CLOUD COMPUTING IN NIGERIAN UNIVERSITIES: BENEFITS, CHALLENGES AND PROSPECTS

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Abstract
Both Education and Technology currently operates from the cloud. At the same time, both are evolving and dynamic in nature, thus the diffusion of technology into education revolutionizes the educational system. Cloud computing is an integral part of Information and Communication is an integral part of Information and Communication Technology (ICT). The advents of ICTs have therefore brought different dimension to the education sector especially the tertiary institutions. Hence the world is witnessing one of its transformations with cloud computing penetrating into education. Cloud computing is a network of computers that work together performing different functions such as storage, processing and delivering a large amount of data. These computer networks are inside warehouse across the world as data centres hosting in the cloud. It harnesses the web as the ultimate platform to serve all kinds of users; individuals, businesses, institutions, the industry and others. Through asynchronous or synchronous process, higher institutions such as the universities tap from cloud computing and it is seen as a solution to ICT problems in higher institutions. It has the capabilities to enhance teachers ability to instructs and for students overall learning. Thus these technologies give room for learners to interact, stimulate, collaborate, and document learning experiences. Cloud computing will help to address the role
of technology in proving teaching and learning methodology. Education therefore has a lot to benefit from clouds computing, such as cost saving, more storage space, back up, quick and easy access to information among others. Cloud computing comes with lots of challenges such as availability of services, data protection risk, lack of computers and smartphones, among others. Despite of these barriers, there is the beliefs in no time both teachers and students will very readily avail themselves to those new technologies without much issue. It is recommended that University authorities should make their libraries ICT compliant and partner with NGOs among others.

**Keywords:** ICT, Cloud Computing, Universities, Teachers, Students

Education is evolving, so also is technology. Thus, the diffusion of technology into education can be revolutionary and endless. Information and communication technology is a term coin out of an intermingling of information technology and communication technology, whereby information technology is seen as the processing, acquisition, storing and disseminating pictorial, textual and numerical information by microelectronic based combination of computers and telecommunication. While communication technology comprises of various channels through which information, messages, knowledge and ideas could be transmitted from the sender to the received.

Cloud computing is an integral part of information and communication technology (ICT). The word Cloud connotes internet or web. It is a term used to refer to the use of network servers that are remotely located. Users can access the remote servers via the internet to manage, store, and process relevant data, rather than on the personal computer of a local server (Passary, 2015). Cloud computing works the same way as consumers tapping into the national electricity supply, instead of running their own generators (http://www.moonther.com/cis492/aboveclouds.pdf).

Buck (2014) as cited in Ughelu (2016) viewed cloud computing as a term that applies to applications and data storage that are delivered over the internet or wireless technology. In these circumstances, the individual user’s device (computer, cell phone, etc.) only provides an interface between the internet and the computer programmes and data. Buck asserted that it is a process by which users rent or borrow software instead of actually purchasing and installing it. Similarly, Gonzalez (2015) saw cloud computing as a website server to which users consents their files, including music, movies, video and photos. The idea behind the cloud according to Gonzalez is to upload users’ files to be saved online (i.e. the cloud) where they can access them from any computer or device that can connect to the internet. The author further stated that it is the site’s massive data centre where data are stored in the warehouses full of computer services.

These new technologies therefore have the capabilities to enhance teachers’ ability to instruct and contribute to student’s overall learning. According to Rackley &
Vururu (2013) there is a need to empower future educators with the right resources to appropriately teach tomorrow’s technology users. These technologies therefore give room for learners to interact, stimulate, collaborate and document learning experiences and real-world problem-solving. In collaboration of this, Blue and Tirotta (2011) and Sharma and Ganpati (2013) averred that education cloud though is at its nascent stage in the developing countries, will address the role of technology in improving teaching and learning methodology.

Education has a lot to benefit from cloud computing such as cost saving, staffing, third party reliance, maintenance, upgrading, more storage space, back-up and recovery, quick and easy access to information among others (Viswanathan, 2015). It also has its challenges such as availability of services, performance unpredictability, data lock-in, bugs in large distributed systems among others (Armbrust, 2009). Despite these challenges the entire world, especially the developing countries may see a transformation in the education industry with the emergence of the new technology.

Concept of Cloud Computing

Information and communication technology has been in transforming state from time to time. Presently, the world is witnessing one of its transformation with cloud computing. Cloud computing has potential to penetrate into education, transaction, collaboration, information sharing and other areas of life. Cloud computing is a network of computers that work together performing different functions such as storage, processing and delivery of a large amount of data. These computer networks are inside warehouse across the world as data centres hosting in the cloud to tap what exist from large forms of renting computing power and also storage facilities by paying for what they use as it is done through electricity and water with the aid of meters for what has been used.

The web is the ultimate platform that serves all kinds of users; individuals, businesses, institutions, the industry and others. Shimba (2010) saw cloud computing as provider of computing resources on-demand on a pay-per-use basis via a cloud service provider and is a powerful tool that can deliver sustainable advantages. Similarly, Mell and Grance(2010)as cited in Passary (2015) opined that cloud computing is a comprehensive infrastructure that allows for increased streamline of inter-office activities. In collaboration with this ITU-T (2011) posited that cloud computing is a model for enabling network users on-demand access to a share pool of configurable computing resources that can be rapidly provisioned and released to the client without direct service provider’s interaction.

Cloud computing consists of hardware and software resources made available on the internet and managed third-party services. It is a process by which computers tasks are performed using services delivered entirely via the internet, or over wireless technology. Cloud computing is a kind of computing that relies on sharing a pool of physical and/or virtual resources, rather than deploying local or personal hardware
software. It is somewhat synonymous with the term utility computing as users are able to tap into a supply of computing resources rather than management the equipment needed to generate it themselves (http://ww.months, com/CIS492/abovecloud.pdf).

To Forster, Zhao, Raieu and Lu (2009) in Blue and Tirotta (2011), cloud computing is the large scale distributed computing paradigm in which a pool of abstracted, virtualized, dynamically scalable, managed computing power, storage, platforms, and services are delivered on demand to external customers over the internet. This presupposes that cloud computing is a completely internet-reliant service offered to external customers who have no control over the cloud to which they are tied. In line with this, Hewith (2008) saw cloud computing as a concept in which information is permanently stored in computer servers on the internet and cached temporarily on clients that includes desktops, table computers, notebooks, wall computers, sensors, monitors etc. Hence, cloud computing is a style of computing in which IT-related capabilities are provided as a service, allowing users to access technology – enabled services from the internet (in the cloud) without knowledge of expertise with or without control over the technology infrastructure that supports them (Craig & Leger, 2008).

Cloud computing can be used to seek skills which will enable users to update their knowledge on a daily basis. It is use to create records and files: storing these created files amongst educators and learners (Ariwa, Ibe-Ariwa & Ibe, 2014). Ernst and Young (2011) stated that teaching materials can be made available through the provision of cloud services to educate the client users on the available risk management. Some researchers have considered cloud computing as a technological revolution of the twenty-first century which will go a long way towards resolving issues concerning corresponding technology between domestic and foreigner.

ITU-T’s (2011) noted that the development of cloud computing in recent years has increased the interest of internet and information technology (IT) users seeking to derive the greatest benefit from the services and application available on-line via web service-on-demand. It gives a new room for economic model of ICTs. With cloud computing, organizations, institutions and companies no longer need to invest heavily in resources which necessitate limited burdensome and costly internal management of their resource especially to purchase or lease resources online.

In the present global information technology, cloud platforms such as Microsoft and Google are providing free services to students and staff of educational institutions which include email, contact lists, calendars, document storage, creation and sharing of documents and the ability to create websites (Sclater, 2010). Dahunsi and Oweseni (2015) posited that cloud computing has pervasive access to open up ICT penetration in education where its usage is simple, utilities are offered in pay-as-you-use. Hence, it has the potentials to open up information and communication technology (ICT) and penetrate into education, transaction, collaboration, information dissemination and in other areas of humanity. Although the cloud includes a broad set of different services, its most widely used application are: - email services, such as
This new developments has linked tertiary institutions all over the world. Through asynchronous or synchronous processes, higher institutions tag from cloud computing (Ughelu, 2016). Gerald and Eduan (2012) suggested that, public universities and colleges should adopt a set of services through cloud computing in a more cost effective way since they share many similar operational processes such as course offerings, admissions, enrolment, bursaries, research and graduations that can be standardized across the higher education sector. Abdulsalam and Zambuk (2011) in a study on cloud computing in Nigeria higher educational institution viewed cloud computing as a model for enabling convenient, on-demand network process to shared pool of configurable computing resources (e.g. network, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service providers. The authors concluded that cloud computing is a solution to ICT problems in higher institutions in Nigeria.

Abdulsalam and Zambuk (2011) identified scanty ICT infrastructure and lack of access to computer, high cost of ownership, unsteady and inadequate electricity power supply as factors militating against the use of ICT in teaching and learning in Nigeria higher institutions but posited that with cloud computing some of these problems are solved. Gartiner (2000) identified prerequisites for using cloud computing in teaching-learning as good internet connectivity, a sound software and hardware market; application needs to be virtualized; trust in the security of the system used; access, privacy, reliability and compliance in cloud computing and data location. Gartiner mentioned some guidelines adopting cloud computing in teaching and learning process:

- The strategy for the transition to cloud computing
- Capacity building programme
- The harmonization of legislative and regulatory reference frames
- The adoption of data-center selection criteria
- Attracting investment and seizing business opportunities

Ughelu (2016) mentioned some characteristics of cloud computing technology to include, viz:

- Cloud computing users do not own the IT resources they use, the servers they exploit are host in external data centers.
- Services are provided via the pay-per-use model or on subscription.
- The resources and services provided to the client are often virtual and share among other users.
- The services are provided via the internet.
According to Nabil (2010) with cloud these services are provided remotely under different services or layers viz;

**Types of Cloud Computing**
Mell and Grance (2009) gave different types of cloud computing viz:

- **Infrastructure as a service (Iaas)**; This include virtualized on-demand server, virtualized data centre, flexible on-demand storage space, flexible local networks (LANS), firewalls, security services etc. It is also called processing clouds.
- **Platform as a service (Pass)**; Platform for cloud computing services provide services like customer service management billing etc. It is also called storage clouds that offer an alternative to local files systems.
- **Software as a service (Saas)**; It can be used in business applications, customers relations and support. Human Resources (HR), finance, online payment, electronic markets place for different sizes of enterprises such as very small, small and medium sizes. Another term for Saasis the application clouds which allow a thin client to interact with services that are completely hosted on an external infrastructure.
- **Communication as a service (Caas)**; this involves audio-video communication services, collaborative-services, unified communication, e-mail, instant message, data-sharing like web conferencing.
- **Network as a service (Naas)**; this involves managed internet that is, guaranteed speed, availability etc. Virtualized network (VPNs) coupled with cloud computing services, flexible and on-demand bandwidth.

**Cloud Applications**
According to Sharma and Gampati (2013), prominent SaaS applications are as follows:

- AmazonWeb Services,
- Yahooomails,
- Google docs,
- Enterprise Resource Planning (ERP),
- Business Process Management (BPM) and
- Customers Relationship Management (CRM)

Masud, Young and Huang (2012) mentioned some typical uses of cloud computing in Higher Education, and these include:

- It can be used as a personal workspace;
- A convenient tool to make teaching and learning interactive has strong potential for social interactivity;
- Personal Learning Environment (PLEs) used by many people as an alternative to institutionally controlled virtual learning environments (VLEs) with different personalized tools to their own personal needs and preferences;
Benefits of Cloud Computing

According to United Nations Educational, Scientific and Cultural Organization (UNESCO) (2010) there are some major potential benefits cloud computing services have for education, they include viz;

- **Economic**: the primary advantage for many institutions and schools is that the services such as email are offered free by external providers (financial cost reduction).
- **Elasticity**: Institutions begin with small-scale services and build them up gradually without significant up-front investment.
- **Enhanced availability/accessibility**: Students increasingly dependent on online service for learning and assessment, hence cloud providers give the best possible availability to students, as there is no worry of back-up or loosing as it is safely stored in the cloud with large storage capacity provided for free.
- **Multilinancy and resource pooling (sharing resources)**

Other benefits of cloud computing according to several authors (Armbust, 1999; Dave, 2008; Stains, 2013; Viswanathan, 2015&Passary, 2015) include:

- **Cost saving**: Cloud Computing saves money by eliminating on-site hardware and software installations which cost a lot of money. In as much as users are free from hardware and software installations, they are not free from associated problems of device configurations. As these services are being offered by cloud providers, the management no longer needs to fill their offices which hardware or train staff in various complex software systems. Armbrust (2009) asserted that internet services no longer require the large capital outlays in hardware to deploy their services or the human expense to operate it. The author further claims that cloud computing lets an organization pay by the hour for computing resources, potentially leading to cost savings. Passary (2015) observed that many businesses are cloud computing that usually turns out to be cheap, fast and easy to maintain.
- **Staffing**: Cloud computing reduces the pressure on both under and over staffing, and it takes few people to do more work on a cloud and increase volume or productivity with fewer people and less cost per unit (http://www.veno.com/resource-center/articles/cloud-computingbenefits/). Less staff is therefore required to run any organization whose services are provided on the cloud.
- **Thirty party reliance**: The cloud is regarded as the third party in a business circle. Hence clients of the cloud have the advantage of their information technology services thing managed by a third party.
• **Maintenance**: One of the benefits of cloud computing services is that the providers manage all IT for organisations/institutions.

• **Upgrading**: The cloud providers have the responsibilities for upgrading expensive services, software and hardware, and thus, getting rid of all-house technology staff, and just keeping a skeletal crew to oversee your information technology operations.

• **Constant software update**: SaaS is always up-to-date. It runs the most recent versions of the applications. The pain of installation upgrading is replaced by a simple request to run a specific version of the software. It eliminates the need to install hardware or software on the client’s premises (Dave, 2008).

• **Globalized workforce**: Once connected to the cloud, people throughout the globe can have access to it provided there is internet connectivity.

• **More storage spaces**: To store information in the cloud, large storage capacity for clients. Clients therefore need not worry about running out of storage space or increasing their current storage space availability (Visivanathan, 2015).

• **Backup and recovery**: Viswanathan (2015) affirmed that since all clients’ data are stored in the cloud, backing and restoration of same is relatively much easier than storing the same on physical device. The author furthermore stated that most cloud service providers are usually competent enough to handle recovery of information, thereby making the entire process of back-up and recovering much simpler than other traditional methods of data storage.

• **Easy and automatic integration of software**: Cloud providers provide quick, easy and automated software integration instead of additional efforts usually made by clients of the cloud to customize and integrate newer applications. Cloud computing allows clients to customize their options by handpicking those services and software applications that they think will best suit their particular enterprise (Viswanathan, 2015).

• **Quick and easy access to information**: There is a 24 hours access to clouds’ data and information is always in the fingertips of clients once all registration requirements and fulfilled. This is because the information could be accessed anytime and anywhere provided there is internet connectivity. In the teaching and learning process, most of the teaching materials, such as power points slides, lesson notes, and other digital teaching materials are easily uploaded to the cloud (internet) and easily accessed.

• **Moving devices**: When information is stored in the cloud, there is no need to move computer devices around. Hence, there will be no fear of losing or damaging any of the computer devices during such movement.

• **Security**: Information or data stored in the cloud is highly secured because access to data/information is usually pass-worded (authenticated). Hence, individuals anywhere have no access to the information they are not supposed to have.
• **Sharability**: Files can easily be shared amongst teachers. That is, files can be linked to each other via hypertext markup language (HTML).

• **Paperwork**: With cloud services, paperwork (printing and photocopying) and other paper works are reduced to the minimum. If students have their own smart devices (computer, laptop, tablet, etc.) quizzes, test, assignments can be taken, scored, shared with students and parents, and stored (Stains, 2013).

• **File cabinets**: With cloud computing services, there will be no need for file cabinets, lockers or shelves for filling and storing papers. Cloud computing system is regularly backed-up. Hence, the loss of information/data in the cloud is very remote.

• **Flexibility**: Flexibility in cloud computing is achieved through scalability. Denotatively, scalability means the degree to which a computing system is able to grow and become more powerful as the number of people using it increase. Thus, cloud computing system has the ability to adapt and scale to changes in workload.

• **Automatic provision of resources**: Cloud technology allows for the automatic provision of a resources as and when it is necessary, thus ensuring that the level of resources available is as closely matched to current demand as possible. Resources are usually delivered in blocks (e.g., individual servers, downloaded software applications) usually with fixed capacities and upfront costs. With cloud computing, users pay only for the resources they use and so avoid the inefficiencies expense of any unused capacity.

**Challenges of Cloud Computing**

Cloud computing, in spite of its benefits/advantages, has a lot of challenges and limitations. Scholars, Armbrust (2009), Viswanathan (2015) and Passary (2015) have identified some obstacles to the growth and use of cloud computing in higher institutions of education viz:

1. **Compatibility of hardware**: Researchers have shown that not all applications run on the cloud computing, as old hardware may not fit the latest software. Also, sometimes newer application software may render the old data useless. Clients of the cloud providers should therefore be ready to keep pace with technological innovations before venturing into computing services.

2. **Data protection risk**: Risk related to data protection and management is very high, as internet hackers and crackers can easily have access to data and cause havoc.

3. **Access to staff**: With a cloud providing all the tasks of the organization, it becomes extremely difficult for the management to easily and quickly have access to staff in case things go wrong during services delivery. There is no way to reprimand or disciplines staff for unacceptable actions.
4. **Provision for computers**: In the teaching and learning process, it means that each student must have a computer. At this point of dwindling resources where institutions are facing financial strangulation, the school authorities will definitely face some difficulties in providing computing resources to the students and faculty members due to various factors.

5. **Provision of networks**: Computers alone cannot work on a cloud without internet connectivity. Hence, network services availability is necessary for efficient and effective computing.

6. **Hardware update**: There is no doubt that the processing capacities of computer systems are constantly being increased for better service performance. Accordingly, the memory capacities of removal or secondary storage devices are constantly being increased as meager gigabyte of storage device capability has risen to terabyte storage capacities. Many teaching institutions may not be ready to face the brunt of the continuous upgrading of processors at the pace of technology innovations. This, however leads to financial burden and requires management of such activities. As the hardware gets obsolete, new ones are acquired to replace them, so as to function effectively and efficiently in the cloud.

7. **Software installations and upgrading**: With the continuous improvement on hard work, there is the evolution of software. As new hardware are being invented and installed, so also do new system application software with better features are needed to complement them for compatibility. Moreover, heavy expenses are incurred in the course of purchase of costly licensed systems and application software as newer versions emerged in the market in order to keep pace with time.

8. **Personnel**: The hardware and software components cannot work in isolation from human beings. With the advent of new technologies, they have to be hired and trained to meet the pace of technological innovations. Large amounts of money are required to perform this task.

9. **Computer virus**: Once services are internet-based, users are heavily prone to virus attacks. So, cloud providers face the risk of data loss, corruption or damage. Consequently, they must be prepared to protect their data by continuously purchasing and installing up-to-date anti-virus software to safeguard their systems. If serious consideration is not take, a virus may paralyze institution’s work and students research information may also be cracked.

10. **Limitation to working hours**: Sometimes, academic institutions may not log on continuously to the cloud. The institutions may have periods in which they log on to the clouds. Due to this factor, the student will be restricted to making use of computer resources within the working hours of the institutions. So, the students will not work at their own desired time, but could be tied to the logging periods of the institution.

11. **A limitation to working area**: Cloud computing require all participants to work with computers or its equivalents. Students that cannot afford computers and...
cannot have personal access to internet are physically required to go to the institution or are restricted to the institution’s premises for their assigned task. Thus, students’ work will be definitely depend on the available computer resources in the institutions. So, if computers are not enough to go round, the students will be frustrated and their work suffers.

12. **Data transfer delay**: As new hardware is purchases by cloud providers on institutions, some data may be copied from the old hardware to the new system. While these services are being performed, there may be no notice given to the students accessing data during the transfer. Thus, this may hinder the work of the students during that period.

13. **Security**: Undoubtedly, one of the most serious problems confronting cloud computing services is the overall security of clients’ data/information. Everyone can access the cloud, as long as they are connected to the internet and are not restricted in any way. Despite the acclaim that public cloud offers great economy of scale and redundancy, it is more vulnerable than private cloud set up due to high level of accessibility. Since internet is often to all, thus any sensitive information hosted to it is accessible to all, putting sensitive information stored into services that are accessible over the internet. Thus, this means that internet hackers may have access to much information, which means that, any of such services are prone to failure if not properly guided. Hence users need to make the right choice to be absolutely sure that they choose the most reliable service provider that would keep their information totally secured.

14. **Technical problems**: Where machines are concerned, technical issues cannot be 100% ruled out, because there is bound to be some technical fault along the way, that may result in network and connectivity malfunction. If these issues are not properly addressed, they can hinder the services of any cloud provider.

15. **The server and Bandwidth Issues**: Internet connection is one thing, the level of connectivity is another issue. Thus, the issues of the fastness of connectivity, the time it takes to download small items in the cloud and how many timeouts experience while downloading is another. Hence effective, efficient and reliable server with enough bandwidth is needed for fast connection and a quick download of headed items by cloud providers.

16. **Others**: Availability of services, Data transfer Bottlenecks, Performance unpredictability, scalable storage, software licensing, Data confidentiality and Auditability, Reputable Fate sharing, unstable and unpredicted electricity supply amongst others.

**Prospects**

There are a lot of challenges in our educational system. Hence, there is need to address the inadequacies in the system urgently. With the overflow of students from secondary schools into the tertiary institutions the world over, there is need to solve the
problem of overcrowded classrooms in the institutions. Relating this to the educational tertiary institutions in Nigeria, where a teacher needs to teach over 100 students in a class, the need to address the issues is urgent. Knowing the financial challenges facing these institutions, there appear to be no other options left than to adopt, apply and utilize these services of this new technological innovation into the educational system as soon as possible. In spite of the several merits accredited to cloud computing, such as scalability, broader reach, all time among others, its adoption is still slow in Nigeria, even as many organisations/enterprises are beginning to gradually look up into the system.

Studies by Britland (2013) and Elets News Network (ENN) (2013) asserted that despite the fact that technology can be a barrier to teaching and learning, they are very optimistic that the cloud will go a long way to remove this barrier. The authors averred that teachers can use the cloud to set, collect and grade work online; students can have instant access to grades, comments and work via the computer, smartphone or tablet. Thus with the emergences of cloud computing, students’ learn independently, here they take ownership of their own learning, thus teachers could easily adopt a flipped classroom approach. Also with the emergence of e-learning (massive open online resources), which may be documents, videos, and audio podcast or interactive images among others, which can be easily accessed by students via the internet. These can thus, address some of the inadequacies in tertiary educational system, and therefore give hope to the use of the cloud if properly applied.

Conclusion

Cloud computing has tremendous potentials to make available massive amount of education database across the globe, but the poor state of ICT in Nigerian education system has really limited its impact in tertiary education. Cost has been identified as a major barrier to the effective use of ICT in education, which can be leveraged through the adoption of cloud computing. The gradual removal of software license cost, hardware costs and maintenance costs respectively provides great flexibility to the academic institutions/corporate management. Cloud computing provides solution for financial constraints, sustainability challenges and inadequacy of infrastructure in the educational systems. Thus, cloud computing will bring a lot of development to the educational system which will affect all other system. Like every other endeavour, cloud computing has both benefits and challenge. One of such major challenge is cloud providers ability to protect their data/information by providing adequate security and also installing of up-to-date antivirus software in their systems in order to avoid data corruption and damage. Despite all these issues and challenges, cloud computing services have lots of prospect if properly managed and good services are provided to clients.
Recommendations

Based on the discussions above, the following recommendations are made:

1. Government at all levels should implement the Information and Communication Technology policy as documented.
2. University authorities should make their libraries ICT compliant and often have more ICT centres centers in their campuses.
3. Government should give all lecturers in the universities functional computers through soft loans.
4. Various universities should go with private organisations and individuals to invest in computer and other communication devices to provide ICT facilities for cloud computing services.
5. Staff and students should be trained and retrained on the skills of cloud computing through regular seminars and workshops.
6. Parents, who can afford, should provide students with computer, smartphones and cloud computing compliant devices.
7. Regular and stable electricity supply should be provided in University Campuses.

References


