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Challenges and Opportunities of Cloud-Based E-Learning Systems

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Abstract**—**The paradigm of education is drastically changing from conventional to e-learning model. Due to ease of learning with various other benefits, several educational institutions are adopting the e-learning models. Some institutions are still willing to transform their educational system on to e-learning, but due to limited resources, they are still compromising on the old traditional system. The cloud computing could be one of the best solutions to overcome this problem by providing hardware, software, and infrastructure resources with cost efficient manner. The adoption of cloud computing in education will bring revolution in this paradigm. This paper introduces various positive features of e-learning and presents a way how cloud computing technology can be provisioned e-learning model. This paper also investigates the numerous challenges and opportunities that would be observed in cloud computing adoption in e-learning domain. The concept and knowledge present in this paper may create a new direction of research in the domain of cloud-based e-learning.

Keywords**—**Cloud-based e-learning, e-learning, cloud computing application, smart learning.

I. Introduction

WE are in the era of smart technologies; things are becoming more ubiquitous rather than scarce. The future belongs to the intelligent web or web 3.0 technologies that will create a new generation of applications where the need of pervasive, on-demand education is increasing drastically [1]. Electronic learning or E-learning is one of the ways that is bridging the gap between traditional and smart education [2]. By knowing this fact, many institutions are utilizing the benefits of e-learning but due to limited resources, manpower and cost-cutting issues various institutions are still inevitable to continue old traditional routines of education.

It is observed that a complete e-learning setup requires massive resources in the form of big servers, highly equipped infrastructure, huge data storage equipment, trained manpower, hi-tech schemes for security and fault tolerance. The transformation from traditional to e-learning system is the biggest challenge especially for those institutions that have limited resources; less technical staff, improper network infrastructure, and weak financial status. The cloud computing technology could be one of the best solutions for these challenges [1]-[3].

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To survive in today's global village cloud technology may serve the education in various potential ways like to provide infrastructure, platform, and software solution for education [3]. The cloud computing is the best-fitted technology in e-learning paradigm, no worries about the shortage, hardware, or software resources, just pay-as-per-use. No matter how huge data are stored in the cloud, it can be responded from anywhere at any time. The institution is free from all worries like security issues, server, disk space, computing, infrastructures, network administrator and physical location occupied.

In literature, we have limited work on the domain of cloud-based e-learning, full advantages of cloud computing in e-learning are still not described significantly [2]. This paper investigates the opportunity for adoption the cloud computing in e-learning domain and tries to inspect major issues and challenges that could hinder the merger of these two domains. This paper also tries to answer the question, is cloud computing a good way to facilitate all the needs for today's e-learning model?

The rest of paper is organized as follows. Section II provides a brief overview of e-learning, Section III defines an introduction of cloud computing, Section IV describes cloud adoption in e-learning; finally, conclude the paper in Section V.

II. E-Learning Fundamentals

The Internet has a significant impact on education, today's education is reshaping because of Internet. The adoption of the Internet in education has totally changed the learning and teaching paradigm. A new concept of ubiquitous type learning is prevailing that supported by various technologies particularly Information and Communication (ICT) and Internet technologies [4]. The basic idea behind e-learning is to foster learning through up-to-date learning materials, without the bounding of time, space, gender, nationality cast and origin. Only with the Internet connection, high education can be achieved. In fact, the Internet supported technologies that deliver required knowledge and improve learning performance is called e-learning.

The e-learning provides students or learner good facilities of quick, timely and anywhere learning, especially for those who have very busy schedule, don't have enough time to sit in a classroom and learn [5]. Some common e-learning elements are text, picture, image, animation, audio, and video that have a great impact on learning if these elements misuse, the e-learning may lose its usability [6].

Many experts started believing that e-learning could be one of the fastest rising industry in the near future and that is the

reason various large educational institutions are mapping their educational system from traditional to e-learning system.

As in [7], the e-learning environment demanding various new technologies and high equipped system, few of them are listed below:

- Video Conferencing technologies
- Unblemished audio and video streaming
- Enormous data storage capacity
- No compromise on bandwidth, consistently available high bandwidth
- Cross platform i.e. courses can be accessible by any operating system
- Asynchronous environment i.e. system can provide learning material at any time without live-instructor.
- Synchronous environment, the i.e. system must equip to deliver courses in real time with the live instructor.

With all benefits, e-learning has some potential challenging issues that require a concrete solution for enhanced e-learning environment. Few more perilous challenges that e-learning may face are listed below [8], [9]:

- Handling of copyright stuff
- E-learning may create digital-divide issue
- E-learning diminishes social collaboration among students
- Teacher or instructor level / knowledge about the course.
- Timely Check and balance on student
- To avoid cheating, transparent examination process
- Student engagement and dropout issues.

Various features of e-learning differ it from traditional learning system. Table I shows some potential differences between traditional and e-learning system.

TABLE I
TRADITIONAL LEARNING VS. E-LEARNING

Features	Traditional Learning	E-Learning
Cost efficient	No	Yes
Immense number of students	No	Yes
Location dependency	Yes	No
Effective	Yes	Yes
Technology dependency	No	Yes
Ubiquitous	No	Yes
Teacher/ Student Interaction	Yes	No
Interactions with Classmates	Yes	No
Use of interface	No	Yes
Highly time dependent	Yes	No
Learning from classroom environment	Yes	No
Learning competition	Yes	No
Same course instructor for all students	No	Yes
Need electricity / power for learning	No	Yes
Standardization	No	Yes
Human interaction	Yes	No
self-paced learning	No	Yes
Revision as per need	No	Yes
On demand availability	No	Yes
Self-directed learning	No	Yes
Teacher-centered	Yes	No
Student-centered	No	Yes
Push approach	Yes	No
Pull approach	No	Yes

III. CLOUD COMPUTING

The cloud computing is one of the most demanding today's technology that provides individual or enterprises to accomplish their need of data storage, management, and other computing facilities with very easy way, like press a key. This technology utilizes the infrastructure of the already deployed internet and provides complete computing facilities by providing infrastructure, platform, software, APIs and other services. It facilitates pay-as-per-use feature i.e. the cloud users only pay what they use [10].

The cloud computing has various unique attributes that change it from traditional or conventional computing. Following are few most important attributes that differ cloud computing with other traditional computing.

- Provides on-demand self-service
- Provides a shared or pooled resources for various services
- Provides ubiquitous access
- Scalable and elastic in nature
- Utility-based payment

A. Service Delivery Models

A typical cloud computing provides three types of service delivery models i.e. IaaS, PaaS and SaaS [3]-[11].

1) Infrastructure as a Service (IaaS): Infrastructure includes the operating system, hardware, and physical layout. In Iaas number of cloud users virtually received dedicated CPU, hardware and computing resources to manage their computing with shared common infrastructure. In IaaS the user can control everything except for the data center infrastructure
2) Platform as a Service (Paas): It includes application development, software, programming and development tools, middleware, web server, and database. PaaS provides a platform for developers onto the web. In this platform cloud, users have the power to manage the hosting environment.
3) Software as a Service (SaaS): Software development is always tedious, costly and needs a level of expertise, SaaS overcomes this problem. Cloud providers develop a different level of software; users can fulfill their need by utilizing this software. Millions of cloud users access same software via any suitable browser. In provider aspects, they only worry to maintain one software that saves time, cost and space.

B. Deployment Models

As in [10], according to National Institute of Standards and Technology, there are three deployment models (public, private, community) for cloud computing, the composition of these three models create another model i.e. hybrid model.

1) Public Cloud: The public cloud models offers infrastructure that is available for everyone. The users only pay for computing resources. Security and privacy are the major concern of this model.
2) Private Cloud: In private cloud model computing and other resources are managed by the particular organization. This model mostly deploys by enterprises

for their data center and control by internally or by third-party. Security and privacy point of view this model is excellent.

3) Community Cloud: When different organizations with same goals, utilize the cloud infrastructure, we used community cloud model. When different organizations work together, they share their clouds, policies and other concern that indicates community cloud model.
4) Hybrid Cloud: Hybrid cloud model is a composition of private and public cloud models that utilizes the good features for both models.

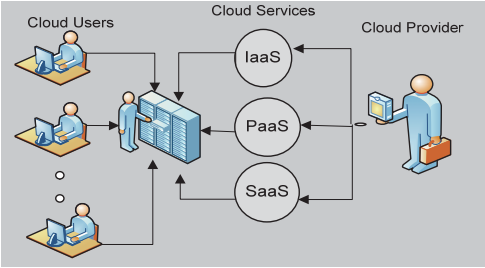

Fig. 1 Cloud Computing Environment

In various aspects, the cloud computing is dissimilar with traditional computing. Table II shows a brief overview of cloud computing technology.

TABLE II
BRIEF SUMMARY OF CLOUD COMPUTING

Cloud Providers	Google, Salesforce, Microsoft, Amazon, etc.	
Service Models	IaaS, PaaS, SaaS	
Deployment Models	Public, Private, Community, Hybrid	
Cloud Users	Virtual Desktop	Desktop can be accessed remotely
	Non-Technical	Use only remote storage
	Service Providers	Provide and manage cloud
	Developers	Application and solution designer
	System Admin	Provide the best cloud for service deployment
Potential Features	On-demand service, location independence, elastically scalable, measured services, ubiquitous network resources access	

C. Conventional vs. Cloud Computing

In many ways, cloud computing is better than conventional computing. Table III shows the fundamental differences between cloud and traditional computing.

TABLE III
TRADITIONAL COMPUTING VS. CLOUD COMPUTING

Traditional Computing	Cloud Computing
Fixed or dedicated hardware	Hardware with sharing basis
Fixed or dedicated capacity	Flexible or elastic capacity
Manually provisioned	Automatic-provisioned
Obtained in advance for memory or other entities	Pay as per use
Infrastructure set-up	No need for any infrastructure
High operational expenses	Nominal rent for operations
Need for system administrator	Self-managed by APIs

D. Cloud Issues and Challenges

Today's cloud computing has some very important issues and challenges that should be addressed before the adoption of cloud computing in e-learning. Undoubtedly, these issues may impact on cloud-based e-learning system. The major issues and challenges that may disrupt the amalgamation of cloud computing and e-learning are listed below.

- Cloud computing technology is prone to security attacks; security issue is one of the important issues for cloud computing [12].
- To some extent, the traditional Information Technology (IT) infrastructure is reliable, but as a whole, cloud technology is still vulnerable, raising many questions about its reliability and trust.
- The IaaS providers deliver their services on a sharing basis on the common infrastructure. The possibilities of the impact of one user might be high to disrupt other tenant utilizing the same resources on the same provider.
- [13] claimed that if in cloud computing any type of failure or disaster occurs, still it is unclear who will be responsible for that disaster or recovery.
- As the cloud computing technology is getting mature, new and more dangerous cloud security attacks are up-and-coming. These attacks might be phishing, fraud, cross virtual machine exploits, cross application vulnerability exploits, etc. [14].

IV. CLOUD ADOPTION IN E-LEARNING

Nowadays cloud computing is not only an idea or concept, but it is a fact, and many commercial, business and even individual are moving on to the cloud. Tremendous cloud-based applications can be observed in various different fields. As we know that the traditional education is transforming its shape and many institutions are converting their conventional classroom learning to e-learning. The world is now aware of the usability of e-learning, new e-learning courses are designed, the old-fashioned learning is transforming into e-learning system [15]. In fact, e-learning is a complex learning system that demands several technical expertise, complex infrastructure, costly updated software, large memory space and concrete security. Owing to this fact many institutions have desired to transform their education on to e-learning system but due to limited resources they cannot do it. Mostly the organization with limited resources faced difficulties to opt e-learning system. The cloud computing could be one of the best solutions to facilitate e-learning with cost efficient manner [2]-[16]. In Section III we are defining the cloud computing attributes, by keeping them in mind, we can easily identify that the cloud-based e-learning could be one of the best cloud applications that facilitate learner, teacher, and administrator. The cloud adoption in e-learning would be the first choice for e-learning system implementation [17].

A. Advantages of Cloud-Based E-Learning

Through cloud computing technology any educational institution particularly low budget institutions can easily be established e-learning environment with cost-effective manner

[18], [19]. The student, teacher, researcher, and other academic staff can get equal opportunities in this system. The inclusion of cloud computing with education brings tremendous benefits; some of them are listed below.

- The main infrastructure for e-learning is provided
- Institutions are free for any hardware and other maintenance.
- Guaranteed resource availability
- No study materials lost, even if institution main server corrupted but the data on cloud remains to save.
- It reduces the cost of software, hardware, storage, infrastructure, power, cooling, administrator, software license or upgrades, security schemes and physical space.
- Learning stuff can be accessed at anytime, anywhere and from any system.
- Learning materials are more safe and secure on cloud no need to worry about backup or data loss
- The storage capacity and other resources can be used by institution unrestricted only pay for services used.
- Many students can be accessed learning materials simultaneously from various locations even with different machines.
- Students can establish a repository of learning stuff and add more and more; the cloud will provide space and maintain them.
- Cloud-based e-learning is ubiquitous; it is independent of time, space and location.
- Ready to use software possible.
- No one knows about the location of data storage on the cloud, this feature can reduce the chances of physical theft of examination papers or other stuff.
- The various features of cloud computing will defiantly increase the learning performance.

Apart from all these advantages, the cloud-based e-learning will receive more benefits in the form of performance enhanced the learning environment.

B. Issues and Challenges of Cloud-Based E-Learning

Apart from these, all advantages, the cloud-based e-learning system deployment will receive various issues and challenges [20]. These challenges and issues would be the biggest barrier to cloud computing adoption in e-learning. The few most challenging issues are discussed below.

- In cloud-based e-learning, the high data rate for data communication is required. Due to the old infrastructure of the internet the demand for high-speed communication some time compromises. This challenge could be overcome by utilizing the features of broadband technologies and fiber optics in place of copper wires.
- Most of the e-learning data require a high level of security, but in the case of cloud-based e-learning, data is at the mercy of cloud providers. The data leakage and malicious activities on data could be one of the challenges for this system. Any mischievous activity could easily be launched and manipulate the stored materials. To avoid this type of possible malicious activities, the critical data should be stored by utilizing encryption technologies.
- Privacy is one of the biggest challenges for all cloud-based applications. In cloud-based e-learning system, the data presents on the cloud are the mercy of cloud-provider. The cloud providers can easily see any part of data even the most private data, picture or any materials can easily be observed by providers, and they can get all possible benefits especially in a cloud-based e-learning system. This situation would increase the privacy issues in a cloud-based e-learning system. To overcome this issue we have to introduce some schemes that should reduce the access right of cloud providers and third parties [21].
- To achieve high performance in cloud-based applications is still a challenge. The more complex situation could occur when we try to implement high-security schemes, and full privacy may affect the performance. It is obvious the more security checks, privacy, and strong authentication must be disturbed the performance.
- Mostly for the management of e-learning system, we practice any suitable Learning Management System (LMS), but according to [22] in cloud-based e-learning, the management could be one of the complex and challenging tasks. To handle learning materials, fee charging, exam conduct, result display, certificates dispatching, etc. demand extensive management. To handle this challenge the traditional types of LMS should design for cloud-based e-learning systems.
- Mostly it is observed that the cloud-based applications charge for their services via credit cards or in any electronic form through the internet. The students generally have no credit cards, and in many countries, the National Identity Card (NIC) is mandatory for a credit card. The particular age limit is required for NIC, so how the lower age-limit students are able to pay their fee. One of the solutions for this challenge could be the parents/guardians are liable to pay a fee but if they have no credit card how can they pay their children fee. Payment or fee submission in cloud-based e-learning demands more studies for establishing an appropriate model of payment.
- The cloud-based e-learning system may observe some legal issues. Since the country where cloud data are hosting their laws may possibly govern cloud data [23].

V. Conclusion

The adoption of cloud computing technology in e-learning with possible challenges and opportunities for cloud-based e-learning system has been discussed in this paper. This paper also provided a cost-effective solution especially for low budget or limited resource institutions to transfer their education from traditional to e-learning system. The main reason for aggregating cloud computing and educational technology predominantly e-learning is due to wide range of services and ease of deployment provided by cloud computing technology.

The prospective benefits or gains are discussed here that will create new opportunities in e-learning paradigm. This paper particularly highlighted those issues of cloud computing that may hinder the adoption of this technology in e-learning,

and that must be resolved before the deployment of cloud-based e-learning model.

This paper elucidated the vital opportunity to utilizes the cloud computing technology in e-learning system, the knowledge present here would be a good literature for the researchers of this domain. As a future work, we are interested in designing a comprehensive framework for cloud-based e-learning system.

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