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ASTRAide: Implementation of Online Learning Platform through Learning Management System and Web-based Integrated Development Environment

[1]Kyle Vincent Faraon, [2]Kim Darnell Magtibay,[3]Claudio Valentin Recreo, [4]Emmanuel Rivera, [5]Jerwin P. Cruz,[6]Dr. Maricel M. Gaspar, [7] Philip V. Mojares, [8] Bryan Christian M. Briones

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Abstract*:* The development of a Learning Management System (LMS) and a web-based Integrated Development Environment (IDE) was the primary goal of the developers and researchers to aid the College of Computing and Information Technology department of FAITH Colleges in facilitating learning. Instructors using the website could create classes, add lessons and activities, view the progress of the students, comment on their works, and message them. Students, on the other hand, could view the lessons, answer activities, monitor their progress and scores, and most especially, message their professors about their classes. In building the project, the developers used the Agile Development Method to minimize the risks and issues as the development progressed. The survey was conducted to gather information from the possible users of the system. The results revealed that the system was effective and offered different functionalities that could aid both instructors and students in facilitating learning and creating knowledge. The developers and researchers concluded that ASTRAide and its features could provide the needed aid for the CCIT department in teaching young IT professionals.

Keywords - *Learning Management System, Integrated Development Environment, online learning, web-based system, and online learning platform.*

Introduction

Studying and learning in the field of Information Technology require practicing different specializations, and one of them is coding and programming. In this area of activity, it is necessary to select a specific language of programming and its corresponding compiler, or Integrated Development Environment (IDE). Although these programs and software are small in terms of size, different languages require different IDEs. Students may find it a hassle to install different programs just to compile their codes and programs. Having a single software or system that can both compile and run codes and programs written in different programming languages can ease the students' situation and minimize the time they need to set up offline IDEs.

One of the systems that offers an all-in-one programming IDE is CodeChum. However, using and accessing this website requires subscriptions that cost money, which also burdens both instructors and students who need to use the site. With this, the developers thought of the same idea and system, yet it was free and exclusive to the First Asia Institute of Technology and Humanities. Since Faith Colleges is one of those that subscribes to CodeChum, developing such a program cuts costs and provides an environment where instructors and students could provide and facilitate learning.

ASTRAide acts as a Learning Management System (LMS) and provides a web-based IDE for languages such as C, C++, Java, Python, and JavaScript. The system is not only an online compiler but also a Learning Management System (LMS) where instructors and students can interact through posted lessons, activities, and can connect end-to-end messaging. Instructors can unenroll the students once they are done with the semester. Using ASTRAide utilizes learning through completing and finishing the learning objectives.

FAITH Colleges does not have a web-based Integrated Development Environment (IDE). Currently, FAITH Colleges subscribes to a web-based IDE that costs a lot. The researchers wanted to reduce the expenses of FAITH colleges, and creating a web-based IDE is one of the possible solutions. ASTRAide provides a web-based IDE for the C, C++, Java, Python, and JavaScript languages. ASTRAide makes the connection between students and teachers for their programming activities. Students may use ASTRAide to test their answers, receive immediate feedback, and keep track of their progress by utilizing problem stories that are linked to learning objectives. The development of the ASTRAide system was intended to ease the work of the CCIT Department, where instructors

[1234]Students, FAITH Colleges, Tanauan City, Batangas, Philippines
[5678]Faculty-Advisers, FAITH Colleges, Tanauan City, Batangas, Philippines
[1] kvfaraon21@gmail.com,[2] kimmagtibay123@gmail.com, [3-]cvmr14@gmail.com
, [4]emem.rivera159@gmail.com [5]jpcruz@firstasia.edu.ph,
[6]mlmalabanan@firstasia.edu.ph, and
[7]pvmojares@firstasia.edu.ph, and [8]bmbriones@firstasia.edu.ph

would be able to facilitate the learning of computer programming through the Learning Management System (LMS) and Web Integrated Development Environment (IDE). Specifically, this research aims:

1. To create an automated checker that enables the system to automatically verify the activities of students.
2. To provide teachers a platform or classroom for creating lessons. It also allows teachers to post activities.
3. To display statistics and analytics to better assess the student's performance.
4. To provide teachers a comment section to improve the student's work.
5. To create a system where it can compile and run student's source code in C#, Visual Basic, Java, Python, C, C++, PHP, Lua, Node JS, and Python 3
6. To design a system that would allow students to communicate with their teachers via private message.
7. To develop a system that can be evaluated in terms of:

7.1 Usability
7.2 Performance
7.3 Functionality
7.4 Security
7.5 Reliability
7.6 Interactivity and User-Friendliness
7.7 Security

Conceptual Framework

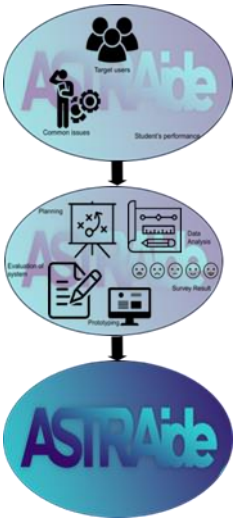

Fig 1. Conceptual Framework of the Study

Figure 1 shows the conceptual framework of the study. The research and system development involve three (3) frames or stages for their completion. The first frame presents the research inputs based on the needs of both students and instructors in the CCIT department of FAITH Colleges. The second frame deals with the steps and processes involved in the project development, including the planning, the analysis of data, building prototypes and testing them, evaluating the whole system, and lastly, the survey result regarding the use of the reservation and membership system. Finally, the last frame presents the developed ASTRAide.

Research Design

The developers applied a descriptive research design. The type of method used is the descriptive method. The descriptive method was used to describe and explain the use and process of the built system, which is ASTRAide. With this design and method, the group was able to expound on the insights of the target respondents to the system and study. Descriptive research methods are scientific tools that researchers use to gather data and describe the specifics of the study (Reynold, 2022). The researchers utilized descriptive-development research design.

Project Development Method

The developers used the Agile Development Methodology in building the system. Using the agile model of development minimized the risks and software issues when the group added features. This cycle consists of several steps, such as requirement analysis, design creation, coding, testing, and review. The agile model provides a highly organized process for developing software and the ability to discover the system's requirements. During the requirement analysis stage, the researchers identified the requirements needed for the system. The researchers observed and identified that the users of the system are the instructors and students from the College of Computing and Information Technology department. During the creation of the design stage, the researchers used bootstrap, CSS, and JS. Photoshop is also used to sketch the design of the system, and it allows the researchers to revise the design to fit the ideal theme for the proposed system and make it engaging to use and to be utilized. During the coding stage, the researchers used

Laravel and Visual Studio Code to code the proposed system. The researchers also used Git and GitHub Desktop so they could collaborate on developing the system. This covers the entire development process, and it is also the most prolonged phase of system development. Once the system's coding phase is complete, the testing stage will start. The program underwent various testing stages to ensure everything was working as intended and in the best condition. Once a cycle is finished, another one will start.

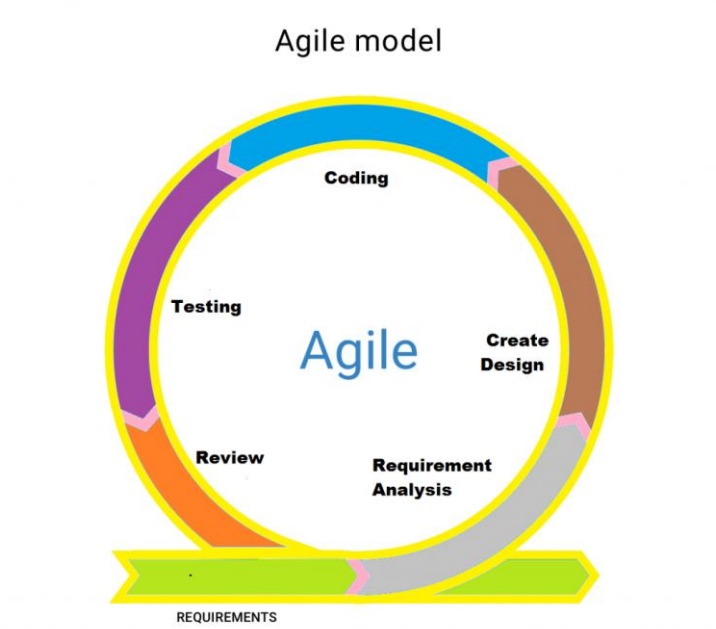

Fig 2. Agile Development Model

Figure 2 shows the Agile Development Model utilized in the development. The researchers followed the five identified processes of this model – Requirement Analysis, Create Design, Coding, Testing, and Review.

Respondents and Subject of the Study

There were two participating groups for this study. The first group is classified as instructors or professors from the CCIT department who are responsible for facilitating the learning process. The second group is categorized as students, who would benefit more from using LMS and web IDEs.

Data Gathering Instruments

To accomplish this project development, the present LMS and its uses were observed to gain a better view of the things that could be improved and added. In addition, research was done to gather additional information on how to build the system more efficiently. Lastly, to gather relevant data for the system development and implementation of ASTRAide, the developers created a survey questionnaire to describe the results of the study. The survey form was composed of thirty-two (32) statements to which the faculty and students answered their level of agreement based on how the system is useful. Aside from the survey forms for both the faculty members and students, additional questions were used to evaluate the whole system.

Weighted Mean. According to Keni (2022), the weighted mean equation is a statistical method that calculates the average by multiplying the weights with their respective mean and taking its sum. It is a type of average in which weights assign individual values to determine the relative importance of each observation.

$$\underline{X} = \sqrt{\frac{\Sigma W_{\mathrm{n}} X_{\mathrm{n}}}{\Sigma W_{\mathrm{n}}}}$$

Whereas;

$\underline{X}$ = the mean value of the set of given data.

W = corresponding weight for each observation.

Composite Mean. This refers to the grouping of equities, indexes or other factors that provide a statistical measure of an overall market or sector performance over time. A composite score is a single variable or data point that represents a combination of information from multiple variables or data points. In other words, it is a single score derived from multiple pieces of information.

Data Analysis

The data gathered are tabulated and given verbal interpretations. The statistical treatment to be used is a weighted mean, based on a four-point Likert scale, to get the average of the survey answers and interpret the data gathered.

Point	Scale Range	Interpretation
4	3.26-4.00	Strongly Agree
3	2.51-3.25	Agree
2	1.76-2.50	Disagree
1	1.00-1.75	Strongly Disagree

Table 1. Weighted Mean and Interpretation

Table 1 shows the verbal interpretation for each scale range or weighted average. The Likert scale has a point range from 1 to 4. And the interpretations are categorized as Strongly Disagree, Disagree, Agree, and Strongly Agree.

Data Flow Diagram

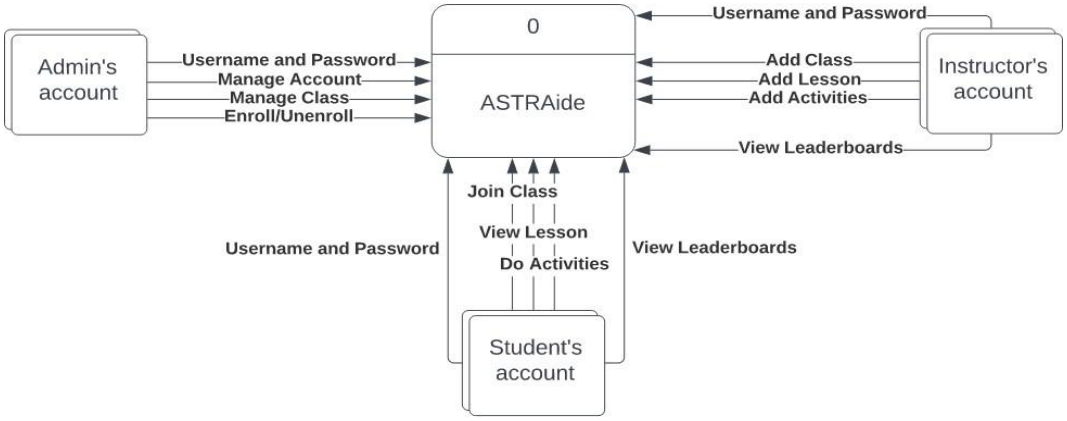

Fig 3. Level 0 Data Flow Diagram

Figure 3 shows the Level 0 Data Flow Diagram of the developed system. It depicts the processes of the system. These processes work together and form the flow and operation of the system.

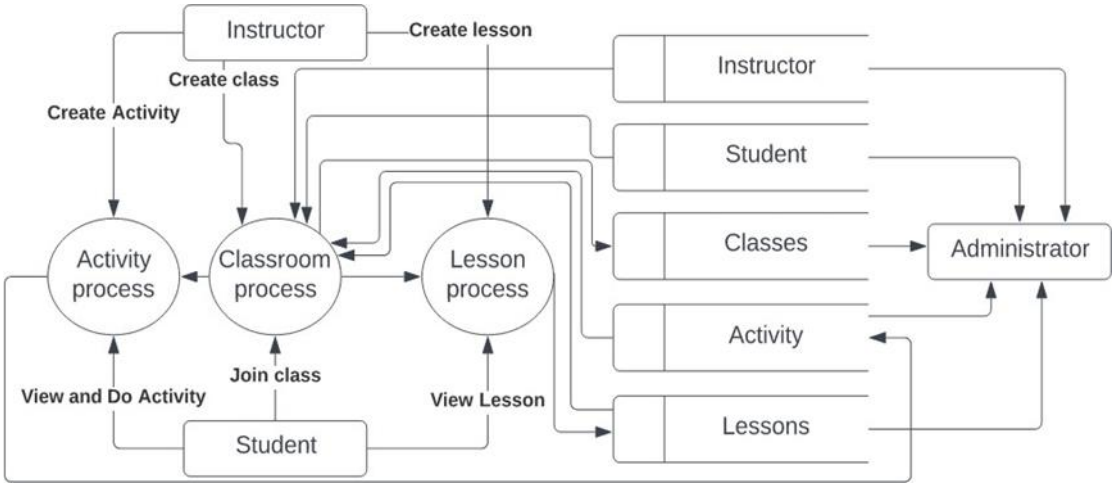

Fig 4. Level 1 Data Flow Diagram

Figure 4 shows the Level 1 Data Flow Diagram of the designed system. It is a high-level overview of the entire system or process being analyzed or modeled. It is intended to be a high-level overview, displaying the system as a single high-level process with its relationship to entities.

Database Schema

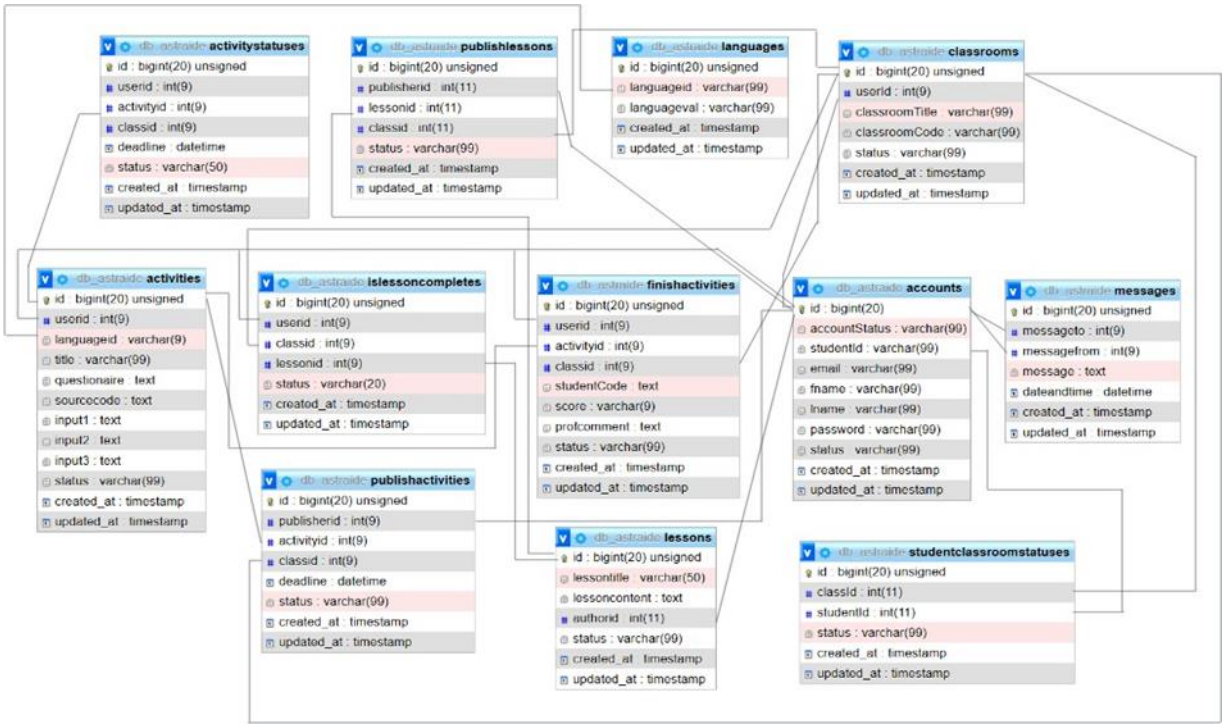

Fig 4. Database Schema

Figure 4 shows the database schema of the developed system. The database schema of the developed system includes how the system stores data and relationships between each attribute or table, as shown in the figure. It was created using MYSQL, which is fully managed by the system's developers.

System Architecture

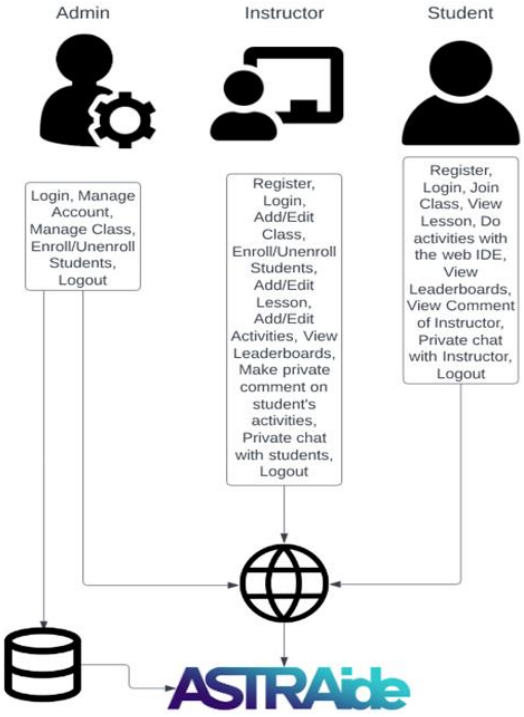

Fig 5. System Architecture

Figure 5 shows the system architecture of AstrAide. The LMS would be used by three (3) users. The first user of the system is the administrator, who is responsible for accepting or denying the registration of a professor or student. The administrator could also view, edit, and delete the class that the instructors added. Also, the administrator could view, edit, delete, unpublish lessons and activities, and unenroll students. The second users are

the instructors, who are responsible for learning management. They could create classes, accept, or deny students, create, and publish lessons and activities, view the student leaderboards and the analytics and assessment for each class, students, lessons, and activities, and provide private comments to the students' answers for the activities. The last type of users are students. They could join classes, view lessons, answer activities, view their progress and scores, and most importantly, message their professors privately through the messaging feature of ASTRAide.

Results and Discussion

The developers built an LMS website that caters to the programming needs of CCIT students through its web-based IDE. It was built and developed based on the specific objectives that were the foundation of the system. Accessing and utilizing the website lets the user register and login to their accounts. Depending on the type of user, whether instructor or student, the system enables them to use each feature of the website. The interfaces, or graphical user interfaces (GUIs), present in the system are the homepage, the registration form for both the instructor and student, and the login page. The administrator has GUIs for the user controller, classroom controller, lesson controller, and activity controller. The instructor has a class page as well for adding classes and managing the students. There is also a lessons page for creating, publishing, and editing lessons. The activities page is used by the instructor to create, publish, and edit activities. The students have a class page and an activity page. All types of users have a messenger page where they can send messages to anyone registered in ASTRAide.

Not only was the development of ASTRAide significant, but so was how potential users perceived it. With this, data was gathered and analyzed through survey questionnaires composed of twenty-five (25) questions answered by 39 students and twenty-four (24) questions answered by 4 instructors. With the administered survey, the summary of results per section is as follows:

Statements	Weighted Mean	Verbal Interpretation
The website presents an appealing interface.	4.00	Strongly Agree
The design of the website is not confusing and complicated to use.	3.90	Strongly Agree
Buttons and tabs are labeled properly for easier navigation.	3.90	Strongly Agree
Composite Mean	**3.90**	**Strongly Agree**

Table 2. Usability Interpretation

Table 2 shows the evaluation result of the system's design. Based on the table above, the respondents strongly agreed that the design of the system is appealing and not complicated, and buttons and tabs were labeled properly. It is important for a system to have a good design to help and impose on the users an easier, yet effective way of serving the purpose and objective of the website.

Statements	Weighted Mean	Verbal Interpretation
The contents of the system are straightforwardly describing its purpose.	3.80	Strongly Agree
The system is simple yet relative and has the appropriate contents for a learning management system (LMS).	4.00	Strongly Agree
Composite Mean	**3.90**	**Strongly Agree**

Table 3. Performance Interpretation

Table 3 shows that the respondents strongly agreed that the contents of ASTRAide were straight forward and relative to the system's purpose. Having relevant contents were essential to better project the system to the target audience and users of the system.

Statements	Weighted Mean	Verbal Interpretation
The system performs its functions properly.	3.90	Strongly Agree
The tabs and navigation lead to appropriate pages of the system.	3.90	Strongly Agree
The buttons are working according to their functions.	3.90	Strongly Agree
The system responds to the actions done.	4.00	Strongly Agree
The system works and performs all the intended functions and tasks.	3.90	Strongly Agree
Composite Mean	3.92	Strongly Agree

Table 4. Functionality Interpretation

Based on the table 4, the respondents strongly agreed that the system functions well: its navigation, its buttons, is responsive, and performs the intended actions of the user. Creating objectives required having them served and offered to the users of the website. With these functions, we could say that the objectives have been met.

Statements	Weighted Mean	Verbal Interpretation
Learning is efficient because I can easily navigate between classes, lessons, and activities.	3.90	Strongly Agree
I can easily see the lessons posted, their contents, and my progress in every lesson.	4.00	Strongly Agree
I can easily see the activities, their deadlines, my scores and ranking.	3.90	Strongly Agree
It is valuable for me to see my professor's comment on my activities to help me be motivated.	4.00	Strongly Agree
It is very useful to have a messaging page, so I can contact my professor regarding classes, lessons, and activities.	3.90	Strongly Agree
Composite Mean	**3.94**	**Strongly Agree**

Table 5. User Interface of Student's LMS Interpretation

Based on Table 5, the students strongly agreed that the LMS could help them in several ways. The respondents could navigate easily around their classes. They could view and answer the activities. They could view and study their lessons. The respondents also strongly agreed that the comment section is valuable, as is the messaging feature of ASTRAide.

Statements	Weighted Mean	Verbal Interpretation
Practicing coding is easy because of the compiler playground.	3.90	Strongly Agree
Having different languages to choose from can help to know my strengths as a programmer	4.00	Strongly Agree
I can code freely in the playground, and it works fine.	3.80	Strongly Agree
Composite Mean	**3.90**	**Strongly Agree**

Table 6. Student Web IDE Reliability Interpretation

Table 6 shows that the students strongly agreed that by using the web IDE, they were able to practice coding, they benefit from the options from different programming languages, and that the IDE works fine.

Statements	Weighted Mean	Verbal Interpretation
Facilitating classes is done efficiently because of the different actions available.	4.00	Strongly Agree
Creating and posting lessons is effective because I can custom make lessons based on the needs of my students.	4.00	Strongly Agree
Creating and posting activities is effective because I can write my own problem and code for the students to answer.	4.00	Strongly Agree
I find it helpful to have an option of editing lessons and activities.	4.00	Strongly Agree
I find it helpful to grade my students with the automated checker for the activities.	4.00	Strongly Agree
The comment section on the students' activity answers is valuable.	4,00	Strongly Agree
I can make sure that the students who enroll in my class are valid and authentic because their accounts pass the administrator first.	4.00	Strongly Agree
Composite Mean	**4.00**	**Strongly Agree**

Table 7. Instructor LMS Reliability Interpretation

Based on Table 7, the instructors strongly agreed that the LMS could help them in several ways. The respondents could facilitate their classes, and they could create and edit their own lessons and activities. The respondents also strongly agreed that the automated checker and comment section are valuable, as well as checking the legitimacy of the students enrolling in their classes.

Statements	Weighted Mean	Verbal Interpretation
The LMS and web-IDE is interesting and encourages me to code and facilitate learning.	3.90	Strongly Agree
The system is easy to use and is recommended to be used.	4.00	Strongly Agree
The system is reliable.	3.90	Strongly Agree
Composite Mean	**3.93**	**Strongly Agree**

Table 8. Interactivity and User-Friendliness Interpretation

Table 8 shows that the respondents strongly agreed that the system is interesting, easy to use, and is reliable. Having a user-friendly website and system attracts users and users would be interested in using them.

Statements	Weighted Mean	Verbal Interpretation
I can make sure that the system can only be accessed by authorized users only, who passed the administrator's authorization and authentication.	3.70	Strongly Agree
The system makes sure that data can only be accessed by authorized users.	3.70	Strongly Agree
The system and administrator tracks the actions of each user.	3.60	Strongly Agree

I can make sure my password is safe because they are encrypted and converted to hash	3.70	Strongly Agree
Composite Mean	**3.70**	**Strongly Agree**

Table 9. Security Interpretation

On average, based on Table 9, the respondents strongly agreed that the system is secure. However, there were instances where individual respondents disagreed on the security of their passwords and data. With this, it is important to create secured systems to avoid issues and data leakage.

Summary

The main goal of the developers was to develop a web-based Integrated Development Environment (IDE) for students from the CCIT Department that also serves as a Learning Management System (LMS). After the complete development, testing, and implementation of the system with several participants, the system was effective and offered different functionalities that could aid both instructors and students in facilitating learning and consuming knowledge. The online compiler provided students with a coding area inside the LMS. The instructors were able to have classroom management as well as post lessons of different file types. Instructors were also provided with analytics and statistics on classes and students based on how they performed based on the activities created by the instructors and were able to comment on their feedback on those activities. Lastly, communication between the instructor and students was easier because of the messaging module integrated with the system.

Conclusion

Considering the findings obtained, the following conclusions were drawn:

1. The system has a playground where users can compile and run the code using C#, Java, Python, C, C++, PHP, Lua, Node JS, and Python 3. The choice of programming language for an activity is determined by the instructor's selection of language. The automated checker is based on the four (4) test cases that the instructor will input into the activity creation.
2. The system allows the instructor to create a class for the students, and the instructor can accept, deny, or unenroll a student in a class. The system also allows the instructor to create a lesson and publish it, just like the activity. Once the student is done with their activity, the instructor is able to comment on their work and give feedback.
3. The system allows the student to join the class created by the instructor. The system also allows the student to view the lesson that the instructor posted and do the activities with the system's web IDE.
4. The system allows the instructor to view all of the analytics of all of the students inside the classroom or the analytics of a single student.
5. The system allows the administrator to manage the accounts of the users, manage the classes, and enroll or unenroll students in class.
6. The system has a messaging feature, the messenger page shows the recent messages, and it allows the instructor or student to send a private message to another user.

Recommendations

After determining the findings and conclusions, the developers were able to give the following recommendations:

1. Video Conferencing: Future developers may add this feature so that the instructor can hold an online meeting instead of doing face-to-face meetings in school.
2. Programming Languages: Future developers may add more programming languages, as there are a lot of increasing programming languages.
3. Mobile Friendly: Future developers could optimize the system and make it more accessible to mobile phone users. In addition, future developers could make a mobile application for ASTRAide.
4. Object-Oriented Programming: Future developers could create a more optimized compiler that can handle multiple source codes to support OOP. This would greatly help in practicing advanced programming.
5. Class Bulletin: The future developers could add a class bulletin for the instructors to create and post announcements for their classes. This could also include notifications for the students to be alerted.

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