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Transforming Education Delivery Using Cloud-Based Blended Learning

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Abstract

The unprecedented crave for access to tertiary education coupled with increased awareness in the use of communication devices and technologies necessitated the need for a transition from traditional classroom to online educational delivery model. The need to improve teaching and learning experiences motivated researchers to develop the blended learning model. This model essentially combines the strengths of both traditional classroom and online approaches for teaching and learning. The aim of this paper is to propose the use of cloud computing technology to facilitate widespread adoption of blended learning. This paper explores the problems and prospects in the adoption of cloud computing in blended learning and suggests how tertiary institutions can utilize cloud computing technology to ameliorate inherent blended learning challenges. Additionally, this paper proposes a community cloud deployment option for tertiary institutions, and proffers a strategy for tertiary institutions to successfully migrate their computing services to the community cloud model.

Teaching and learning has evolved considerably over the years with the use of information and communication devices and technologies playing a significant role in this evolution. Charalampos, Adamantios, and George **(**2009) noted that one of the oldest approaches for dispensing knowledge is the traditional classroom method. This method of teaching and learning later evolved into some more technology-based approaches which involved the use of multimedia and hypermedia technologies, Yue, and Yuanchun (2008). Rapid developments of Internet technologies offered exciting opportunities for web-based learning. In mid 90's, a number of web based learning environments like e-learning systems were developed (Black, 2002). Presently,

educational institutions deploy a wide range of options for learning. The learning form has gradually evolved from e-learning to mobile learning to blended learning.

Blended Learning is about the latest model in the history of the technology based learning. It strategically integrates the previous learning types with a view to building a better learning environment. The aim of blended learning is to provide the most efficient and effective learning experience by combining delivery modalities. Welker and Berardino (2006) argued that unlike traditional classroom methods, the focus is shifted from the teacher to the learner. The teacher is more of a facilitator of learning and not a dispenser of knowledge as is the case in the traditional method. Learning is made independent and more useful by providing practical opportunities for learners and teachers. Practical instances of blended activities include putting assessments/supplementary materials online, and accessing instructors live online. Study materials placed online can be updated more easily compared to the printed materials. Also, these materials can be enhanced with the help of audio and video (Sife, Lwoga, & Sanga, 2007). In spite of the potentials of benefits and potentials of blended learning, several identified challenges hinder tertiary institutions in developing countries from widely adopting the blended learning model. (Lwoga, 2012;Ssekakubo, Suleman, & Marsden, 2011) maintained that these challenges include the cost of acquiring, managing, and maintaining ICT infrastructure; high cost of bandwidth; inadequate competent technical manpower, and dearth of standard blended learning policies. However, the emergence of cloud computing offers an opportunity for tertiary institutions to ameliorate most of these identified challenges by effectively utilizing the potentials of cloud services.

Cloud computing is a revolutionary computing concept that has progressively developed in recent years. Mell & Grance (2011) defined cloud computing as "a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction". Cloud computing involves hosting ICT infrastructure, software applications, and other computing services into cloud servers and being accessed via the internet. The institutions can only pay for services based on usage the same way as utility services, such as water, electricity, gas, and telephony (Carroll, Merwe, & Kotzé, 2011).

By migrating blended learning services to the cloud, institutions stand to overcome the cost of procuring, hosting and managing Information and communication Technology (ICT) infrastructure in their premises. Thus, rising costs associated with hardware purchase, software licensing and updating, electricity generation, and salaries for IT support personnel would be significantly reduced (Mokhtar, Ali, Al-Sharafi, &

Aborujilah, 2013). However, Sultan (2010) opined that the decision to migrate BL computing services into the cloud depends on institutional awareness of the benefits as well as challenges associated with cloud services. Creating this awareness amongst administrators of tertiary institutions in developing countries is the main motivation for writing this research. Specifically, the aim of this paper is to propose the use of cloud computing technology to facilitate widespread adoption of blended learning. This paper examines the problems and prospects in the adoption of cloud computing in blended learning and suggests how tertiary institutions can make use of cloud computing technology to ameliorate inherent blended learning challenges. Additionally, this paper proposes a community cloud deployment option for tertiary institutions, and proffers a strategy for tertiary institutions to successfully migrate their computing services to the community cloud deployment model.

Overview of Blended Learning and Cloud Computing Concept

Blended learning or learning that combines different modes of delivery, such as online and traditional face-to-face learning is fast becoming pervasive as improved and innovative technologies become increasingly available. Welker, & Berardino (2006) posited that blended learning could be defined as any combined use of electronic learning tools that supplement but do not replace face-to-face learning. They added that the main justification for implementing this educational delivery model is to optimize the students' learning outcomes and experiences by finding a balance between the quality of students' learning communities and the limitations of the educational institution.

Vaughan (2007) identified a number of potential blended learning opportunities. These include increased degree of social interaction compared to a complete online delivery method; ease of Implementation; and an optimal learning environment.

Fernando (2006) pinpointed several challenges inhibiting an efficient deployment of blended learning systems. These include dearth of appropriate infrastructure; lack of standard blended learning curriculum, change/transition process management; lack of Awareness, and the need for comprehensive training.

Cloud Computing Concept

The philosophy of Cloud Computing mainly implies a change in the way of solving problems by using computers. Mell & Grance (2011) aptly described cloud computing as a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction. The idea behind cloud computing is to enable clients (e.g., users, or institutions) to access computing

resources via the internet and pay per use as utilities, the same way users normally pay for water, electricity and related utility services (Alshuwaier, Alshwaier, & Areshey, 2012).

Users (individual clients and business organizations) as well as providers of cloud computing services stand to gain tremendous benefits from the adoption of the computing model. Clients would be able to access their applications and data from anywhere at any time. They could access the cloud computing system using any computer linked to the Internet. Data wouldn't be confined to a hard drive on one user's computer or even a corporation's internal network. Carroll, Merwe, Van Der, & Kotzé (2011) explained that today's IT realities make cloud computing a good fit for meeting the needs of both IT service providers (who demand unprecedented flexibility and efficiency, lower costs and complexity and support for varied and huge workloads) and Internet users (who expect availability, function and speed).

Cloud Delivery Models.

Services offered by cloud service providers could be grouped into three categories usually referred to as cloud delivery models (Barrie, 2011). These models are:

(i) Software as a Service (SaaS): In this model, the consumer uses an application, but does not control the operating system, hardware or network infrastructure on which it's running. Software as a service features a complete application offered as a service on demand. A single instance of the software runs on the cloud and services multiple end users or client organizations.

(ii) Platform as a Service (PaaS): With PaaS, the cloud service provider delivers whatever is required for both software development and runtime environment. Here the consumers (client organizations) use a hosting environment for their applications. The consumer controls the applications that run in the environment (and possibly has some control over the hosting environment), but does not control the operating system, hardware or network infrastructure on which they are running.

(iii) Infrastructure as a Service (IaaS): In the case of IaaS, the cloud service provides the hardware as well as a toolkit to build software applications. The consumers are usually software developers who host their applications on the platform and can control the operating system, storage, deployed applications and possibly networking components such as firewalls but not the cloud infrastructure beneath them.

Cloud Deployment Models

Cloud computing architects are expected to make several considerations when transiting from standard enterprise architecture to a cloud-based model. These considerations are generally dependent on the deployment model being considered.

Mell, & Grance (2011) highlighted the U.S Government's National Institute of Standards and Technology (NIST) endorsement of four deployment models for cloud computing. They include:

(i)Public Cloud: Public cloud services are characterized as being available to clients from a third party service provider via the Internet. A public cloud does not mean that a user's data is publicly visible. Third-party public cloud vendors typically provide an access control mechanism for their users. Public clouds provide an elastic, relatively cost effective means to deploy cloud computing services. Public clouds are most often hosted away from customer premises, and they provide a way to reduce customer risk and cost by offering a flexible extension to enterprise infrastructure.

(ii)Private Cloud: Private clouds are built for the exclusive use of one client, providing the utmost control over data, security, and quality of service but are relatively expensive to deploy. The client/organization owns the infrastructure and has control over how applications are deployed on it. Private clouds can be built and managed by an organization's own IT personnel or by a cloud service provider.

(iii) Hybrid Cloud: A hybrid cloud is a combination of a public and private cloud that inter operates. In this model, users typically outsource non-business-critical information and processing to the public cloud, while keeping business-critical services and data in their control.

(iv) Community Cloud: A community cloud is one where the cloud has been well thought-out to serve a common purpose. A community cloud is controlled and used by a group of organizations that have shared interests, such as specific security requirements or a common mission. The members of the community share access to the data and applications in the cloud and also share the costs of implementation and management of cloud services.

Attributes of Cloud Computing Models

Some vital attributes that are typical to the aforementioned deployment models include but not limited to:

Rapid Elasticity: Elasticity is defined as the ability to scale resources both up and down as needed. To the consumer, the cloud appears to be infinite, and the consumer can purchase as much or as little computing power as they need.

Measured Service: In a measured service, aspects of the cloud services are controlled and monitored by the cloud provider. This is crucial for billing, access control, resource optimization, capacity planning and other tasks.

On-Demand Self-Service: The on-demand and self-service aspects of cloud computing mean that a consumer can use cloud services as needed without any human interaction with the cloud provider.

Ubiquitous Network Access: Ubiquitous network access means that the cloud provider's capabilities are available over the network and can be accessed through standard mechanisms by both thick and thin clients.

Location-Independent Resource Pooling: Resource pooling allows a cloud provider to serve its consumers via a multi-tenant model. Physical and virtual resources are assigned and reassigned according to consumer demand. The location of the physical resources underneath the cloud infrastructure is not known to the consumer, and can change dynamically.

Opportunities and Challenges in the Adoption of Cloud Computing in Blended Learning

Opportunities in the adoption of cloud computing for blended learning include:

Affordable Investment Cost: Lwoga (2012), observed that the high cost of acquiring, and managing ICT infrastructure has been a major factor that deters tertiary institutions from adopt blended learning in developing countries. However, hosting blended learning services into the cloud would significantly reduce ICT investment cost due to the fact that ICT infrastructure needed to administer blended learning courses will no longer be procured by an individual institution. Rather, they would be hosted in cloud-based servers which are maintained by cloud service providers (Rindos, Vouk, Vandenberg, Pitt, Harris, Gendron, & Danford, 2009).

Provision of System Support and Maintenance Services: System support and maintenance services are usually provided by in-house technical staff. However, with the migration of computing services to the cloud, institutions will be able to reduce support and maintain costs. In addition, the need to reduce manpower in the IT department would be necessitated as management of hardware with its accessories will be moved to the cloud service provider. Truong, Thoai, & Dustdar (2012) demonstrated that the North Carolina State University reduced the number of IT staff from 15 to 3 employees by migrating its computing services into the cloud.

Metered Cost Model: In many education institutions, IT services are usually in maximum demand only in a short period due to the structure of teaching semesters (Truong, Thoai, & Dustdar, 2012). Therefore, when students are on vacation, computing services are barely used. Consequently, institutions incur unnecessary costs for services that are hardly being used. With cloud computing, institutions stand to gain

considerable savings due to the fact that institutions will pay for only services they have used as is the case with other utilities such water, electricity, and other related services,(Sife, Lwoga, & Sanga, 2007).

Availability of High Performance Computing Facilities: Many institutions in many developing countries lack high computing facilities for research and teaching advanced concepts like simulations and analysis of computation models. Considering the precarious financial positions of many institutions in developing countries, procuring high performance facilities is almost impossible. Truong, Thoai, & Dustdar (2012) argued that as a result of financial constraints, investment for research facilities is normally prioritized below teaching facilities as the use of Google App Engine, Amazon Hadoop or related cloud-based platforms would provide the needed facilities at affordable costs.

Challenges in the adoption of cloud computing for Blended Learning

Some of the identified challenges militating against the widespread adoption of cloud computing for the implementation of blended learning include:

Security Risk: Lack of control of an organization's IT assets presents a security challenge in the adoption of cloud services. Normally, institutions do not need to own and control ICT infrastructure once they are hosted into the cloud. This is because cloud infrastructure is usually not physically located in institutions' premises (Mokhtar, Ali, Al-Sharafi, & Aborujilah, 2013). This increases the tendency for the institutions data to be compromised. However, the emergence of improved cloud security techniques have helped to handle most of these data security and privacy challenges.

Need for Policy Review: ICT policies in many institutions in Nigeria were developed without taking into account the complexity of cloud computing. In addition to developing cloud adoption strategy, institutions would have to review their policies and rules to accommodate cloud services in blended learning delivery (Laisheng & Zhengxia, 2011).

Inadequate Manpower: Cloud computing is a new form of technology, clearly, many institutions in developing countries lack cloud computing experts for both technology and regulatory compliance (laws, data compliance, tax & payment, etc.). There is a need for tertiary institutions in developing countries to invest in capacity building especially on long term and short term training in various aspects of cloud computing (Ssekakubo, Suleman, & Marsden, 2011).

Proposed Cloud Deployment Option for Tertiary Institutions

As already emphasized, clouds can be classified based on the underlying infrastructure deployment as Public, Private, Community, and Hybrid clouds. The different deployment models are distinguished by their architecture, the location of the datacenter where the shared needs of the clouds' intended users/customers which could be regulatory, legal or other requirements. The choice of the community cloud deployment model for tertiary institutions is mainly informed by the fact that tertiary institutions in developing nations share common ICT needs. In the same vein, Shirley (2012) maintained that the community cloud can be a good option if participation is based on the institution's needs and reflects the institution's requirements for infrastructure, business processes, and data management. Additionally, other potential benefits to be derived by tertiary institutions adopting community cloud deployment model are highlighted below.

Benefits of Educational Community Cloud for Blended Learning

Potential benefits to be derived with the deployment of community cloud model for blended learning include:

Economies of Scale: Cloud providers can realize economies of scale, including cost savings that the community (participating institutions) can pass on to participants.

Savings on Investment: Occasionally, institutions expend limited financial resources on costs that do not provide strategic solutions. It is critical to be able to differentiate between essential and non-essential investments. Cloud computing offers reliable options for strategic deployment of resources.

Performance: The capacity and costs associated with access to and storage of data are common concerns. Community offers significant performance advantage over the public cloud by providing institutions with both high-performance access and storage solutions.

Troubleshooting: Community clouds can streamline troubleshooting by migrating responsibility for the troubleshooting from individual institutions to the service providers.

Privacy: The academic community is sensitive to issues of information privacy and ownership laws. The steps that community clouds take to ensure the integrity of data and its protection offers institutions' administrators and their legal counsel desired assurances.

Control and Risk Management Issues: Partners in a community cloud influence its administration and operations, share control of that cloud, and have a strong voice in ownership of data. Similarly, they shape key decisions about the business model, policies, and technology upgrades. The cloud also alleviates vendor lock-in, supports integration of technologies, and makes migration to better solutions easier.

Proposed Approach for Migration of Computing Services to the Community Cloud

This section presents a proposed approach for tertiary institutions to successfully migrate their computing services to the community cloud deployment model. Today, there are a good number of cloud service providers in the market even in the developing countries that offer cloud services both for commercial and non-commercial purposes. It is imperative for institutions to develop a strategy that will provide a seamless migration of blended learning services into the clouds. The developed strategy should take the institutions' needs into consideration. Mircea and Andreescu (2011) suggested five stages for migrating strategy towards the cloud as indicated in Figure 1 below. These include:

Knowledge base development: This entails developing knowledge base about cloud computing through attending seminars, workshops as well as conducting discussions with the service providers and consulting the most recent researches in the field.

Evaluation of State of Facilities: From the point of view of the IT needs, structure and usage. This stage will help the institution to understand which data, services, processes and applications that may be migrated or need to be maintained within the institution.

Solutions experimentation: Experimenting cloud computing solutions could be carried out done gradually as pilot test projects in specific departments, and thereafter scaling it to all users in the institution.

Choice of Cloud Solutions: In choosing the cloud computing solutions, institutions are required to conduct thorough evaluation to compare cloud service providers' capabilities, licensing mechanisms, and pricing models in order to make sustainable choices.

Implementation and management: This involves the Implementation and management of the chosen cloud computing solution.

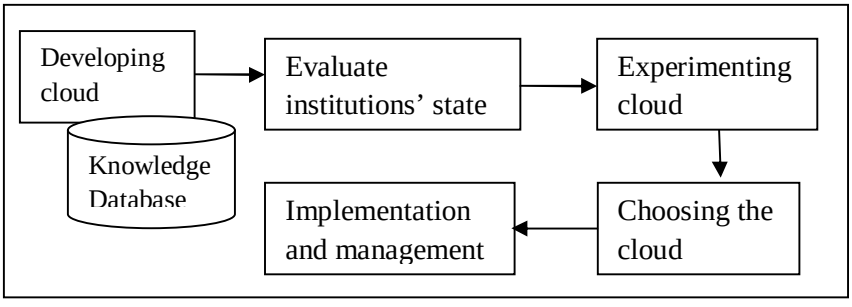

Figure 1: An illustration of the community cloud deployment approach for tertiary institutions (source: Mircea & Andreescu, 2011).

Conclusion

The implementation of blended learning approach in the delivery of educational services has the capacity to tremendously enhance better teaching and learning experiences. Having explored the problems and prospects in the adoption of cloud computing in blended learning, this paper proposed that integrating cloud computing technology in the implementation of blended learning is aimed at transforming the education delivery process as well as facilitating widespread adoption of blended learning.

Recommendations

Having examined the problems and prospects in the adoption of cloud computing in blended learning, this paper recommends that:

(i) Administrators of educational institutions should embrace blended learning model due to its capacity to immensely increase students' learning outcomes.

(ii) Educational institutions should collaborate to constitute an education community cloud so as to reap the benefits of economies of scale, performance, troubleshooting, and privacy offered by the deployment of community cloud computing model in the management and administration of IT services within educational institutions.

(iii) Consultants in the education sector should adopt the proposed strategy for migrating computing services to the education community cloud as this would facilitate a widespread and sustainable adoption of blended learning.

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