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Cloud-Based Mobile Learning for Higher Education in Nigeria: A Review

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ABSTRACT

The combination of cloud and mobile computing has the potentials to increase flexibility and resource accessibility for effective teaching and learning in higher education. However, there is lack of understanding of the concepts of mobile cloud learning andits potentials in higher education. The purpose of this conceptual paper is to explore the use of mobile cloud learning and how it enhances teaching and learning. The methodology used was exploratory, based on literature review focused on the use of mobile cloud learning from well-known databases. The finding shows that mobile cloud learning can offer cost effective, flexibility and mobility of learning across geographical areas. The value of mobile cloud learning is not yet explicit, but needs further attention. The paper highlights the basic of cloud computing, delivery models, services, and challenges of implementing cloud-based system especially in higher education. Through these understanding, the potentials of cloud-based system be appreciated in teaching and learning in higher education especially in Nigeria.

KEYWORDS: Cloud-Based, Mobile Learning, Higher Education, Cloud Computing, Services, Models

Introduction

Cloud Computing is a new technology that delivers many types of resources over the Internet. It could be identified as a technology that uses the Internet as the communication medium to deliver its services. Cloud services can be offered within enterprises through LANs but in reality, cloud Computing cannot operate globally without the Internet (Indika, 2011). The National Institute of Standards and Technology (NIST) defines cloud computing as a computing model which offers network access to a configurable resource pool, the access being location transparent, convenient and on-demand. These resource pools consist of networks, servers, storage, applications and services which can be used by the end user with a minimum management effort and interaction with the cloud provider (Mell and Grance, 2009a, Grance, 2010). It is distinguished as on demand services, broad Network access, resources pooling, rapid elasticity and measured services. Furthermore, Chauhan & Kumar (2013) observed that the successful use of cloud computing presupposes the existence of three key elements, namely *virtualization*, the *intelligence* from the network and a *robust ecosystem*, and these offer the basis for obtaining operational efficiency, security, activity continuance, scalability, and interoperability leading in the end to innovation.

Cloud based learning system offers broad accessibility to network services, anywhere, anytime access to learning applications, instant scalability to meet growing learner populations, seamless compatibility with social and collaborative tools and features, streamline learning delivery, enhanced video and mobile learning access, improved management costs and efficiency and provide autonomy to the user (Chauhan & Kumar, 2013). Similarly, Chao &Yue (2013) observed that cloud based offer lower cost, safe and reliable data storage, low devices requirements and higher performances platform. The development in cloud computing bring about increased in cloud based system. The cloud based system applications offered benefits to health, business, industries, education, military, high-tech research centres etc.

The remaining part of this paper include: Cloud services, cloud deployment models, mobile cloud learning, cloud services for educational institution, challenges of cloud based system, conclusion and further work.

Cloud services delivery models

Cloud service models are classified based on the computing requirements of the clients and represent different layers of the cloud computing architecture, namely: Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS). This classification is grounded on the abstraction level of the capacity provided and the service model of providers. These different delivery models are known in different industries from an end-user's perspectives. Cloud computing goes beyond simply providing software as a service (SaaS); it also provides platform as a service (PaaS), and infrastructure as a service (IaaS), which gives it the potential to meet the requirements of large sectors of the market (Grance, 2010). This classification is discussed as follows:

- **Software as a Service (SaaS):** This computing model allows users to access simple desktop applications such as word processing and spread-sheets as a service on the web. The application itself runs on the cloud, which means that users do not need to install and run the application on their computers, and it can be accessed on-demand at any time from any location. The SaaS model organises clients' applications in a single logical environment on the SaaS cloud with the aim of achieving economies of scale and optimization in terms of speed, security, availability, disaster recovery, and maintenance. Examples of SaaS include personal applications such as Gmail, TurboTax Online, Facebook and Twitter, to enterprise-level applications such as Salesforce, NetSuite, and Google.
- **Platform as a Service (PaaS):** Cloud providers give the consumer a higher level of abstraction to deploy onto the cloud infrastructure consumer created or acquired applications created using programming languages, operating system, web server, libraries, services, and programming language tools. In this delivery model, cloud users have the ability to develop applications directly (e.g. SaaS), using a development platform. Examples of PaaS include Microsoft's Azure Services Platform, Google's AppEngine, Amazon's Relational Database Services and Rackspace Cloud Sites.

- **Infrastructure as a Service (IaaS):** The virtualization resources provided to the consumer (computing, storage, and communication) on demand are known as infrastructure as a service. The concept started under the term Hardware-as-a-Service (HaaS) and was later transformed to Infrastructure-as-a-Service (IaaS) to show the holistic approach for all hardware to run an IT infrastructure as a services

Cloud Deployment Models

Cloud computing offer services to individual and organizations based on their needs and services. Chauhan and Kumar, 2013, Grance, 2010) state they are four deployment models at present, these are:

- **Public Cloud:** A public cloud can be accessed by any subscriber with an internet connection and access to the cloud space. Applications, storage, and other resources are made available to the general public by service providers. These services are either free or offered on a pay-per-use model.
- **Community Cloud:** A community cloud is shared among two or more organizations that have similar cloud requirements. Shares infrastructure between several organizations from a specific community with common concerns (security, compliance, jurisdiction, etc.), whether managed internally or by a third-party and hosted internally or externally. The costs are spread over fewer users than a public cloud (but more than a private cloud).
- **Hybrid Cloud:** Is a composition of two or more clouds (private, community or public) that remain unique entities but are bound together, offering the benefits of multiple deployment models. A hybrid cloud is essentially a combination of at least two clouds, where the clouds included are mixture of public, private, or community.
- **Private Cloud:** A private cloud is established for a specific group or organization and limits access to just that group or cloud infrastructure operated solely for a single organization, whether managed internally or by a third-party and hosted internally or externally.

Mobile Cloud Learning

Mobile learning is designed based on electronic learning (e-learning) and mobility. However, traditional mobile learning applications have limitations in terms of high cost of devices and network, low network transmission rate, and limited educational resources (Dinh etal. 2013, Bora, 2013 & Afolabi, 2014). Cloud-based mobile learning applications are introduced to solve these limitations. For example, utilizing a cloud with the large storage capacity and powerful processing ability, the applications provide learners with much richer services in terms of data (information) size, faster processing speed, and longer battery life. The potentials and benefits of using mobile cloud based learning system in higher education has been recognized by many Universities among which are University of California, Washington State Universities, school of Electrical Engineering and Computer Science, higher institutions from UK and, Africa (Sultan, 2010). In commonwealth, many institutions had collaborated at the Virginia virtual

computing lab, and this has been found to reduce the IT cost and staffing (Wyld, 2009).

The cloud based system, allow learners to connect to internet and use the resources online any time anywhere. Wang *et al.,* (2014) have defined the four characteristics of cloud learning; storage and sharing, universal accessibility, collaborative interactions, learner centered. Storage and sharing provides infinite storage capacity and the resources stored over internet can be shared by different users. Universal accessibility allows the users across different regions, different platforms to access the same data and resources. Collaborative interactions enable users to build common knowledge through these interactions. Learner centered characteristic mean that learners can choose the resources that are suitable for them and keep track of their learning progress.

As cloud systems development is moving further, more web-based and mobile applications are being developed using cloud technologies. In addition, these technologies provide elasticity and flexibility of the resources for cloud enabled applications (Butoi *et al.,* 2013). Further Butoi *et al.* (2013) opined that mobile learning can benefit from this technology expansion and can easily be developed as cloud-enabled applications. Cloud-enabled mobile learning has the advantage of resources elasticity and will enable the device resources limitations. Benson and Morgan (2013) stated that Higher education institutions invest in technology to improve student experience and increase efficiency. Furthermore, Gupta, (2012) in cloud computing in education in current financial crisis concluded that, educational institutions are under increasing pressure to deliver more for less, and they need to find ways to offer rich, affordable services and tools. Both public and private institutions can use the cloud to deliver better services. By sharing IT services in the cloud, our educational institutions can outsource non-core services and better concentrate on offering students, teachers, faculty, and staff the essential tools to help them succeed. Chutipong, *et al.* (2012) in a study on cloud computing adoption in Thailand found out that the significant factors are Internet and technology; cost; and some difficulties in ICT usage. Deepa *et al.,* (2012) and Angela, *et al.,* (2012) opined that Cloud computing in education gives better choice and flexibility. The software and platform in education can be on- premises, off-premises, or a combination of both, depending on the educational institutions need. Education as a service (EaaS) is used to deliver advanced software, computer lab resources as services to students, researchers, and faculties at schools, colleges and universities.

Nowadays, many learning management system (LMS) are being developed as cloud-based mobile learning applications to enhance flexibility, collaboration and personalized learning (Wang *et al.,* 2014; Brhanu & Mulugeta, 2015; Scerbakov *et al.,* 2015). Lim *et al.* (2015) explored the benefit and challenges of using cloud computing in Swedish schools. Despite the challenges of security and privacy, the benefits such as accessibility, collaboration and mobility ability outweigh its challenges. Moreover. Wang et al., (2014) explored Moodle in cloud which enhanced storage and sharing, universal accessibility, collaborative interactions and learner centered. This increased students and staff interaction. Cao *et al.* (2013), investigated quantitatively the adoption of cloud storage by students in China. The findings showed that perceived risks, perceived cost, personal innovativeness,

performance expectancy, effort expectancy, social influence, and facilitating conditions affect the students' adoption of cloud storage.

From these related literatures, it is clearly shown that cloud-based mobile learning increase virtual learning communities and virtual teams without restriction to locations (Brhanu & Mulugeta, 2015). Furthermore, the kind of informal learning through the use of mobile devices makes it an even more potent tool of educational communication than the customary forms and modes of traditional education (Brhanu & Mulugeta, 2015).

In Nigeria over the past few years has, however, been experiencing an exponential growth in mobile usage. Mobile technologies nowadays provide important opportunities for institutions to utilize mobile applications to enhance learning experiences potentially reducing illiteracy in developing countries, increasing flexibility and access to learning materials (Salawudeen, 2010; Jacob, 2014; Afolabi, 2014). Francis *et al.* (2012) Advocated that Nigeria education delivery has not been effective in terms of access to lectures halls, materials and the burden of face to face method of learning and conclude that mobile enabled learning and face to face could blended to enhance educational delivery.

The cloud-based mobile learning system increase virtual learning communities and virtual teams without restriction to locations (Tao & Long, 2011, Sarddar & Rajesh, 2014, Brhanu & Mulugeta, 2015). Furthermore, the kind of informal learning through the use of mobile devices makes it an even more potent tool of educational communication than the customary forms and modes of traditional education (Brhanu & Mulugeta, 2015). These increase opportunities for institutions to utilize mobile enabled applications to enhance learning experiences potentially reducing illiteracy, increase interactions and access to education in Nigeria higher education.

Cloud services available for education

Leading cloud providers have recognized the importance of adjusting their computing services specifically to the needs of educational institutions. These include customized software packages at low prices that more institutions can afford. Some of the most widely used educational platforms are:

- **Microsoft for Education:** Microsoft is one of the companies whose services have been reforming education for more than two decades. The Microsoft cloud is currently available to the educational institutions in the following forms: Office 365 for Education (formerly Microsoft live@edu), Business Productivity Online Suite (BPOS), Exchange Hosted Services, Microsoft Dynamics CRM Online and Office Web Apps.
- **Google Apps for Education:** Google Apps for Education is a widely used platform for outsourcing free web-based email, calendar and documents for collaborative study. Google has initiated two important campaigns for introducing improvements in the education sector. *Chromebooks for Education* is one of the most important Google projects aimed at education innovation. Another important Google initiative is *Tabletswith Google Play forEducation*, which enable educators to smoothly implement the latest

technology solutions into classrooms and make useful apps available to their students.

- **Amazon Web Services (AWS) in Education:** Is an education-friendly set of services that provides cost-efficientsolutions to universities, community colleges, vocational schools and districts. AWS users have at their disposal computing and storage resources that contribute to a creation of flexible IT infrastructure in these institutions.
- **Salesforce.com Education Cloud Platform:** The Salesforce.com platform provides all the tools needed for the educational institutions to instant scalability, ease of configuration and support for multiple functional roles. It enables comprehensive oversight of operations and applications allowing students, researchers and faculty to track, analyze and refine every aspect of their efforts. The Salesforce.com platform can also assist educators manage their services more efficiently from application to graduation while tracking individual details such as study abroad term, participation in campus organizations, study groups and other operations (Salesforce.com).
- **IBM Cloud Academy:** The benefit of IBM Cloud Academy form access to a broad portfolio of IBM Cloud Computing projects, offerings and services that are designed for education and learning. Their researchers can innovate on the next generation of Cloud Computing technologies. They can collaborate with peer member institutions, as well as with the IBM research and development community, to create new approaches and strategies to improve educational services through Cloud Computing. The higher educational institutions pursue Cloud Computing initiatives, develop skills and share best practices for reducing operating costs while improving quality and access to education. According to IBM, Cloud Computing makes it easier for those in the education environment such as students, faculty and administrators, to gain immediate access to a wide range of new educational resources and research software and tools.

Challenges of Cloud Based System

- Cloud based system has some challenges and concerns that need to be clearly understood, defined and agreed before making a decision on implementing and adopting it. Few among others are listed in this conceptual paper:
- **Reliability:** An outage is the absence of the cloud service. Kim et al. (2009) stated that an outage is unavoidable and users should take it into account before adopting Cloud Solutions. It might happen for a short or a long time, a few or many times. Even large companies such as Google and Amazon experienced many similar cases in the past and they will have many more in the future. Kim et al. (2009) recommends that critical applications should not be taken into the cloud. Actually, most of the applications hosted in the cloud are currently non-critical such as back up and software testing. Moreover, users who are using Cloud Computing solutions should make sure to have backup of their data in other places. Nowadays, Cloud

providers are trying to avoid outage and promise a high level of availability in the Service-Level Agreement (SLA) and try to compensate their users in the case of an outage of the service. This factor represents a risk and it is one of the effective factors in Cloud Computing adoption. It will determine the kind of applications that can be used in the cloud along with its adoption strategy.

- **Security:** Users of Cloud Computing give the cloud provider full control over their data, and they should trust that this third party will take care of their business, secure the data, and do backups for them. This issue can be partly solved by Service-Level Agreements (SLA) where the conditions of security issues in the contract will be clarified (Benlian and Hess, 2011). They found that the security issue is one of the biggest doubts when users think about adopting Cloud Computing as the users do not have their own data in their companies anymore. "Our findings suggest that in respect to both SaaS adopters and nonadopters, security threats are the dominant factor influencing IT executives' overall risk perceptions" (Benlian and Hess, 2011). Marston et al. (2011) asserted the same idea stating that "almost 75 percent of IT executives and CIOs report that security is their primary concern". Kim et al. (2009) argued that we can enhance the security of the computer system by hosting it in the cloud as we will have some expert people who will care about securing the server and the computer system which might not be possible for small and medium companies.
- **Scalability:** Scalability is an important factor that should be taken into account in terms of performance. As the requirements of the Cloud Computing adopters increase, the cloud provider should be able to scale up their resources and infrastructure to satisfy the adopter's new requirements of storage, processing, and connection bandwidth (Kim at al., 2009; Benlian and Hess, 2011). On the other hand, scalability in Cloud Computing is one of the main strength points and constitutes an important opportunity for companies. As these companies' requirements change, their infrastructure will be scaled up or down dynamically providing a high level of strategic flexibility (Benlian and Hess, 2011; Marston, et al., 2011).
- **Cost:** Cost is a very important factor and opportunity in Cloud Computing. Cost advantages are the strongest driver affecting IT executives' perceptions of SaaS opportunities" (Benlian, and Hess, 2011). Marston et al. (2011) stated that companies need to spend a big part of their balance on the IT infrastructure, while less than 10 % of their servers can be really utilized, resulting in a big waste of money. In addition, these servers need to be replaced almost every three years and need to be maintained and administrated, increasing the total cost of IT operations radically. Cloud Computing can reduce these costs remarkably. Economies of scale for datacenters cost savings can lead to a five to seven-time reduction in the total cost of computing
- **Integration with other Services:** Higher education need to adopt different types of applications from different cloud providers and these applications

might need to interact with each other. At the same time, some institutions might adopt a hybrid strategy of Cloud Solutions as public clouds have different characteristics from that of private clouds.Consequently, the integration between the data from these different applications needs to be achieved and this issue poses many technical and business challenges for cloud providers and adopters. On the other hand, Mashups can be a real opportunity in cloud solutions. Mashups are a web service providing data or functionality relying on different external sources (Marston et al., 2011; Kim et al., 2009).

- **Performance:** The main source of performance problems come from the connection quality between the user and the Cloud Computing server, mainly when more users are connecting at the same time and large amounts of data are transferred between the end user and the cloud server. This result in a slowdown in the cloud service (Kim et al., 2009; Benlian and Hess, 2011). The performance issue is an important factor which companies have to think about when adopting Cloud Computing.
- **Compliance and Physical Location:** Since Cloud Computing is a fairly young technology, no rules and governmental regulations really exist to set the boundaries and laws regarding the storage of data by enterprises on third-party computing facilities that are shared with others. Moreover, some old regulations already exist concerning the enterprise data privacy, access, and location without taking Cloud Computing into account, and these regulations might be violated by Cloud Solutions (Kim et al., 2009).For instance, while many countries have regulations concerning the physical location of enterprise data, the cloud providers cannot guarantee the exact physical location of the data, and even some of them have policies to hide such kind of information from the end user.

Conclusion and further work

Cloud-based mobile learning offer centralized resources and low cost services. Cloud computing has become a dominant technology especially in higher education. Applications and adoptability still been fathom in both the developed and developing world. The benefits of cloud services and deployment is irresistible, many of its services and adoptability seems to reduce some burden on IT needs in higher education as some challenges and concerned need to be clearly understood, defined and agreed with the provider at the early stage of planning. The choice of the deployment model will be based on the organizational needs, infrastructures available and terms of services. Higher education in Nigeria can take the advantages of this technology with the increase of usage of mobile devices and reduction in the cost of internet.

In the future, this conceptual paper will conduct feasibility study on institutional readinessin developingand implementingcloud-based mobile learning in higher education in Nigeria.

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