

Contemporary Development in E-Learning Education, Cloud Computing Technology & Internet of Things

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Abstract

The enterprise educational environment will involve big data technology, cloud computing, Internet of Things (IoT) and artificial intelligence (AI), which will characterize the current society extreme automation and enterprise productivity through reinventing the new world educational reform. This current paper captured the manageability issues in electronic learning environments and explored ways through which the managerial performances could be improved in the perspective of electronic learning investments through incorporation of context-awareness and self-reconfiguration adaptive systems. The aim is to allow the open source electronic learning system to provide educators, administrators, and learners with a single robust and integrated system for creating a personalized and autonomous learning accomplishments. The paper reviewed the contemporary development in electronic learning system in internet of things and cloud computing and established the prospect for the continued educational investment. A survey of four tertiary institution in the south eastern Nigeria provided a justification for the adoption of cloud computing technology as the best alternative approach for organizational data warehousing in the ongoing society automation. The result of the paper indicated that technology implementation in schools are fundamental to students' academic accomplishment, which made it obviously imperative that teachers in the 21st century should adjust digitally and technologically and prepare students for the opportunities in the emerging digital new world. The paper concluded that the successful curriculum implementation in the twenty first century will require a blend of technology innovation and enterprise platform adaptability as potential leverages in achieving the global educational sustainability.

Keywords: e-learning education, cloud computing, Internet of Things (IoT), internet security, multimedia, data mining, pervasive learning, ubiquitous learning, mobile learning and data warehouse.

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1. Introduction

The computer technologies have been deployed in education to improve the quality and learning outcomes in the twenty first century electronic learning environment in internet of things (IoT) computing. The educators (professors, lecturers, instructors and teachers) can use audio, video, graphics aids and text resources through computer to prepare lesson and deliver interactive lectures

in a digital platform without physical classroom engagement. Under the interactive educational pedagogy, multimedia presentations can be delivered by the teachers and university lecturers in an interactive participatory and in ubiquitous synchronous digital environment [16]. With synchronous presentations, a lot of efforts and time are saved while ensuring increased productivity in the overall digital classroom management. Moreover, multimedia presentations are interesting to view, hear and analyzed especially the audio, video components, 3-D simulation environment in addition to the visual effects that make

lectures very emphatic. The use of computers in the electronic learning education will be helpful in the twenty first century educational business as boredom are removed in the active teaching and learning process. The utilization of computer technology within schools will impact additionally in technological advancements and in methodology of digital teaching and learning [25]. In the recent time, computer technology had witnessed several advancements in all facets of human managerial responsibilities, as it incorporates all aspect of media for an interactive engagement while holistically addressing every aspect of modern ubiquitous teaching and learning in a meaningful pedagogical accomplishments.

Today, computer development is leading in research and innovation as it is rapidly creating headways in education through innovative modernism with focus on increase in availability of modern computing device such as mobile phones, personal computers (PCs), personal digital assistance (PDAs), all with the capabilities to impact positively towards knowledge transfer [59]. The development in science and technology had brought into lime light the key aspects of the digital society in the perspective of information management in other words referred to as information communication technologies (ICTs). The computer technologies have touched the lives of every students in Nigeria, Africa and entire global world including those living in the remotest part of our planet. There is no point denying the way that computers, mobile technologies and internet had absolutely controlled the life of a typical student in the twenty first century academic space either graduate or undergraduate [43]. In the current paper, the researchers analyzed the applications of computers technologies for teaching and learning in the worldwide educational perspective with emphasis to the twenty first century e-learning education design in IoT computing. Several educational institutions across the world have adopted e-learning education smart platform for learning accessibility irrespective of geographical boundaries and e-learner location. The outbreak of COVID-19 global pandemic which led to closure of all the academic institutions had undoubtedly revealed the technological significances of e-learning education development paradigm, providing numerous benefits such as strengthening learning and knowledge transmission, enabling better access to curriculum of education and training, cost reduction and ubiquitous utilization of mobile computing platform for pervasive digital learning and intellectual exchanges [61]. The twenty first century e-learning education platforms such as Zoom technology are very smart and enterprise able , interactive and flexible, offering a well-structured learning environment that is flexible and accessible to digital learners in an adapted customizable environment for ubiquitous and synchronous information transmission [89]. The modern innovative educational technologies projected in the twenty first century e-learning education, blended learning , distance learning, mobile learning(m-learning), virtual learning and e-library, provided opportunities for members of the academic communities

such as professors, lecturers, instructors , teachers, researchers and students to acquire, develop and maintain core skills in essential digital knowledge without obstructions [85].

The e-learning education systems depends largely on the internet framework as the information gateway but regrettably, the internet and its infrastructures have transformed into a new breed of dishonest undertakings such as cybercrime, cyber-terrorism, eavesdropping and espionage as information associated with e-learning environment travels through the internet protocol cyberspace and constantly exposed to security threats as e-learning systems are distributed, open and highly interconnected [6]. The information communication technologies diffusion and prevalence of cyber-crimes in the twenty first century digital e-learning environment is an issue of optimum importance in guiding post COVID-19 e-learning educational investment. Adopting data from multiples sources, the researcher tried to establish the ICTs penetration pattern, cybercrime trend and prevention mechanics towards curtailing cybercrime invasions in the Nigeria educational investment terrain through technology surveillance. The findings of the research demonstrated that ICTs diffusion, internet usage and cybercrime in Nigeria are significantly on the increase [74]. This research aimed at exploring wider perspective of information communication security in e-learning education, mobile cloud computing technologies, information technology infrastructures and the possibility of providing more robust security in the e-learning platform through the application of policy-based computing framework. The research work is structured into introduction, background of the study, review of the related literature, research methodology , research design, research implementation, analysis/discussion of findings, Internet of Things and cloud technology implementation, challenges in e-learning environment, future research focus, recommendation and conclusion.

2. Background of the Study

In multimedia e-learning education development , personal computers (desktop, laptops and handheld devices), platform as a service (PaaS), infrastructure as service (IaaS) and software as a service (SaaS) are combined in delivering essential services such as e-tutoring, self-assessment and communication applications such as zoom platform, chat apps, forum and video call apps are utilized in providing support for distance learning education. The mobile e-learning environments concentrates on the extent and perspective of technology mobility, pervasive learning environments on social interdependence from the sphere of activities and set of relationships between organization and individuals in their environmental ecosystem [99]. On this note, the ubiquitous learning (U-learning) amalgamates mobile-learning (M-Learning) and pervasive learning (P-learning) into a high level of mobility and a high level of social

interconnectedness. The U-learning environments are sustained by mobile and ubiquitous computing technologies together with mobile devices, implanted computer devices usually global positioning system (GPS), radio frequency identification (RFID) tags made up of a tiny radio transponder, a radio receiver-transmitter and sensors, pads and badges together with wireless sensor networks [39]. The context-awareness ubiquitous learning utilizes mobile devices, wireless communications and sensor technologies in learning activities and can be judged as a special case of learning with ubiquitous computing technologies [58]. The ubiquitous computing technologies are usually utilized in order to effortlessly collect environmental data and provide personalized information associated with the e-learner's context-awareness. The context-awareness of the e-learner's educational activity, takes into account the perspective consciousness, environment situation, system infrastructure, ubiquitous learning environment offering the perspective of student's participation even with the exclusiveness of learners consciousness of the learning activities.

Currently, activities regarding the development of U-learning environments for various applications are receiving attention to enable connection of RFID tags within the surrounding e-learning environment [17]. The context awareness will be incorporated within the e-learning environment to transform into an adaptive U-learning digital environment. The improvement in U-learning digital environment had augmented traditional learning paradigm by offering the perspective of multimedia components (audio, video, simulation), chatting for synchronous and continued interactive pedagogy [50]. With respect to synchronous U-learning, students in the classroom are provided with the perspective to move around within the ubiquitous digital space and communicate with the mobile device and computing technologies with various embedded digital devices. To provide flexibility of understanding, the current paper is structured into introduction, background of study, literature review, research methodology, research design, research implementation, analysis/discussion of finding, Internet of Things and cloud technology implementation, challenges of e-learning education environment and internet of things infrastructures, future of the research, recommendation and conclusion.

3. Review of the Related Literature

The electronic learning (E-learning) is a system of educational technology in which the amalgamation of the core aspect of the information system, computer hardware, communication networks, software, lifeware and educational theory and practice are systematically joined to facilitate the process of intellectual exchanges [60]. This is true because, educational technology formulates and accomplished technological developments

and deploy informative resources to support the improvement for individual intellectual performances. The e-learning is a system of education in which learning activities are carried out outside of the traditional classroom setting with smartphones, mobile computing devices, personal computers, which possibly could be a good substitute for learners who are not able to study in the traditional classroom learning environment for obvious reasons [12]. The development in smart multimedia technologies had provided opportunities for e-learning education in the twenty first century digital environment referred to as online learning, virtual learning, distance learning and automated digital library environment. The automated digital library also known as e-library or virtual library is the collection of multimedia digital information with all the associated services as information are stored in the digital formats and made accessible over the large computer networks [55]. The digital library software availability have enhanced the opportunities for creation and sharing of information through digital library collection among the innovative professional librarians, students, researchers and several other communities of users. The digital libraries permit consumers to gain online access to the electronic versions of full-text documents, the associated images and other digital categorizations, refer to figure 1. The E-learning innovation also known as internet based training or web based training is any form of education reinforced through the adoption of ICT infrastructures or electronic media content management [13].

However, the internet components and conventional electronic media channels such as television, radio, telephone, satellite, video and compact disk read only memory and digital versatile disk read only memory are pictured along electronic learning education practice [21]. The multimedia e-learning education is essentially the networked collaborative transfer of digital skills and knowledge through electronic media in a technology negotiated processes [59]. The multimedia e-learning applications and processes include web based learning, computer based test, virtual classrooms and high definition computer based simulation and digital collaboration. The merger of multimedia e-learning education and digital libraries innovation indicated a fusion and convergence of an inseparable link between e-learning and digital libraries [45]. From a broad perspective, both multimedia e-learning education and digital libraries innovation are applying similar communication technologies to enhance learning, teaching, research and digital collaboration across several computing platforms with particular emphasis to Figure 1.

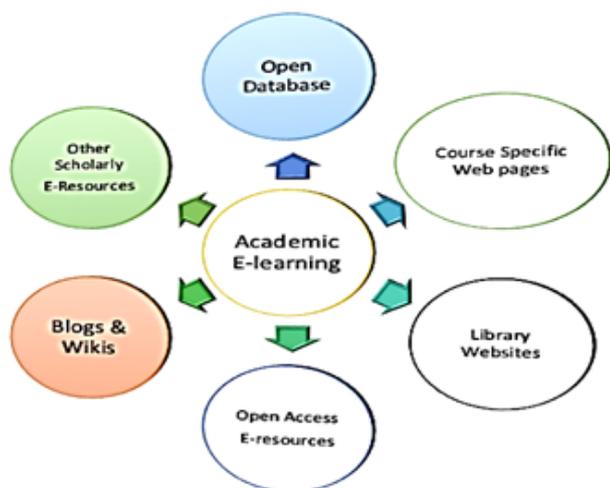


Figure 1. Adopting the ubiquitous e-learning tools in e-library environment [10]

The multimedia e-learning education environment possessed certain degrees of collaborative synergy that fundamentally allowed integration of multiple digital contents, resources and services as a reinforcement of adaptable learning, teaching, research and innovation [7]. According [10], the academic libraries, research institutes, faculties, colleges, departments and institutions planning to deploy e-learning functionalities may incorporate the same technologies within the digital library to facilitate learning and access to networked resources and services. The incredible growth in internet accessibility particularly the world wide web (w³) had ushered in a set of information dynamics, assisting the e-learners to have multiple access to vast range of digital information resources available at the fingertip of the handheld computing device of the potential digital user [9]. Usually, in planning and building the digital libraries, the information managers have the obligation to present e-learners with direction to essentially prevent the situation that may lead to information overload. The digital libraries are networked to enable the e-learners access to library catalogues, licensed journal databases, electronic book collections, selected internet resources, dynamic multimedia elements, 3D-simulation packages, electronic course reserves, tutorials, online forum for communication, collaboration and interaction with the outside digital world [1]. While the digital libraries enabled the e-learners to access networked resources and services whenever the internet connection and computing devices are reachable, the e-learning functionality were integrated into university curricula in most academic institutions, faculties, colleges and departments to support learning, teaching, research and digital collaborations [31]. From educational perspective, digital libraries and multimedia e-learning environments are interwoven, interlinked and integrated within the technology negotiated environment for persuasive and

interactive pedagogy [24]. The multimedia e-learning symbolizes the ICTs supplemented learning activities delivered through the internet, intranet/extranet, audio/video, satellite broadcast, interactive TV and distributable CD-ROM/DVD-ROM [30]. According to [63], the technological experiences of e-learning education and digital library services when combined together enable educators to employ the knowledge of the subject matter in the teaching and learning while advancing creativity and innovation in both face-to-face and virtual environments. It uninterruptedly enhances professionalism in teaching, learning, collaboration and content awareness through successful use of digital technology tools for interactivity and effective pedagogy in the modern educational management[20]. The e-learning education paradigm encompasses the use of ICT tools to support learning process in an electronic distributed information system and the internet [59]. In the contemporary time, the population of learners taking part in an online education had significantly improved which indeed had evoked the concern what the online education had performed for the institutions and also suggested whether all the academic professions and fields of human endeavors are equally represented online [36].

Usually, the preference for technology adoption are determined by the requirements of the prevailing academic circumstances and learners who are the potential beneficiaries of the course content. On the other hand, there exist several possibilities that countless educational establishments are over-exaggerating their contentions of being an online studying institute, so these expressions should be comprehensively categorized [18]. Numerous academic establishments are adopting e-learning education to create profits and harness the plenteous advantages that electronic learning education presents. The electronic learning education system had developed into a formidable instrument and assumed the pillar for the twenty first century educational business, teaching and knowledge management in the global academic perspective[80]. In accordance with [18], the open and distance education present the flexibility considered necessary for adults to proceed with their educational pursuit alongside the career engagement. Several agencies of the government and private organizations have emphasized the relevance of the life time knowledge acquisition and distance education increases the chances for cost-effective throughput and job accomplishments. Academic and business organizations in specific, comprehends the significance for the workforce continuous education on their own time, devising the convenience required for learning without sacrificing time away from organization employment [67]. Specifically, employees within the unpredictable job environment particularly in the information based and highly specialized occupation will absorb the tensions to proceed with education as the precipitous development in the knowledge areas such as health technology, academics and human resources management will compel individuals employed in these

areas to proceed with education and learning to keep up with the prerequisites knowledge required for the job satisfactions. The electronic learning environment and distance education management are the ultimate approaches for all-time educational performances in the twenty century digital extreme automation [61].

However, the e-learning education infrastructures are principally delivered into two platforms according to the learning objectives which include:

- (i) **Scheduled delivery platform synchronism** – The scheduled delivery platform synchronism occurs when e-learning activities happened in real-time with participants dynamically communicating with each other within a time frame[22]. Such synchronous e-learning transmission can be conducted by way of Webinar, Tele-video conferencing, Zoom tele-presence broadcast or skype over the computer network with live Chat, live web based classes and digital collaboration. In the scheduled delivery platform synchronism mode of e-learning education , there exist effective interactions between the presenter and learner as the communication can flow in cyclic model, allowing each participant to take turn in discussion but the major drawback is over reliance on high internet network connection for unbroken transmission and information flow.
- (ii) **On demand delivery platform asynchronous:** On this account, information is provided around the fixed schedule from any geographic location but does not occur in real time. This form of e-learning activities include web-based training classes, online resources, blog, e-mails services and interactive CD-ROM/DVD-ROM electronic contents accessible by the learner at the most preferable convenience[60]. While the information is available at the learners' demand, it potentially offers the participants the enormous control over the manageability and learning process.



Figure 2. Electronic interactivity in a collaborative digital learning environment [62]

With **Figure 2**, the e-learning education depend on ICT infrastructures in delivering it's key potentials in higher education and learning environment , while concentrating attention on information and knowledge sharing which is the sole objective of education, especially in the formal educational setting. Web based instruction (WBI) can be developed and delivered through the help of ICT and deployed through the computer cloud network [77]. The WBI is an innovative approach to distance learning in which computer based training (CBT) is transformed by the technologies and methodologies of the World Wide Web (W3), the internet and intranets [83]. The WBI present content in a structured format that allows self-directed and self-paced instruction on any meaningful context. The web based test (WBT) is actually in the form of CBT that uses the internet framework or intranet as the delivery medium instead of disks or compact disk read only memories. Altogether, the CBT and WBT are part of a larger e-content categorization considered as electronic performance support system (EPSS) that relied on ICT for its value chain [60]. The fundamental objectives of ICT in e-learning education proposed that:

- (i) ICT fashions approaches required for knowledge synthesis and application of novel concepts.
- (ii) ICT evolves pedagogical approaches required for information society engagement.
- (iii) ICT models students' academic performances such as greater scores in the key subject areas in addition to learning new expertise that are indispensable for building and sustaining the digital and knowledge economy.
- (iv) ICT develops teachers' knowledge base, digital skills and technology expertise for new pedagogic methodologies together with value-added services in the perspectives of interactive teaching.
- (v) ICT evolves communicative power in the course of computation and digital automation.
- (vi) ICT provides the foundation for digital adjustment, intellectual capacity building, promptness, digital inquisitiveness and accuracy of information processing.
- (vii) ICT Intensifies innovativeness in the disciplines and access to the community of users in the manner that enforces mass education, information and media literacy.
- (viii) ICT reinforces knowledge, promotes interaction and collaboration between

- professors, lecturers, teachers, students and all major stakeholders notwithstanding the geographic boundaries.
- (ix) ICT improves education and stimulates the thematic integrative methodology towards training and knowledge discovery. The methodology jettisons the artificial disjunctions stuck between the distinctive fields of human endeavours and between theory and practice, which characterizes the modernistic approach to interactive educational pedagogy.
 - (x) ICT is an instrument for establishment and administration of tertiary institution, technical and vocational schools as it assist the overall management take control of meaningful investment of the global educational reforms.

According to [84], the requirements for flexible modes of delivery of educational curriculum in tertiary education in the perspective of online learning, e-learning, blended learning, m-learning and distance learning have significantly increased over the recent time. There exist number of factors promoting the upsurge of student's participation and educator's involvement in the online learning, e-learning and distance education in the contemporary time. Several educational institutions of higher learning are currently investing in e-learning to generate income through massive ICTs infrastructural deployments and negotiating the numerous benefits which e-learning design presents [53]. On like every other electronic systems, e-learning education infrastructures anchors on the IoT, cloud infrastructures and big data technology supported services for acquisition and distribution of information [75]. Generally, IoT backbone of most electronic systems are partially insecure and susceptible to security breaches such as software attacks, worm infections, viruses, service denial, espionage, eavesdropping, hardware malfunction, script exploitation, intellectual property theft, piracy breaches, copy right infringements [71]. Federal agencies had warned that cyber hackers can breach secured networks through simple IoT mobile devices anchorage [38]. The digital challenges are coming upon the backdrop of unified definition of the IoT as it applied to such a wide range of devices and situations whether the user is aware or otherwise leaving us to view the IoT with exceptionally deep considerations. The Federal Trade Commission (FTC) in its January 2015 report "Internet of Things: Privacy & Security in a Connected World," acknowledged that there is still no widely accepted definition of the IoT and offers its own interpretation as what could be regarded as IoT as "devices or sensors-other than computers, smartphones, or tablets-that connect, communicate or transmit information with or between each other through the Internet" [27]. With over 25 billion devices already connected around the digital

globe [96], the IoT is expected to grow in leaps and bounds as businesses continue to invest in connecting devices and the infrastructures necessary to keep them flourishing. Research suggest that a single vulnerability anywhere in an IoT solution can put an entire system at risk and because many IoT solutions rely on cloud services, the risks can extend even further, facilitating attacks not only individuals but also on related systems or even unrelated systems, depending on what data has been compromised [88].

This rises a fundamental question on what exactly the global world want from IoT as situations emerge. The lack of absolute security on consumer facing IoT solutions can put electronic infrastructure such as credit cards, bank accounts, cars, homes, healthcare records, server, spacecraft and even individuals at risk [81]. Imagine an IoT solution that monitors a user's location via a mobile device, wearable sensor devices, PDAs and then uses the information to control settings such as lighting and temperature within the ecosystem. The organizations and institutions should be very comprehensive when implementing IoT solutions due to quantum of the associated digital threats across the cyber physical systems which the infrastructures are expected to deliver [29]. The quantity and complexity of data can increase security challenges significantly as technological advances in web services and cloud computing provide fertile soils for IoT growth [35]. Projections for the number of connected devices ranged in the trillions healthcare devices, automotive devices, robotics, home security, manufacturing, educational technology infrastructures and personal fitness are but a sample of the IoT promised scope and part of that promise is the potential for the new world order and greater productivity. The next generation computing technologies in the perspective of big data science, cloud computing, IoT, block chains and others are all concept promise to deliver a step change in individual quality of life and enterprise productivity in reinventing the new world educational order [77]. The potential objectives of those cutting edge technologies are to enable extensions and enhancements of fundamental services in ICTs and digital hub activation, IoT, cyber security, educational policy, governance and every areas necessary for human development considerations.

The security in e-learning education should be given attention to prevent breaches, infringements and ensure a safer learning environment [73]. Ideally, e-learning functionalities have potential for increasing information usability and must be well protected to avoid the loss of confidentiality, availability and integrity. In e-learning educational environment, teachers and students have opportunities for new trends in pervasive computing, employing ubiquitous devices and technologies in the classroom activities to improve learning [34], as the young people are adapted to carrying mobile computing devices around and playing with new gadgets [58]. The twenty first century educators and curriculum developers should recognize the actuality in adoption of mobile cloud

computing technologies for the 21st-century digital space for 21st-century digital learners. The multimedia e-learning environment is embodied with dissemination of information, scientific knowledge and academic ideas over the internet for the consumption of the digital natives.

4. Research Methodology

The current research focused on the various aspect of educational services obtainable through the cloud computing technology infrastructures. The wide adoption of software as service (SaaS), infrastructures as service (IaaS) and platform as service (PaaS) highlights the requirement for the twenty first century business automation [69]. The information technology (IT) development have metamorphosed recently from the innovativeness of the cloud computing technology and IoT into a sustainable investment climate, offering opportunities for more process automation [78]. The cloud computing architectures was propelled by the captains of industries such as Google, Amazon, Microsoft Corporation and several others in the middle of 2006 as the state-of-the-art IT stage infrastructure to expand businesses and commercial enterprise models where companies, organizations or individuals can acquire computing power and software manageability, hosted on the Internet or other enterprise computer networks to improve administrative competences [79]. In modeling the twenty first century digital electronic society into its components and functional economic units, the economists should give adequate attention to the newest and fundamental drift which is the emergence of software as services (SaaS), platforms as service (PaaS), infrastructures as service (IaaS) and the economic impact it has on the entire states economy and overall national development. In the recent time, the culture of workplace have significantly transformed due to progressive knowledge of information communication technologies (ICTs) tools, software services and software engineering development paradigm [97]. Adopting cloud technology provided lots of conveniences for the academic communities which include the professors, lecturers, students, teachers and researchers. Infrastructures as service enabled educational providers with the virtual infrastructure to deploy and run software applications and operating systems across the cloud platforms [32]. In the ongoing digital automation, SaaS, IaaS and PaaS initiative are deployed to allow educational institutions to use application through the software cloud via the internet. The essential aspect of SaaS were in the expressive elimination of expenses of software licensing, installation and support. The educational apps services deployed and downloaded through the cloud community such as Google play store does not require software licensing. The Platform as Service (PaaS) in education will enable teachers to advance the development and deployment of

applications through software programming tools for the cloud platform provider's offer.

The current investigation utilized a quantitative research methodology adopting a random sample population comprising of the Centre for Information Technology (CIT) staff and students from the four selected tertiary institutions in the South Eastern Geopolitical Zone of Nigeria. The data collection method involved delivering a set of questionnaires to 500 randomly selected CIT staff and students from four (4) Tertiary Institutions in the South Eastern Nigeria. The questionnaire comprised of single and multiple choice questions divided into two sections. The first section was on demography to collect personal information about the respondents. Questions in section two were concerned with the mobile devices and Cloud Internet of Things (CIoT) utilization by the respondents and the type of activities they were used for within the academic environment and for educational objectives. The survey gathered data on e-learning education design and IoT awareness, educational activities and if CIoT innovation improves students learning skills and academic performances. The questionnaires were administered between the first and second semester of 2018/2019 academic session after ethical consent was sought and obtained for the survey through the authority of the institutions as the respondents were assured of anonymity. In furtherance to the issues regarding the questionnaire, the CIT Staff copy were structured to provide detailed explanations on the exact scenario regarding the Institution Cloud Infrastructure development as an alternative to physical machine server that are mounted with several hard disk storage capacity on the server machines. The CIT operations, budget planning and implementation, level of intervention and general CIT administration in the perspective of overall academic business of the Institutions were of particular emphasis to the current research. Out of five hundred (500) questionnaires distributed, four hundred and twenty (420) questionnaires were returned to the researchers, corresponding to 84% response rate which is very encouraging for such survey. The collected data were analyzed and presented using descriptive statistics tools.

5. Research Design

The current research was designed to gather information on institutional cloud adoption for process modernism and implementation of industry 4.0 educational business automation. In doing so, the research engaged a questionnaire which were divided into two segments and distributed each categorized parts which are expected to investigate individual expectation of the ongoing research objective. The first section was well-thought-out in order to obtain insight on the targeted audience about the cloud technology in the educational management in the South Eastern Nigeria in the perspective of data warehousing and multimedia data mining in digital

libraries automation for academic business process, responsiveness to course management, digital integration , collaboration and digital learning leverages. The second part consisted of enquiries regarding the respective institutions IT infrastructure development and managerial inclinations towards realizing the organizational goals in implementing the cloud based system infrastructures. Five hundred (500) questionnaires

were distributed to the four selected federal government owned tertiary institutions in the South Eastern Nigeria, comprising of the CIT staff, Academicians and Students from the mixed departments and faculties. Four hundred and twenty (420) questionnaires were dully filled and returned representing 84% response rate of the entire questionnaire distributed.

Table 1. ICT Infrastructure Development & Cloud Technology in E-Learning Education Sustainability

Federal Tertiary Institution	No. of Questionnaires Distributed	No. Questionnaires Retrieved	Percentage of Questionnaires Retrieved
UNN	140	125	89.3%
NAU	122	105	86.1%
FUTO	123	100	81.3%
NEKEDE	115	90	78.3%
Total	500	420	84%

Field Survey, 2019

The **Table 1** above expresses the extent of questionnaires disseminated and the proportion of the individual categories recovered. The maximum proportion of the questionnaire repossessed was from the UNN, although more questionnaires were distributed to the institution based on the level of digital characterization and student population of the institution. Moreover, the researcher stayed within the institution as the contact base throughout the period of the data

collection. The largely response was eminent with the mean proportion of 89.3%. That became a prove of readiness and how enthusiastic the respondents are in attainment of advanced digital future for e- learning , education innovative teaching and cloud infrastructural investment. The next in rank is NAU with proportionate response rate of 86.1%, followed by FUTO with 81.3% response rate and lastly NEKEDE with 78.3% response rate.

Table 2. Institutional CIT Server Infrastructure

Federal Tertiary Institution	Server Hosting Infrastructure	Performance Rating	Vulnerability Index
UNN	Physical Machine Server system	Networked Device Constraints	Moderate
NAU	Cloud Server Infrastructure	Cloud Data Center	Low
FUTO	Cloud Server Infrastructure	Cloud Data Center	Low
NEKEDE	Microsoft Cloud Server Infrastructure	Cloud Data Center	Low

Field Survey, 2019

The **Table 2** is the cloud backbone infrastructure model, authorizing network users to access combined pool of configurable computing resources that can be precipitously delivered to the client without direct service provider communication. The cloud infrastructure enables the adoption of the disruptive technologies which had paved way for autonomic computing, grid computing, mainframe computing, client-server model architecture, virtualization, utility computing and peer-to-peer information sharing. Taking Nigeria as a case study, leveraging cloud computing technologies for distributing diverse services such as courseware management systems, e-learning environment, enterprise resource planning systems and digital

libraries researchable archives that will give more dynamic resource utilization and flexibilities to curb inadequacies in the tertiary education administration. The framework validates the usefulness of the cloud Internet of Things infrastructure as it present the improvements of real world cloud services. The proposed framework seeks to accelerate teaching and e-learning initiatives, customized learning management system (LMS) and mechanism that will sustain tertiary education virtual learning ecosystem in Nigeria. The figure 3 shows the proposed tertiary institutions cloud framework for synchronous e-learning management system.

Table 3. Institutional ICT Capacity Development & Infrastructural Marginal Propensities

Institution ICT Infrastructure	Mean	Ranking
Cloud/Computer Server System	3.9	1
Networking	3.69	2
Organization Center for Information Technology (CIT) Systems	3.43	4
Wireless Digital Solution	3.34	5
Broadband Communication	3.65	3
Digital E-Learning Platform (LMS)	3.10	6
Multimedia Digital Library Power	3.9	1

Field Survey, 2019

The information in Table 3 shows the availability of information technology (IT) infrastructures in the various institutions mentioned in the current study. The mostly used educational paraphernalia are computers and servers in the CIT Centre and multimedia digital libraries which generated the high-pitched mean of 3.91. The next highest ranked Institutional ICT capacity development infrastructure is networking and Broadband Communication which has the mean value of 3.69 and 3.65 correspondingly. On the contrary, the least considered IT infrastructures are organizational system wireless digital solutions and Digital e-learning platform(LMS) which have a mean value of 3.43 , 3.34 and 3.10 respectively, the total mean for the IT infrastructure for the overall respondents was computed to be 25.01.

6. Research Implementation

This section analyzed the learning platform which hosted the e-learning education courses for seamless access through the Cloud Internet of Things Infrastructure. The implementation of the system comprised of architecture of the software systems involved in the delivery of the cloud computing, typically involving multiple cloud

components communicating with each other over a loose coupling mechanism such as a messaging queue [8]. The Cloud technology innovations are growing at a rapid pace as many academic institutions and organizations are no longer bordered buying or managing their individual servers rather will prefer hosting their services on the third party cloud infrastructures. This option empowers organization to switch to clouds infrastructures where the cloud owner will provide them with certain enterprise able services at a fee. The organization/institution applications and data from the local data store are moved to the cloud services such as Equinix hub over the dedicated confidential line within the account created for Equinix cloud exchange server, linking the workload through the cloud destination [19]. The data hub will usually authorize the critical indispensability for the CIoT, real-time analytics, data collection, data security, data protection, data compliance and efficient utilization of business indispensable data anywhere the users are positioned around the global world, **Refer to Figure 3.**

The Equinix cloud exchange portal being the IoT web established implementation for the Equinix Cloud Exchange application programming interface (API) will always provide customers with business identity management capabilities [91]. On this note, consumers who do not have the in-house capability and technical

competence of developing cloud API to configure the third party cloud facilities for their automated multi-cloud connectivity and utility services effortlessly toward realizing business computing performances. This approach helps to reduce business unpleasant scenarios and guide against all avoidable business environmental disasters coupled with considerable returns on the investment [11].

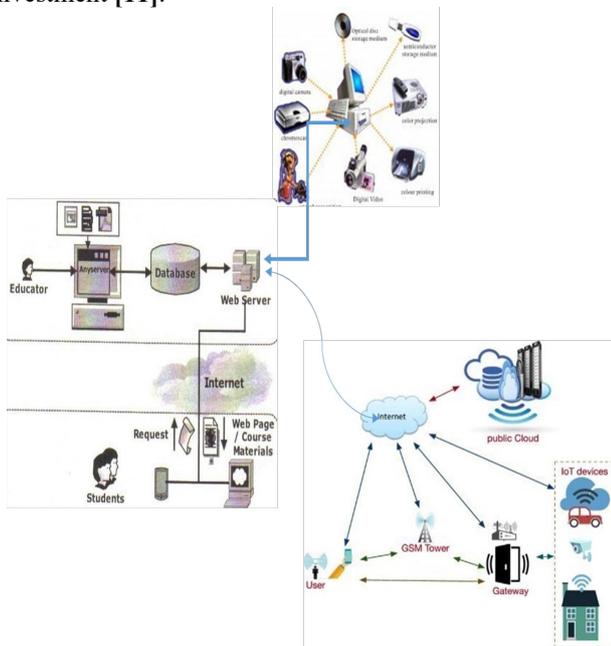


Figure 3. Enterprise Mobile E-Learning Education Implementation using Cloud Internet of Things Infrastructure: Illustrated by the authors

7. Analysis/Discussion of Finding

The current cloud computing adoption will require the educational innovation for m-learning, u-learning and e-learning, utilizing mobile devices as gateway to inspire research and educational accomplishment through online collaboration which will enhance information sharing [3]. The cloud innovations will enable the educational sector to provide hosting for electronic learning management systems (LMSs) such as module and blackboard within the cloud environment [85]. There are two main entities of the e-learning system which include educators and students. The students usually obtain access to exams, electronic courseware materials and can relay their assignments online, whereas the trainers can relay tests, manage courses and evaluate homework and assignments for the students and the two parties can communicate with one another. It is not possible for the e-learning solutions to ignore the current trends associated with cloud computing [70]. Using cloud (SaaS) applications, it is possible for both teachers and students to access their individual data using a web browser from a computer or mobile phone at school, home, library or from any other

places, hence ensuring efficient collaboration, communication and exchange of shared documents, notes, as well as contacts among others. The information in Table 3 shows the availability of information technology (IT) infrastructures in the various institutions mentioned in the current study. The mostly used educational technology paraphernalia are computers and servers in the CIT Centre and Multimedia Digital Libraries which generated the high-pitched mean of 3.91. The next highest ranked institutional ICT capacity development infrastructure is the Networking and Broadband Communication which has the mean value of 3.69 and 3.65 correspondingly. On the other hand, the least considered IT infrastructures are organizational system wireless digital solutions and digital e-learning platform(LMS) which have a mean value of 3.43 , 3.34 and 3.10 respectively. The total mean for IT infrastructure for the overall respondents were computed to be 25.01.

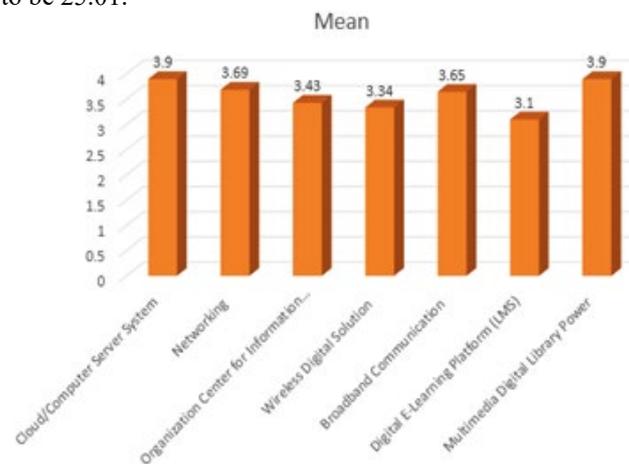


Figure 4. Institution ICT Infrastructure

8. Internet of Things and Cloud Technology Implementation

Big data science, cloud computing and IoT works in conjunction and complementary to each other [100]. Data extracted from IoT devices provides a mapping for device interconnectivity. Such mappings have been used by the media, education, industries, companies, healthcare and governments to more accurately target their audience and increase service efficiency [64]. The IoT is also increasingly adopted as a means of gathering sensory data and this sensory data has been used in healthcare sector, education , manufacturing , governance and transportation logistics to maintain supply and distribution of essential services[54]. The IoT is a system of interconnected and interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with unique identifiers (UIDs) having the potential to transfer data over a computer network without requiring human to human(H2H) or

human to machine(H2M) interactions [14]. Ashton became very popular for inventing the context of the IoT to describe a system where the internet is connected to the physical world via ubiquitous sensors. An IoT can be a person with a heart monitor implant, a farm animal with a [biochip transponder](#), an automobile that has built-in [sensors](#) to alert the driver when tire pressure is low or any other natural or man-made object that can be assigned an IP address and is able to transfer data over a network. Interestingly, organizations are varieties of industries utilizing IoT to operate in a more efficient ways and better understand their customers to deliver enhanced customer services, improve decision-making and increase the value of the business. The IoT has evolved from the convergence of wireless technologies, microelectromechanical systems ([MEMS](#)), [micro services](#) and enterprise platforms as service and internet as infrastructure in keeping abreast with the internal policies of organizational business rules [41].

The convergence has helped tear down the silos between Operational Technology (OT) and Information Technology (IT), enabling unstructured machine-generated data to be analyzed for insights to drive improvements [65]. IoT evolved from Machine-to-Machine (M2M) communication, i.e., machines connecting to each other via a network without human interactions. The M2M techniques involved connecting a device to the cloud, managing it for data collection, analyzing the data and communicating the information within the network communication system such as satellite information or unmanned aerial vehicle (Drone) reconnaissance [82]. Considering M2M to the next level, IoT is a sensor network of billions of smart devices that connect people, systems and other applications to collect, analyze and share data. The M2M offers the connectivity that enables IoT wide range information transmission. The IoT is also a natural extension of [SCADA](#) (supervisory control and data acquisition), a category of software application program for process control, the gathering of data in real time from remote locations to control equipment and conditions [95]. The SCADA systems include hardware and software components that enables the process of data acquisitions, data communication, information-data representation and information control. Those activities are executed by sensors, remote terminal units (RTUs), controller and a communication network distribution channels [4]. Most often, sensors are utilized to assemble the significant information and remote terminal units (RTUs) are adopted to transmit those information to the controller which then managed the status of the SCADA systems [40]. The hardware gathers and feeds data into a computer that has SCADA software installed, where it is then processed and presented in a timely manner. The evolution of SCADA is such that the late-generation SCADA systems had developed into first-generation IoT systems [5]. The concept of the IoT ecosystem, however, didn't really come into its own until the middle of 2010 when the government of China said it would make IoT a strategic

priority in its five-year plan[93]. The IoT aggregated numerous beneficial concepts for organizations that adopted it within its business life [56]. Numerous industrial specific advantages of IoT are applicable across multiple business organizations in the current twenty first century digital economy. Among the potential benefits of IoT within businesses organization and supply chain include :monitoring the overall business processes, upgraded customer relationship experiences, timely and resources management , enhancement of employee productivity, incorporation and adoption of essential business models, comprehensive business decisions and revenue generations [51].

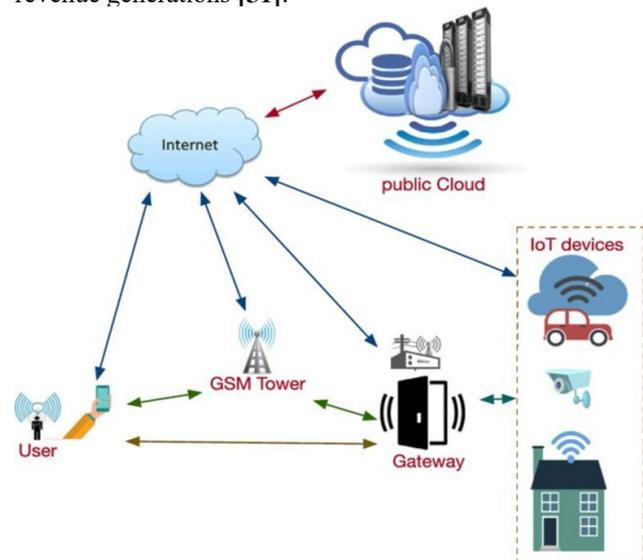


Figure 5. IoTs Supported Mobile Computing Framework: Illustrated by the authors

With reference to Figure 5 , cloud computing technology is the distribution of numerous information technology services through the Internet resource platforms [42]. The internet infrastructural resources comprised of applications, distributed networks, data warehouse storage , cloud servers, database software and enterprise tools. Cloud computing technology enables the organizations or individuals to share various services in a seamless and cost-effective manner over the computer distributed networks, usually public/private networks using wireless area network, local area network or virtual private network [87]. The virtualization, grid computing and utility computing are the most popular emerging technologies which are adopted in the cloud computing, which had developed into a great technology for the end users [92]. The idea of virtualization is utilized as a strategy that permits sharing of single physical instance of an application or resource among different associated clients. A grid computing application is processor-concentrated software that splits up its processing into little lump then each piece is handled as an individual procedure in the cloud computing business solution. The

main advantage with cloud computing is having utility computing concept which is Pay per use model, offering computational resources on demand as a metered service [94]. Generally, the term is used to establish and offer explanation to data centers, accessible to considerable consumers on the [Internet infrastructure](#). The substantial clouds investments available in today business domain are frequently distributed over multiple locations from central servers [2]. If the connection to the user is relatively close, it may be designated as an [edge server](#). The clouds may be limited to a single organization (enterprise clouds) or be available to many organizations (public cloud), or a combination of both ([hybrid cloud](#)) [72]. Cloud computing relies on sharing of resources to achieve coherence and [economies of scale](#). The advocates of public and hybrid clouds noted that cloud computing allows companies to avoid or minimize up-front [IT infrastructure](#) costs through information security administration and enforcement of comprehensive business information security policy management [44]. The proponents also claimed that cloud computing allows enterprises to get their applications up and running, with improved manageability and less maintenance cultures and that enables IT teams to more rapidly adjust resources to meet fluctuating and unpredictable business demands [15]. The availability of high-capacity networks, low-cost computers and storage devices as well as the widespread adoption of [hardware virtualization](#), [service-oriented architecture](#) and [utility computing](#) has led to growth in cloud computing technologies [46].

However, the cloud service provision usually characterized all formations of cloud infrastructures required for platform integration [47]. The cloud service providers usually deliver a combined architectural framework to enable platform integration in maintaining and administering those services reliably. Therefore administering those services should be the basic prerequisite for all cloud service infrastructures and managing the platforms effectively for mutual assistance and for the performances of the business requirement. Cloud computing is a combination of various services offered by the IoT enterprise solution. The cloud technology infrastructure delivers numerous services to educational sectors in general, permitting historic checks to run all educational verification, in which all the information supplied on the application process are verified with all relevant educational institutions to ensure authentication [98]. Every educational institutions are provide with cloud functionalities to fundamentally chart a part of digital future and improve pedagogical methodologies through utilization of secured cloud computing innovations [90]. While the cloud computing infrastructures are generally suited for educational sectors, it contained budget boundaries to enable every institution cope with funding. Adoption of cloud computing technology into the twenty first century central business ecosystem had resonated every aspect business information system. Even though cloud technology innovations have advanced the current society business

automation, it has not been proportionately implemented in all the service sectors [68]. The cloud computing technologies are assisting academic institutions in cutting down administrative costs in the purchase of legacy software and maintenance of the physical server machineries [86]. The considerable open online coursework management usually assist teachers and students in distant areas to manage and organize themselves with the digital knowledge which is the bedrock of information democracy.

The cloud technology infrastructure capacity were evident in the Drone technology systems, providing the physical means of controlling Drones beyond visually line of sight (BVLOS) in the twenty first century computing expeditions in IoT. The cloud connectivity infrastructure via Veronte cloud services were adopted for the integration of Drones in the Internet network to expedite airspace navigation and missions BVLOS. The initial design was focused on the use of satellite communications but now Veronte Autopilot had switched to cloud internet connectivity with increased efficiency. The Veronte cloud services empowers the harmonization of unmanned aerial vehicles (Drones) flight data through the cloud server in the online flight schedule. The IoT interconnection with the logistics location via the PC and 4G/5G/6G communications modem installed in the unmanned aerial vehicle switches the Veronte cloud connectivity for an amplified adaptation in M2M coordination [66]. It describes the direction for the amalgamation of M2M datalink synchronization in unmanned aerial vehicles driven by the development in end user acceptance of technology services. With the boost in the Microsoft Azure Cloud computing and Google Cloud technology, many companies will join the space Drones technologies with different specifications and definition of operations [57].

The unmanned aerial vehicles (UAVs) network are usually managed simultaneously to enable them operate over a large areas on hybrid IoT cloud infrastructure which allows data synchronization through the cloud storage data warehouse [66]. The systems and infrastructures permitted multiple UAVs to install Veronte Autopilot and perform flight operation simultaneously [28]. With effective compliance to the standard requirements defined in the International Standard Union, the UAVs system have the capabilities to record telemetry data, transmit and keep log record with data recorded on every operational assignment [52]. Among several improvement recorded with utilizing Veronte cloud infrastructure for coordinating unmanned aerial vehicles on airspace include the increased collision avoidance, safety in UAVs flights management and smart multimedia data acquisition by Veronte Autopilot component manipulation. These Autopilots Drone systems are empowered jointly to communicate among themselves and efficiently exchanged multimedia data ubiquitously and autonomously. The system and its infrastructure improved the algorithms for collaboration,

senses avoid repulsion and as well as the flight control [37].

This technology infrastructure allowed for analysis and coordination with the information from transponders in the real synchronize able time management. The systems allowed for synchronous configuration of events taking place in the UAVs environment managed through the Veronte cloud facilities. Performing automatic actions in unison, which include reporting the track of their current location and activities, analyzing all environmental data, sending of multimedia information (images, photos and video) through the cloud infrastructure to enable ground logistics managers take advantage for planning and coordinating responses[49]. The innovative IoT Drone systems will assist the digital natives to perform some classified operations which will include but not limited to the current paper submission. The cloud infrastructure are classified into the following:

- (i) **Public Cloud:** The public cloud computing infrastructure forestall that all the essential tools such as platform as service(PaaS) , infrastructure as service(IaaS) and software as service(SaaS) should be located on the remote server of the cloud computing service provider which offers the **cloud services** at a fee [33].
- (ii) **Private Cloud:** This approach requires hosting all the computing infrastructure on the cloud that is not
- (iii) **Shared:** The security and control level is highest while using a private network.
- (iv) **Hybrid Cloud:** The hybrid cloud is the amalgamation of the private cloud infrastructures in connection with the public cloud facilities adoption to improve cloud environment performances.

The cloud infrastructure approaches exist usually to merge services and synchronize data through several IoT computing platforms, establishing unification that will enable data aggregation through different cloud model computing frameworks [23]. Amalgamating public cloud services and private clouds to form a coupled data center as a hybrid is a novel characterization of commercial business computing initiatives. Commercial organization investment in enterprise data warehouse development were necessitated by cloud computing technology innovation and practices, increasing the efficiency of the organizational business intelligence while reducing the operational costs across organization IT investment ecosystem [70]. As most of the business organization such as educational sector are customer and database driven, the demand for cloud enterprise data warehousing became increasingly necessary to keep the life wire which is data (information) open for business decision and logistics planning. This approach satisfied business priorities that

motivated investment in the modern enterprise data warehouse development with expectation of increasingly investment and performances as most businesses are customer centered and database driven.

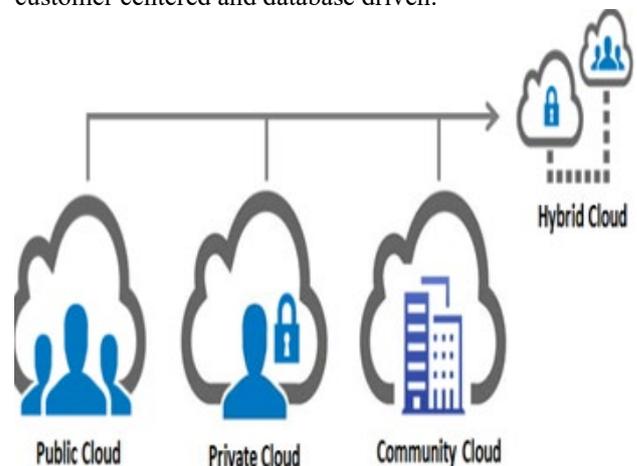


Figure 6. Microsoft Azure Hybrid Cloud Server Architecture for the E-Learning Ecosystem

Several cloud computing infrastructures should be considered indispensable for global educational businesses to enable collaboration which include web2.0 cloud services, enterprise applications, data stores, servers spaces and computer networks [76]. Occasionally, cloud infrastructure are usually hosted on the third-party server services located in the data center or privately owned cloud data warehouse. These provisions makes data access settings dependable, flexible, reliable and efficient, with minimal administrative superintendence. Usually, cloud computing infrastructures relied on distribution of resources to attain consistency and economic scalability and performance centric. Often times, this is equally cost-effective allowing many small , medium ,enterprise businesses and firms consider it easily for implementation.

9. Challenges in E-Learning Environment & Internet of Things Infrastructure

Despite the excellent performances of cloud based e-learning education in the twenty first century digital environment, there exist several challenges that cannot be denied in the cloud computing which extended to e-learning technology. Some of the e-learning challenges within the cloud technology provisions are discussed below, refer to Figure 7.

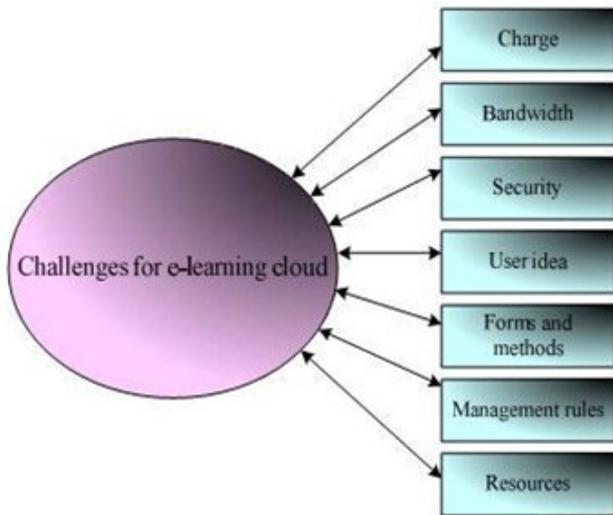


Figure 7. Challenges for E-Learning Cloud [48]

- (i) **Cloud Service Charges:** Hosting e-learning education courseware on the Cloud Server and associated infrastructures for pervasive computing and ubiquitous learning comes with a considerable cost. The cloud service vendors charges the institutions, schools and individuals based on the capacity of service utilization.
- (ii) **Bandwidth Subscription:** Providing Cloud based e-learning activities will require Internet service availability, therefore, bandwidth subscription will enable data services for the Cloud internet servers.
- (iii) **Security:** Security mechanism are key aspect of the e-learning content and Cloud infrastructures. The e-learning system is provided with user authentication, digital signature, privacy policy configurations and confidentiality definitive apparatus. However, the confidential data attributes are packaged and encrypted during deployment and storage on the cloud servers.
- (iv) **User idea and digital competency:** The Cloud computing technologies and its associated infrastructures, information technology (IT) service delivery usage patterns and e-learning activities, total deviated from the traditional ways of using computer technology in the classroom setting. Therefore, this new configuration will influence the e-learner ideology and their approval on further development on cloud based e-learning functionalities. The fundamental solution

to this kind of problem rest on building a good case models for cloud based e-learning and promote wide applications adoption to reach more e-learners.

- (v) **Educational Dynamics:** Among the key obstacles confronting e-learning education technology is the prevalence of traditional educational system and its administration. The emergence of e-learning education technology is not completely undermining the effectiveness of the teachers commitments in the traditional classroom management, rather it offers flexibility and freedom to enable the teachers to model a new electronic smart digital environment for students interaction. The twenty first century smart electronic classroom will require teacher’s involvement with the business and activities of cloud based e-learning applications.
- (vi) **Educational Management Strategy:** The social dynamics of the traditional learning environment deviates significantly from digital e-learning environment from all indications. In such a manner that Cloud technology is used for e-learning systems, there is likelihood of new problems to emerge on the learning environment through the Cloud based e-learning education. Surmounting such development required suitable management strategy for the cloud based e-learning design, teaching content digitization and management, course management, examination management, performance management, student management and teacher’s workload management should be definitively structured [48].
- (vii) **Resources Development and Capacity Building:** The new educational investment and technological management will require a total blend of all the stakeholders to be involved in the development, deployment and configuration of the e-learning environment. Configuring the Cloud based e-learning environment requires the teachers and every other educational experts to be involved in the resource development to enable blend of scientific dynamics and social interest and synergy in learning resources.

10. The Future Research Focus

The future research will focus on the technology and scientific adjustment in the knowledge generation, knowledge distribution and knowledge circulation within the Nigeria educational system and sub-Saharan Africa. The educational investment in the twenty first century digital e-learning environment will require a comprehensive reworking and overhaul of the current curriculum of education to integrate technology innovations and inventions into the main stream educational program through early adoption of scientific methodology. Such methodology will require hybridation of the current teaching procedures, next generation innovative and inventive paradigm. Early adoption of artificial intelligence (AI), machine learning (ML), IoT, Cloud computing and software innovations will offer potential leverage in the production of scientific knowledge for the 21st century digital natives. The mobile device systems will be adapted to primarily provide perceptions for touchscreen devices configuration, cell phones, tablets and other android smartphone accessories for interactive digital class room pedagogy. The android operating system like any other operating system design, will enable the digital natives manipulate the mobile devices intuitively with finger movements that mirror common motions such as pinching, swiping, and tapping.

In addition to mobile devices intensive utilization of the android OS, the digital natives will employed android software in televisions, cars, wristwatches and several other wearables each of which is fitted with a unique graphical user interface (GUI) for interaction. Innovations, improvements and progresses in technology will led to increasingly sophisticated development in mobile phone computing from early generation to the IoT generation witnessing several updated android smart phones and portables. While iPad together with the iPhone will try to reconfigure the future of mobile phone communications and personal computing technologies, android low-priced hardware and software availability will offers another possibility methods that will guarantees convenience to use bench-marked software applications that meet the precise needs of individual consumers. The current educational curriculum will undergo fundamental overhaul being the instrument and catalyst for the nation development. The production, distribution and management of knowledge within every nations of the world are determined based on the essentiality of the academic curriculum adopted for use within the educational objectives. Therefore, the future research will capture the essence of designing and developing a curriculum that will ultimately specify the roles of teachers, instructors and lecturers as the main workforce who actually controls what is to be taught and how it is taught and how it is consumed, the manner of teaching and the beneficiaries who receives it and why it is taught and how to get the best desired outcomes from the entire exercise. Curriculum execution being the systematic cooperation linking those who have structured the programme and those who are

commissioned to deliver the content and the impact it created in the life of the beneficiaries (the students). According to [26], paying adequate attention in developing the curriculum will automatically change the focus on gaining some requisite knowledge by the students in the 21st century digital learning education.

Consequently, an effective curriculum implementation will require an articulated aims, sufficient visions and flexibility to enable the teachers to respond to the needs of students academically with maximum support to sustain future changes. A successful curriculum development will require;

- (i) Consideration and implementation that will enable educators to functionally shift from the existing and contemporary programme which they are already acquainted with and accustomed with to more innovative programmes.
- (ii) Implementation of new knowledge ecosystem that functionally transforms and reforms peoples actions, ideologies, attitudes and behaviours.
- (iii) Implementation that professionally provide development and growth to the physical man in his environmental ecosystem.
- (iv) Implementation that clarifies individuals and groups to essentially understand the practice of change in attitudes and behaviours often involving using new resources.
- (v) Implementation that commands a compassionate atmosphere in a healthy competition where there are trusts and open communication between administrators, teachers, educators and students without fear of victimization.

11. Research Limitations

Regardless of the scope and opportunities embedded in the current research and what the current digital natives stand to benefit in the ongoing digital society automation, the prospects of e-learning education and digital media management, the researchers have identified some core areas of concern and as well offer some solution.

Digital Divide: The problem of digital divide will affect the distribution and consumption of the new technology envisioned in the current research. The gap between rural dwellers and urban dwellers are very clear in terms of responses to digital scenario. Students and people from the remote villages with less mastery of the digital gadgets and computers will face challenges assimilating the new technological paradigm. Although,

the phobia will vanish with time as they get familiar with the digital tools.

Knowledge Divide: The knowledge divide is generally the gap between those with requisite knowledge to operate the new modern technologies and those without the ability and skills to perform such task. With the current distribution of the society, the rich people will always have access to knowledge and skills than the poor. The rich will always have advantage over the poor due to economic inequality. Notwithstanding, the increasingly support in the global ICT projects and digital activation and paradigm shift, such gaps will be bridged perfectly.

Universal Internet Access: The current adoption will demand internet support and digital grid connection. Connectivity will be optimized to accommodate every logistics and to enable students study at all times. Commitment is highly expected by the government to provide internet connectivity but if internet connectivity is lacking, the workflow may be hindered and that will impact negatively on the learning outcome of the students. Providing high internet connectivity (6G5G/4G) will be of great benefit in delivering the digital functionalities that will open opportunities for electronic media activism.

Electricity Distribution: The current design will demand electricity or its alternative such as solar grid. Government should be proactive and rise to the occasion of providing the basic infrastructures.

12. Recommendation

The twenty first century digital classroom should embrace, e-learning, online courses, ubiquitous learning environments based on ubiquitous technologies, m-Learning, blended-learning and distance learning as an indispensable aspect of post COVID-19 educational management framework. The global efforts on utilizing technology in support for remote learning, distance education, e-learning, online learning and blended learning in the post COVID-19 pandemic will emerge and advance opportunities for interactive educational pedagogy. Moreover, extending school closures and economic lockdown will cause degradation of teaching and learning opportunities in the short-term, loss of human capital and weakened economic prospects in the long-run. To curb the adverse effects of COVID-19 pandemic on educational opportunities for teaching and learning, many countries need to engage options available for exploiting remote learning opportunities such as e-learning, distance learning, m-learning, online learning, u-learning and blended learning to manage the situations already created by COVID-19 global pandemic. The multimedia e-learning system will give possibilities for various operations that will connect students, teachers, lecturers, administrators and readers in the ongoing educational reforms. In achieving the set objectives in the post COVID-19 educational reforms, the following points are recommended:

- (i) The implementation of the sharable e-learning platform, cloud computing services and IoT learning environment for learners should be supported with reliable infrastructures.
- (ii) The implementation of the planned e-Learning platform based on the cloud computing infrastructure should permit an independent learning management system (LMS) entrenched in a distinctive e-Learning requirements.
- (iii) The integration of the e-learning education system into the cloud services in IoT must highlight its flexibility and scalability for the resources utilization with respect to computational requirements, storage and network access in addition to lower cost of new hardware, machines and software licences for educational programs.
- (iv) The institutions of higher learning should make most use of cloud computing for e-learning due to its reliability, efficiency, cost effectiveness, security adaptation and portability across several computing platforms.
- (v) Installation of internet facility through the digital grid to enable radio frequency transmission and cloud IoT connectivity ubiquitously within every tertiary institution academic environments.
- (vi) In the use of mobile computing devices, students and lecturers should adopt compatible phones/software that can assist them have a broad view of online resources.
- (vii) The contemporary students are predominantly young and are actively on social media, they have a lot to achieve through the use of social media in communication updates, librarians can pass announcements of new acquisitions and even send remote login credentials to students both within and without at ease.

13. Conclusion

The twenty first century e-learning education offers several prospects for improvement, growth, advancement and expansion of education and learning far beyond the traditional classroom setting. The most difficult moment facing the twenty first century e-learning education presently is the issue of security and sustainable investment. It became very imperative to focus attention on the security issues particularly the availability, privacy, integrity and confidentiality in e-learning, m-learning and u-learning environment to foil security infringements. E-learning education is an innovative idea to make

possible students and lecturers interaction in educational collaborative environment and connective teaching and learning to intellectually stimulate knowledge exchanges. This research enthusiastically established that e-learning, m-learning, u-learning and p-learning will ultimately become very popular and subsequently dominate the future e-learning digital environment and cryptographic techniques can be used to send and receive communication among the participating parties to enable the users feel comfortable and secured from espionage.

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