

## International Journal of Computer Science and Mobile Computing



A Monthly Journal of Computer Science and Information Technology

ISSN 2320-088X

IMPACT FACTOR: 6.199

*IJCSMC, Vol. 9, Issue. 2, February 2020, pg.56 – 73*

# CLOUD SECURITY CHALLENGES: IMPLICATION ON EDUCATION

**Edeh Michael Onyema<sup>1</sup>; Nwafor Chika Eucheria<sup>1</sup>; Ugwugbo Ann Nneka<sup>2</sup>;  
Rockson Kwasi Afriyie<sup>2</sup>; Ogbonnaya Uchenna Nwoye<sup>3</sup>**

1. \*Lecturer, Dept. of Mathematics and Computer Science, Coal City University, Nigeria

\*Associate Professor, Dept. of Science Education, Ebonyi State University, Nigeria

2. \*Researcher, Dept. of Science Education, University of Nigeria, Nsukka, Nigeria

\*Senior Lecturer, Dept. of Information and Communication Tech..WA Polytechnic, Ghana

3. Dept. of Science and Technology, University of Lagos, Nigeria

\* **Corresponding Author:** Edeh Michael Onyema. E-mail: [mikedreamcometrue@yahoo.com](mailto:mikedreamcometrue@yahoo.com)

**Abstract:** Security remains a major challenge to most emerging technologies (ETs). Although, emerging technologies offer potential benefits which ease systems and human activities, but they also have some security issues that often affect their adoption and usage. Cloud technology has brought a lot of transformations to data storage for both individuals and organizations. Cloud offers flexibility for data storage, access and recovery, but it is not immune to the security challenges associated with other ETs. There have been concerns about data integrity and privacy of cloud customers. Outsourcing data in the cloud exposes the data to several kinds of attacks ranging from data leakage, data tampering, repudiation, Denial of Service (DOS) attack, spoofing identity, and unauthorized access to data. These attacks are often orchestrated by insiders and outsiders, and can compromise the confidentiality and integrity of cloud data. Most educational institutions are digitalizing their data which are ultimately moved to the cloud to be managed by a third party. Considering the sacred nature of educational data, the study examines the implications of cloud security challenges on education. The findings show that security is very significant to the successful migration and implementation of cloud technology in the educational sector. It also shows that the growing security limitations associated with cloud computing technology has the tendency to discourage many educational institutions from adopting cloud services. Therefore, there is need for all stakeholders particularly the cloud vendors to continuously upgrade cloud security system in order to effectively counter both existing and emerging cloud threats. This would go a long way to preserve the integrity and privacy of customers; increase clients' trust and patronage, and enhance safer cloud experience.

**Keywords:** Cloud computing, Security, Education, Data leakage, Privacy.

## 1. INTRODUCTION

There is a growing demand for use of emerging technologies (ETs) in education across the globe. The evolution of emerging technologies is changing all facets of educational process ranging from; the nature of classrooms, quality of content, methodologies, mode of students' engagement, and evaluation (Edeh, 2019a). Emerging technologies such as cloud computing, Mobile computing, Distributed computing, Artificial Intelligence, IoT, Big data, Blockchain and wearable technologies have brought tremendous changes to education globally. These technologies come with interesting features that make them attractive and effective instruments for teaching and learning. Cloud Computing (CC) technology has caused a paradigm shift from traditional IT outsourcing to a more scalable, flexible and accessible means in the cloud.

Most modern organizations and institutions, including educational institutions are now embracing the cloud to outsource their data. The cloud facilitates data recovery and cost reduction thereby lessening the burden of data management. Education remains one of the sectors that cloud computing has influenced to a large extent. Many educational institutions have deployed cloud services to simplify their processes, communication and storage. Millions of people across the globe currently use cloud technology for educational activities. Cloud computing can bring an increased number of benefits to an educational setting (Behrend, Wiebe, London and Johnson, 2011). Enterprises are starting to look into cloud computing technology as a way to cut down on cost and increase profitability (Brandl, 2010). Cloud minimizes institutional expenditures on software and hardware infrastructures. It lowers budget on data management and enhance innovation in education. Some of the cloud vendors include; Yahoo, Amazon, Google, Microsoft, and many others who provide different categories of services ranging from Software-as-a-Service (SaaS); Platform-as-a-Service (PaaS), Infrastructure-as-a-Service (IaaS), and Storage-as-a-Service. These service models have different security challenges associated with them, as well as benefits. They equally play important roles to enhance research, content, and methods in education.

According to Navneet and Rekha (2014), cloud computing can be seen as Internet-based computing, in which software, shared resources, and information are made available to devices on demand, but using a cloud computing paradigm can have positive, as well as negative effects on the security of consumers' data. Chuleeporn *et al.* (2014), states that cloud model have become tremendously popular due to its benefits but security is still a top concern. Cloud in education

reduces IT infrastructure cost and enable teachers to upload their class materials and assignments on the cloud server for students to access (Aminur et al., 2017). For Kiryakova (2017), more and more educational institutions are turning to the use of cloud services, because they are extremely effective alternative for providing the high quality resources and services to all participants in the learning process at an affordable price. Crucial Cloud Hosting (2014) states that Microsoft Office 365 Education, a cloud-based communication and collaboration tool is currently being used by 110 million students, faculty and staff.

Data security is a common concern for any technology, but it becomes a major challenge when cloud users have to rely on their providers for proper security (Rittinghouse and Ransome, 2009). Outsourcing data in the cloud introduces new security vulnerabilities due to the corporation's limited knowledge and control of external providers operating in foreign countries (Kevin, Hamlen and Bhavani, 2013) Security is one of the main obligations of cloud providers. The cloud service provider is the one responsible for the security of the data while is being processed and stored (Ju , Wang, Fu , Wu and Lin, 2010). Subashini and Kavitha (2011) states that data backup is a critical aspect in order to facilitate recovery in case of disaster, but it introduces security concerns as well. At the moment, no organization or institution who patronizes cloud services is impregnable to cloud security threats. Just recently, Facebook suspended thousands of applications due to privacy issues and abuse of customers' data. Even Google who is a major cloud service provider has been a victim of several attacks. The study examines the implications of cloud security challenges on education with a view to highlight the educational potentials of cloud technology, and to draw the attentions of stakeholders on the need for more proactive steps to be taken to curb cloud security issues in order to optimize the potential benefits of cloud technology in education.

## **2. REVIEW OF RELATED WORK**

Cloud computing technology offers different platforms that are helpful in achievement of set educational objectives. It is ubiquitous, which makes it even more useful for implementation of technology in any educational setting. Several researchers have carried out studies on cloud application to education, and many seem to agree that cloud is an effective educational tool but security remains an issue to be tackled to optimize its benefits. Jonathan (2018) states that Software-as-a-Service (SaaS) apps are being used primarily for collaboration, content delivery, communication, and accessing learning materials, and higher education is increasingly adopting SaaS because of the economic advantages, speed, agility, flexibility and elasticity. Mitchell (2008)

provided an overview of existing learning architectures, and raised questions about how educational institutions are managing cloud computing resources. He also brought reasonable explanations for the challenge of indexing web resources for optimum discoverability by students and educators. Praveena and Betsy (2009), provides a comprehensive introduction to the application of cloud in universities. Tuncay (2010) examines the effective use of cloud computing in educational Institutions. He focused on the educational usage of the cloud services and how it will support these virtual services in a secure manner.

Thomas (2011), explored the salient features of digital scholarship (DS), and the nature and educational potential of ‘cloud computing. He stated that cloud computing has a significant place in the higher education landscape both as a ubiquitous computing tool and a powerful platform that can enhance engagement among educators to understand and improve practice, and thus, increase productivity. A study by Aminur *et al.* (2017) examines the potentials and challenges of cloud computing in education in Bangladesh. They reported that in 2011, cloud infrastructure was successfully applied to host National University Bangladesh admission test result (2011-12) for more than 400,000 students.

Khalil *et al.* (2017), carried out a survey on cloud computing security challenges in higher educational institutions. He found that data security risks constitute the biggest challenge for adopting cloud computing in higher education, and cloud users remain concerned about security issues that represent the major obstacle that may prohibit the adoption of cloud computing on a large scale. Similarly, Arsalan and Hina (2014), conducted a study on “data integrity issues in cloud servers”. They found that the integrity of user data in the cloud servers is one of the most important concerns of users nowadays. Kiryakova (2017), explored the application of cloud services in education. The study discovered that cloud computing offers an infrastructure, platform and educational services that create an affordable and innovative learning environment; such an environment that allows collaboration between all participants in the learning process and between different educational institutions that reflects on the quality of education.

Rania (nd), carried out a survey on the Adoption of Cloud Computing in Education Sector. He concluded that “cloud computing is taking a center stage in academia because of its various benefits, and that various learning institutions use different cloud-based applications to help their students and staff to perform both academic and business-related tasks, and to increase their productivity”. Also, Kiran (2014) examined the role of cloud computing in education. His findings

shows that cloud helps to ensure that students, teachers, faculty, parents, and staff have on-demand access to critical information using any device from anywhere. From the forgoing, there is a growing literature on cloud computing but there seem to be a dearth in literature on the implications of cloud security issues on education. The present study seeks to bridge that gap.

### 3. ADVANTAGES OF CLOUD COMPUTING

Cloud computing is attractive to all kinds of people and organizations including entrepreneurs, telecommunication companies, educational institutions, businesses, public institutions and even start-ups. It offers users great opportunities and cost reductions that save large amounts that could have been spent on data management infrastructures and services. The use of cloud tools like Google Drives, One Drive Microsoft Skydrive, Cloud Office Suites such as Apple productivity apps, Thinkfree Online, and Amazon Workdocs have transformed data access and storage for good. Cloud computing provides individuals and organizations with the options of outsourcing their data to cloud service providers with the necessary facilities to link their data, and make it easily accessible via the internet at any time and location.

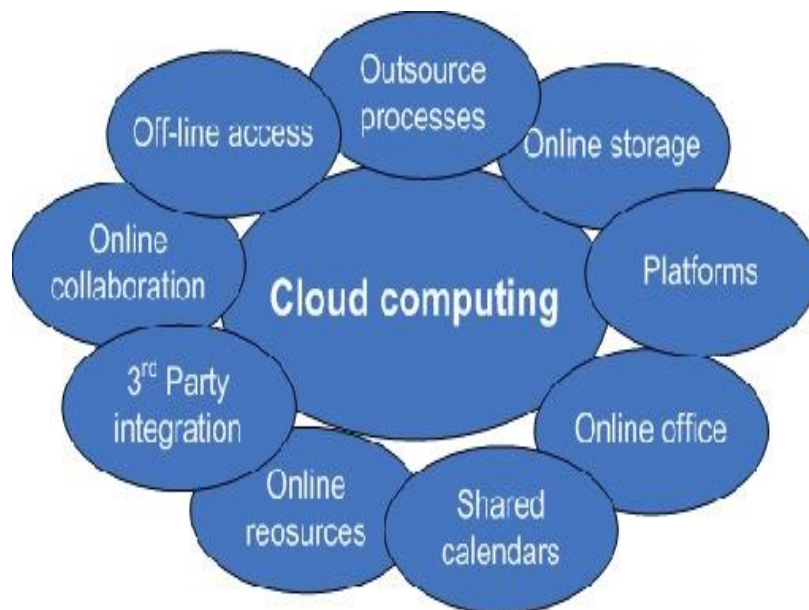


Fig.1: Cloud Computing Resources (CloudTweeks, 2010; cited in Anthony and Syed, 2011).

Cloud-enabled activities shown in Fig.1 are few examples of the enormous capabilities of cloud technology both in the educational sector and many other sectors of human endeavours.

According to Weaver (2014) cited in Aminur et a., (2017), the advantages of cloud in education are as follows:

- i. **Back Up:** An essential function of the Cloud is that it automatically stores content, making it impossible to vanquish or drop any valuable material. This means that even if a user's computer crashes, all content and documents will remain saved, safe and accessible in the cloud.
- ii. **Storage:** The Cloud system grants its users to save any kind of content and data including applications, music, eBooks, documents, photos, and much more.
- iii. **Accessibility:** Any data can be accessed easily from any device such as mobile, smartphones, computer that is stored in the Cloud.
- iv. **Collaboration:** At the same time the Cloud permits multiple users to edit and work on a document, it enables easy sharing and transmission of ideas. With this feature, group projects and or collaborative lesson schemes can be optimized for both students and teachers.
- v. **Resource and Time Conscious:** It is no longer essential for teachers to spend time for resource copying or printing lengthy documents or lesson schemes, with the availability of content online. Now, students are also capable to access assignments, homework, notes, and other components online.
- vi. **Assignments:** I love that the Cloud allows teachers to post assignments online. Students are able to access these assignments, complete them, and save them in a folder to be reviewed later. This means no wasting time turning in papers at the beginning of class (Aminur et al, 2017).

Also, one of the unique features of cloud computing is file sharing. The ability to share files creates prerequisites for building repositories of educational materials, which can be available to all learners. Sharing resources between teachers contributes to spread and reuse of the learning content (Kiryakova, 2017). Cloud computing is very essential in today's educational setting. It will enhance the use and integration of technology in the teaching and learning process, and ensure connectivity and collaboration in education. Cloud facilitates interactivity and flexibility to education. It takes teaching and learning beyond the walls of schools or classrooms. Hence, cloud computing is unarguably one of the technologies that will influence the future of education.

#### 4. CLOUD COMPUTING AND EDUCATION

The educational landscape around the world is in a constant state of flux and evolution, mainly as a result of significant challenges arising from efforts in adopting new and emerging technologies and pedagogies in their teaching and learning environments (Thomas, 2011). Most components of education are becoming electronic ranging from admission, registration, teaching and record management. Almost all branches of education can use cloud services to improve productivity. Thomas (2011), states that the benefits of the cloud computing model are for teachers and students as well as for the educational institutions. For Aminur et al (2017), the users of an education cloud system include students, faculty, administrative staff, examination branch and admission branch as shown in Figure 2.

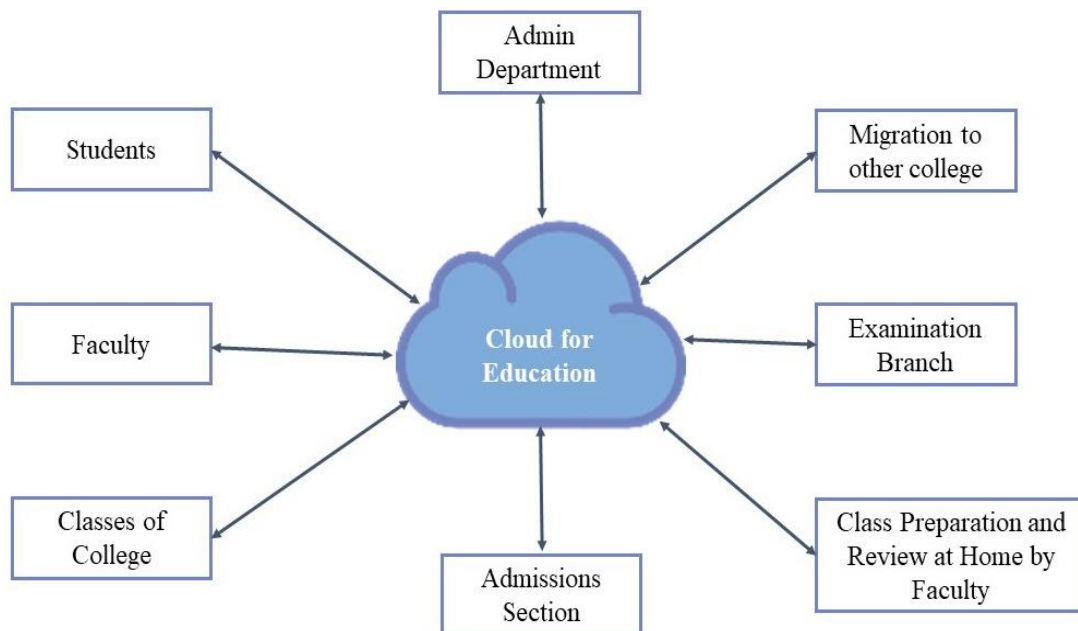


Fig. 2: Cloud System in educational Setting (Aminur *et al*, 2017)

Poonam and Sarika (2014) states that cloud technology offers instructors an easy and flexible platform to prepare their course tutorials, presentations, conferences, articles, and to work from home and use their own devices to finish assignments, prepare on-line tests, grading, and scheduling. Cloud computing has the potentials to become a major factor in the future of education globally. Educational institutions would have to embrace the cloud to meet the demand for use of emerging technologies in education. Chuleeporn *et al.*, (2014), states that education is a driving force for the continuous improvement of cloud computing. Cloud computing offers different level of services to clients using different model ranging from ranging Software-as-a-Service (SaaS),

Platform-as-a Service (PaaS), and Infrastructure-as-a-Service (IaaS), all of which are useful in the educational sector. Today's "cloud" platforms such as "Microsoft" and "Google" are providing free services to students and staff at educational institutions which include email, contact lists, calendars, document storage, creation and sharing documents and the ability to create websites (Sclater, 2009). The proper deployment of cloud technology facilitates integration of technology in education. Tuncay (2010), states that Cloud computing infrastructures accelerated the adoption of different technological innovations in academia, and its facilities and resources could be accessed by the colleges as on-demand. Cloud platforms can support teachers to prepare teaching portfolio; presentation on teaching to a local audience; a conference presentation; a manuscript to be submitted for publication (Thomas, 2011).

Educational resources can easily be accessed from the cloud by students and staff using the various cloud applications such as Microsoft office 365. The concept of Massive Open Online Courses (MOOCs) is being aided by cloud computing technology. Teachers can easily improve their content areas through the accessibility of educational materials stored in the cloud. Mass adoption of mobile devices over the last couple of years is a trend that is often put shoulder-to-shoulder with cloud computing (Khalil *et al.*, 2017). Cloud technology promotes mobile learning, tablet learning, virtual learning and remote education. Mobile technologies such as smartphones and tablets have wide spread among students (Edeh, 2019b) and can easily be used by them to access useful materials from the cloud. The increase access to educational resources could boost students' academic performances. Also cloud computing enhance modernization in education, including facilitation of transition from traditional to modern pedagogy that accommodates diversity in teaching and learning.

Cloud provides a platform like the Platform-as-a-Service (PaaS) where students and educators can build, customize and practice different application in various programming language without cost hindrance. They can also store their files and data in the cloud for easy retrieval in times of need. Tuncay (2010), states that cloud computing is a significant alternative in today's educational perspective, and it provides opportunity to quickly and economically access various application platforms and resources through the web pages on-demand. Educational data, including students' results and records are better managed in the cloud compared to the traditional approach which are more prone to damage and loss. With the increasing penetration of internet among students and staff, educational institutions can easily leverage on the potentials of cloud computing to make data more available and accessible. When educational institutions embrace cloud technology, it saves



them some burden of data and infrastructure maintenance in addition to mitigation of loss during disasters.

The educational benefits of cloud computing can be summarized follows:

i. **Individualized Learning:** With the aid of cloud computing, students can learn at their convenience. They can easily access large volume of learning resources to support their learning.

ii. **Affordability:** Cloud technology reduces cost of IT infrastructure for educational institutions. They no longer have to bother about cost of installing and maintaining huge IT infrastructures to manage their data. Cloud offers them the opportunity to outsource their data based on pay-as-you go service.

3. **Increased Accessibility:** Both students and staff can have access to information or learning materials from any location. Cloud environment is ubiquitous. It eliminates the stress of moving around looking for means to access data. With their mobile devices, they can use the internet to gain access to cloud resources.

4. **Reduced Distractions:** Cloud computing reduces the burdens of educational institutions about provision of facilities and infrastructures for record management. The energies that could have been spent on planning or budgeting for data infrastructures can be channeled to other areas for better service delivery.

5. **Promotion of technology application to education:** Cloud services provide platforms that enhance integration of technologies in the teaching and learning process. It aids electronic learning, including; distance learning, mobile learning, virtual learning and tablet learning. Several applications like the Microsoft Office 365 (Live@edu) are vital tools for mobile learning.

6. **Creativity:** Students can develop software and applications and run them in PaaS using python programming without much hindrance. This inspires their creative thinking, and enhances productivity in education.

7. **Collaborations:** Cloud computing opens opportunities for partnerships among educators from different regions. They can easily connect people with shared interests, and also share resources and arrange meetings or discussions.

8. **Time Saving:** It reduces time for sourcing for educational information, records or materials.

9. **Flexibility:** Cloud facilitates flexible storage of data for easy access and connection.

10. **Robust Backup for Data:** Cloud enhances data recovery particularly in times of disaster. Educational institutions can easily recover their outsourced data from the cloud during emergencies or major disasters compare to the traditional file cabinet system. In order words, it lowers the risk of data loss.

The Microsoft's 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, while Google Apps for Education is a widely used platform for outsourcing free web-based email, calendar and documents for collaborative study (Khalil et al., 2017).

Despite the many benefits associated with cloud computing in education, there are serious concerns about security challenges ranging from; eavesdropping, hacking, cracking, malicious attacks and outages. Outsourcing data to the cloud could be very risky because if the platform is not secured, data can easily be lost, attacked, and compromised. Talbot (2009), reported that if an attacker is on the same cloud servers as his victim, a conventional denial-of service attack can be initiated by tamping up his resource usage at once. While it is obvious that cloud computing offers a lot of advantages to education, including communication, collaboration, file Sharing, storage and data recovery, these benefits cannot be optimized unless adequate security measures are put in place to counter cloud security challenges.

## 5. CLOUD SECURITY CHALLENGES

Security challenges have continued to be a headache for providers and users of emerging technologies globally. The recent data leakage that involved Cambridge Analytical in which more than 86 Million of Facebook customers' data were illegally used without their authorization is an evidence of some security weaknesses of most technologies and I.T platforms. Security issues in cloud computing is affecting the adoption and spread of the technology. This is because many users are fast becoming sceptical about cloud due to privacy issues. Even though there are copious benefits attached to cloud technology, there seem to be some serious concerns on the security of cloud data across boards. Many of the important features that make cloud computing very

attractive, have not just challenged the existing security system, but have also exposed new security risks (Navneet and Rekha, 2014).

Anthony and Syed (2011), states that in the not too distance future cloud computing adoption rate will skyrocket and cloud computing vulnerability to viruses, worms, hackers and cyber attacks will increase because organized criminals, terrorist and hostile nations would see this as a new frontier to try to steal private information, disrupt services and cause harm to the enterprise cloud computing network. Cloud computing is vulnerable to many security threats, many of which are also common with other emerging technologies. These threats and vulnerabilities come in various forms depending on the network and service model in use. Several researchers have identified different security issues in the cloud. For instance, Aminur *et al.* (2017), summarized cloud challenges in the table.

Security	The key concern is data privacy: users do not know where their data is being stored and they have no control.
Interoperability	A universal standard about cloud have not yet been defined, resulting in a significant risk of vendor lock-in.
Control	The quantity of control that the cloud user has over the cloud environment varies greatly.
performance	All access to the cloud is done via the internet, introducing latency into each communication between the environment and the user.
Reliability	Many existing cloud infrastructures leverage commodity hardware that is known to fail unexpectedly.
Performance of Language specific	Some cloud environments provide support for specific platforms and languages only.

Table 1: Cloud Security Challenges (Aminur *et al.*, 2017).

Meanwhile, Cloud Security Alliance (2010) cited in (Anthony and Syed, 2011) were of the views that cloud computing is limited by the following major security threats:

- Abuse and Nefarious Use of Cloud Computing
- Insecure Application Programming Interfaces
- Malicious Insiders

- Shared Technology Vulnerabilities
- Data Loss/Leakage
- Account, Service & Traffic Hijacking
- Unknown Risk Profile

Cloud security issues have varying degree of consequences on both customers and the vendors. For instance, Naughton, 2009; Leavitt, 2009; Rania,(nd) reported that, in February 2008, Salesforce.com was out of service for at least 6 hours, while Amazons EC2 (Elastic Compute Cloud) and Amazons S3 (simple storage service) experienced an outage for 3 hours in the same month, and later in July 2008, S3 experienced an outage for 8 hours. In 2009, Gmail, a webmail service by Google was out for 3 hours leaving more than 110 million users stranded. The security challenges in cloud computing are capable of discouraging many users particularly in the educational sector from adopting the technology. This is because no individual or organization would want to keep their data where the privacy and integrity is not guaranteed. Therefore, there is need for improvement in the security arrangements and network architecture of the cloud to enable potential users to leverage the opportunities that it provides.

## 6. CLOUD SECURITY ISSUES IN EDUCATION

Cloud computing presents security challenges that can deprive users of the benefits of the technology. Cloud users in the educational sector are not exempted from cloud threats. These threats often emanate from both the cloud infrastructure and the various network medium used by the client to access the cloud service. Cloud customers depend majorly on the internet to connect to the cloud infrastructure, and some of these networks can be corrupted and exposed to several attacks like data leakage, Denial of Service, eavesdropping, spoofing, malware injection, and phishing. Data leakage is a noticeable security issue in cloud computing, and it happens when the data gets into the wrong hands while it is being transferred, stored or processed (Grobauer, Walloschek and Stocker, 2011). Therefore, if the network or server is not protected, it can increase the susceptibility of cloud service to attacks. According to Jonathan(2018), the top security challenges facing educational institutions running multiple clouds include:

**Poor visibility:** Each cloud vendor approaches security in a different way, making consistent policy and meaningful visibility very difficult.

**No integration or coordination:** Security measures are often piecemeal and isolated.

**Reactive security:** In this era of zero-day threats and shrinking intrusion-to-breach windows, schools can't afford to be reactive in their security approach (Jonathan, 2018).

Educational institutions must weigh the security implications of using cloud services before migration to it. This would enable them to prepare for eventualities.

## 7. SOLVING CLOUD SECURITY CHALLENGES

The adoption of cloud services requires risk analysis by individuals and organizations. This is because as researchers' struggles to fix existing cloud security threats, more and more threats have continued to emerge making it more difficult to tackle cloud security challenges. This means that cloud vendors have to invest more on security of data to retain customers' trust and patronage. Edwards (2009) cited in Anthony and Syed (2011), recommended that institutions that want to outsource their data to the cloud should use the following steps to verify and understand cloud security provided by a cloud provider:

- **Understand the cloud** by realizing how the cloud's uniquely loose structure affects the security of data sent into it. This can be done by having an in-depth understanding of how cloud computing transmit and handles data.
- **Demand Transparency** by making sure that the cloud provider can supply detailed information on its security architecture and is willing to accept regular security audit. The regular security audit should be from an independent body or federal agency.
- **Reinforce Internal Security** by making sure that the cloud provider's internal security technologies and practices including firewalls and user access controls are very strong and can mesh very well with the cloud security measures.
- **Consider the Legal Implications** by knowing how the laws and regulations will affect what you send into the cloud.
- **Pay attention** by constantly monitoring any development or changes in the cloud technologies and practices that may impact your data's security (Edwards, 2009).

Khalil, et al., (2017), posited that to avoid data leakage in the educational institutions, the I.T center in the university may host the SaaS application on its own private server or deploy it on infrastructure services provided by trusted third-party provider such as Amazon, Google, etc.

The present study recommends the following measures to help curb cloud security challenges:

- i. Access Control
- ii. Use of Digital signature and Hashes
- iii. Use of Intrusion detection mechanisms
- iv. Strong encryption
- v. Strong legal framework to sanction hackers
- vi. Authentication and Authorization
- vii. Increase users' awareness on cloud security issues
- viii. Data backup in case of disaster
- ix. Proper vetting of staff and users to avoid insider attacks.
- x. Physical policing of networks and servers.

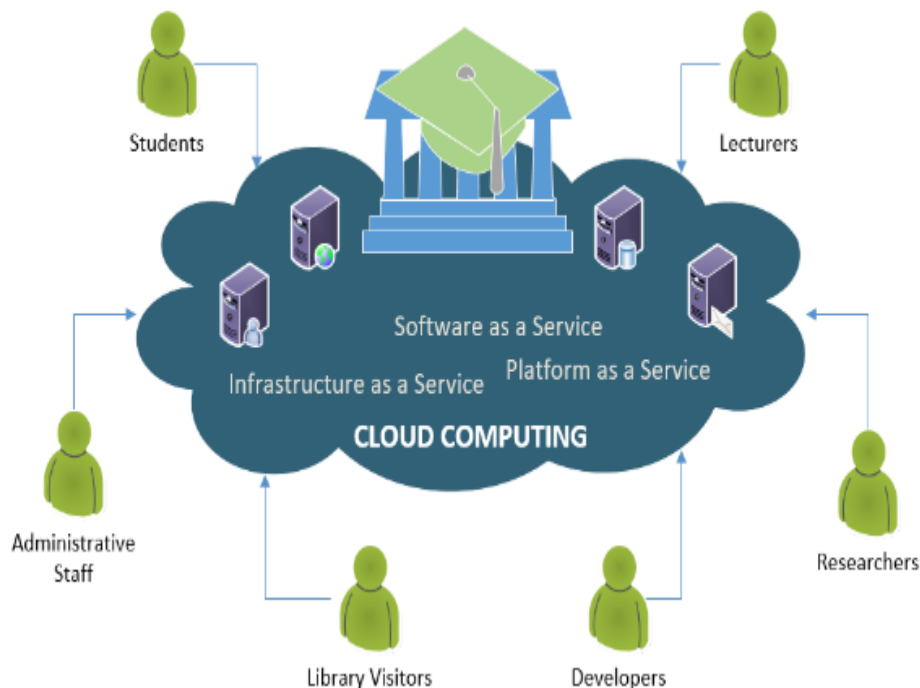


Fig. 3: Stakeholders of Cloud in an Educational Institution (Khalil, et al., 2017).

The above mentioned stakeholders in Fig.3, have to work assiduously and collectively to ensure a safer cloud for current and future generations. Educational institutions also have the responsibility to support research on possible solutions to cloud challenges. There has to be a stronger synergy between universities, research institutes, and cloud providers to facilitate collaborations particularly in areas of security.

## **8. CONCLUSION**

The study establish that cloud computing has become a force in education but some security challenges associated with it remains a major source of concern to users. Cloud security issues obstruct the successful implementation of cloud technology in education, and they compromise the privacy and confidentiality of cloud users. From the study, it can be inferred that cloud offers many educational benefits to students, educators and educational institutions including; opportunities for exploration and experience of online education, cost efficiency and reduction, communication, and collaborations. Many educational institutions have migrated to the cloud to facilitate their activities. However, the increasing security issues in the cloud are capable of discouraging educational institutions from adopting the technology. Consequently, there is need to strengthen cloud security system in order to eliminate cloud threats. This will enable customers to maximize the potential benefits of cloud technology. It will also go a long way to equip learners with the relevant I.T skills necessary to increase their employability, productivity and competitiveness in a digital world of works. Cloud technology will play important role in the future of education but stakeholders must find a way to tackle the associated security risks in order to optimize its benefits.

## **9. RECOMMENDATIONS**

The study recommends the following:

1. Migration to the cloud should be considered by all educational institutions in line with trends in education.
2. Provision of good internet connections to facilitate cloud adoption and usage in educational sector.
3. Cloud vendors should invest more on security to curtail emerging cloud security challenges.
4. Educational institutions should carry out risk analysis before migration to the cloud.

5. Periodic training of students and educators on emerging cloud security threats and barriers.
6. Physical measures should be put in place to protect local network infrastructures used educational institutions to access the cloud.
7. Cyber security should be included in school curriculums.
8. More research on cloud security should be encouraged in educational institutions.

## References

- [1]. Aminur M.D. I; Faisal, B.A.K.; Shakib-Uz-Zaman. K; Md. Tarek H.; Farruk, A. (2017). Cloud Computing In Education: Potentials and Challenges for Bangladesh. *International Journal of Computer Science, Engineering and Applications (IJCSEA)*, 7 (5), 11-17.
- [2]. Anthony, B. and Syed, M. R. (2011). An overview of the security concerns in Enterprise Cloud Computing. *Int. J. of Network Security & Its Applications (IJNSA)*, 3 (1), 30-45.
- [3]. Arsalan, I. and Hina, S. (2014). Data Integrity Issues in Cloud Servers. *Int. Journal of Computer Science Issues*, 1 (3), 118-121.
- [4]. Behrend, T., Wiebe, E.N., London, J., & Johnson, E. (2011). Cloud computing adoption and usage in community colleges. *Behavior & Information Technology*, 30 (2), 231-240.
- [5]. Brandl, D. (2010, January). Don't cloud your compliance data. *Control Engineering*, 57(1), 23.
- [6]. Chuleeporn, C. et al (2014). Students' Perceptions of Cloud Computing. *Issues in Info. systems*.15, 312-322.
- [7]. Crucial Cloud Hosting (2014). Cloud Computing in Education: Introducing Classroom Innovation. Retrieved online via: <http://www.crucial.com.au> Accessed August, 2019.
- [8]. CloudTweeks (2010, January). Plugging into the cloud. Retrieved from
- [9]. <http://www.cloudtweeks.com/cloud-diagrams>. Accessed August, 2019.
- [10]. Cloud Security Alliance (2010). Top Threats to Cloud Computing. Cloud Security Alliance. Retrieved from <http://www.cloudsecurityalliance.org/topthreats/csathreats.v1.0.pdf>
- [11]. Edeh, M.O. (2019a). Integration of Emerging Technologies in Teaching and Learning Process in Nigeria: The Challenges. *Central Asian Journal of Mathematical Theory and Computer Sciences*, 1 (1), 35-39.
- [12]. Edeh, M.O. (2019b). Opportunities and Challenges of use of Mobile Phone Technology in Teaching and Learning in Nigeria-A Review. *International Journal of Research in Engineering and Innovation*, 3(6), 352-358.<http://doi.org/10.36037/IJREI.2019.3601>.
- [13]. Edwards, J. (2009). Cutting through the fog of cloud security. *Computerworld*. Framingham, 43 (8), 3-26.
- [14]. Grobauer, B; Walloschek, T; and Stocker, E. (2011) Understanding Cloud Computing vulnerabilities. *IEEE Security Privacy*, 9 (2), 50-57.
- [15]. Ju J, Wang Y, Fu J, Wu J and Lin, Z. (2010). Research on Key Technology in SaaS. In: International Conference on Intelligent Computing and Cognitive Informatics.
- [16]. Jonathan, N. (2018). Overcoming multi-cloud Security Challenges in Education. Published by FORTINET. Retrieved from online via [www.fortinet.com/blog/industry-trends/overcoming-multi-cloud-security](http://www.fortinet.com/blog/industry-trends/overcoming-multi-cloud-security). Accessed August, 2019.
- [17]. Kiryakova, G. (2017). Application of Cloud services in education. *Trakia Journal of Sciences*, 4, 277-284.
- [18]. Kevin, W. Hamlen and Bhavani, T. (2013). Data security services, solutions and standards for outsourcing. *Computer Standards & Interfaces*, 35, 1-5.
- [19]. Khalil, H.A., Faiz, M. A. A., Mohammad, R.H; Hassen, F. (2017). Cloud Computing Security Challenges in Higher Educational Institutions - A Survey. *Int. J. of Computer Applications*, 161 (6), 22-29.
- [20]. Kiran, Y. (2014). Role of Cloud Computing in Education. *International Journal of Innovative Research in Computer and Communication Engineering*, 2 (2), 3108-3112.
- [21]. Leavitt, N. (2009). Is cloud computing really ready for prime time?," *Computer*, 42 (1), 1520.
- [22]. Mitchell, P. (2008). Learning architecture: issues in indexing Australian education in a Web 2.0 world. *Indexer*, 26 (4), 163-169.
- [23]. Navneet, S.P and Rekha, B.S. (2014). Software as a Service (SaaS): Security issues and Solutions. *International Journal of Computational Engineering Research*, 4 (6), 68-71.

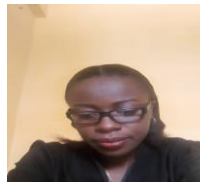


- [24].Naughton, J. (2009). There is silver lining to Googles cloud computing glitch,” The Observer, <https://www.theguardian.com/technology/- outage-cloud-computing>. Accessed August, 2019.
- [25].Praveena, K., & Betsy T. (2009). Application of Cloud Computing in Academia. *IUP Journal of Systems Management*, 7 (3), 50-54.
- [26].Poonam, R.M and Sarika, R.S.(2014). Review Paper on E-learning Using Cloud Computing. *International Journal of Computer Science and Mobile Computing*. 3 (5), 1281-1287.
- [27].Rittinghouse, J.W and Ransome J.F. (2009). Security in the Cloud. In: Cloud Computing. Implementation, Management, and Security, CRC Press.
- [28].Rania, M.A (nd). A survey on the Adoption of Cloud Computing in Education Sector. College of Computing and Informatics, Saudi Electronic University, Jeddah, Saudi Arabia.
- [29].Subashini, S and Kavitha, V. (2011). A survey on Security issues in service delivery models of Cloud Computing. *J Netw Comput Appl*, 34(1),1–11.
- [30].Sclater, N. (2009). Cloudworks, eLearning in the Cloud, <http://cloudworks.ac.uk/cloud/view/2430/>
- [31].Tuncay, E. (2010). Effective Use of Cloud Computing in Educational Institutions. *Procedia-Social and Behavioural Sciences*, 2 (2), 938-942.
- [32].Thomas P. Y. (2011). Cloud Computing: A potential paradigm for practising the scholarship of teaching and learning. *Edu. Techn.Unit Centre for Academic Dev. University of Botswana*.
- [33].Talbot, D. (2009). Vulnerability seen in Amazon's cloud-computing. Technology Review. . Retrieved from <http://www.cs.sunysb.edu/~sion/research/sion>.
- [34].Weaver, D. (2014). Advantages of Cloud computing in Education. Published Online at [www.pearsonschoolsystems.com/blog](http://www.pearsonschoolsystems.com/blog). Accessed August, 2019.

## **AUTHOR BIOGRAPHIES**



**EDEH MICHAEL ONYEMA** is currently a doctorate student at Ebonyi State University, Nigeria. He earned a masters degree in Computer Science Education at Tai Solarin University of Education (2017). He has taught Computer Science courses to students at different higher institutions in Nigeria, including: Southwestern University Nigeria; Coal City University, Nigeria; Enugu State College of Education Technical (ESCET) Nigeria; and Pogil College of Health Technology, Nigeria. He has facilitated multiple professional development programmes for students and youths including members of the National Youth Service Corps (NYSC) Nigeria. His research interest includes Learning technologies, Machine learning, Inquiry-based teaching, and IT Security.



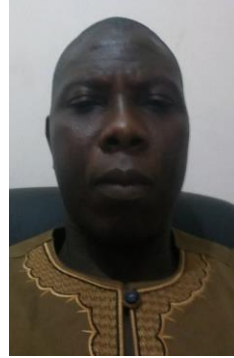
**UGWUGBO ANN NNEKA** is a doctorate student at University of Nigeria, Nsukka (UNN). She obtained a Masters degree in Science Education from UNN (2017). She is an educationist and a researcher. Her research interest includes Science pedagogy with special interests in Biology Education.



**OGBONNAYA UCHENNA NWOYE** is an educator, and a renowned author. He is currently pursuing his masters’ degree in Biology Education at the University of Lagos, Nigeria. He has authored 3 books, and has also volunteered in different organizations for humanitarian activities. He is a teacher par excellence. His research interest includes: inquiry-based teaching, learning technologies in Science Education, and Gender education.



Nwafor Chika Eucheria is an Associate Professor at the Department of Science Education, Ebonyi State University, Nigeria. She is a seasoned educationist with several years of experiences in the Lecturing profession. She has published widely in high impact factor/indexed journals both at the local and international level. She has also mentored and supervised many students at different levels of education including Ph.D students.



Rockson Kwasi Afriyie is a Senior Lecturer at the Department of Information and Communication Technology, WA Polytechnic, Ghana. He received his M.Phil. in Information Technology from Kwame Nkrumah University of Science and Technology, Ghana in 2014. He is currently a Ph.D student. His research interests include Data compression, Software Engineering, Algorithms: design and Analysis, Mobile computing, Information Security and IT in Education.