growth as a programming language, supported by research from various magazines and popular websites. It explores Python's key characteristics, the types of programming it supports, and its applications, shedding light on the reasons behind its recognition as one of the fastest-growing programming languages in recent times.

Python has been optimized being good for both learning and programming. As Python is really simple for programming, and it is one of the fastest growing languages which makes it important to focus in. Python has been supported by various users creating lots of libraries for support and help studies.

As Javed, Aaquib and Zaman, Monika and Uddin, M. Monir and Nusrat, Tasnova [10] has stated in their study, "An Analysis on Python Programming Language Demand and Its Recent Trend in Bangladesh", Python programming language is one of the many programming languages there are for people to learn. Python is highlighted as a programming language suitable for both learning and real-world programming. Javed, Aaquib and group [10] state after running investigations in Bangladesh and several universities, he has concluded that Python is now the most demanded and fastest-growing language using articles for researches and popular websites. The paper states that Python programming language has a lot of features, which makes it user-friendly, as a result of this, programmers that are learning Python can easily understand it.

According geeksforgeeks.org, which is one of the famous websites for computer engineers, states that Python programming language is the 2nd most popular language in the world. Javed, Aaquib and group [10] runs a comparison in code to notice the difference between Python, C/C++ and Java, to show how easy it is to use the language.

"PILeT: an Interactive Learning Tool To Teach Python" study from Alshaigy, Bedour and Kamal, Samia and Mitchell, Faye and Martin, Clare and Aldea, Arantza [2] discusses about PILeT, an interactive tool to teach Python. PILeT has different features, such as: a front-end graphical interface (GUI) that displays the material to the user, provides different learning resources to support the user's learning, and the use of databases that stores the user's information and their progress. It also includes the use of visual explanation to the user, such as a video with live demonstration of the concept,

flowcharts, and illustrations.

PILeT also includes the development of learning style depending on the user, and it is developed personalized to every user. Also, it includes the use of Google Analytics, which tells the website interactions and their functionality to the users. PILeT is a program that has been in constant development, as seen in a study test that was in Oxford University, making sure that the functionality of the program was the optimal and was effectively used by users.

LMS Platforms

"ONLINE EXAMINATION SYSTEM USING PYTHON" from Rambabu, K. and Sravani Devi, Kandulapati Bhagya [14] introduces an Online Exam System for an "Introduction to Management" course, designed to facilitate online examinations for students and streamline the management process for lecturers. The system allows students to take exams online, and lecturers can upload questions and answers, as well as track student performance. Developed using the Python programming language and a database, the system involves user registration for both lecturers and students. Users log in to access the system, which comprises functions such as login, data insertion, and data extraction. The current manual examination process is identified as a drawback due to its time-consuming nature for both lecturers and students. The Online Exam System aims to address these issues by providing a more efficient and streamlined approach to conducting exams.

Stapic, Zlatko and Orehovacki, Tihomir and Danic, Predrag in their study, "Determination of optimal security settings for wireless networks"[17],state the importance of e-learning in higher education institutions and emphasizes the need for a suitable Learning Management System (LMS) to achieve modern and high-quality education. The LMS Moodle is recognized as a leading solution, gaining popularity in Croatia. Despite its "open source" model, which allows for quick responses to security issues within the LMS, the paper highlights that the system's vulnerability relies heavily on the security configurations of the hosting server. The authors aim to present a summary of common security flaws in Moodle LMS and propose optimal settings for both the LMS and the server. They support their claims with results from stress tests and security analyses to determine the most effective configurations.

N. N. M. Kasim, F. Khalid in their study, "Choosing the Right Learning Management System (LMS) for the Higher Education Institution Context: A Systematic Review" [12], discuss the potential of various Learning Management Systems (LMS) like Moodle, ATutor, Blackboard, and SuccessFactors for enhancing teaching and learning in Higher Education Institutions. It compares these platforms (LMSs) based on characteristics such as flexibility, ease of use, accessibility, and user-friendliness through a literature review. The findings of the study offer insights for institutions to make informed decisions when selecting an LMS platform for their specific needs. With this said, there are different LMSs that can help different kind of requests, in this case they are targeting for Higher Education, as it is important for student focus.

The comparison of various Learning Management Systems (LMS) highlights distinct features and capabilities. Moodle, Sakai, and SumTotal excel in integrating them with other systems, while Moodle and Sakai offer private drafting and journaling areas. ATutor uniquely supports course coordination and file storage. SuccessFactors provides access control for administrators, and SumTotal specializes in contextual learning and talent assessment. Commercial LMS involve licensing fees, contrasting with open-source options that offer flexibility through code modification without additional costs. This distinction influences platform selection, as organizations must align LMS features with their training delivery needs and organizational requirements. By mentioning these aspects of LMSs, the selection of open-source LMSs has been increasing as it is being developed regularly, there are multiple LMSs for different tasks.

Sooyoung Jung and Jun-Ho Huh in their study, "An Efficient LMS Platform and Its Test Bed" [15], discuss the development of an efficient Learning Management System (LMS) platform. They address the challenges of traditional e-learning systems, such as vulnerability to threats and high equipment costs. Their proposed solution involves utilizing cloud services like AWS to reduce expenses and enhance security. Over three years of testing, the efficiency and effectiveness of this cloud-based LMS were demonstrated. Notably, the proposed LMS design improves performance by addressing traffic overload issues common in web services, while its adaptable interface supports various web servers.

Vaughn Malcolm Bradley in the study, "Learning Management System (LMS) Use with Online Instruction" [5], examines the role of Learning Management Systems (LMS) in online education. LMS platforms serve as virtual

classrooms, facilitating collaborative learning, discussions, and communication among users. Instructors play a vital role in balancing active learning with technological resources provided by the LMS, while adhering to curriculum guidelines. The presence of instructors within the LMS fosters an engaging learning environment, promoting autonomy, enthusiasm, and motivation among students. Scientific studies supporting LMS contributions in various academic subjects, including mathematics, are essential in the educational community.

Security of the System

Khan, Momeen in his study ."A Multi-Layered Security Model for Learning Management System"[11], talks about the importance of the administration, tracking, reporting and delivery of the educational courses. And because of the quality of information that is being shared to instructors and students, it becomes a valued target for attackers on LMS platforms. It mentions that in Modern LMSs, do not pay enough attention to the security gaps that their system has, as unauthorized access to break into the system. The model of a complete multi-layered is shared.

When it comes to ethical implications for LMSs, security is the key of these problems. The security needs to improve, to make it more secure to all users and consumers, as instructors and students. The security flaws are the ones that need to be addressed, and take into account the settings that are used in Moodle and how are being used.

The multi-layered model that was proposed in "A Multi-Layered Security Model for Learning Management System"[11], is a great solution for the LMS to be covered with good security. It mentions the security issues in Learning Management Systems that include, Authentication Attacks, Authorization Attacks, Availability Attack, Confidentiality Attack and Integrity Attack. Here is the model that includes all the layers that need to be more secure in an LMS.

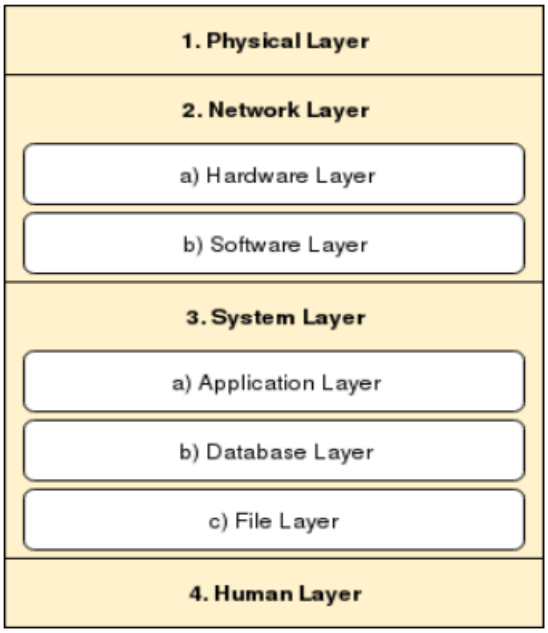

Figure 2: Layers in LMS Security Model

"A Multi-Layered Security Model for Learning Management System", Khan, Momeen [11]

Gaps found that could be implemented

Additionally, the analysis makes the Gaps of the project stand out. The Gaps of the project should be identified for project growth and excellence, in other words, the Gaps that ProgMagus has have been identified.

One of the Gaps that have been found in the project is that ProgMagus only offers education tools for Python Programming Language and other tools, including LMSs, websites, or other, include other languages like Java Programming Language but not Python Programming Language. Which recognizes that there are a lot of programming languages that in the future can be included in the software being developed, ProgMagus LMS.

Another of the Gap that has been found is the number of users that can be on the server editing, adding and completing lessons, which makes it a hard to test the stress that the server can handle. As mentioned in another

article, the server developed had over 600 visits per course, it does not specify if it was at the same time, but it is a good thing to cover. The stress that the server can handle.

In addition to these Gaps, there is another one that makes the system lack a little the functionalities for now. ProgMagus is aiming only form Computer Science courses to be displayed on the system, even though it is aiming just to Computer Science courses, specifically Python Programming Language courses. The system can be used to upload any kind of information about a course and its lessons as it has the capability, but it is not aiming those subjects.

Tracking student performance would be great for ProgMagus. If in the future the instructors want to see how their students are doing in the class they can check it. It would be great to address it and add it as a functionality to the program, as it can be functional to the instructors to see how their students are performing in the class.

Method of approach

This chapter answers the "how" question - how did you complete your project, including the overall design of your study, details of the algorithms and tools you have used, etc. Use technical diagrams, equations, algorithms, and paragraphs of text to describe the research that you have completed. Be sure to number all figures and tables and to explicitly refer to them in your text.

ProgMagus was specifically for Python programming language education, which is aiming to work with students and instructors. Both of the customers or users need to have a good experience with the software that ProgMagus delivers, as the software is the one that develops an effective way or learning or the opposite. When it comes to effective, it includes simplicity, so the software is not complicated for the users to collaborate in.

This is where ProgMagus LMS comes in. Designed specifically for Python programming language education, ProgMagus LMS aims to fill this gap in the market. It offers a Python terminal embedded in the lessons, allowing students to practice programming within the context of the lesson. This hands-on approach to learning, combined with features such as user authentication, user management, content manager/custom content, and quizzes, sets ProgMagus LMS apart from existing LMS platforms.

In addition, while numerous LMS platforms are available, there is a distinct need for a system like ProgMagus LMS that focuses specifically on computer science education. By addressing the limitations of existing systems and offering specialized features for programming education, ProgMagus LMS has the potential to enhance the learning experience for the computer science community significantly.

[13] relates to ProgMagus as I still do not know the capacity of the server and how many users can the on the website at the same time while doing coding. That is a test that needs to be done. As including introductory computer science programming courses it has been included on the website.

Making an experimentation survey will be a part of the study when the experiments are being conducted, like [8]. There is an experimentation survey with the users from Allegheny College to test the tool and tell me about their experience and if they could complete the lessons successfully.

The reason that Python is being used in ProgMagus is because of the same reasons that [16] explain that is one of the fastest-growing programming languages right now. Which makes it relevant to be learned and there are a lot of libraries to the user to use.

The management system that has been created with ProgMagus is trying to solve all the difficulties for instructors, as mentioned in [14]. It is important to keep creating online examination for the students to get used to the systems and for the instructors to not have more issues with tracking student performance.

When it comes to system's vulnerability, ProgMagus has a system of security that works on requests and includes the security of MongoDB. Even though the security is good, there can be data leaks or any vulnerability that can affect the system performance or data. As mentioned in [17], for being a delivery for high education institutions and for high education systems.

For those projects whose implications address social or moral issues (i.e. ethical standards, causes, effects), you will want to use this section to describe how you actively mitigated or considered these issues.

Programming Languages and design

Progmagus LMS was developed using HTML, CSS, JavaScript, and SQL. The design of Progmagus came to something simple and easy to use, as it is the most important idea of this LMS. The programming languages used, HTML was for structuring the content of the web pages, CSS was used for the style of the webpages that gave life to the website, JavaScript was used for the functionality and interactivity of the website so the students and instructors could have a simple and easy to use web service LMS to learn Python. The data of Progmagus was developed with MongoDB, an SQL server database that stores all the data that is being included in ProgMagus and that is being managed for the classes and lessons, to the information about the students and instructors.

Website Provider

There are many website providers to deploy the website to be live and running all the time. In this case, the website provider is Render, because it offers features that are useful for me as environment variables to set the database information as encrypted and hidden.

Render was chosen as the website provider for deploying ProgMagus due to its robust features and capabilities that align closely with the project's requirements. Render stands out among other website providers for several reasons:

1. **Security Features**: Render offers advanced security features, including the ability to securely store environment variables. This is particularly crucial for ProgMagus, as it allows sensitive database information to be stored encrypted and hidden from unauthorized access.

2. **Reliability and Uptime**: Render boasts a reputation for reliability and uptime, ensuring that ProgMagus remains accessible to users without interruptions. This reliability is essential for maintaining a seamless learning experience for students and instructors relying on the platform.

3. **Scalability**: Render provides scalability options, allowing ProgMagus to accommodate varying levels of traffic and usage demands. As the platform grows and attracts more users, Render's scalability features ensure that performance remains optimal without compromising user experience.

4. **Ease of Deployment**: Render offers a user-friendly deployment process, making it straightforward to deploy updates and changes to the ProgMagus platform from GitHub. This simplicity streamlines the development and maintenance workflow, enabling rapid iterations and improvements to the platform.

5. **Cost-Effectiveness**: Render offers competitive pricing plans tailored to the needs of projects like ProgMagus. By optimizing costs without sacrificing performance or reliability, Render provides excellent value for deploying and hosting the platform.

6. **Community and Support**: Render has an active community and comprehensive support resources, ensuring that assistance is available whenever needed. This support network is invaluable for resolving technical issues promptly and maximizing the effectiveness of the ProgMagus platform.

Overall, Render emerges as the ideal website provider for ProgMagus, offering a combination of security, reliability, scalability, ease of deployment, cost-effectiveness, and robust community support. By using Render's capabilities, ProgMagus can deliver a seamless and secure learning experience for students and instructors alike.

Render was chosen because of its ease of use, which plays an important role in accommodating other people using the software. In the context of ProgMagus, where instructors and students will interact with the platform regularly, simplicity and user-friendliness are key for the success of the program usability. Render's user-friendly interface and straightforward deployment process gives the instructors a chance to focus on creating content and managing courses without the need for extensive technical expertise.

By selecting a platform like Render that prioritizes ease of use, ProgMagus ensures that instructors can effortlessly navigate through the deployment process, update content, and manage their courses without encountering complex actions. All of this can be done by being connected to the database in MongoDB.

Furthermore, Render's ease of use extends beyond deployment to ensure ongoing management and maintenance tasks. Render as it includes clear documentation, ProgMagus administrators can efficiently monitor platform performance, troubleshoot issues, and implement updates without significant difficulty.

Database Management

The database is one key to ProgMagus LMS that has been making ProgMagus LMS run and showing content. The content management that the website includes is one of the most important ideas of the LMS as it is a Learning Management System for Python programming language.

The database has been set up as a Cluster in MongoDB, which includes all the data and credentials for the users and professors that operate the website.

It also includes the data from the courses and some other information from the courses that is important to have stored. The database was created locally at first and then adapted to be launched to the MongoDB online servers, as it works differently locally than in a server.

To approach the ethical concerns, the database was created accessing those data leaks and security of the user's data. These ethical considerations were important to maintain trust and integrity in the handling of sensitive information within ProgMagus LMS.

When it comes to using it locally it was used:

- MongoSH

It is MongoDB for Windows computers to operate MongoDB in the shell.

MongoDB was chosen as the database server provider to accommodate other people using the software. By using MongoDB's flexible architecture, ProgMagus ensures seamless access to data for students and instructors interacting with the platform. MongoDB's cluster setup allows for efficient storage and retrieval of user credentials, course information, and other critical data that is needed for the optical performance of ProgMagus LMS.

Furthermore, MongoDB's ease of use from local deployment to online servers enhances accessibility and usability for all users using the software. This transition of local and online server use, ensures that the database operates consistently, minimizing potential disruptions for users, instructors and administrators.

Schema:

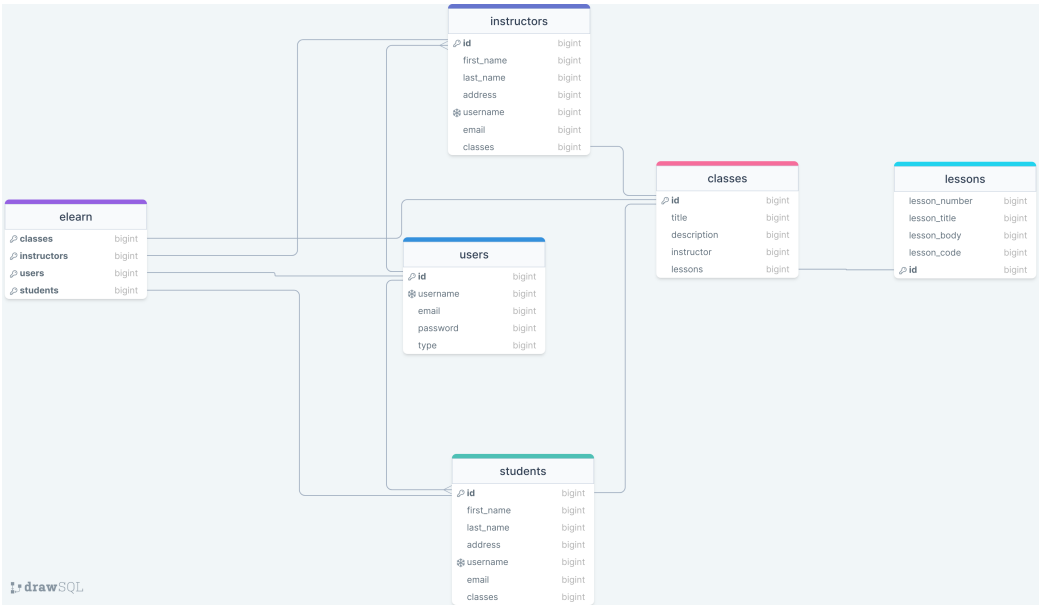

Figure 3: Schema

In Figure 3, the schema for ProgMagus LMS, outlines the structure of a Learning Management System (LMS) database. Elearn Database consists of five primary entities: 'instructors', 'classes', 'lessons', 'users', and 'students'.

The 'instructors' table includes attributes like 'id', 'first_name', 'last_name', 'address', 'username', 'email', and 'classes'.

The 'users' table contains attributes such as 'id', 'username', 'email', 'password', and 'type'.

The 'students' table has attributes like 'id', 'first_name', 'last_name', 'address', 'username', 'email', and 'classes'.

The 'classes' table represents the classes that are being taught, with attributes like 'id', 'title', 'description', 'instructor', and 'lessons'.

The 'lessons' table includes data about the lessons, with attributes such as 'id', 'lesson_number', 'lesson_title', 'lesson_body', and 'lesson_code'.

The relationships between these tables are indicated by lines connecting them, showing the associations between different entities in the system. This schema provides a robust structure for managing a Learning Management System, allowing for efficient data retrieval and manipulation.

Libraries and tools

A variety of libraries were used to get ProgMagus LMS up and running and those are:

Table 1: Libraries and purpose

Library	Purpose
express	Express is a web application framework for Node.js.
path	Path is a Node.js core module for working with file paths.
logger	Logger is a logging library for Node.js applications.
cookieParser	CookieParser is a middleware for parsing cookies in Express.js.
bodyParser	BodyParser is a middleware for parsing request bodies in Express.js.
exphbs	Exphbs is a handlebars.js view engine for Express.js applications.
expressValidator	ExpressValidator is a middleware for validating data in Express.js.
flash	Flash is a middleware for handling flash messages in Express.js applications.
session	Session is a middleware for managing user sessions in Express.js applications.
passport	Passport is an authentication middleware for Node.js applications.
LocalStrategy	LocalStrategy is a passport.js authentication strategy for username/password authentication.
mongo	Mongo is a MongoDB driver for Node.js applications.
mongoose	Mongoose is an object modeling library for MongoDB and Node.js.
async	Async is a utility library for asynchronous JavaScript programming.
crypto	Crypto is a Node.js core module for cryptographic operations.

ProgMagus LMS is structured in this manner:

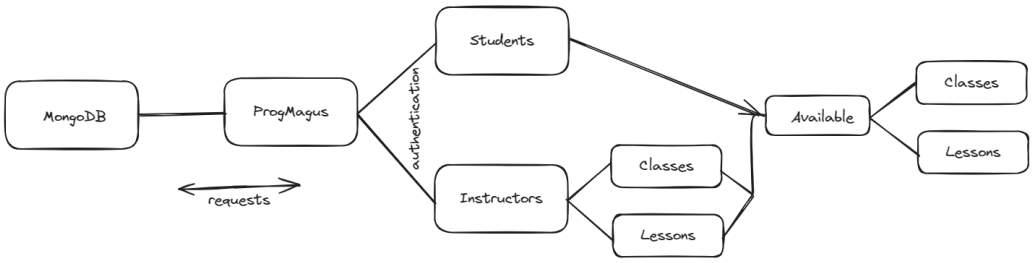

Figure 4: Structure

In Figure 4 we can see the structure of how ProgMagus is developed and structured. ProgMagus was developed with HTML, JavaScript, and CSS. Everything starts by requesting ProgMagus back to the database whenever the authentication is going to take place. Checks for credentials and goes back to ProgMagus. Same to checking out the lessons and classes the process is going back to the database and checking who you are and what you have saved within your profile.

Security of Software

The security has been created with the ability to use requests user type, in which the program checks the req.user.type of each user to be able to access some just the instructor side and then the student side.

Once the user is authenticated, the system checks their role or type to determine what actions they are allowed to perform. This is known as authorization. In the case of the project, the system checks the req.user.type to differentiate between instructors and students and grants appropriate access based on this information.

```
// Example code for user authorization
function authorization(req, res, next) {
    // Check if the user is an instructor
    // Implement your logic here to determine if the user is an instructor
    if (req.user && req.user.type === 'instructor') {
      return next();
    } else {
      res.status(401).send('Unauthorized');
```

```
    }
}
```

In the code above there is a series of steps happening. First there is a function that is in a folder called middleware, which controls the security of the program. The function authorization has some parameters, in this case req, res and next. These parameters mean firstly req, means request, which will follow the instructions given. Secondly there is res, that is the response of the request, in which will answer the instructions. Lastly there is next, which after following the instructions a following command will happen. After that there is an if statement to check the status of the user, which will make sure if the user type is instructor as it is set up in the registration of the user. If the user is an instructor, it will continue to the next page. If the user is not an instructor and its user type is set up to anything else, it will move to another page that contains an error 401, which means that is not authorized to continue to the next page.

```
// Define a function named authorization taking parameters req, res, and next
function authorization(req, res, next):
    // Check if the user is an instructor
    // If the user exists and their type is 'instructor'
    if (req.user exists and req.user.type is 'instructor'):
        // Proceed to the next middleware function
        return next()
    // If the user is not an instructor
    else:
        // Send a 401 Unauthorized status code with a message
        send 401 Unauthorized response with message 'Unauthorized'
```

Lesson Creation

Whenever you are trying to create a lesson in ProgMagus LMS, you must make the content and the code you want to use. There are multiple sections in the creation of a lesson that needs to be taken into consideration, such as “Instructions,” “Body text,” “Code,” and “Result.” With these aspects, you can create a lesson, but it will still deliver an interactive lesson with the students. Creating an interactive lesson for the students needs to include all

the coding and body for all the sections and make the students complete the coding instead of just running the code and getting the output.

```
Body:
Body 2:
Body 3:

Code:
Code 2:
Code 3:

Result Code:
Result Code 2:
Result Code 3:
```

Experiments

Experimental Design

Especially as it pertains to responsible computing, if conducting experiments or evaluations that involve particular ethical considerations, detail those issues here.

The experimental design aims around engaging with the target audience directly within the campus environment. This approach allows for real-time interaction and feedback collection, ensuring a diverse pool of participants from varied backgrounds, which have not taken a Computer Science class. The experimental design revolves around engaging with the target audience directly within the campus environment. This approach allows for real-time interaction and feedback collection.

Participant Recruitment

Recruitment of participants involves a proactive approach, where I will personally engage with individuals across campus to introduce the ProgMagus LMS project and invite them to participate in the evaluation process and the posters that will be all around campus. Efforts will be made to target students, ensuring a comprehensive representation of potential users.

Figure 5: Poster

Data Collection Methods

Data collection will primarily involve the distribution of feedback forms to participants after they interact with the ProgMagus LMS platform. These forms will include structured questions aimed at assessing usability, functionality, and overall user experience. Additionally, qualitative feedback will be encouraged to capture insights and suggestions for improvement.

Evaluation Procedure

Participants will be given access to the ProgMagus LMS platform either through personal devices or designated terminals set up on campus. They will then be encouraged to explore the platform, engage with its features, and complete specific tasks designed to assess its efficacy in facilitating Python programming education.

Results Analysis

Upon completion of the evaluation phase, collected data will be systematically analyzed to identify patterns, trends, and recurring themes in participant feedback. Quantitative metrics such as completion rates and satisfaction scores will be supplemented by qualitative insights from open-ended responses.

Ethical Considerations

Ethical considerations was be considered throughout the experimental setup and evaluation process. Measures were taken to ensure informed consent from participants, confidentiality of collected data, and respectful treatment of feedback provided.

Survey

Survey

Yes/No Questions

Yes/No questions were essential in this study as they provided straightforward answers that helped assess basic functionalities of the ProgMagus LMS platform. Questions such as "Were you able to find information about 'Intro to Python'?" and "Could you log in?" were crucial for understanding the accessibility and usability of the platform. Additionally, questions like "Were you able to complete the 'Strings' lesson?" and "Were you able to complete the mini challenges by running the code?" provided insight into the effectiveness of the platform in delivering course content and engaging users in interactive activities.

- Were you able to find information about “Intro to Python”
- Can you log in?
- Were you able to register for the program? Explain.
- How easily were you able to register to the courses?
- Can you access the classes?
- Can you access the lessons?
- Were you able to complete the “Strings” lesson?
- Were you able to complete the mini challenges by running the code?

Rating Questions

Rating questions proved to be valuable for obtaining more varied feedback on specific aspects of the platform. In this study, questions like “How easy was it for you to find the Strings Lesson?” and “How easy was it for you to answer the Strings Lesson?” allowed participants to provide ratings on the ease of navigation and comprehension of course materials. These ratings helped identify areas of improvement and prioritize enhancements to enhance the overall user experience.

- How easy was it for you to find the Strings Lesson?
- How easy was it for you to answer the Strings Lesson?

Feedback Questions

Feedback questions were essential for capturing qualitative insights and suggestions for improvement from participants. Questions such as “How could the website be more beneficial for your learning?” and “What aspects of the lessons confused you?” provided valuable feedback on usability, content clarity, and user satisfaction. By soliciting open-ended responses, researchers gained deeper insights into user experiences and preferences, guiding iterative development and refinement of the ProgMagus LMS platform.

- How can the website be more beneficial for your learning?

- What aspects of the lessons confused you?
- What aspects of the site helped you in your learning experience?

Evaluation

Regarding the evaluation, the students who participated in the study and filled out the survey positively impacted the study as it gave feedback on what should be done better and what is done right. There have been multiple answers, some of which still need validation, as some people have taken computer science classes. For this evaluation, the results were separated into two sections: qualitative and quantitative. This survey looked at students' feedback and learning effectiveness using the platform.

The completion of the forms by the students will determine the effectiveness of the learning experience for them. This analysis will be evaluated in different sections to determine effectiveness. It contains if the lesson was easy, if the software was easy to use, if the students could find the class, if they could find information about the class, if they could log in, and if they could complete the lesson.

As for the qualitative results here is a graph of everything that was listed in the survey for this section:

How easily were you able to register to the courses?

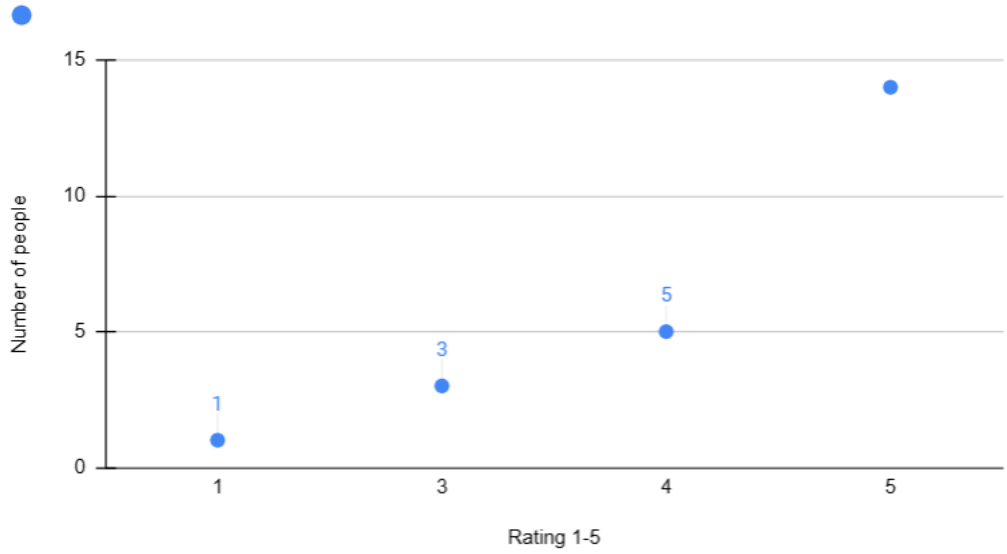

Figure 6: Register

From the plot, we can observe the following points:

- There is one response each at a rating of 1 and 3, suggesting that one person found it very difficult to register, and one found it somewhat tricky.
- There is no response at a rating of 2, indicating that no one chose this as their difficulty level.
- A few responses, five people rated the ease of registration with a 4, suggesting that they found it relatively easy but not without some difficulty.
- Most responses are clustered at a rating of 5, indicating that most found it easy to register for courses.

The fact that most responses are at the higher end of the scale (4 and 5) suggests that the registration process is generally user-friendly and accessible. However, the presence of lower ratings (1 and 3) indicates that there may be

some issues that need to be addressed to make the process smoother for all users.

In the context of your description, this quantitative data from the graph complements the qualitative feedback from the users. When analyzing the effectiveness of the learning experience for students using the platform, it is essential to consider both types of data. The qualitative data might provide insights into why certain students found it challenging to register (e.g., confusing instructions, technical issues, prior knowledge, or lack thereof), and the quantitative data gives a broader overview of how widespread these issues are.

Students' completion of such forms is a critical component of evaluating the educational platform's effectiveness. By assessing various factors, such as the ease of finding and completing lessons, the usability of the software, and the registration process, developers and educators can identify strengths and weaknesses in the platform. The platform is generally effective in the registration process, but there may be room for improvement, especially for those who rated the ease of registration lower. These insights can inform targeted improvements to ensure the platform is accessible and user-friendly for all potential students, regardless of their background in Computer Science or other areas.

How easy was it for you to find the Strings Lesson?

Find

Figure 7: Find

From the plot, we can make the following observations:

- No one rated the ease of finding the lesson as a 1, which suggests that no one found it extremely difficult.
- Some people rated it as a 2, indicating that a few found it somewhat challenging to find the lesson.
- There are no responses for the rating of 3, which would be a neutral ease of finding the lesson.
- A few more respondents found it quite easy, rating 4.
- Most respondents rated it as a 5, showing that most found it easy to locate the Strings Lesson.

This indicates a generally positive response, with most students finding the lesson easily. This could suggest that the lesson is well-indexed, has clear guidance to find it, or is well-placed where students expect to find their lessons. It also implies that the platform's design for locating specific lessons is adequate for most users. However, the existence of ratings at 2 and 4 signifies that there might be room for improvement in navigability or clarity for a minority of the users.

How easy was it for you to answer the Strings Lesson?

Answer

Figure 8: Answer

The graph is a scatter plot representing survey responses to the question, "How easy was it for you to answer the Strings Lesson?" Respondents were asked to rate the ease on a scale from 1 to 5, where one is likely to mean "not easy at all" and five means "very easy."

The points on the graph represent the number of people who gave each rating. Here is what we can deduce:

- Some people 2 rated the ease of answering the Strings Lesson as a 1, indicating they found it difficult.
- No respondents rated it as 2 or 3, representing varying degrees of moderate difficulty or neutrality.
- A slightly larger number (approximately three people) rated it as a 4, suggesting they found it relatively easy to answer.
- The largest group of respondents (around seven people) rated it as a 5, meaning they found it easy to answer the lesson.

From this data, most respondents found answering the Strings Lesson to be on the easier side, with the majority finding it very easy (rating of 5). The absence of ratings 2 and 3 could mean that the respondents generally had a clear distinction in their experience — they either found it difficult or easy, with little middle ground. The presence of a few ratings at the lower end (1) suggests that some aspects of the lesson could be challenging for some students. It could be addressed by reviewing the lesson content for clarity

and difficulty or providing additional resources or support for those parts of the lesson that are proving difficult for some learners.

On the other hand, for the qualitative results, here is a graph that contains all the results that are listed in the survey for this section:

Some users who filled out the survey had a great experience with the ease of navigation and use of the program. This gives feedback that the platform's navigation is easy for different users and that they had a good experience finding the content throughout the website.

Ease of Use/Navigation:

The comments related to ease of navigation and use of the website were categorized under this section because they specifically mentioned how easy it was to navigate the platform, log in, find lessons, and access content. Users highlighted the interface's intuitiveness and the navigation system's straightforwardness. Continuous improvement in this area could involve further simplifying the user interface, ensuring that critical features are easily accessible, and optimizing the navigation flow to enhance user experience.

The graph is separated into sections:

Clarity of Instructions:

Comments regarding the clarity and understandability of instructions within the lessons were grouped in this section. Users appreciated well-organized lessons with clear instructions and step-by-step walkthroughs. To improve further, ensuring that instructions are concise, precise, and easy to follow can enhance the learning experience. Providing additional examples and explanations where necessary can also aid in clarifying concepts for users with varying levels of understanding.

Technical Issues:

Feedback mentioning technical issues encountered while using the platform fell into this category. Users reported issues such as non-functional features and errors while running code. Continuous improvement efforts should focus on identifying and resolving technical issues promptly to ensure a seamless user experience. Regular testing and monitoring of the platform's functionality can mitigate technical issues and enhance overall reliability.

Content Organization:

Comments related to the organization and structure of content within the platform were grouped here. Users appreciated well-organized content that was easy to navigate and understand. Continuous improvement in this area could involve further refining the organization of lessons, ensuring logical progression, and providing clear signposts to guide users through the content effectively.

Learning Experience:

Feedback discussing the overall learning experience, including the effectiveness of lessons and practicality of exercises, was categorized under this section. Users highlighted aspects such as ease of learning and practical use of mini-challenges. Continuous improvement efforts could involve diversifying lesson content, incorporating more interactive elements, and providing additional opportunities for hands-on learning to enhance the overall learning experience.

Difficulty Understanding Concepts:

Comments indicating difficulties understanding specific concepts or tasks within the lessons were grouped in this section. Users highlighted specific challenges, such as confusion over instructions or unfamiliarity with coding concepts. Continuous improvement efforts should focus on addressing these specific pain points by providing additional explanations, examples, and resources to support users in understanding complex concepts more effectively.

Suggestions for Improvement:

Feedback providing suggestions or recommendations for improving the platform was categorized here. Users suggested enhancements such as color coding terms, improving the user interface, and providing a section for writing custom code. Continuous improvement should involve carefully considering user feedback and implementing relevant suggestions to enhance the platform's usability and effectiveness.

The table below shows the number of comments that were separated into the following sections:

Table 2: Comments in sections

Clarity of Instructions	Technical Issues	Content Organization	Learning Experience	Difficulty Understanding Concepts	Suggestions for Improvement
5	3	2	3	5	3

Table 2 separates comments into sections, such as Clarity of Instructions, Technical Issues, Content Organization, Learning Experience, Difficulty Understanding Concepts, and Suggestions for Improvement. All of these sections were selected to analyze the data of the people who took the survey and added a comment. As shown in the table, for the first section, Clarity of Instructions, there were five people whose principal idea of each comment was based on the instructions. In addition, the section Technical Issues had three answers. Next, there is the Content Organization, which has two answers. Next, there is a Learning experience that had three answers. Next, there is Difficulty Understanding Concepts, which had five answers. Lastly, there is the section on Suggestions for Improvement, which has three answers. The graph below will address all of the answers and the number of answers in each section.

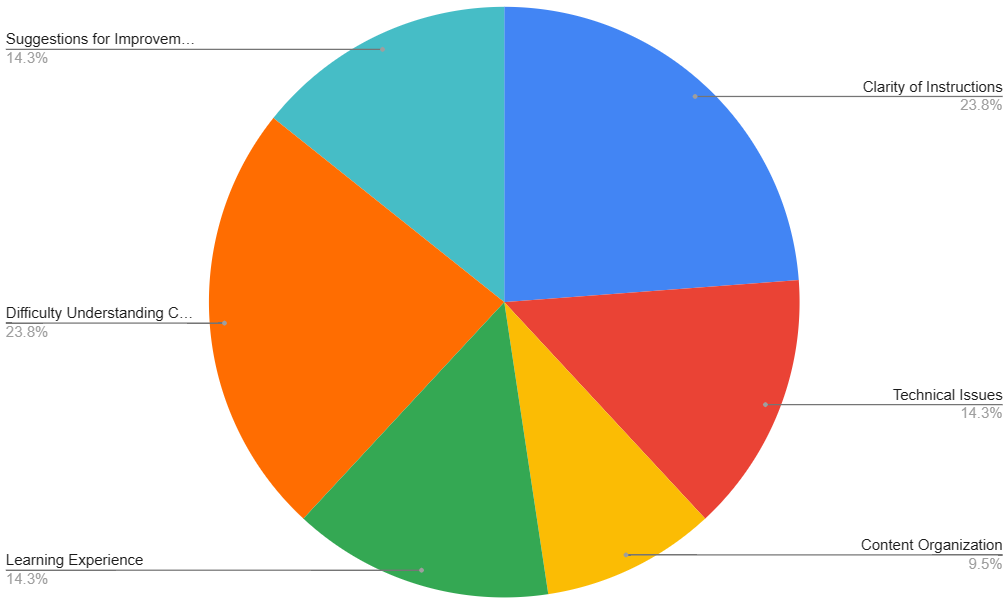

Figure 9: Quantitative

The sections of the chart are color-coded and represent different themes that emerged from the user feedback, indicating areas of user experience and potential improvement.

Here's a breakdown of each section:

- **Clarity of Instructions (23.8%)**: This is a significant portion of the feedback, suggesting that nearly a quarter of the comments pertain to how clear and understandable the instructions provided within the platform are. To improve this aspect, the platform could provide more detailed step-by-step guidance and examples to help users follow along more quickly.

- **Technical Issues (14.3%)**: A notable segment of feedback relates to technical problems users encounter. The platform must address these issues promptly, as they can hinder learning and lead to frustration. Regular updates and bug fixes can help to minimize these problems.

- **Content Organization (9.5%)**: Fewer comments relate to how content is structured and organized, but it is still essential as it affects

how users navigate the lessons. Good content organization can facilitate learning by ensuring that information is presented logically and cohesively.

- **Learning Experience (14.3%)**: This category is as prominent as technical issues, which indicates that users are commenting on the overall experience and the effectiveness of the learning material. Improvements here include making lessons more interactive and engaging and incorporating real-world applications.
- **Difficulty Understanding Concepts (23.8%)**: Tied with the clarity of instructions, this large segment indicates that users struggle to grasp certain concepts. The platform may need to review how complex information is presented and consider adding supplementary materials like tutorials or glossaries to aid comprehension.
- **Suggestions for Improvement (14.3%)**: This shows a healthy level of engagement from users who are not just identifying problems but are also suggesting solutions. This feedback is valuable for iterative improvement and should be carefully reviewed and, where feasible, implemented.

From the data provided, we can infer that the two most common areas of user feedback are related to the clarity of instructions and difficulty understanding concepts, each comprising 23.8% of the comments. These areas might be interrelated, as unclear instructions can lead to difficulty understanding. The most minor feedback is on content organization, which might suggest that users find the current structure primarily satisfactory.

Given the feedback, it seems essential for the platform to focus on improving instructional clarity and addressing conceptual difficulties. This could involve using more user-friendly language, breaking down complex ideas into smaller, more manageable parts, and providing additional learning aids.

In conclusion, the chart provides actionable insights that can improve user experience for the educational platform. The platform can enhance its effectiveness and user satisfaction by addressing these highlighted areas.

Conclusion

In this chapter, we will summarize the results obtained from both qualitative and quantitative analyses of the survey conducted on the ProgMagus LMS platform. We'll also discuss this project's future work, including potential improvements and future research directions. Lastly, we will address the future ethical implications and provide recommendations based on the findings.

Summary of Results

The results of all the experiments varied across the survey. For the Qualitative section of the open-worded questions, the answers were separated into sections: Clarity of Instructions, Technical Issues, Content Organization, Learning Experience, Difficulty Understanding Concepts, and Suggestions for Improvement.

The qualitative feedback provided insights into various aspects of the platform's performance. Users generally appreciated the ease of navigation and use of the platform. They also highlighted the lessons' clarity of instructions and the exercises' practicality. However, some users encountered technical issues, faced challenges in understanding certain concepts, and provided suggestions for improvement.

For instance, users appreciated the intuitive navigation system but reported encountering technical glitches, particularly non-functional features and errors while running code. Additionally, feedback highlighted the importance of precise instructions, with users noting the effectiveness of well-organized lessons and pointing out areas where instructions could be further clarified to enhance comprehension.

Quantitative data revealed patterns and trends in user responses to specific questions. For example, most users found it easy to register for courses,

locate lessons, and answer the Strings Lesson. However, some users encountered difficulties in these areas, indicating potential areas for improvement.

From the quantitative data, we observed that most users found the registration process relatively easy, with a significant proportion rating it at 4 or 5 on the scale. Similarly, most users reported finding the Strings Lesson easily and relatively easy to answer. However, there were outliers in both categories, indicating that while the platform generally performed well, there were still areas where users faced challenges.

The survey received responses from diverse users, providing valuable feedback on the platform's usability and effectiveness.

Qualitative Feedback:

The qualitative analysis of user feedback provided valuable insights into various aspects of the platform's performance. Users generally appreciated the ease of navigation and clarity of instructions within the lessons. However, some encountered technical issues and needed help understanding certain concepts. Suggestions for improvement included enhancing instructional clarity, addressing technical glitches, and refining content organization to enhance the overall learning experience.

The qualitative data highlighted specific areas where users found the platform to excel, such as intuitive navigation and clear instructions. Users praised the platform's user-friendly interface and appreciated the practicality of the exercises. However, technical issues emerged as a common concern, with users reporting non-functional features and errors while running code. These insights provide valuable guidance for future development efforts, indicating areas of strength and requiring attention.

Quantitative Data:

Quantitative analysis revealed patterns and trends in user responses to specific questions. While most users found it easy to register for courses and locate lessons, there were outliers indicating potential areas for improvement. Similarly, most users found the Strings Lesson easily and reported it as relatively easy to answer. However, there were variations in responses, suggesting differing experiences among users.

The quantitative data provided a broader overview of user satisfaction and highlighted areas where the platform performed well, such as course reg-

istration and lesson accessibility. However, it also identified areas of concern, such as variability in user experiences and potential challenges in certain aspects of the learning process. These findings complemented the qualitative feedback, offering quantitative metrics to support qualitative insights and identify areas for improvement.

Survey Respondents:

The survey received responses from diverse users, providing comprehensive feedback on the platform's usability and effectiveness. Students from various backgrounds participated, offering insights into their learning experiences and preferences. The diversity of respondents ensured that the feedback represented a wide range of perspectives, enriching the analysis and ensuring that recommendations could address the needs of different user groups.

The participation of a diverse group of respondents enhanced the validity and reliability of the findings, ensuring that the feedback reflected the experiences and opinions of the platform's user base. This diversity allowed for a more comprehensive understanding of user needs and preferences, enabling more informed decision-making regarding platform improvements and enhancements.

Actual Results and Implications:

The qualitative and quantitative data analysis highlighted critical areas for improvement in the ProgMagus Learning Management System (LMS). These include enhancing instructional clarity, promptly addressing technical issues, and refining content organization to improve the learning experience. The results underscore the importance of continuous improvement efforts to ensure the platform meets users' needs effectively.

By addressing the identified areas for improvement, the project can enhance its usability, accessibility, and overall effectiveness. Improving instructional clarity and content organization can help users navigate lessons more effectively and understand complex concepts better. Additionally, addressing technical issues can enhance user satisfaction and minimize disruptions to the learning experience.

The combination of qualitative and quantitative feedback provides valuable insights that can inform targeted improvements to the platform. By prioritizing user feedback and implementing relevant recommendations, the

project can optimize its educational offerings and better serve its user base. This iterative approach to development ensures that the platform remains responsive to user needs and preferences, fostering a positive learning environment for all users.

Future Work

Additionally, several areas warrant attention for future work and research:

- Enhancements to User Experience: Addressing technical issues and improving instructional clarity could enhance the overall user experience.
- Refinement of Content Organization: Further refining the organization and structure of content within the platform can aid users in navigating lessons more effectively.
- Expansion of Interactive Elements: Incorporating more interactive elements and real-world applications could enhance the learning experience for users.
- Tracking Reports: Adding the tracking report for the instructors to see of how the users are doing throughout the classes and lessons.
- Completion Record: Implementing a completion record that can be saved throughout the platform and users.

Further improvements can be made to enhance the security of the ProgMagus LMS platform in addition to these areas. While the current security measures, such as the method used with requests, may be effective, continuous improvement is necessary to avoid potential security threats.

To improve security of ProgMagus LMS in the future, the platform could implement additional layers of protection, such as:

- Encryption: Implementing robust encryption techniques to secure user data and communications between the platform and users' devices.
- Authentication Mechanisms: Introducing multifactor authentication or biometric authentication methods to ensure that only authorized users can access sensitive information and features.

- Regular Security Audits: Conducting regular security audits and penetration testing to identify and address vulnerabilities proactively.
- Security Training: Providing comprehensive security training to developers, administrators, and users to raise awareness of best practices and potential risks.
- Patch Management: Establishing a systematic approach to applying software patches and updates promptly to mitigate known security vulnerabilities.

Furthermore, the platform can expand its curriculum to include additional programming languages like Java, JavaScript, C programming, and HTML. This expansion would provide instructors with more options for teaching various topics in coding and computer science, thereby enhancing the platform's educational offerings and catering to a broader audience.

By prioritizing these areas of future work, ProgMagus LMS can continue to evolve as a comprehensive and secure educational platform, offering enhanced user experiences and expanding opportunities for learning and skill development in Computer Science.

Future Ethical Implications and Recommendations

In addition to the findings mentioned above, several ethical implications and recommendations should be considered:

By addressing these ethical considerations and recommendations, the ProgMagus LMS platform can continue to evolve as an effective and inclusive educational tool, benefiting users from diverse backgrounds and experiences.

As ProgMagus LMS continues to evolve and potentially undergo public release or widespread use, several ethical implications and recommendations need careful consideration:

Data Security and Privacy:

- Recommendation: Implement robust security measures to protect user data from unauthorized access or disclosure.

- Ethical Implication: Users trust the platform with their personal information, and any breach of this trust can have serious consequences. It is critical to prioritize data security to maintain user trust and integrity.

Integrity of Information:

- Recommendation: Ensure the accuracy and reliability of the data stored within the platform.
- Ethical Implication: Manipulation or misuse of data can lead to misinformation, harming users' learning experiences and potentially causing reputational damage to the platform. Upholding data integrity is essential for maintaining trust and credibility.

Potential Misuse and Security Risks:

Recommendation: Mitigate the risk of misusing the system for unethical or illegal activities. Ethical Implication: The platform must guard against potential misuse, such as sharing inappropriate content or engaging in cybercrime. Implementing measures to detect and prevent such behaviors is crucial for maintaining a safe and ethical learning environment.

Third-Party Risk Management:

- Recommendation: Address the potential risk external entities to the security and privacy of the platform and its users.
- Ethical Implication: Unauthorized access to the system or its data by third parties could compromise user privacy and undermine trust in the platform. Proactive risk management strategies are necessary to safeguard against external threats.

Ethical Data Collection and Use:

- Recommendation: Ensure transparent and ethical practices regarding the collection, storage, and use of user data.
- Ethical Implication: User data should be collected and utilized responsibly, with clear guidelines in place to protect user privacy and rights.

Ethical data practices are essential for maintaining user trust and regulatory compliance.

Culture of Ethical Use:

- Recommendation: Foster a culture of ethical use and respect for privacy among all system users.
- Ethical Implication: Users, instructors, and administrators should encourage and enforce ethical behavior. Education and training on the ethical use of the platform can help mitigate risks and promote responsible conduct.

By addressing these ethical considerations and implementing the recommended measures, ProgMagus LMS can uphold its commitment to data security, integrity, and ethical use, thereby ensuring a safe and trustworthy learning environment for all users.

Conclusions

In this chapter, we have comprehensively analyzed the ProgMagus Learning Management System (LMS) through both qualitative and quantitative lenses. The qualitative feedback provided valuable insights into various aspects of the platform's performance, highlighting strengths such as intuitive navigation and clear instructions and identifying areas for improvement, such as technical glitches and challenges in understanding certain concepts. The quantitative data complemented these insights, offering broader trends and patterns in user responses, indicating areas of satisfaction and potential challenges.

The survey received responses from a diverse group of users, enriching the analysis and ensuring that recommendations could address the needs of different user groups. This diversity allowed for a more comprehensive understanding of user needs and preferences, guiding future development efforts to optimize the platform's usability and effectiveness.

Furthermore, several areas warrant attention for future work and research. Enhancements to user experience, refinement of content organization, and expansion of interactive elements can further enhance the platform's effectiveness and user satisfaction. Improving security measures, including en-

cryption, authentication mechanisms, and regular security audits, is crucial to safeguarding user data and maintaining trust in the platform.

Ethical implications must also be carefully considered, including ensuring informed consent, maintaining confidentiality, promoting accessibility and equitable access, maintaining transparency, and fostering community engagement. By addressing these ethical considerations and implementing recommended measures, ProgMagus LMS can uphold its commitment to data security, integrity, and ethical use, ensuring a safe and trustworthy learning environment for all users.

In conclusion, the analysis presented in this chapter provides valuable insights that can inform targeted improvements to the ProgMagus LMS platform. By prioritizing user feedback, addressing identified areas for improvement, and attaching to ethical principles, the project can continue to evolve as an effective, open-source, and inclusive educational tool, offering enhanced user experiences and expanding opportunities for learning and skill development in Computer Science.

As a whole, after reviewing all the investigation of information about Python, LMSs and Python LMSs, the project has been developing great features within its capability. Reviewing the material gathered has given the opportunity to find gaps in the project that were not taken into consideration at the beginning. The project was successfully used by users by conducting the evaluation, and it helped some students learn something about Python programming language. The project had some limitations like the development of the database with a server that is paid, in which the money is an important factor for the best performance of the program, although there was another solution to this that was applied. ProgMagus LMS, will continue in development to improve its features and in the future be integrated into some Introductory Programming classes at Allegheny College.

References

[1] H. Abbas, S. Gupta, M. Hasib, and A. Raza. 2021. THE ROLE OF CONTINUING PROFESSIONAL DEVELOPMENT AND LEARNING MANAGEMENT SYSTEMS IN THE SUCCESSFUL ROLLOUT OF PYTHON IN THE GULF COOPERATION COUNCIL. In *EDULEARN21 proceedings* (*13th international conference on education and new learning technologies*), 2021. IATED, Online Conference, 6920–6924. https://doi.org/10.21125/edulearn.2021.1396

[2] Bedour Alshaigy, Samia Kamal, Faye Mitchell, Clare Martin, and Arantza Aldea. 2015. PILeT: An interactive learning tool to teach python. Retrieved from https://dl.acm.org/doi/pdf/10.1145/2818314.2818319

[3] Terry Anderson. 2008. Theory and practice of online learning. Retrieved from https://www.aupress.ca/app/uploads/120146_99Z_Anderson_2008-Theory_and_Practice_of_Online_Learning.pdf

[4] Tony Bates. 2015. Teaching in a digital age. Retrieved from https://pressbooks.bccampus.ca/teachinginadigitalagev2/

[5] Vaughn Malcolm Bradley. 2021. Learning management system (LMS) use with online instruction. Retrieved from https://files.eric.ed.gov/fulltext/EJ1286531.pdf

[6] Vaughn Malcolm Bradley. 2023. Learning management system (LMS) use with online instruction. Retrieved from https://eric.ed.gov/?id=EJ1286531

[7] Nadire Cavus, Huseyin Uzunboylu, and Dogan Ibrahim. 2006. The effectiveness of using learning management systems and collaborative tool in web-based teaching of programming languages. Retrieved from https://eric.ed.gov/?id=ED503541

[8] Nadire Cavus, Huseyin Uzunboylu, and Dogan Ibrahim. 2006. Combining collaborative learning with learning management systems in teaching programming language. Retrieved from https://eric.ed.gov/?id=ED503163

[9] training industry. 2023. The evolution of the learning management system (LMS). Retrieved from https://trainingindustry.com/wiki/learning-technologies/the-evolution-of-the-learning-management-system-lms/

[10] Aaquib Javed, Monika Zaman, M. Monir Uddin, and Tasnova Nusrat. 2019. An analysis on python programming language demand and its recent trend in bangladesh. Retrieved from https://dl.acm.org/doi/pdf/10.1145/3373509.3373540

[11] Momeen Khan. 2021. A multi-layered security model for learning management system. Retrieved from https://www.researchgate.net/profile/Momeen-Khan/publication/338293839_A_Multi-Layered_Security_Model_for_Learning_Management_System/links/5e1194394585159aa4b2c01c/A-Multi-Layered-Security-Model-for-Learning-Management-System.pdf

[12] F. Khalid N. N. M. Kasim. 2016. Choosing the right learning management system (LMS) for the higher education institution context: A systematic review. Retrieved from https://d1wqtxts1xzle7.cloudfront.net/46940438/5644-18966-1-PB-libre.pdf?1467412901=&response-content-disposition=inline%3B+filename%3DChoosing_the_Right_Learning_Management_S.pdf&Expires=1713912119&Signature=JYX0HQLbwraia~0tsU9KmcjZvNE3yQ-eTVpTA0rXbRWsLNaCnOSkECiJCtu3OeMqb3Xi-qHuYh2Z_&Key-Pair-Id=APKAJLOHF5GGSLRBV4ZA

[13] Kerttu Pollari-Malmi. 2018. An integrated practice system for learning programming in python: Design and evaluation. Retrieved from https://telrp.springeropen.com/articles/10.1186/s41039-018-0085-9

[14] K. Rambabu and Kandulapati Bhagya Sravani Devi. 2021. ONLINE EXAMINATION SYSTEM USING PYTHON. Retrieved from https://ijesat.com/ijesat/files/V23I9073_1694760559.pdf

[15] Jun-Ho Huh Sooyoung Jung. 2019. An efficient LMS platform and its test bed. Retrieved from https://www.mdpi.com/2079-9292/8/2/154

[16] K. R. Srinath. 2018. Python – the fastest growing programming language. Retrieved from https://www.irjet.net/archives/V4/i12/IRJET-V4I1266.pdf

[17] Zlatko Stapic, Tihomir Orehovacki, and Predrag Danic. 2008. Determination of optimal security settings for wireless networks. Retrieved from https://d1wqtxts1xzle7.cloudfront.net/31665433/357101.MIPRO2008_Stapic_Orehovacki_Danic-libre.pdf?1392398440=&response-content-disposition=inline%3B+filename%3DDetermination_of_optimal_security_settin.pdf&Expires=1702710333&Signature=CZetTXF9onupsY~WPdsfspUy6T4NXahypb6rb0Rah6F2SoNGd-rfM1oLO6rivfockD5GUnTgM-g1_&Key-Pair-Id=APKAJLOHF5GGSLRBV4ZA