

Enhancing the Usability of Cloud based LMS Architecture in Covid Pandemic

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Abstract

The learning system is evolving all throughout the world. From traditional classroom systems to digitalization systems, the new trend is everywhere. Because they provide end users with a flexible, easy-to-use, secure, and cost-effective learning process, cloud-based Learning Management Systems (LMS) will propel the educational industry forward in the next years. The cloud-based LMS model is the most appropriate and trustworthy learning model in the global educational sector, especially when the economy is in a slump due to a global pandemic situation. It can be utilized in faraway locations through the web with several users on the same platform. As a result, the initial requirement is secure access to the LMS model. Having said all the perfect uses of LMS, the model is having challenges like security, user friendly and traffic. In this pandemic situation like covid 19, the whole world is depending on secured LMS model to get the confidence of student and teachers. In this paper it is taken into consideration and tried to describe one LMS model which can give its user optimum security, user friendly environment and fast access.

Keywords LMS, Cloud Computing, DBMS, Moodle, Google Classroom, Virtual Reality, Dynamic Learning

1. Introduction

Education is the backbone of any developed and developing country. To exist in society and to live, minimum level of education is necessary for all. The traditional educational system is basically one on one or face to face classroom process which is mainly till graduation. Higher education system is mostly depending on Cloud Base Learning Management System (LMS) which is known as online class system (Ajayi and Akai, 2019; Phongphaew and Jiamsanguanwong, 2018). Now, it is all was till mid or end of 2019. After spreading and rising of Novel Corona Virus; the whole educational system has changed and become digitalized. The old classroom system will never be like earlier as Government taken policies like Lockdown, social Distance, Isolation, etc. to fight against this deadly virus (Pandey et al., 2021; Raza et al., 2020). From primary education to higher education all now depending on this cloud based learning management system or online classroom system. All Global educational institutes are introducing various e-learning concepts or making user friendly LMS to make easier for the end users (Kilanko et al., 2019). Thus the emerging technology on cloud based LMS is now priority of all educational service provider. Based on which all communication related tools like computers, mobiles etc. and mediums are like software, internet getting upgraded and user friendly day by day (Turnbull et al., 2019). With the technological up gradation and its enhanced facilities changed the total environment of modern educational system and globally primary to higher education found e-learning model to exchange and upgrade their knowledge (Raza et al., 2020). The advanced and innovative technology has upgraded the total LMS foundation for LMS service provider and its users (Ajayi and Akai, 2019). With

this advancement of technology the usability of mobile gadgets are increasing in huge rate. Now, with the enhancement of technology the risk involved in total LMS system like security, flexibility etc. are also considerably increasing as it is a common platform where multiple users are accessing at the same point of time. Also latency is the challenge for remote users in India. The current paper is trying to compare few LMS system and its security and flexibility through different journal and related research paper and will try to provide optimum prevention so that the users can get a dynamic, flexible or user friendly, low latency and low risk LMS system.

The Research work is having following sections, Section 2 Presents a brief knowledge of Cloud Based LMS. Section 3 Described Related works till date by extensively going through related articles and researches. Section 4 said about the proposed works and Methodology with optimum explanations in details. Section 5 briefly described Result Analyses. Lastly, the Conclusion and Way Forward described in Section 6.

2. Learning Management Systems on the Cloud (LMS)

Cloud based LMS is a new method for digital or e learning process followed by global educational service provider and users in current decade specially after covid pandemic situation. Before getting into any further let us see a data on internet users in some main cities in India in figure 1(Chatterjee et al., 2020).

State	Computer User(including rural and urban area)	Internet Facility(Including rural and urban area)
West Bengal	9.39%	16.52%
Kerala	23.47%	51.25%
Maharastra	14.27	33.71
Gujrat	11.20	33.21

Fig.1 (Source: ABP dated 27th July 2020, Data by National Sample Survey 2019) (Chatterjee et al., 2020).

Again the following chart 1 will show how usability of smart phone gone up in India during the period of last few years and what will the tentative usability till the year 2025.

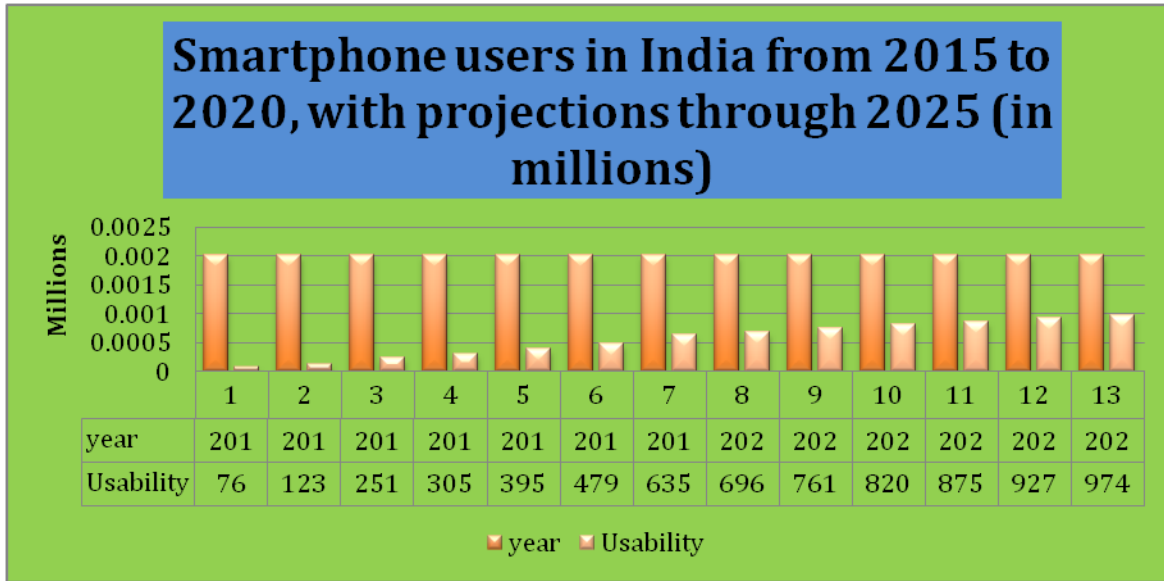


Chart1

2.1 Cloud Computing

Now when we are saying Cloud Based Learning Management System, let us know what Cloud is. A cloud is a virtual platform or resource which is to provide services through Internet. This virtual platform is also known as cloud computing platform (Siddiqui et al., 2019). The following figure 2 is showing the basic idea of Cloud computing.

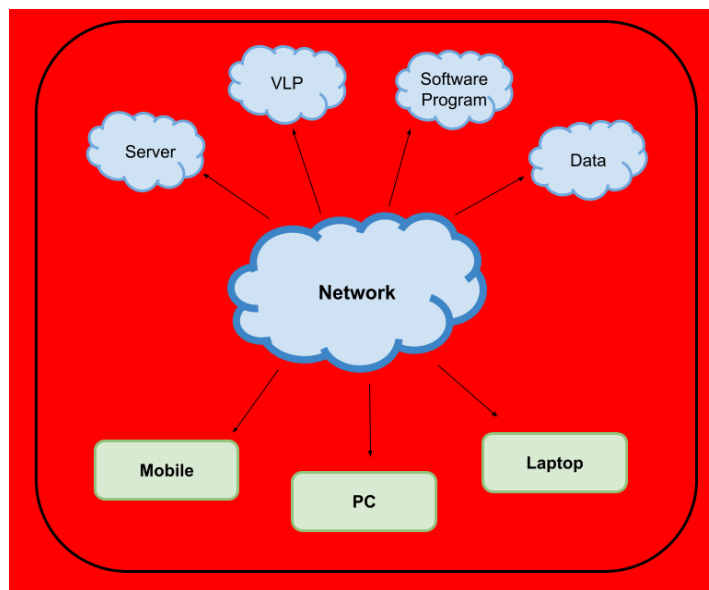


Fig.2 Cloud Computing (Chatterjee et al., 2020)

Again the following figure 3 is showing different level of services provided by cloud computing service provider (Chatterjee et al., 2020) .

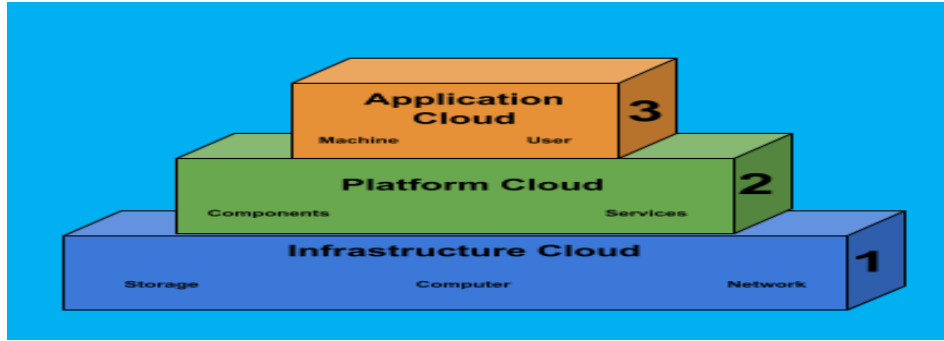


Fig.3 Cloud Computing Services

Different layers or levels of cloud are having different set of role as far as providing services. The brief descriptions are as follows (Aldheleai et al., 2017; Masud et al., 2013):

Infrastructure as a service (IaaS): As the name suggest this is a infrastructure service model which provide services related to network, operating system, storage system etc. Microsoft Azure, Google Cloud, Amazon Elastic are the examples of IaaS. The pictorial presentation shown is figure 4

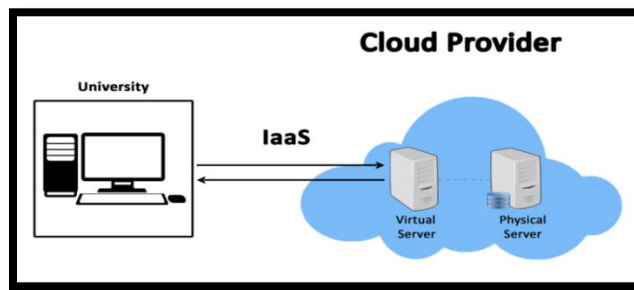


Fig.4 IaaS (Masud et al., 2013)

Platform as a service (PaaS): Cloud computing at this level provides a virtual platform for service providers to produce, control, and manage data. PaaS services include Google App Engine, Windows Azure, and others. Figure 5 depicts a visual presentation.

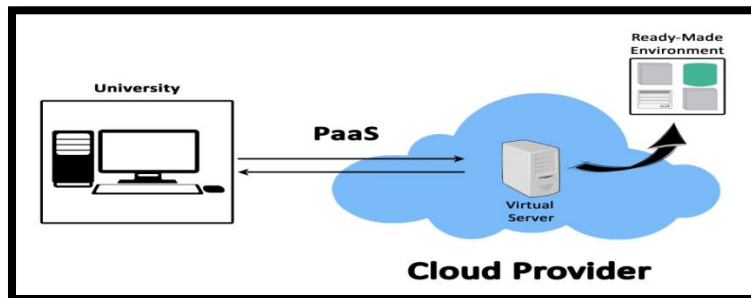


Fig.5 PaaS (Masud et al., 2013)

Software as a service (SaaS): At this level users can apply with the help of Internet through different software and browser. The pictorial presentation shown is figure 6.

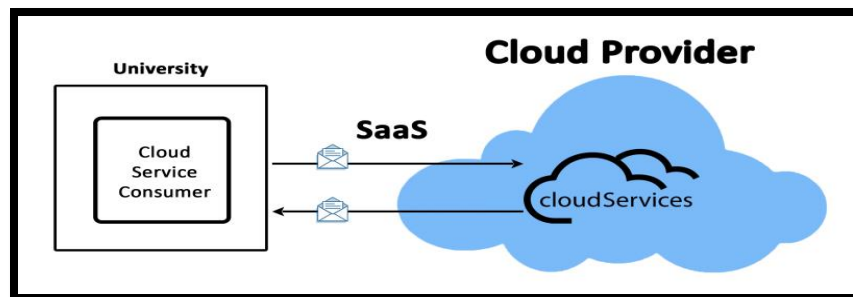


Fig.6 SaaS (Masud et al., 2013)

Based on the usability, flexibility and security, there are basically three types of cloud viz. (Aldheleai et al., 2017; Masud et al., 2013). Following figure 7 is depicting the different types of cloud.

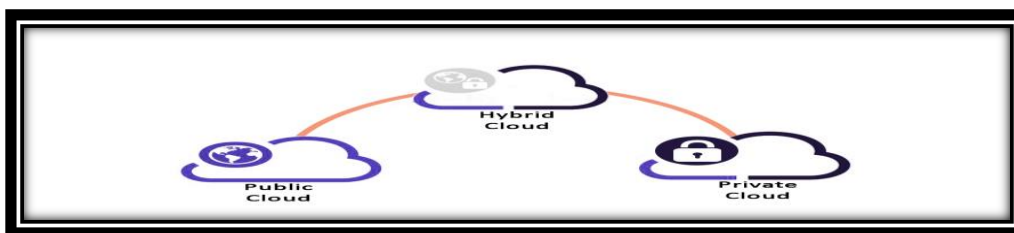


Fig.7 Types of cloud

2.2 LMS

A LMS is a web-based instructional technique that can be accessible through traditional IT or through any cloud-based service. The global education system currently relies on it, and numerous studies are underway to make the process more user-friendly and safe, particularly in pandemic situations. The benefits and the challenges of LMS are shown in table 1

Table 1: The Benefits and the Challenges of LMS (Chatterjee et al., 2020)

Benefits	Challenges
➤ Flexible in time as one can adjust his or her learning time as per convenience.	➤ Security concern in respect to data protection such as
➤ Low conveyance cost as one can access class from anywhere with the help of internet.	✓ Lock-in
➤ Users can have the option of getting relevant subject material as per their interest	✓ Isolation Failure
	✓ Loss of Governance
	✓ Compliance issue

<p>and which can help to increase their knowledge. Huge virtual storage space.</p> <ul style="list-style-type: none"> ➤ Users are getting more efficient in using internet and computer. ➤ LMS is generating more confidence in its learners as they are matching themselves with the pace of modern IT era. User friendly access of LMS as ❑ Using 5th generation mobile network (wireless technology) ❑ Enhanced mobile broad band ❑ Delivering always available secured cloud access ❑ Low latency ❑ Reliability & availability ❑ More signal capability ❑ Uniform user experience ❑ Increased data consumption ❑ Explosive growth in video traffic 	<ul style="list-style-type: none"> ✓ Data loss or insecure use ✓ Malicious use ✓ Data Protection in cloud ➤ Students having low intelligence may face difficulties and confidence. ➤ Unstructured discipline may take place. ➤ Learners may get themselves isolated. ➤ Availability of teacher is restricted. ➤ Availability of internet facility may be one of challenge or users as poor internet may create problem in connection. ➤ Few contemporary classroom courses may difficult to understand.
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The following figure 8 is giving an idea about universal acquisition of e learning methods and its mediums (Matthew et al., 2021).

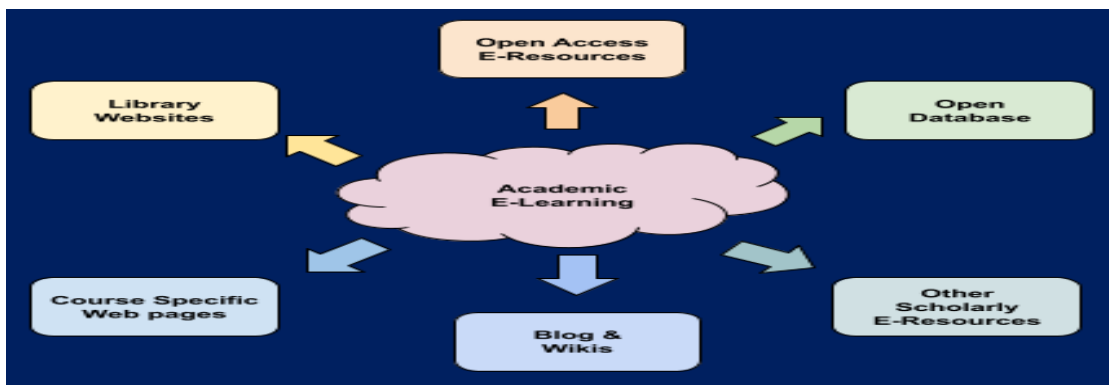


Fig. 8 Learning Methods and its Mediums

As it's already mentioned that the primary technological challenge for the LMS user is security and user friendliness. Based on which here is some examples and comparison of different cloud based LMSs.

2.3 Case Study

A. Moodle Cloud (Modular Object-Oriented Dynamic Learning Environment): This is a free online LMS that allows educators to create their own private website with dynamic courses that allow students to learn at their own pace and from any location. It is simple to use on any devices, including desktops, laptops, tablets, and smartphones. Moodle also gives thorough reports on course and site activity and engagement. MoodleCloud is the quickest method to set up a Moodle site for testing or ready-to-use apps. MoodleCloud offers a variety of low-cost and low-maintenance hosting services, including updates and backups, which include Moodle's most popular features. MoodleCloud is a hosting service given by Moodle's creators, where you may receive a fully-hosted Moodle site (MoodleCloud site) and build Moodle courses.

Technical Requirements (Chourishi et al., 2012): As Moodlecloud is open source, not bounded by a set of technological equipments and may be worked with a wide range of CPUs, both old and new models, making it extremely adaptable. The technological requirements for Moodle are listed in Table 2 below.

Table 2 Technical Requirements for MoodleCloud (Chourishi et al., 2012)

<p>i) Hardware resources: Windows 95, 98, 2000, NT, or ME/ XP/ Vista/ Pentium2-3/ MAC 9/ OS X.</p> <p>ii) The screen resolution can be changed to 800x 600 pixels or greater, up to 1024x 768 pixels.</p> <p>iii) For Internet Connection a 56k modem or a high-speed ADSL/Cable may be used.</p> <p>iv) Internet browsers include Mozilla Firefox, Internet Explorer, and others. The built-in HTML editor is not visible in the Opera and Safari browsers.</p> <p>v) Most apps, such as Microsoft Word, Excel, and PowerPoint, can be easily utilised in Moodle. The Excel and PowerPoint viewers, as well as a rudimentary text processor, are all functional. As an alternative, Open Office can be utilised.</p> <p>vi) Multimedia plugins such as Windows Media Player, RealPlayer, Apple Quicktime, Acrobat reader, Flash player, Shockwave player, Java Applets, and Java Mac OSx are supported.</p>
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B. Google Classroom

Security Aspect of MoodleCloud: Following Table 3 describe the security aspects of Moodle

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Table 3 Security aspects of MoodleCloud

For reducing system risk, decrease the number of users with administrator privileges.
Back up your courses on a regular basis. The Backup feature can be used to package courses into a single zip file. Any Moodle server can be used to restore these.
Set the enrolling method by through the key once the admittance is complete, and the key to a difficult-to-guess string. It will prevent unauthorized individuals from accessing the course.
Wherever a student is permitted to submit a file, set sensible upload limitations.

B. Google Classroom: Google Classroom is a fantastic resource for teachers and students looking for a solution to bridge the learning divide in our modern, geographically divided society. It's lightweight, easy to use, and absolutely free. Figure 9 depicts a web-based educational programme for vocational education in technological learning that utilises GOOGLE's cloud services.

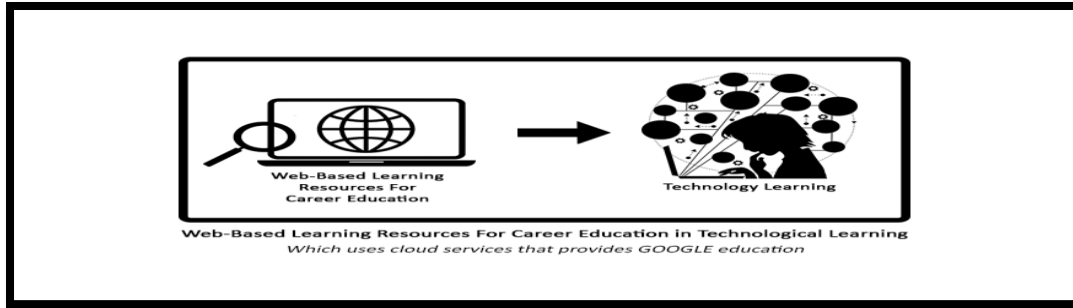


Fig.9 Google Classroom Platform (Tosheva, 2016)

Using the “Google collaborative platform” as an example, one aspect of E-learning environment construction-“the collaborative learning platform”-has been constructed, as well as the “collaborative learning responsibility” (see Figure 10).

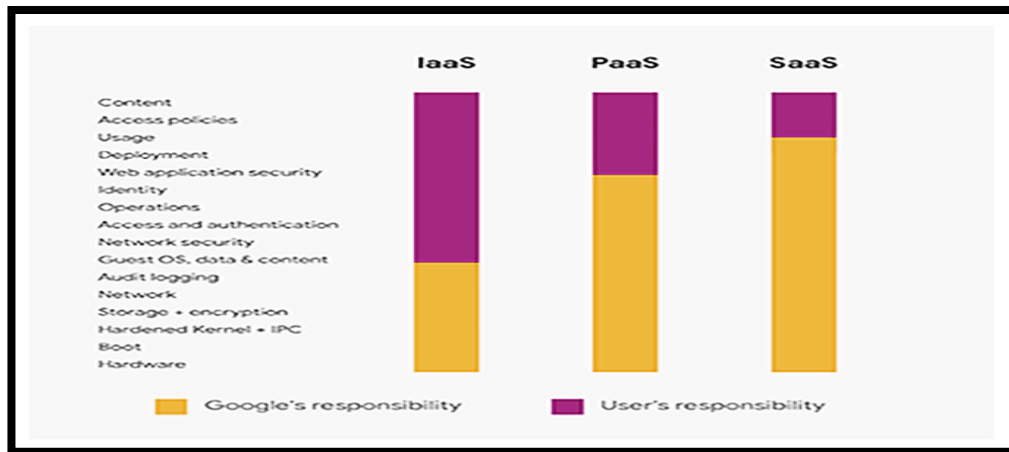


Fig.10 Collaborative Learning Responsibility in Google Classroom

Google Classroom's Security: Classroom was built using one of the most secure cloud architecture infrastructures in the world. The most prevalent causes of Google Classroom security vulnerabilities include misconfigurations, weak passwords, and human error. Google Classroom has four major security issues, as listed below:

Account Takeovers, Data Loss, Student Safety and Communications, Misuse Phishing and Malware

3. Related Work

After going through numbers of studies and on the topic this is found that there are researches and studies going on to smoother the usability of cloud based LMS with optimum security. View point of some papers and researches given below:

Paper (Ajayi and Akai, 2019) described the nontechnical issues of faculty and student while using cloud based LMS. In paper (Phongphaew and Jiamsanguanwong, 2018) described The goal of this study was to identify the primary myCourseVille interface flaws using a usability evaluation method that included five usability features on the student and teacher interfaces, as well as LMS software recommendations. Paper (Pandey et al., 2021) discussed the satisfaction level of users and significance of using cloud based LMS in pandemic situation and what are the parameters that should increase the satisfaction level of users. In paper (Raza et al., 2020) or described and discussed about behavioral intention of LMS in COVID situation. It shows moderation analysis of e learning acceptance among students influenced by Corona Virus. In paper (Kilanko et al., 2019) studied and discussed about the current trends and guide for future research directions based on architectural benefits. In paper (Siddiqui et al., 2019) discusses the top five e-learning tools that are expected to grow in popularity as the number of learners grows in the future years. The proportion of e-learners is growing at rapid pace with each passing day with few of the existing tools with their pros and cons in which some platforms are too complex. In paper (Matthew et al., 2021) discussed and survey on technological implementation and adaptability of digital learning including IoT and AI among educational institutes and students and teachers in 21st century. In paper (Mershad and Wakim, 2018) it is discussed about LMS model and its course content, distribution, tracking and technological enhancement using IoT. In paper (Aydin et al., 2016) it is discussed about LMS used by engineering students by State-of-the-Art Matrix analysis. In Paper (Ibrahim and Elmasry, 2021) it is proposed to host LMS through cloud by adapting hybrid cloud system for higher education institutions.

In this paper other few related papers are studied to continue further work.

4. Proposed work and Methodology

In this proposed work author is trying to describe usability of cloud based LMS architecture, It's easier to understand if one divide it into two parts:

- Front-end development • Back-end development

They communicate with one another across a network, the most common of which is the Internet. The front end is the part of the application that the computer user, or client, sees. The "cloud" component of the system is the back end.

- Front-end development

The client's workstation (or computer network) and the application necessary to access the cloud computing system make up the front end. The user interfaces for all cloud computing technologies are distinct. Web-based e-mail programmes leverage existing Web browsers like Internet Explorer or Firefox. Other systems give customers their own apps that let them connect to the network.

- Back-end development

The various computers, servers, and data storage systems that make up the "cloud" of computing services are on the system's back end. A cloud computing system may theoretically

incorporate any computer software, from data processing to video gaming. Each piece of software will usually have its own dedicated server. The system is managed by a central server, which keeps track of traffic and performs other activities. Machines on a network can communicate with one another thanks to middleware. Servers are rarely utilized to their full potential. That means a lot of computational power isn't being utilized. It's possible to make a physical server believe it's a collection of servers, each with its own operating system. Server virtualization is the name of the technique. Server virtualization eliminates the demand for more physical computers by optimizing the efficiency of individual servers (Masud et al., 2013).

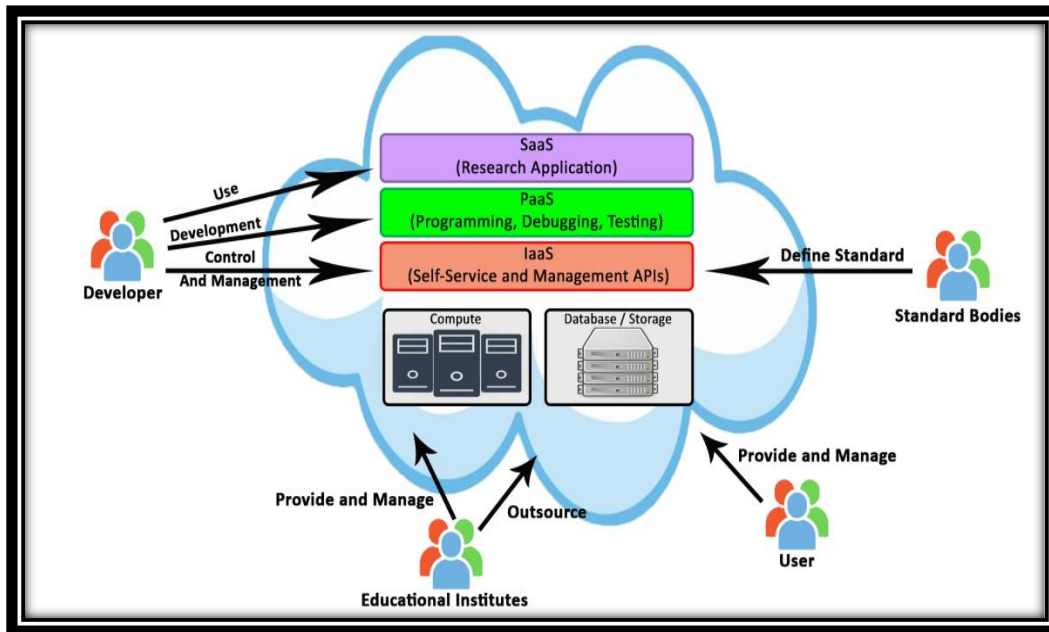


Fig. 11 Architecture (Cloud)

4.1 Proposed Application implementation - Virtual Reality of Dynamic Learning

User roles are one of the most essential building elements in the structure of LMSs, and these roles can be used to study LMS characteristics. Users with various responsibilities can access content on the LMS via a network connection (Internet, intranet, or extranet) based on their authority in the LMS design. Users' data, course data, system data, and so on are all stored in relational databases. The LMS must be accessible for interaction with other IT systems, as well as mutual information transfer and synchronization (Ülker and Yılmaz, 2021).

The user model, network, and cloud models are the three core modules of the system. Users can log in or enroll in the cloud via an app on their devices that are linked to the internet via an internet service provider / Wi-Fi. These models are depicted in Figure 12.

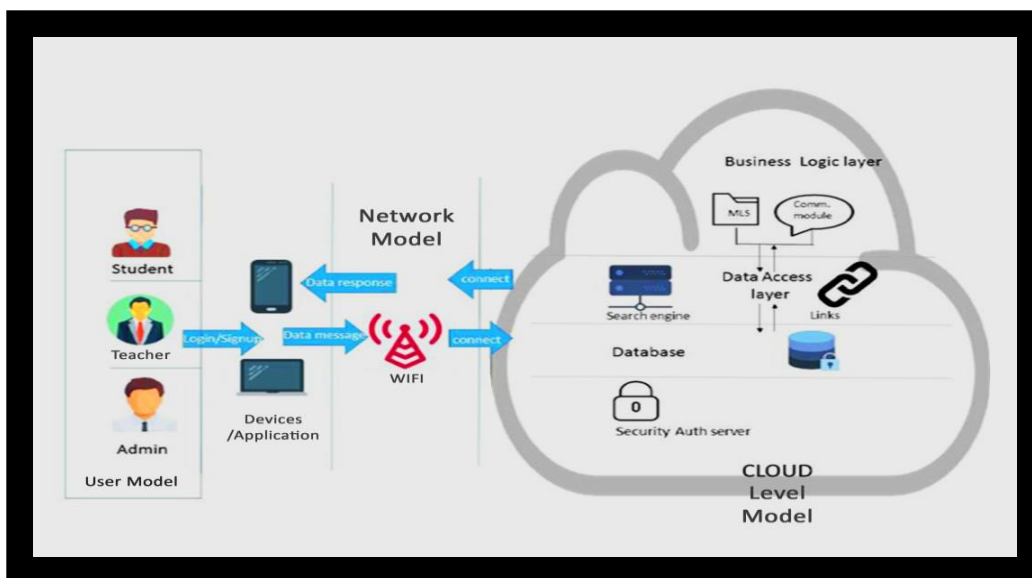


Fig 12 Different Models

The user sends the request for a resource to the cloud server, which is received by the business logic layer, which processes it and sends a request message to the data/file access layer, which returns the requested resource. If the user is authorised to use the resource, the data access layer grants access, and the requested resource is fetched from the database via a data query/search engine and transferred to the user device for display via the business layer. In the meantime, if the learners or instructors are not authorized to access this resource, the data access layer pursues an error code to the business layer, which depicts the appropriate error message to user.

Communication Module gives ability for system users to communicate with one another via messages at any time and from any location. Every user gets an inbox where he can receive messages and send messages to other users. This feature is significant since it allows for continuous communication while learning. For long-term storage and retrieval, all messages are securely kept in a cloud database.

Data Access Layer has a search engine as well as links which major role plays for receiving information requests from the business logic layer and then should be ended the database querying, refreshing, and modification. These results are then returned to the business logic layer server.

Authentication and authorization are handled by the Authentication Server. It determines if a user has access to the system and the ability to perform undesired data activities (such as updating, retrieving, transferring, deleting, and so on). Users with certain privileges, such as administrators, lecturers, and others, are given passwords, whilst other users, such as students, are just required to register in order to access into the system.

Learning documents, assignments, videos, and audios are all stored on the Database Server, and they should be accessed at various times. The cloud offers the file storage architecture that makes

managing and serving files a breeze. All files are arranged in a logical manner, and their contents are stored in a database. As a result, it's vital that it's available at required times because data can be accessed at any time and from any location, and that it's regularly stored and backed up. All of this is made easier by the cloud, as cloud service providers give functionalities for automatically performing database maintenance, which is critical because the database is the system's backbone (Ikuomola, 2018).

4.2 Flowchart & Algorithm

The flowchart for suggested cloud-based LMS database is shown into Fig. 13.

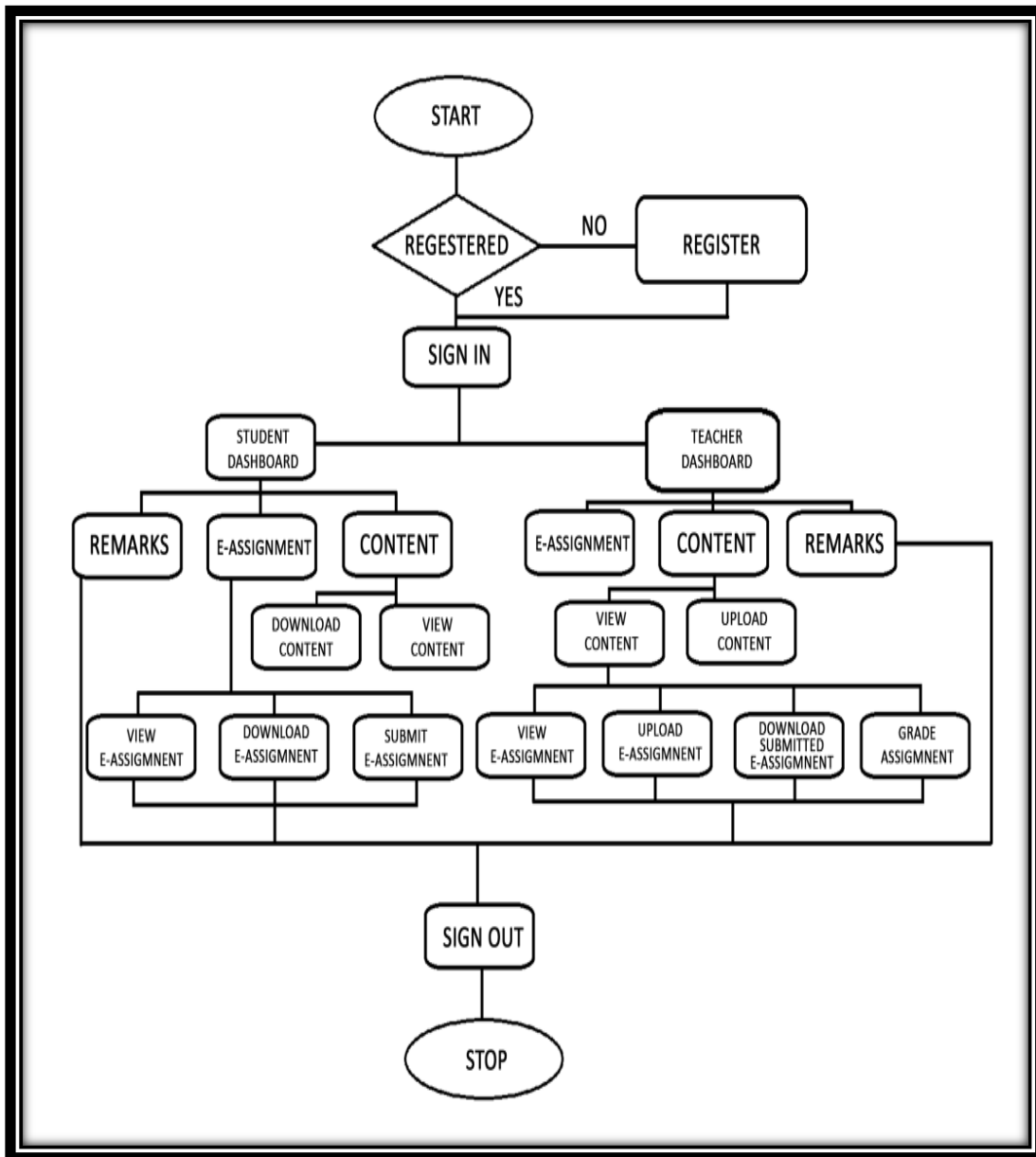


Fig 13 Flowchart

Following figures are describing the related algorithms (Ikuomola, 2018):

```

Step 1: Start
Step 2: If user level= special, goto step 3
Else print "Access is denied.
Please contact a admin". Goto step 8
Step 3: select file for upload
Step 4: input full details of file e.g. name, type, course
code, department, etc.
Step 5: submit form for upload
Step 6: If file is valid go to step 7
Else print " Invalid file" go to step 3
Step 7: Store file details in database and move file to
cloud storage.
Step 8: Stop
    
```

Fig.14 Algorithm- LMS materials-upload

```

Step 1: Start
Step 2: if user login is successful goto 3
Else goto 1
Step 3: Get all course materials from the cloud
and display them, grouped by department and
course code.
Step 4: Select file for download
Step 5: Get file from cloud storage and save to
user device
Step 6: Stop
    
```

Fig.15 Algorithm- LMS materials-view, download

```

Step 1: start
Step 2: If user level = special, goto 3
Else print "Access is denied. Please contact
a admin". Goto 7
Step 3: select assignment file for upload
Step 4: Fill details e.g. deadline, course, etc. and submit
form
Step 5: if file is valid goto 6
Else print "invalid file" goto 3
Step 6: Store assignment details in database and upload
file to cloud storage.
Step 7: stop.
    
```

Fig.16 Algorithm- uploading assignment

```

Step 1: start
Step 2: if user login is successful goto 3 Else goto 6
Step 3: Show a prompt displaying assignment details
and options to download and upload answer.
Step 4: if user select download, save assignment file to
user device.
Step 5: if user select upload answer goto 6
Step 6: display upload form
Step 7: On form submit, if file is valid goto 8
Else goto 6
Step 8: save answer details in database and upload file to
cloud storage.
Step 9: stop
    
```

Fig.17 Algorithm- Assignment Answer Upload

```
Suppose  $UL$  is the access level of a user  
At start up,  $UL = normal$   
Step 1: Start  
Step 2: User input details in login form.  
Step 3: Search details in database records.  
Step 4: If email and password exist in the database and  
user type = lecturer or admin change  $UL =$   
special goto 5 Else Print "INVALID USERNAME /  
PASSWORD", goto 2  
Step 5: log user in with special privileges.  
Step 6: stop.
```

Fig.18 Algorithm- Authorization

Figures 19 and 20 depict Some Screen Shots of LMS Application Software implemented by PHP programming and MySQL (Database System).

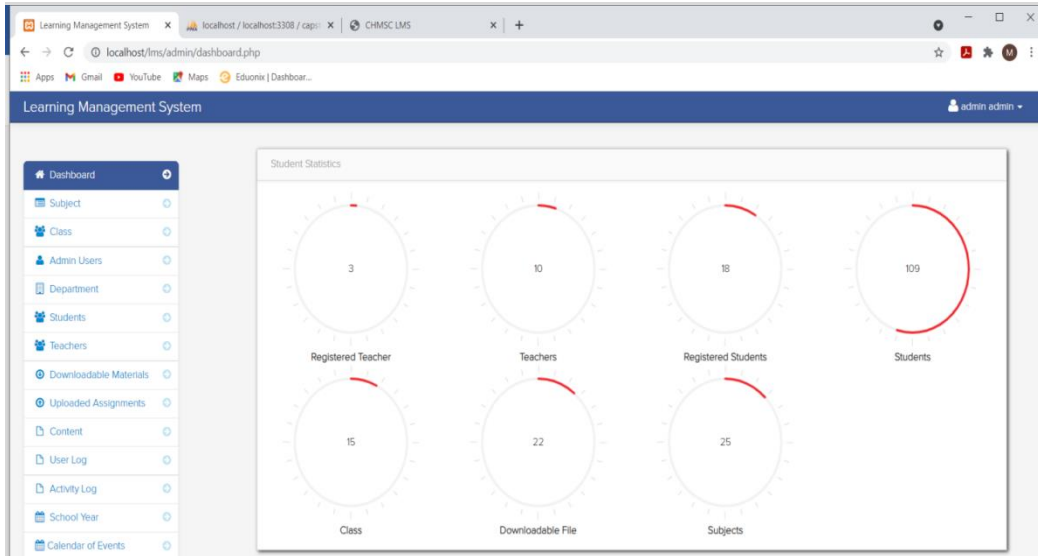


Fig. 19 LMS Application Software-Dashboard

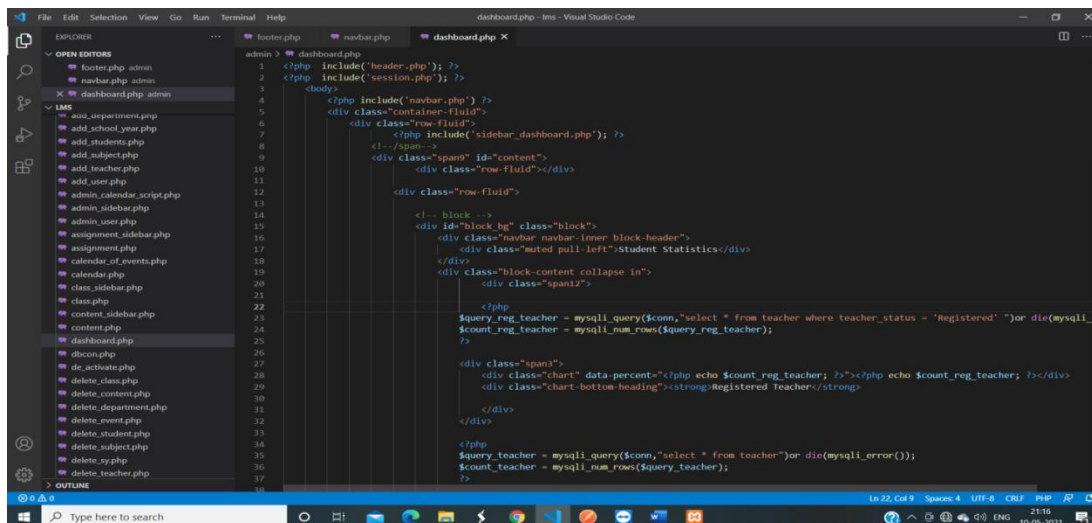


Fig. 20 LMS Application Software-Programming

5. Result

There are separate logins for students and teachers. Before proceeding to the next phase, students must first register in the system. Users who are not registered are unable to access any of the system's functions. Students can view/download course materials and assignments after logging in, as well as submit assignments, leave comments, and engage with other students and teachers. After logging into their own profile, teachers may upload course materials and assignments for students, view or download submitted assignments, assess or mark them, and also do comments. Finally, for security concerns, users must logout of the system after completing their responsibilities in their separate accounts.

To receive a login id and password, every new user must first register. The user's id will be used to validate the user, ensuring that unauthorised users are denied access. The following are some of the anticipated outcomes of implementing the developed cloud-based Learning management systems which are shown in table 4:

Table 4 Outcomes

- (i) The system allows for accurate student and professor registration;
- (ii) It permits authentication, ensuring the only authorized users for accessing services; and
- (iii) This includes functions and features including validation and user friendliness.
- (iv) This delivers cloud-based secured mobile learning solution.
- (v) It allows students and professors to communicate in real time.
- (vi) The system was created with collaborative learning in mind.

(vii) The system can be configured to work in a variety of settings.

This concept includes "Smart Classroom" and "Smart Lab," both of which are available via portable devices and integrated into a cloud-based LMS with IoT that captures and uploads real-time data for later use. Another feature called "Smart Notes Sharing" allows any campus network user to contribute classroom notes by automatically transmitting real-time data from an IoT-enabled smart board to the LMS application. Another essential component of the "Smart I-Campus" is the use of augmented reality and 3D virtual objects in the "Smart Classroom," which will allow students to find important and real-time information when they get close to learning materials that will be connected to sensor devices (Aldheleai et al., 2017). Cloud storage also enables for real-time data exchange, allowing several people to see the same information at the same time. As a result, this system is appropriate for both remote and in-house education, as the storage overhead and encryption decryption computation time must be kept to a minimum, even when numerous groups need file access. While malicious software that can penetrate a cloud computing infrastructure is a major source of danger perception, the possibility of unauthorised software deployments in an infrastructure-as-a-service model can expose an affected cloud service provider to a slew of legal and statutory difficulties. Managing software licences and performing licence validation checks can be a time-consuming operation. Both the cloud service provider and its clients are responsible for controlling and managing software licences placed on an infrastructure-as-a-service cloud model. The convenience and use of an efficient licence auditing management tool to which auditors can connect through a secure conduit, on the other hand, is critical to effectively managing software licences. In cloud computing settings where software licences are delivered on virtual machines in IaaS or PaaS modes, a secure web-based software licence agent could be proposed as part of a monitoring and management architecture. The suggested paradigm not only allows users and auditors to look into software licence usage at any point in time, but it also allows them to do so over a secure channel. The importance of security in cloud computing settings cannot be overstated, and the suggested approach offers a distinct benefit to cloud service providers (Chakraborty et al., 2019).

6 Final Thoughts and Future Work

The learning management system is a very specific and difficult technology, and in order to minimise user experience issues, the LMS developer must provide an intuitive human-centric navigation experience. The cloud-based learning management system is a step forward from standard LMSs in that it incorporates cloud computing infrastructure. The services provided by these sources can improve the education system, thanks to new technical breakthroughs such as mobile technology, intelligent agents, and cloud computing. This proposed paradigm offers a helpful option for addressing challenges of availability and security. Privacy and data integrity are two of the most important cloud concerns. The majority of the data exchanged concerns the user's personal information. How to give suitable authorization regulations and procedures while guaranteeing that only authorized users have access to sensitive data is a particularly critical topic that has yet to be addressed. There are a variety of methods

for safeguarding data on a network, with cryptography being one of the most used and well-known. Furthermore, one of the main reasons for using cryptography for security is its inexpensive cost of implementation, as well as the flexibility and adaptability with which it can be changed to meet changing needs. Future research should focus on addressing the issue of security and privacy in cloud environments by developing a hybrid Lightweight Cryptographic Algorithm for Enhancing Data Security that can be utilized to safeguard cloud computing LMS applications.

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