

Cloud Computing Based e-Learning: Opportunities and Challenges for Tertiary Institutions in Nigeria

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Abstract: With the significant advances in Information and Communications Technologies (ICTs), teaching and learning styles are changing fast and learning environments are greatly been influenced and transformed. E-learning is one such innovation and relates to the use of electronic mechanisms to support learning process, which is growing in popularity and becoming a powerful trend for the immense benefits it offers to learning environments. However, deploying and managing e-learning systems require huge investments in IT and many educational institutions cannot afford the cost. Cloud computing, a recent shift in computing paradigm which is envisioned to be the next generation architecture of IT industry, promotes the delivery of powerful computing resources as a service. We give an overview of the concepts and structure of cloud computing and its potential value as a platform for e-learning. Despite being in their early stages of development, we nonetheless argue their confluence will provide access to and enabling environment for delivery of effective and quality knowledge.

Key words: Cloud based e-learning, cloud computing, cloud service, educational institutions, virtual learning environment.

1. Introduction

The future of every successful society depends to a large extent on the significance it gives to acquisition and delivery of effective and qualitative knowledge. In the present information age, information and communications technology (ICT) plays a vital role in transforming the manner in which knowledge and skills are transferred to learners from traditional face-to-face approach, partly as a result of the increasing number of students seeking a place in one of the various departments in universities and other tertiary institutions. This year alone (2015), about 1.5million students apply to study in Nigerian universities for the 2015/16 academic session. Obviously, with only 79 public universities available [1], these prospective students cannot be accommodated in all the universities departments. Modern approach to teaching and learning such as e-learning platforms therefore becomes unavoidable, there is need to redesign the delivery of educational system in response to the changing world as influenced by advancement in ICT [2].

Recently, there has been growing trend regarding the use of electronic-learning approach. e-Learning systems are growing in popularity and a powerful trend. Factors leading to the spread of e-learning practice include reduced training cost [3], flexibility and ease of access, convenience and

availability of variety of courses [4]. However, e-learning platform requires huge investments in IT infrastructure (hardware & software) of which many educational institutions cannot afford. Fortunately, cloud computing evolves to address the increasing enterprise computing power demands, and can be adopted to cut-down such IT investments.

The notion behind cloud computing is the delivery of computing resource as a service for people to consume, rather than a product to run on their individual computers [5]. In this paper, we give an overview of e-learning systems and the core concepts of cloud computing and its key advantages. Despite being innovations not yet matured, we argue their convergence in learning environment will significantly improve teaching-learning process. The rest of this paper is structured as follows: Section 2 introduces e-learning and discusses its advantages, disadvantages and limitations in our tertiary institutions; Section 3 describes the core concepts of cloud computing and presents its convenience for e-learning platforms; Section 4 describes the cloud approach to e-learning systems and discusses real examples of such platforms; followed by the conclusion in Section 5.

2. E-Learning

E-Learning implies the use of all forms of electronic media to support teaching-learning process. The concept of e-learning has significantly received research attentions as one innovation changing the patterns of teaching across the globe [6], [7] in support of, or partly replacing the traditional face to face approach to the delivery of knowledge and skills. E-Learning is a modern approach towards the delivery of well-designed and interactive learning environments that everyone could adopt in a learner-centred atmosphere [8] and continue to grow as an established method of learning.

E-Learning involves the use of computer and network-enabled means of knowledge and skills transfer, through processes and applications such as Computer-Based Training (CBT), Web-Based Training (WBT), Virtual Learning Environments (VLEs) and digital collaborations. In e-learning approach to teaching and learning, educational contents are delivered over the Internet or in the form of text, audio and video available on CD-ROMs [9] and these contents may be delivered as learner-paced or instructor-led. In e-learning techniques to knowledge transfer, educational institutions are solely responsible for the construction and maintenance of all applications and tools used.

An important feature of e-learning approach is that students are able to easily interact with learning environment and resources at their own convenience [10]. Venkataraman and Sivakumar [11] engaged students in a student-centred approach group-based learning scenario using e-learning techniques, and realised that the approach causes huge impact on students' performance and effective learning environment. Benta *et al.* [12] study the use of e-learning platform to support traditional face to face learning, and their results show improved teacher-learner communication and increased overall students' satisfaction. The emergence of e-learning provides prevalent as well as straightforward access to effective and qualitative education. Nonetheless, the effectiveness of information and communications technologies depends on the way and purpose being used for. Educators [3], [10], [13] believed motivation is the key to success and delivery of effective results, therefore e-learning usage in different settings and applications has its advantages as well as disadvantages and limitations.

2.1. E-Learning Advantages

On the one hand, e-learning provides the opportunity for teaching and learning process be scheduled not necessarily in school premises and training centres, but accessible even from remote

areas [10]. Specifically, e-learning offers the following key advantages:

- *Ease of access*: learners can easily access educational resources or enroll on training without being physically available at training centre or share same local time with instructor's location.
- *Group-based collaboration*: so learners can interact among themselves to brainstorm and share ideas as well as improved teacher-learner communication [11].
- *Flexibility*: learner can freely join discussions in the bulletin board threaded discussion areas at any hour or visit with classmates and instructors remotely in chat rooms.
- Self-paced learning modules allow learners to study at their own pace, learning new skills and able to develop own learning curve [12].
- *Universal dimensions of knowledge*: enable learners search for and find unlimited information required and data using ICT-enabled tools [11].
- Improved response to meeting up deadlines for homework submissions compared to traditional learning approach [12].

2.2. E-Learning Disadvantages

On the other hand, despite the numerous advantages and simplicity of e-learning approach to teaching-learning process, it suffers a number of disadvantages some of which are outlined below:

- *Learner is "isolated"*: some learners perform better upon physical interaction with colleagues. On e-learning platform, such learners feel isolated and lack social interaction.
- *Instructor availability*: the habit of direct physical contact with teacher plays a vital role in academic excellence to many students in traditional face to face environment, although this problem seems to be diminishing as technology ripe [11].
- *Inappropriate for lab-based courses*: conduct of practical based courses such as agricultural courses become difficult.
- Managing learning software can involve a learning curve which may be difficult for new learners.

2.3. Limitations of e-Learning

E-learning creates an enabling environment for accelerated and simplified teaching—learning process. However, as Talebian *et al.* [10] recognise, a number of factors exist in several communities that decrease the rate of its growth and usage, Nigeria too is not an exception. Some of the factors responsible for slow growth of e-learning in Nigeria include:

- *Digital divide*: access to computer and ICT resources is the bedrock of training and skills acquisitions on e-learning. Very few students have access to computer, equally the cost of personal computers (PCs) is very high in Nigeria considering the income level of an average employee.
- *Knowledge of computer*: because of the wide gap between the "have" and the "have not" (i.e. digital divide), many students have no computer knowledge background, hence they are afraid of operating one, and the very few who have access to the computer do not know how to use it and maximize its usage.
- *Inadequate power supply*: e-learning platforms are run and managed using computers and ICT resources, which are electrically powered. Overall, poor supply of electricity is responsible for the poor growth of IT industry in Nigeria [14].
- *Internet accessibility*: access to the Internet in our schools is quite poor, considering the

number of students. Even in areas where Internet is accessible, the bandwidth is very low unsuitable for e-learning platform.

- *High cost of establishment:* e-learning system requires sophisticated computing resources (hardware & software) of which many educational institutions are unable to afford the huge investment needed [9], [15].
- *Training suitability:* not all courses are suitable for e-learning, some courses requires students participate in practical and field work [10].

3. Cloud Computing

The emergence of Cloud computing which is envisioned to be the next generation architecture [16] of IT industry represents a fundamental change in the way ICT services are delivered. Whilst the price of computers continue to swiftly drop and computers are becoming more powerful [17], the increasing complexity of managing the underlying infrastructure, eventually made the computing become expensive to organizations than ever. Cloud computing is putting steps forward to address such huge computing power demands.

The innovation of cloud computing originates from advancement in various technologies, most notably advances in the followings [14], [18], see Fig. 1:

- *Hardware technology (virtualization and multi-core chips):* the notion of virtualization dates back to the introduction of virtual machines by the IBM [14] in 1960s. Virtualization achieves cutback in hardware cost however promote system productivity allowing multiple users simultaneous access to instance of a computing resource.
- *Systems management (e.g. data centre automation):* autonomic computing aimed to provide self-managed computing systems “using the technology to manage technology” [19] with minimal or no human intervention.
- *Internet technology:* Internet technologies such as Web services, Web 2.0 and SOA standards too greatly contributed to advances in systems integration and information sharing [20] over well-known technology (XML for instance).
- *Distributed computing:* cluster and grid computing that bring together large distributed compute and storage resources and connect remotely located computers via a large network [14].

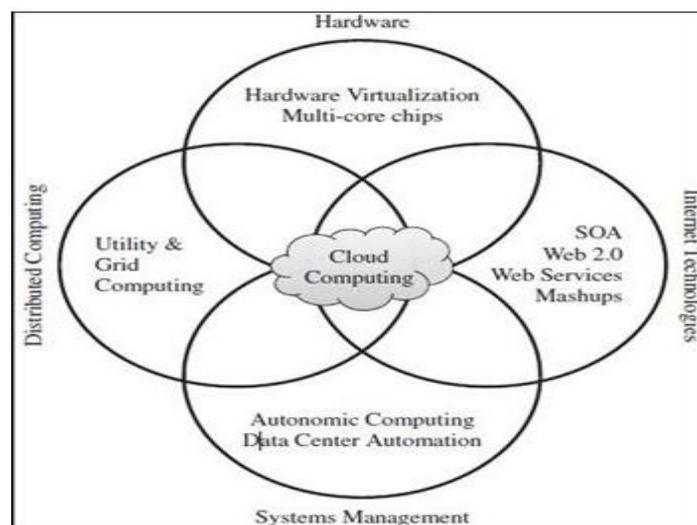


Fig. 1. Roots of cloud computing [18].

3.1. Cloud Computing in Brief

Although cloud computing is a recent development in computing technology, the paradigm is fast gaining popularity and many researchers and commentators have given various definitions on the subject. Key-points in those definitions are that it enables the delivery of computing resources “as a service” [18], [21] with two distinctive features: use of resources on-demand and transparent scalability of these resources.

The most comprehensive definition however, is that supplied by the US National Institute of Standards and Technology, NIST [20] which defines cloud computing as the delivery of computing resources as-a-service, having five essential characteristics, three service models and four deployment models [14].

3.2. Cloud Essential Characteristics

Cloud computing promotes the availability of the following five characteristics.

1. *On-demand self-service*: that is the automatic provision of computing resource to clients (e.g. server time and network storage) when needed without providers interaction.
2. *Broad network access*: enabling applications to be accessed through heterogeneous platforms (PCs, & PDAs, mobile phones for instance).
3. *Resource pooling*: location independent pooling of computing facilities for serving multiple clients (multi-tenancy), such resources are assigned to consumer dynamically in response to their demands.
4. *Rapid elasticity*: enabling scalability of services provided, (as though unlimited) to quickly scale out and released to quickly scale in.
5. *Measured Service*: provides for automatic control and optimized resource use measured in a pay-per-service use manner for the type of service provided.

3.3. Cloud Service Models

The term “service” refers to an encapsulated task supplied to cloud consumers [4] that is the type of service that cloud providers deliver to the consumers.

1. *Software as a Service (SaaS)*: the provision of software applications to customers by the cloud service providers which typically are running on the provider’s infrastructures and are accessed through client’s browser (e.g. Google Apps and Salesforce.com).
2. *Platform as a Service (PaaS)*: this involves delivering to the customer the ability to create and deploy owned applications using programming languages and tools from the provider’s cloud infrastructure, such as servers, network and operating systems, without the customer taking full control of the underlying infrastructure.
3. *Infrastructure as a Service (IaaS)*: provisioning of fundamental computing resources such that customer can run own application, or store data to cloud provider’s infrastructure in a manner that the customer has control of owned application, operating system or stored data.

3.4. Cloud Deployment Models

The NIST definition identifies the following four cloud deployment models.

1. *Private cloud*: cloud deployment model that is operated by an organization, although might be managed by a third party.
2. *Community cloud*: cloud infrastructure deployment that is shared by many organizations.
3. *Public cloud*: is a cloud computing deployment model in which infrastructure is made available to general public.
4. *Hybrid cloud*: this deployment model consist of two or more type of the above models.

3.5. Convenience of Cloud Computing for e-Learning

Despite being an innovation in early stages of maturity, cloud computing has the potential to offer profound opportunities towards improved teaching-learning process [5] by providing linkage between cloud infrastructure and e-learning platform [4]. In what follows, we summarize the key benefits of cloud computing that make it convenient for e-learning systems.

- *Cut-down cost of IT investment:* e-learning systems require sophisticated computing resources of which many educational institutions cannot afford the huge investments. With cloud based e-learning, cloud infrastructure is pooled to consuming institution [12].
- *High availability:* cloud computing system can automatically detect node failure and exclude it without affecting the normal operation of the system [22].
- *Accessibility:* an important characteristic of cloud computing as highlighted in this work is “broad network access” which enables cloud service to be accessed through heterogeneous platforms [14].
- *Scalability:* cloud computing makes it easier for consuming institution to scale their services as according to their demand [12].
- *Backup and recovery:* if client computer crashes, there are almost no data lost because everything is stored in the cloud [6].

4. Cloud-Based e-Learning Systems

Many e-learning platforms are currently in use by academic institutions globally, among which include the well-known Virtual Learning Environments (VLEs) such as Blackboard and Moodle [23]. The drawback of such e-learning platforms is they are content-centric designed not learner-centric, thus educational resources are delivered to students uniformly irrespective of learner’s background. Furthermore, not only do the current e-learning platforms suffer the limitation of costs of development, deployment and maintenance, but also face the issue of dynamic scalability in response to infrastructure demands [8], [24] and integration with other e-learning platforms [4].

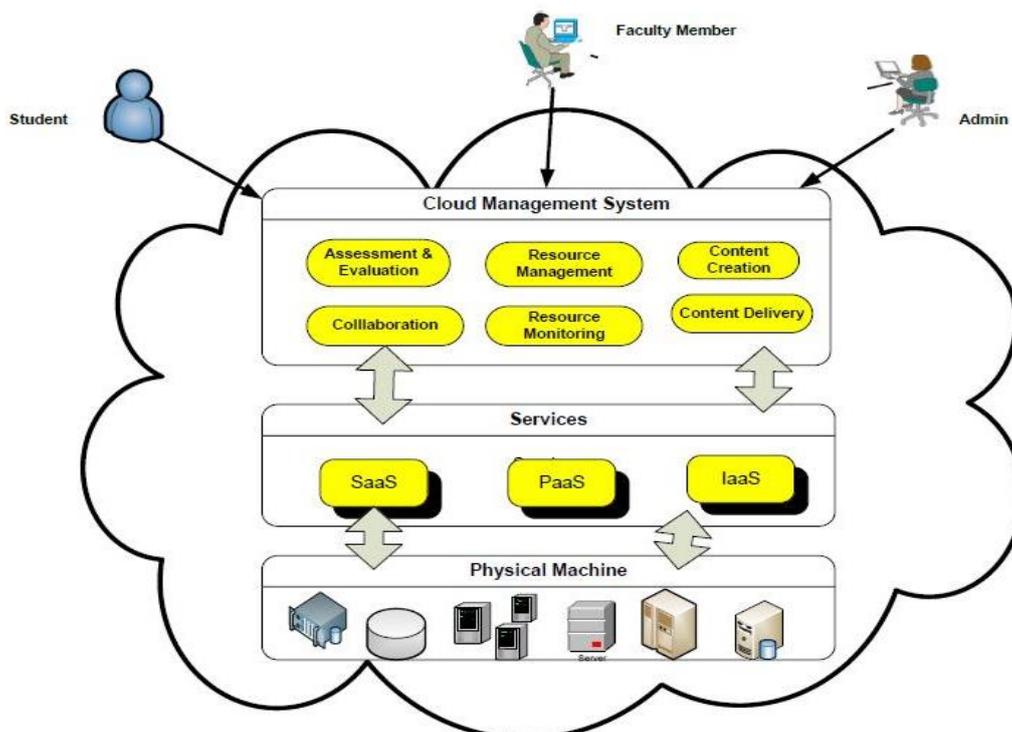


Fig. 2. Simplified architecture of cloud based e-learning [22].

Ercana [15] observes how cloud infrastructure could be pooled to educational arena, universities in particular and explores the benefits of common applications among teachers and learners. Cloud computing has made available virtualized resources, centralized data storage, low cost of running, ease of monitoring and overall improved performance to e-learning solutions [25]. Educational institutions have since seized the opportunity of cloud service enabling them carry out task that would normally require interventions from its providers (installation, maintenance etc) [26], [27]. Hossain and Huang [22] present an e-learning ecosystem architecture based on cloud computing (Fig. 2). The authors believe the proposed architecture scale the test of educational institutions' demands in terms of scalability, flexibility and availability of e-learning systems.

As we highlighted in this contribution, cloud computing will in the future impact the teaching-learning environment. Cloud based e-learning systems are presently being deployed in educational institutions. Bluesky [8] is one such system deployed across China, which made use of cloud technologies on top of traditional middleware features and efficiently delivers reliable and scalable services. Madan et al. [28] present a cloud based e-learning framework "Educational Learning as a Service -ELaaS", the authors claim the framework is essential for educational institutions with budget restrictions and sustainability challenge. Moreover, Rădulescu [5] proposed a virtual laboratory cloud system offering ways to advance the learning process by adopting cloud based Virtual Laboratories as a Service (VLaaS). Other proposals include [23] that combines virtual learning environment that interact with cloud based service (GoogleDocs and YouTube) and achieve its goal as environment that promotes sharing of ideas and monitoring and modifying educational resources.

Finally, we see it necessary to emphasize the need on setting foundation for an easily accessible and reliable educational information infrastructure that should be delivered to students to enable them focus on their courses of study.

5. Conclusion

The success of every tertiary institution in the 21st century will to a large extent rely on effective utilization of various forms of information and communications technology resources, understanding of ICT is therefore essential to meeting up the changing world. In this paper we have discussed the main components of e-learning platform and focused specifically on advantages and limitations of such systems with regards to our tertiary institutions. We have settled on the convenience of cloud computing approach to tacking limitations of e-learning.

Finally, we have enumerated various cloud computing based e-learning approaches previously been proposed and described how the approaches greatly placed a significant impact on the teaching-learning environment.

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