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Cloud Computing Revisited For E-Learning Systems with Some Improvements with Auditing

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ABSTRACT

***E-learning* has brought great dynamics and parameters in the field of education and research. It has revolutionized the way learning has imparted to students. The perks of *e-learning* include consistency, scalability, cost cut down, in contrast to the traditional learning method. It is equally well-being and doing great in every field of learning. During this period of COvid-19 e-learning is developing and has completely taken over and administrated the education system. But along with the advancement of the field there comes the challenges. One would always keen to look up for the technology to make the learning process reliable, faster, easier to use, and can enhance with more interactive features. This is the spot where cloud computing stands with a bunch of its unmatchable capabilities. Cloud Computing refers to provide the computing assets on the internet which may include storage, servers, software systems, databases, online management systems, and online applications. Having a paradigm like *Cloud Computing* gives an edge for innovators and entrepreneurs to design and develop their mainstream projects and products with ease. This paper provides an insight into how Cloud Computing has the potential and can be the primary driver of e-learning. How the field of e-learning can benefit from this revolutionary technology. This research discusses the cloud services, architecture nature as a service for the *e-learning* environment. Further, the comprehensive converses about the impact of Cloud Computing on e-learning along with the security fears and features can potentially get the most out of the combination of both fields with the introduction of auditing of the system .**

Keywords: E-learning environment, Cloud Computing, E-Learning.

INTRODUCTION

What is e-learning?

An official learning system based on formalized education but with the aid of electronic assets is known as e-learning. The major component of e-learning includes the computer and the

internet. Moreover, e-learning is a network- facilitated the transfer of skills and knowledge which makes possible the transference of education at the same or different time to many receivers [1].Figure-1 shows the basic learning structure of e-learning.

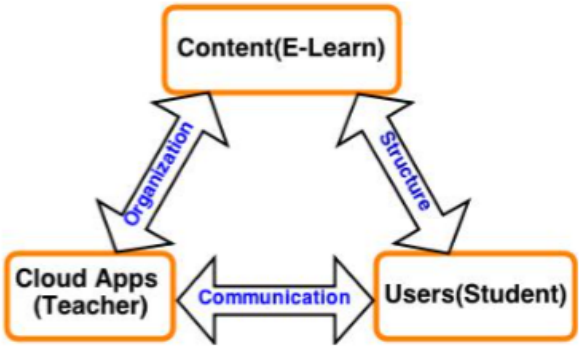


Figure-1: e-Learning Structure [2]

Basics of e-learning

E-Learning is linked to many terms and occurs in a variety of techniques. Some cases are mentioned here. **Hybrid learning** is the technique of instructing distant and in-person apprentices with practical instruction solutions at the same time. In contrast, mixed learning is the method of education in-The Existing classroom with workouts and content that can be accomplished outward of the classroom by different places and time [3]. In **online learning**, students get an education at their home using a computer via internet assets [4] while **Digital Learning is the** process of learning digital technologies and tools are used to create a better educational experience for students. **Distance Learning or Remote Learning is the kind of** learning in which the key elements are the physical separation of students and teachers and several technologies are used to assist student-student and student-teacher communication. Digital learning is also known as e-learning, online learning, and distance learning [5]. **Instructor-Led Training (ILT**) training takes place usually in an office, in the training room, conference, or classroom. There may be more than one trainer who conveys their knowledge or skills via speeches, demonstrations, and negotiations with other participant groups. **Learning Management Systems (LMS)** acts like an engine that controls e-learning. Normally it consists of two components: A Server that carries out the principal functionality (assisting notifications and data, delivering, managing, and creating courses, user verification, etc.) A user interface that act as a web (like Facebook or Gmail) used by trainer, learners, and administrators and runs inside the user's browser [6]. **Micro-learning** is about getting e-Learning based education with short term learning units, activities, and notes that you can understand in a small period (opposite of macro learning which deals with e-learning in heavy doses with long term study by taking classes of a subject and exercises at school)[7]. **Webinars** is an online session used to share ideas and knowledge via video lectures, presentations, or workshops to a worldwide audience.

Welfares of E-learning

E-learning saves time and cost

E-learning provides the content to the learner at any time anywhere. So, the learner can attend classes according to their ease along with jobs. E-learning technique is not only time saving but

also cost-effective. It saves an extensive amount that a learner or teacher would serve on accommodation, travel, venue, and content.

E-learning leads to better retention

Instructors can make attractive learning content by using an e-learning tool for the learner. An attractive content enables the learner to memorize information. Learners enjoy learning with clear concepts and apply these concepts at their work

E-learning is compatible

With the e-learning technique, all learners can get standardized training, and each time they face similar experiences when and where taking the course.

Scalability of e-learning

E-learning is an example of scalable learning. An instructor can add as many learners as needed to take an asynchronous online course. It is a one-time investment and quicker to write off the expenses with more learners.

Personalized E-learning

Personalized e-learning enables each individual to perform learning goals at full potential and make it possible to provide each learner's needs and permit them to choose their learning path.

Ease of Use

Cloud provides ease of use to the developers and the end-users as they don't have the responsibility to update the platform and take care of the security. The firm that provides the services will responsible for all the concerned staff and charge you for the services you are getting.

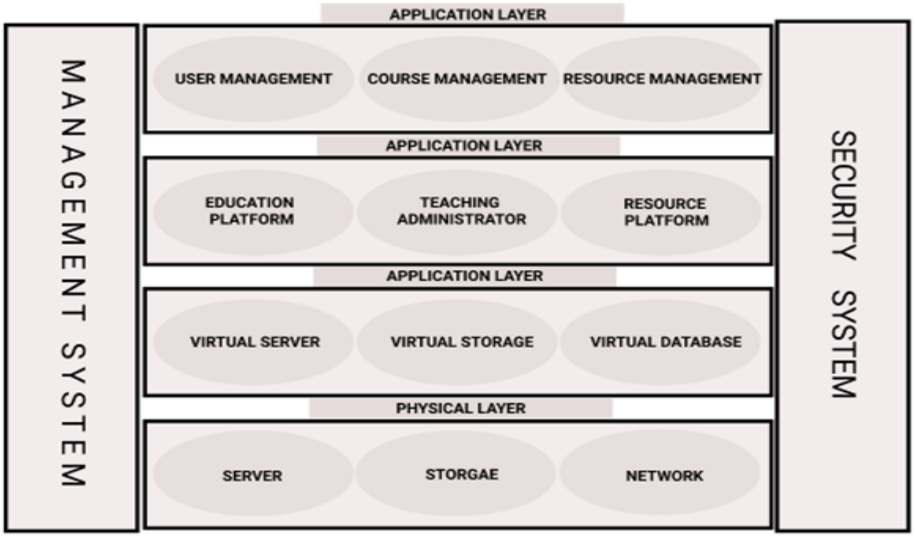


Figure 8: Model-based on cloud Computing [21]

What is Cloud Computing?

The transfer of various assets which include applications and tools such as a server, networking, database, data storage, and software as seen in figure-2 is known as cloud computing[9, 10].

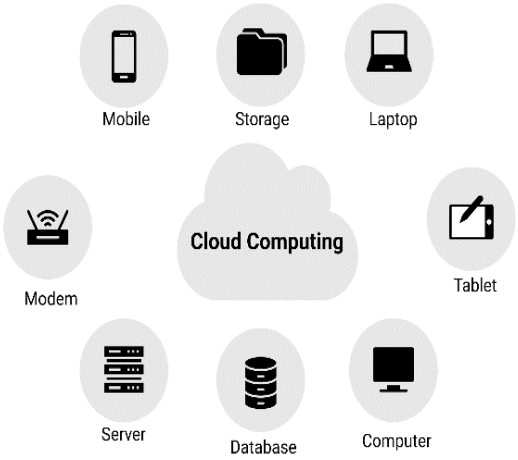


Figure-2: Cloud Structure [11]

Basics of Cloud Computing

In the era of industrial revolution 4.0, Cloud computing is regarded as the most significant technology. It is the driver of many technology fields today because it gives the ease of access to data, security and eliminates additional concerns of setting and maintaining the environment. Cloud computing includes three main contributions which are Software as a Service (SaaS), Platform as a Service (PaaS), and Infrastructure as a Service (IaaS). **SaaS** is a software delivery model by which the seller or facility provider hosts applications and makes the applications accessible to the users over the internet. This software supports Web Services or a developing widespread distribution model as fundamental technologies. **PaaS** permits designers to form applications and services by providing an environment and platform. This service is presented in the cloud and accessible to the users through the internet while **IaaS** along with PaaS, laaS is an essential service model of cloud computing. The cloud computing assets get access to a virtualized environment "the cloud" by laaS over the internet. Computing setup like network connections, IP addresses, bandwidth, virtual server space, and load balancers are provided by IaaS [13, 14, 15]. The group of hardware assets, usually delivered across numerous data centers, is extracted from many networks and servers [16] as shown in figure-3.

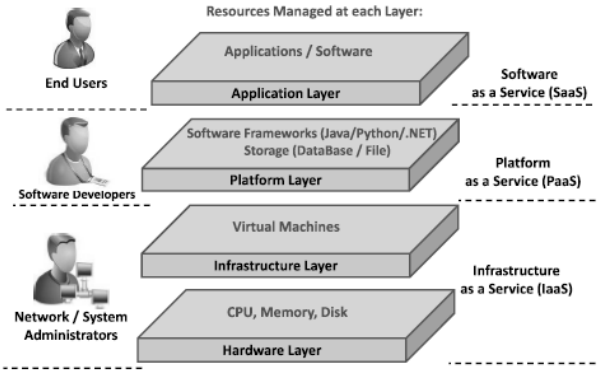


Figure -3 Cloud Model Services Architecture [17]

Cloud Computing Deployment Models

IaaS, Paas and Saas models are available for cloud customers in private, public, community and hybrid cloud deployment models as shown in figure

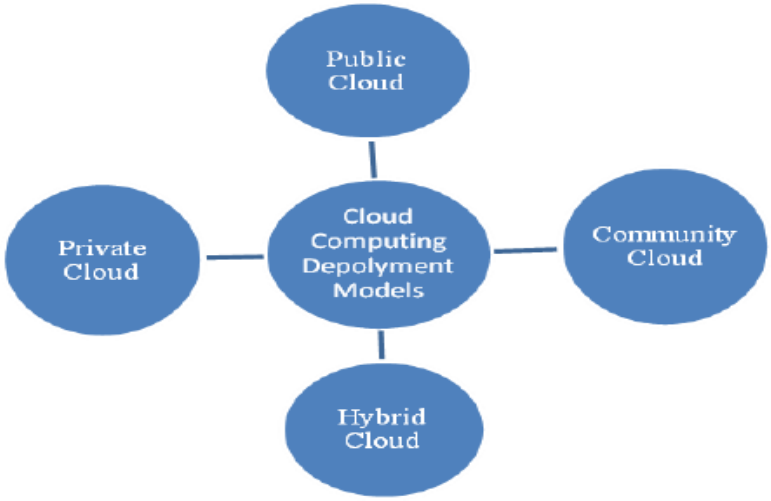


Figure -4 Cloud Computing Deployment Model [18]

Deployment models broadly characterize the management of disposition of computational resources for delivery of services to consumers, as well as the differentiation between classes of consumers [8]. A Public cloud is one in which the infrastructure and computational resources that are made available to the general public [2]. A private cloud is one in which the computing environment is operated exclusively for a singer organization. A community cloud falls between public and private clouds with respect to the target set of consumers [15]. The infrastructure and computational resources are exclusive to two or more organizations that have common privacy, security and regulatory considerations for a shared purpose [8]. A hybrid cloud is more complex than the other deployment models as they involve a composition of two or more deployment models at the same time allowing for data and application sharing [2, 8, 15].

Private Cloud

A private cloud means a single resident environment where the computing assets are installed and operated by one organization and did not share with other organizations. It is applied for intra-business interactions [13 ,19].

Community Cloud

In this method, computing assets are deployed for organizations and societies [19].

Public Cloud

This cloud is frequently used for Business to Consumer (B2C) type interactions where computing assets are personal, administered, and operated by academic, government, or business organizations. [15 ,19].

Hybrid Cloud

This deployment method where computing assets are combined with other different cloud is known as hybrid cloud. It is used for both Businesses to Business (B2B) and Business to Consumer (B2C) types of interactions. [13, 14,15 ,19].

Benefits of Cloud Computing

Several benefits of Cloud Computing include mobility, security, cost savings, flexibility, quality control, loss prevention, automatic software updates, disaster recovery, insight, competitive edge, sustainability, and increased collaboration [13,14,20]

Issues and Concerns

Being a user of the cloud, the following concerns and issues associated with the platform.

1. Data Integrity
2. Data Confidentiality
3. Data Availability
4. Service availability

Ensuring all the above concerns must not be present to guarantee the cloud platform and data security. But what happens when someone tries to spoof the data, breach our platform, and try to steal the information. These situations can be dealt with by maximizing the security and if after all the security measures somethings happen then data forensics can be applied to rectify the problem and to catch the intruder[21].

IMPACT OF CLOUD COMPUTING

Why Apply Cloud Computing on E-Learning

Cloud computing mode is a permitted and widespread environment. Once applied for instruction, it does not only confirm the student's self-sufficiency but also helps increase the efficiency of education. For more effective education of students, building a cloud computing instructive space to take benefit of cloud computing.

SaaS (Software as a Service)

Some elements can be associated with the benefits of "software as services" in educational organizations. First, it offers a solution to the problem of licensed software that needs continuous updating. Secondly, experimentation, analysis, and searching are required in the educational process. Cloud technology provides flexibility and allows users to modify, test, and associate with various kinds of software. Third, provides smooth access to huge data collection opportunity [22, 23,24,25]

CaaS (Communication as a Service)

CaaS, a new service, is obtained from SaaS. E-mail is an example of communication as a service that can be delivered to the students, teachers, and administrations of school. A moreover substantial amount of computer-generated space is specified where students can store mass media or image collections. Using this service student can use email via mobile devices from anywhere anytime [22, 23,24,25].

Daas (Desktop As A Service)

DaaS is a new technology, obtained from SaaS, which offers a completely ready virtual workplace as a service to the users. Students acquire access to space according to their needs and goals that may be further modified. The benefit of DaaS includes minimal hardware requirements, and it significantly reduces costs. The users pay according to their exact needs. Consequently, it seems an opportunity to deliver a substantial amount of academic content by inexpensive hardware[22, 23,24,25]

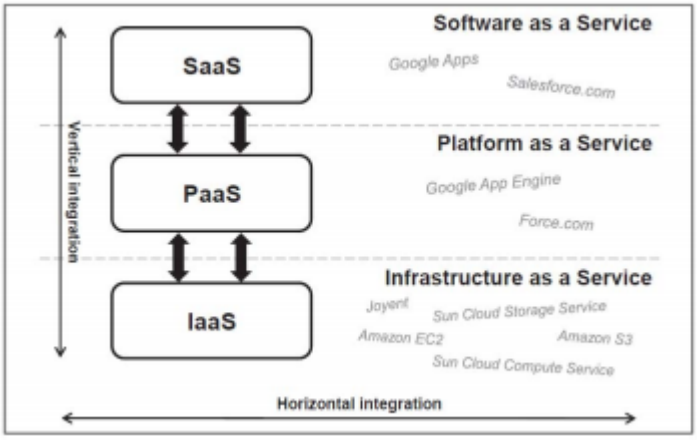


Figure-5 The three layers of cloud computing: Saas,Paas,Iaas [26]

From Traditional to Cloud Architecture

It is an open fact that e-learning has innumerable benefits such as measurement, flexibility, opening, diversity and the list goes on. E-learning will become the primary way of learning in the future. Moreover maintenance and system development are available inside the educational enterprise or institutes in the traditional setting which bring countless issues like substantial investment required to upgrade the systems with the passage of time and to spend on the salary of the IT team who maintain and upgrade the IT infrastructure. However, the cloud-based e-learning model lay the foundation of a scale efficiency mechanism. Development of the e-learning system is trusted to cloud computing dealers, which can make suppliers and customers develop a win-win situation [27]. Furthermore the atmosphere of cloud-based computing supports the creation of a new cohort of e-learning structures, can run on an extensive range of hardware tools although storing records under the cloud. It has produces an advanced e-learning network consists of Web 2.0 technologies while the traditional e-learning structures are not scalable dynamically and difficult to extend –incorporation with new e-learning systems are very costly. In the e learning model the educational institute will be focusing on teaching process, delivery, and content management. The e-learning system can be scaled, both vertically as well as horizontally, and the educational institution providing the e-learning facility may charge to online students as per the usage of resources on cloud servers.

Cloud-Based Architecture and its Characteristics

It is a known fact that e-learning cannot replace teachers and physical learning. E learning is an alternative way of learning with more visual and interactive content. Although teachers are the main driver of this field since they set up the cloud upload and update resources. The mixed learning approach must improve educational performance. Furthermore, interactive and promising content and virtual association guarantee a great retention factor. Contrary to this,

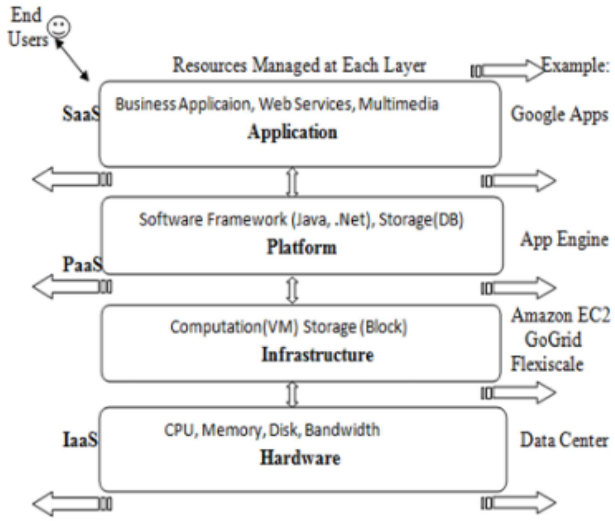
the e-learning cloud is a relocation of technology based on cloud computing in the arena of e-learning, considered as a future infrastructure of e- learning, having all the essential software and hardware computing resources indulging in e-learning. Subsequently, these computing resources transform into virtualized, it can be economical when it comes to education institutions services, learners, and businesses to offer rental services of computing resources. E-learning cloud architecture may be divided into these layers ensuring more security and persistence:

The infrastructure layer is a vibrant and accessible physical host pool, the layer of software resource that proposes a united outlook for e-learning creators, the layer of resource management that attains unattached coupling of hardware resources and software, the layer of service, comprising three stages of services (platform as a service, software as a service, and infrastructure as a service), the layer of application that delivers services such as content production, content delivery, virtual laboratory, management features, assessment, and collaborative learning [29]. The layer of infrastructure is made of teaching resources and information infrastructure. Information infrastructure covers system software, Internet/Intranet, information management system, and certain common hardware and software; educational resources are stored chiefly in the conventional teaching model and dispersed in multiple domains and departments. The location of the layer is in the lowest level of cloud service middleware, the elementary computing power such as CPU, physical memory, and layer provides the memory. By using a physical server, virtualization technology, storage, and network create a virtualization group that is being called by the higher software platform. The physical host pool is a vigorous and upgradable, novel physical host that may be entered to improve physical computing power for services of cloud middleware[31].

The software resource layer principally is made of middleware and operating system. Multiple software resources are combined to deliver an amalgamated interface for software designers, therefore, they can create various applications with ease that are based on software resources and inserted them in the cloud, allowing them accessible for cloud computing consumers'. The layer of resource management is the crucial part to attain the moveable coupling of hardware resources and software resources. By using integration of virtualization and scheduling cloud computing plan, on-demand free flow and supply of software on the top of multiple hardware resources could be attained. The service layer consists of three levels of services that are, Paas (Platform as a service), SaaS (Software as a service), IaaS (Infrastructure as a service). Briefly in SaaS, cloud computing service is delivered to clients. Generally, it is different from conventional software, customers use the software through the Internet, no requirement for a one-time purchase for hardware and software, additionally, no need for maintaining and upgrading, just paying regular service charges is more than enough.

The application layer is the particular application of assimilating the resources of teaching under the model of cloud computing, with interactive courses and distribution of the resources based on education. The interactive programs are chiefly developed for the educators, as per the learners and teaching requirements, getting the full benefit of the fundamental information resources following finishing made, further the course content and the advancement can at any time regulate as per the response and maybe more operative than conventional teaching. Distribution of teaching resources such as teaching information resources (such as digital libraries, information centers), teaching material resources, along with the complete division

of human resources. This layer primarily is comprised of content production, content delivery technology, educational objectives, assessment, and the organization component. The intended benefits came from the offered architecture are as follows: 1) Storage capacity and Powerful computing: E-learning architecture based on Cloud finds in the computing and data is present in a huge number of distributed computers, the umbrella of clouds in the tens of thousands of computers to deliver great computing power and enormous data storage space, labels the "cloud" as a service available to learners through the Internet's high accessibility. By the combination of high-performance and mass storage computing power, this structure can deliver advanced quality of service. Further, The Cloud computing system can automatically sense the node failure and eliminate it, do not disturb the normal process of systemic high safety. Under the cloud computing model, records can be stored intensively. Depending on one or more than one datacenter, administrators manage the united data, assign the balance load, resources, control security, deploy the software, and do trustworthy actual checking, hence guarantee the consumers' data security to the utmost possible extent.



Virtualization

Virtualization is an utmost important characteristic of cloud architecture. Every application installation environment and the existential physical platform is not connected. It is expensed, managed, backup, and migrated via a virtualization platform[15] This places the underlying hardware, as well as servers, networking equipment, comprehensive virtualization, and storage to form a resource pool of distributed on-demanded and shared. The main benefit of the proposal is creating access to provide easy access for unlocking costly software functioning on high-performance computers to rural learners at institutes which is deficient when it comes to substantial facilities for students. Implementation of this architecture needs significant investment, but the advantages outweigh the cost of this system[31]. Figure-7 represents the practical model of how virtualization works in a system.

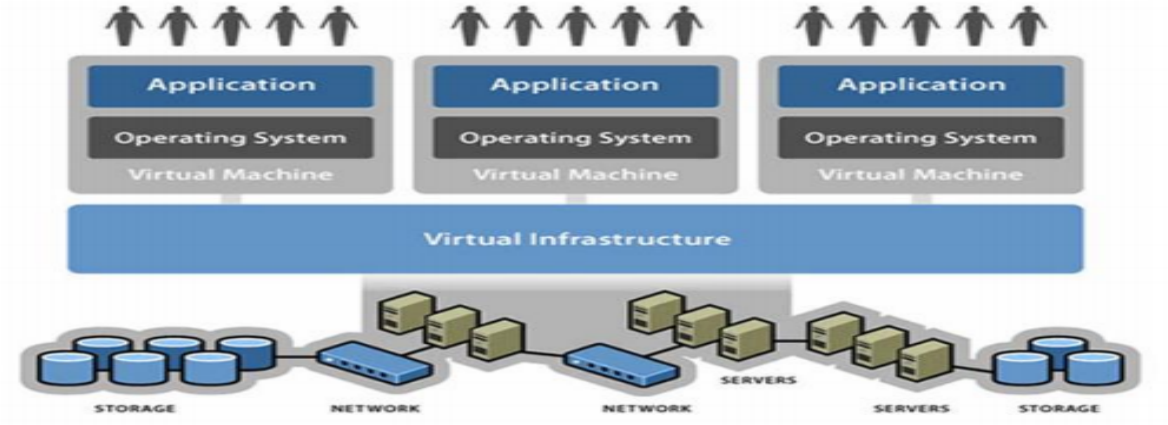


Fig 7: Virtualization Structure [19]& [28]

Cloud computing is composed of several applications, infrastructure, and platforms that perform different operations that the traditional architecture lacks all these technologies layers and you can use the resources already available to you.[27] and

How Cloud Manages Security

As defined in [12] there are various models for the deployment. These models gave and ensure maximum data security and control according to need.

How Cloud Cope-Up Cyber Incident

Cloud Forensics is interdisciplinary between Digital Forensics and Cloud Computing. Cloud Forensics is one of the best applications under digital forensics that supervises the crime that happened on the cloud and inquiries about it. Cloud computing is dependent on a huge network which has its branches worldwide. Thus, Cloud Forensics is the subdivision of Network Forensics [14]. Cloud forensic is a framework for investigating the issue based on the service and deployment model. Having forensically prepared would permit organizations to elevate their aptitude to obtain miscible evidence based on digital and to decrease the expenses of any possible investigation of digital forensics[27]. As shown in figure 9, the steps used in cloud forensics.



Figure 9: Cloud Forensics Techniques [20]

Addition of Features

The application of cloud computing has much potential and flexibility and more unique features can be added to the platform regarding e-learning. Deploying machine learning models is one of them.

Anonymous users join the class and mislead the instructor and create chaos in the online class which can be eliminated. The models of face recognition can be deployed to the e-learning platform so the student can be verified by their device camera and their name and roll number will be marked automatically and visible to the instructor.

RECODMMENDATIONS

1- To increase participation during the learning process with monitoring
2- A subject specific virtual library resource should be integrated on cloud
3- Service model of cloud computing should be encouraged to reduce the cost and pay for the cloud on services utilized by the organization or person.

CONCLUSION

Cloud Computing has appeared as a very capable, convincing ecosystem for the conveyance of amenities using the internet. It shows its great impact on changing technology by removing the barriers related to technology. Overall, it has also completely changed the paradigm of learning from traditional to online learning. Cloud computing is capable enough to assist nations by transforming the shape of education. The present pandemic situation will enforce the nations and communities to adopt these modes of technologies. Apart from the current situation education is interrupted mostly due to bad weather, bad law, or order situations. In these scenarios e-learning is the most vital technology to use.

References

[1]. Kramer, B. J. (2000). Forming a federal virtual university through course broker middleware. In Proceedings: LearnTec Heidelberg, Germany, Hiltz,

[2]. Veeramanickam, M. R. M., and M. Mohanapriya. "Research Paper on E-Learning Application Design Features: Using Cloud Computing & Software Engineering Approach." 2016 International Conference on Information Communication and Embedded Systems (ICICES) (February 2016). doi:10.1109/icices.2016.7518886.

[3]. Doering, A. (2006). Adventure Learning: Transformative hybrid online education. DistanceEducation, 27(2), 197–215. doi:10.1080/01587910600789571

[4]. U.S. Department of Education, Office of Planning, Evaluation, and Policy Development, Evaluation of Evidence-Based Practices in Online Learning: A Meta-Analysis and Review of Online Learning Studies, Washington, D.C., 2010. Available at https://www2.ed.gov/rschstat/eval/tech/evidence-based-practices/finalreport.pdf.

[5]. Saykılı, A. (2018). Distance education: Definitions, generations, key concepts and future directions. International Journal of Contemporary Educational Research*, 5*(1), 2-17.

[6]. N. Adzharuddin, "Learning Management System (LMS) among University Students: Does It Work?," International Journal of e-Education, e-Business, e-Management and e-Learning, 2013.

[7]. Giurgiu, L. Microlearning an Evolving eLearning Trend. *Scientific Bulletin, De Gruyter*, 1(43), vol. XXII, 2017, pp.18-23 (https://www.degruyter.com/downloadpdf/j/bsaft.2017.22.issue-1/bsaft-2017-0003/bsaft-2017-0003.pdf)

[9] Herhalt, J., Cochrane, K.: Exploring the Cloud: A Global Study of Governments 'Adoption of Cloud (2012).

[10] Zain Abbas , S.M. Aqil Burney and Abdul Bari (2016) Few ICT Applications for Improved Healthcare Service Delivery in Developing Countries. INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY SCIENCES AND ENGINEERING, VOL. 7, NO. 6, AUGUST 2016

[11]. Yang, H., Tate, M.: A Descriptive Literature Review and Classification of Cloud Computing Research. Commun. Assoc. Inf. Syst. 31 (2012).

[12]. ISACA (Information Systems Audit and Control Association), *IT control objectives for cloud computing: controls and assurance in the cloud*, ISACA, 2011.

[13]. R. Farrell, Securing the cloud-governance, risk and compliance issues reign supreme, *Information Security Journal: A Global Perspective*, vol. 19, pp. 310–319, 2010.

[14]. W. Jansen, and T. Grance, 2011, *Guidelines on security and privacy in public cloud computing,* National Institute of Standards and Technology (NIST), Department of Commerce, USA. NIST Special Publication 800-144

[15]. P. Mell and T. Grance, 2011, The NIST definition of cloud computing, Special Publication 800-145, National Institute of Standards and Technology,

[16]. Rani, D. R., & Geethakumari, G. (2015, January). An efficient approach to forensic investigation in the cloud using VM snapshots. In Pervasive Computing (ICPC), 2015 International Conference on (pp. 1-5). IEEE.

[17]. W. Hsu, "Conceptual Framework of Cloud Computing Governance Model - An Education Perspective," IEEE Technology and Engineering Education, 2012.

[18]. Veer Manickam, M & Mohanapriya, M (2016) E-Learning Application Design Features using Cloud Computing & Software Engineering Approach, International Conference On Information Communication And Embedded System

[19]. Priyanshu Srivastava, Rizwan Khan, June 2018, A Review Paper on Cloud Computing, International Journals of Advanced Research in Computer Science and Software Engineering vol.8, no.6

[20]. K. Keahey, T. Mauricio, A. Matsunaga and J. Fortes, "Sky computing," *IEEE Internet Computing*, vol. 13, no. 5, pp. 43-51, 2009.

[21]. Burney, A. , Asif, M. and Abbas, Z. (2016) Forensics Issues in Cloud Computing. *Journal of Computer and Communications*, 4, 63-69. doi: 10.4236/jcc.2016.410007..

[22]. Mukundha, C & Vidyamadhuri, K. "Cloud Computing Models: A Survey", Advances in Computational Sciences and Technology, Volume 10, Number 5 (2017) pp. 747-761

[23]. K. Keahey and T. Freeman, "Science Clouds: Early Experiences in Cloud Computing for Scientific Applications," in proceedings of Cloud Computing and Its Applications 2008, Chicago, IL. 2008.

[24]. Foster I, Zhao Y, Raicu I, Lu S (2008) Cloud Computing and Grid Computing 360-Degree Compared.

[25]. Mertz SA, Eschinger C, Eid T, Pring B (2007) Dataquest Insight: SaaS Demand Set to Outpace Enterprise Application Software Market Growth. Gartner RAS Core Research Note, 3 August 2007

[26]. S. Patidar, D. Rane and P. Jain, "A Survey Paper on Cloud Computing," 2012 Second International Conference on Advanced Computing & Communication Technologies, Rohtak, Haryana, 2012, pp. 394-398, doi: 10.1109/ACCT.2012.15.

[27]. Vouk, Mladen A. "Cloud Computing ? Issues, Research and Implementations." Journal of Computing and Information Technology 16, no. 4 (2008): 235. doi:10.2498/cit.1001391.

[28] Fawad Ahmed, Prof. Dr. Aqil Burney and Ahsan Malik (2020) Security Aspects of Virtualization and Its Impact on Business Information Security. 2020 International Conference on Information Science and Communication Technology.IEEE .University of Karachi,Karachi. https://www.researchgate.net/publication/341650660_Security_Aspects_of_Virtualization_and_Its_Impact_on_Business_Information_Security/link/5ecd26f992851c9c5e5b93ba/downlo

[29]. M. Satyanarayanan, "Mobile computing: the next decade," in Proceedings of the 1st ACM Workshop on Mobile Cloud Computing & Services: Social Networks and Beyond (MCS), June 2010.

[30] F. Wang, et al. "The implementation of virtualization technology in EAST data system", Fusion Engineering and Design, vol.84, pp.766–769, 2014.

[31] J. Leonard, "Changes in governance, security," *Network World*, vol. 28, no. 18, pp.28, 2011