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Abstract

This study focused on the impact of cloud services on students' attitude towards mathematics education in public universities in Benue State, Nigeria. Ex-post facto research design was adopted for the study. The instrument for the study is the researcher-developed Cloud Service Impact Questionnaire – CSIQ (Cronbach Alpha Coefficient = 0.92). The CSIQ was administered to a sample of 328 mathematics education students drawn from the two public universities having operational cloud service delivery system in Benue State. Mean and standard deviation were used to answer research questions while t-test was used in testing the hypotheses at 0.05 level of significance. In-depth analysis of data obtained in the study revealed that there is a positive high level of impact of cloud services on the mathematics confidence (cluster mean attitude score = 2.85), affective engagement (cluster mean attitude score = 2.87) and behavioural engagement (cluster mean attitude score = 2.92) of mathematics education students in public universities in Benue State. The results also indicated a high frequency of usage of cloud services, with smartphones (49%), tablets (24%) and laptops (16%) being the set of computer devices readily available among mathematics education students in public universities in Benue State. The t-test analysis of mean attitude scores established a statistically significant difference between the public universities. The mean difference in attitude scores between male and female mathematics education students was also found to be statistically significant. The outcome of this study has shown that adoption of cloud services for augmenting learning results in strong positive mentality and confidence among mathematics education students, leading to students feeling good, thinking hard and actively participating in their own mathematics learning.

Introduction

Education is a conscious effort of the society to inculcate her existing body of knowledge, values, norms, science and technology into the young generation for the purpose of active participation in the society. To achieve this purpose, the society engages the services of educational institutions where children are taken through well-planned structures. From the standpoint of society, one of the most urgent aims of education is to facilitate social and economic development (Cassady, 2014). As such, education is expected to expose learners to the scientific and analytical thinking skills they need to understand, build and innovate new technologies.

Education in the 21st century is more than mere transfer of knowledge. The role of education is not one of following and reacting to trends (Raja, 2002). Education has come to be in the lead and play a major role in societal development of the future. With the integration of available information and communications technology (ICT) components, education has risen to become the fulcrum on which the competitiveness of nations in the global community rests (Iji, Abah & Uka, 2013). ICT networks are now making it possible for developing countries to participate in the world economy in ways that simply were not possible in the past (Baez, Kechiche & Boguszewska, 2010). Emerging economies such as Nigeria are becoming the destination for new investment opportunities via the provision of enabling environment that encourages the development of technological infrastructure.Within the demands of the time, both the education system and the educational process must be amenable. This calls for a fundamental qualitative transformation of education in terms of its content, methods and outcomes. Education should seek to inculcate skills that are aimed at accelerating technological change, rapidly accumulating knowledge, increasing global competition and rising workforce capabilities (Partnership for 21st Century Skills, 2002). Schools must equip students who will ultimately spend their adult lives in a multitasking, multifaceted, technology-driven, diverse and vibrant world. The reality on ground has made it imperative for the education system to be more strategic, aggressive and effective in preparing students to succeed and prosper. Educational institutions must rethink what, but even more important, how and where we learn (Innovation Unit, 2014).Although it is clear that technology is not the solution to present day education (Lokesh, 2013), utilizing emerging technologies to provide expanded learning opportunities is critical to the success of future generations. The level of penetration of ICT among students signals more than a change in pedagogy; it suggests a change in the very meaning and nature of mathematics education itself (Italiano, 2014). Schools all over the world are becoming an integral part of the broadband and technological transformation, harnessing the potentials of technology to drive and empower more personalized mathematics learning. One of the specific ways technology is enhancing present day mathematics teaching and learning is through the utilization of the cloud. The cloud is a set of hardware, networks, storage, services, and interfaces that enable the delivery of computing as a service (Hurwitz, Bloor, Kaufman & Halper, 2010). Cloud services include the delivery of software, infrastructure and storage over the internet, reducing cost and providing flexibility and mobility (Kovachev, Cao & Klamma, 2011). These services are delivered via the internet from high-specification data centres in locations remote from the end user.

The educational cloud involves all the learning students carry out on mobile phones, smartphones, tablets, palmtops, laptops and PCs while connected to Wi-Fi. It may include download of materials for assignments and research, studying online and other individualized learning done via connectivity to the wireless cloud within the campus or elsewhere. The cloud services of public universities provide mathematics education students access to infrastructure and content, increased openness to new technologies, and general support for teaching and learning. With such support readily available, students' perspectives of mathematics, which have been usually attested to be skeptical, stand to be influenced.

Active utilization of cloud services provided by educational institutions has grown in importance as a result of a new genre of students with learning needs vastly different from their predecessors (Thomas, 2011). Present day students require increase network access to sustain their culture of learning, leisure and social interaction. The computing power provided by the cloud avails the opportunity to extend students' mathematics learning beyond the walls of the classroom, thereby offering the learner greater participation and control of the learning process.Students' attitude toward mathematics is seen as the pattern of beliefs and emotional dispositions associated with mathematics (Zan & Di-Martino, 2007). It is the positive or negative degree of affection towards the subject mathematics. Whitin (2007) maintains that what students believe about mathematics influences what they are willing to say publicly, what questions they are likely to pose, what risks they are willing to take, and what connections they make to their lives outside the classroom. Attitude entails confidence and engagement. How students feel about mathematics is an outcome that is heavily dependent on the local culture and context, age and stage (Pierce, Stacey & Barkatsas, 2007). Mathematics confidence is a measure of students' personal belief in their own ability to handle learning situations in mathematics effectively, overcoming difficulties (Mohamed & Waheed, 2011; and Santos & Barmby, 2010). Mathematics confidence affects students' willingness to take on challenging tasks and to make an effort and persist in tackling them.

Generally, engagement in mathematics refers to students' psychological investment in and effort directed toward learning, understanding, or mastering the knowledge, skills, or crafts that academic work is intended to promote (Santos & Barnby, 2010). Affective engagement is students' own interest and enjoyment of mathematics as well as reactions to external incentives (Organization for Economic Co-operation and Development - OECD, 2004). Behavioural engagement draws on the idea of participation and includes involvement in academic, social, or extracurricular activities and is considered crucial of achieving positive academic outcomes and preventing dropping out (Fredricks & McColskey, 2012). The flexibility of cloud services may lend the technology as a compactible tool in mathematics education. The utilization of cloud technology may offer students the opportunity to appropriately use ubiquitous wireless network to access, manage, integrate and evaluate information, construct new knowledge, and communicate with others in order to participate effectively in the society (Partnership for 21st Century Skills, 2002). With the aid of available cloud services, students can drive more personalized learning of mathematics, forming a positive and appropriate image of the subject (Artigue, 2012).

The functionality of the cloud is gradually changing the way mathematics education students study and do research in school. Cloud utilization must have deposited some measure of impact on the students' perception of mathematics education. If this impact exists, then it may contribute in bridging the gender gap attached to students' attitude towards mathematics education. The cloud has come to stay in university education in Nigeria as a tool for hooking students to the information grid. Campuses across the country are already leveraging on the dividends of mobile and wireless technology, considering the ubiquity of smartphones and other computer devices among the present-day student population. The level of penetration of cloud services in public universities, particularly in Benue State, calls for an in-depth assessment of the extent of impact on learners' disposition towards mathematics education. It is against this backdrop that this study sought to investigate the impact of cloud services on students' attitude towards mathematics education in public universities in Benue State.

Statement of the Problem

Historically, mathematics teaching at the lower levels of education does not always allow students to develop favourable disposition towards the subject. Most students cultivated a wrong perspective of the difficulty of mathematics as a school subject. With this misconception strengthened by the deployment of instructional strategies that obviously stunt the growth of mathematical mastery, one of the outcomes of this poor orientation is the lack of mathematics confidence and engagement among mathematics education students. This cause for worry among mathematics educators has led to the quest for technological augmentation in instructional delivery.

Gaining insights into students' attitudes and beliefs has been described as the most important and crucial step in understanding how the learning environment for mathematics is affected by the introduction of computers and other technology. Modern pedagogies of mathematics education lay emphasis on adoption of active-learning strategies that put students in charge of their own learning. Such instructional strategies entail the efficient blend of technologies in the teaching and learning process. Cloud technology in particular lets both the teachers and students stay abreast of current issues in mathematics education while enriching the learning experience. The ICT Directorates of public Universities are usually charged with the responsibilities of anchoring these cloud services. This provision of standard internet services must have influenced the way mathematics education students perceive their discipline. The issue then was do the availability of cloud services in public universities in Benue State affect students' attitude towards mathematics education? Would its impact on attitude of mathematics education students be associated with gender?

Research Questions

The following research questions guide the study.

1. What are the computer devices readily available among mathematics education students for accessing cloud services in public universities in Benue State?
2. How frequent do mathematics education students of public universities in Benue State make use of available cloud services?
3. To what extent do cloud services affect mathematics confidence of mathematics education students in public universities in Benue State?
4. To what extent do cloud services affect the affective engagement of mathematics education students in public universities in Benue State?
5. To what extent do cloud services affect the behavioural engagement of mathematics education students in public universities in Benue State?
6. Which gender's attitude towards mathematics was more affected due to cloud services among mathematics education students in the public universities in Benue State?

Research Hypotheses

The following research hypotheses were formulated and will be tested at 0.05 level of significance:

1. There is no significant difference in the mean response of mathematics education students on how cloud services affect students' attitude towards mathematics education in the public universities in Benue State.
2. There is no significant difference in the mean response of mathematics education students on how cloud services affect male and female students' attitudes towards mathematics education.

Educational Cloud Services

According to the National Institute of Standards and Technology (NIST) (as cited in UNICOM Government Inc, 2009), cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g. networks, servers, storage, applications, and services) that can be provided with minimal service provider effort. Typically, cloud services run in a web browser requiring the user to have only basic components while enjoying high speed, bandwidth and computing power. This simplicity is why the emergence of cloud services is fundamentally shifting the economics of IT-based businesses (Harms & Yamartino, 2010). Education has not remained unaware of this trend in migration to the cloud (Niharika, Lavanya, Murthy & Satya Sai Kumar, 2012). Presently, virtualized resources are being provided to educational institution over the internet, without users having knowledge of, expertise in, or control over the technology infrastructure. More students are enriching their educational experience daily through network access provided by private cloud services.To grasp the extent of utilization of cloud services in education, it is important to briefly study the acceptable architectural model of cloud computing.

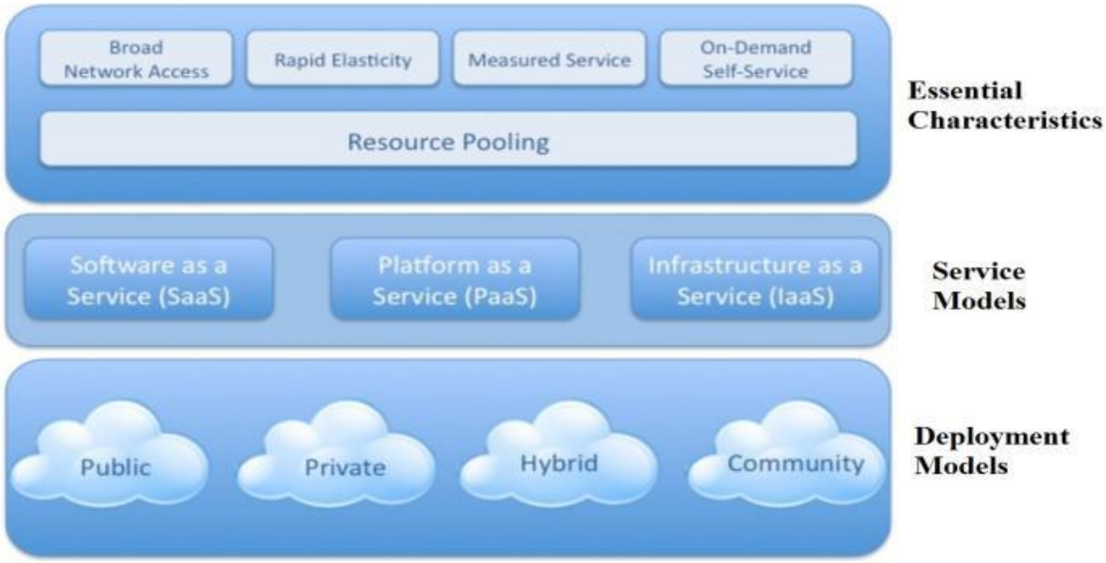

Figure 2: NIST visual model of cloud computing definition (*Source: Niharika et al, 2012)*

Essential Characteristics:

Most commentators on cloud computing agree on five key characteristics

i. Broad Network Access: Services are provided over the network and accessed through standard mechanism.
ii. Rapid Elasticity: The cloud gives the user the impression that the services are infinitely scalable. The service needs to be available all the time and it has to be designed to scale upward for high periods and downward for lighter ones (Hurwitz et al, 2010).
iii. Measured Service: A cloud environment has built-in system that bills users. In educational institutions such as the public universities in Benue State, students are given a number of hours daily to access the cloud, logging in with their user accounts as created on the university portal after payment of tuition fees.
iv. On-Demand Self-Service: The cloud allows the user to request an amount of computing facility needed automatically, without requiring direct human interaction with a service provider.
v. Resource Pooling: Computing services such as storage, processing, network, bandwidth, and virtual machines are dynamically assigned and reassigned according to the user's demand.

Cloud Service Models

Cloud service delivery is divided into three models. They are infrastructure as a service, platform as a service, and software as a service.Infrastructure as a Service (IaaS) is the delivery of computer hardware for customized needs of the user. Such computer hardware include resources like servers, networking technology, storage, and data centre space. Educational institutions benefit maximally from networking technology (wireless network) and access to servers. Platform as a Service (PaaS) is the capability provided to the user to deploy onto the cloud user-created or acquired applications created using programming languages and tools supported by the provider.

Software as a Service (SaaS) implies the provision of applications which are accessible to users from various client devices through a thin interface such as a web browser. The private cloud service of the Universities in Benue State offers web-based email, virtual library, among other application services.

Cloud Deployment Models

The NIST recognizes four deployment models for cloud services.

i. Public Cloud: The cloud infrastructure is made available to the general public or a large industry group and is owned by an organization selling cloud services. Popular examples are the Amazon Cloud and Google Cloud.
ii. Private Cloud: This cloud infrastructure is operated solely for a single organization. It is managed by the organization or a third party, and may exist on-premises or off-premises. The ICT Directorate of the Universities power the private cloud service on-premises, and serves the entire university community.
iii. Community Cloud: This cloud infrastructure is shared by several organizations and supports a specific community that has shared concerns.
iv. Hybrid Cloud: This cloud infrastructure is a composition of two or more clouds that remains unique entities but are bound together by standardized or proprietary technology that enables data and application portability (e.g. Cloud bursting for load-balancing between clouds).

The Wireless Network Technologies in Universities

Considering cost and technical factors, higher educational institutions are seeking private cloud services to provide a common interface, common identity infrastructure, and common service attributes (Katz, Goldstein & Yanosky, 2009). Universities are turning into network hubs, as mobile devices are carried by students and staff, and these devices are communicating with the world around them (Steijaert, Boyle, Leinen, Melve & Mitsos, 2012). Educational institutions are responding to the availability of cloud services by enforcing the use of a limited set of services such as official e-mail, internal university portal, and e-library services. Users are increasingly connecting to the wireless network on campus. One of the primary requirements for benefiting from the wide range of services rendered by the university cloud is access to the school's wireless network. The term "wireless network" refers to two or more computers communicating using standard network rules or protocols, but without the use of cabling to connect the computers together (Bakardjieva, 2014). For a telecommunications network to work, connectivity needs to be ensured at different levels by the elements present (Neto, 2004). The wireless network is basically a system of radio technologies deployed in the 2.4GHz and 5GHz bands. Best (2003) presented a hypothetical network installation as depicted in Figure 3.

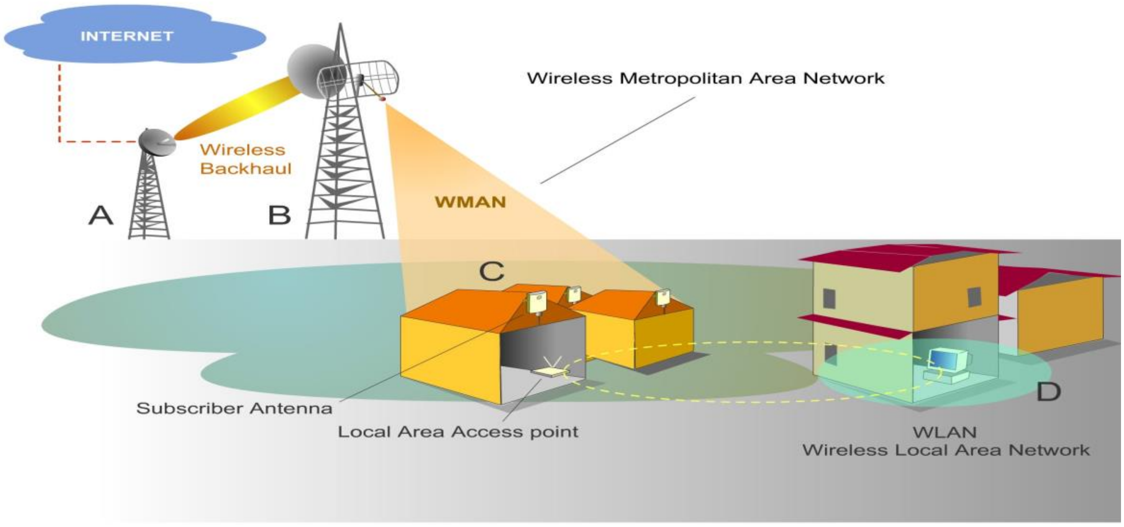

Figure 3: Connectivity in Wireless Networks (*Source: Best, 2003)*

This schematic diagram shows two radio towers (A and B), houses and other buildings (C), and a personal computer inside a building (D). Radio tower A is connected through a wired link to an Internet Point of Presence owned by an Internet Service Provider (ISP). The ISP radio tower could belong to any of the telecommunications companies with presence in the university (e.g. Airtel, Glo, Etisalat, or MTN). So, the PC shown at point D is ultimately connected to the Internet by several wireless links.To start with, a point-to-point connection is used between radio towers A and B, with only one antenna (i.e. one receiver/transmitter) in both extremities. According to Neto (2004), the purpose of this connection is typically to transmit over long distances (in the order of tens of kilometres). Several of these links can be used, one after the other; in this way the signal will be transmitted, in "hops", to a potentially remote location. This is normally referred to as wireless backhaul. The connection from B to C is a point-to-multipoint connection. This means that radio tower B is now radiating to and receiving from several stations of type C – i.e. several buildings with base stations, or access points. This is normally called a Wireless Metropolitan Area Network (WMAN) (Neto, 2004). Finally, there is a radio connection between the subscriber equipment mounted on the side of the building (point C) and the individual personal computer inside the building (point D). This is what is normally called a Wireless Local Area Network (WLAN). An outdoor repeater may be required to redistribute the signals from the access point in a situation where there are blockages in the direct line of site (LOS) between the base station (access point) and the personal computer (PC). For a PC to access the wireless network, it must possess a network interface card (NIC) or a network adapter card. Most modern laptops and mobile devices come with in-built network cards. Such Wi-Fi enabled systems can track signals from base stations available at the offices of the Deans of the various colleges/faculties of the university. The usual transmitting proximity ranges from 100 metres indoors to 350 metres outdoors (Bakardjieva, 2014).

Cloud Architecture for University

According to Mircea and Andreescu (2011), the architectural pattern of using cloud computing in universities may be described starting from the development and supply of services and resources offered to the university community. This may be illustrated as in figure 4.

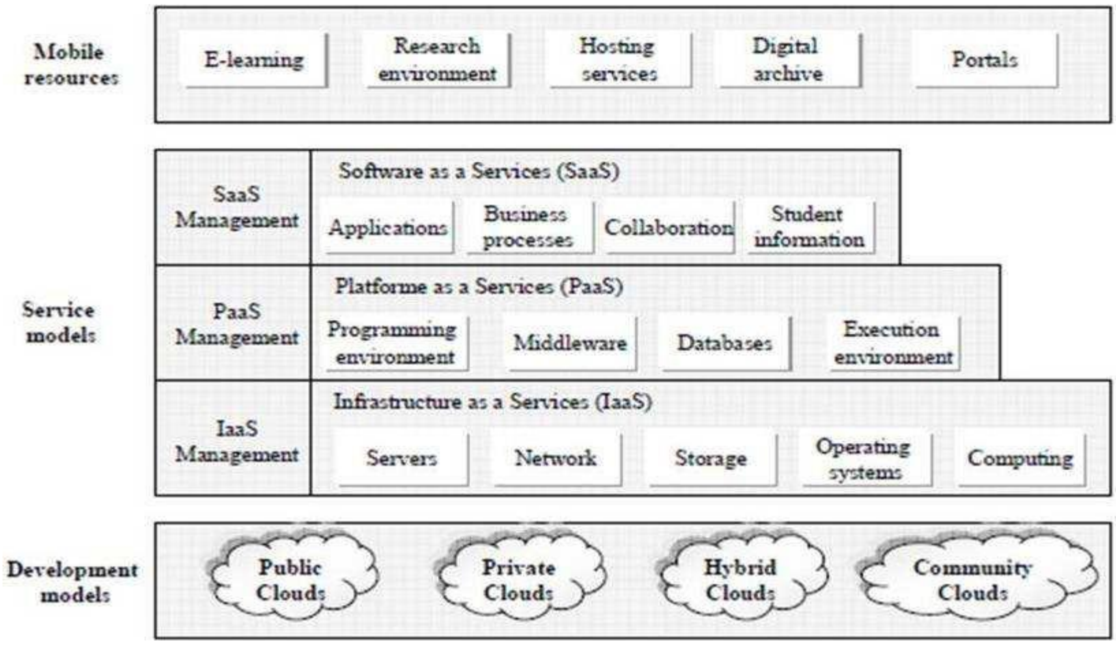

Figure 4: Cloud Architecture for University (*Source: Mircea & Andreescu, 2011)*

As shown in figure 4, students and staff benefit from mobile resources as e-learning, expanded research environment, e-mail hosting services (for instance @uam.edu.ng), digital archive and student portal services. The services models indicate areas of direct impact of the three service models of cloud computing. The widest area of impact is the availability of wireless Internet network as a service.

Empirical Studies

Wu (2013) embarked on a study to observe the difference between the learning behavior and attitude of students before exposure to IT education environment of cloud computing service and after exposure. The study applies a quasi-experimental design on 110 fifth grade students who were selected from Tunglo Elementary School in Miaoli county, Taiwan. 55 of the students were place in an experimental teaching spanning four weeks, one period per week. Before and after the four weeks experiment teaching, all participants had to fill out the "Scale of Using IT Education Environment of Cloud Computing" (Cronbach's alpha = 0.953). Students were given user accounts to access cloud services hosted inside the school. The results showed the means of pretest and posttest of each scale was greater than the reference value. The t-test analysis ($t_{(92.395)}$ = 5.689, p = 0.000, MD = -1.830) indicate that after using the cloud service, students had more positive attitude towards using it, even after school. This study by Wu (2013) relates to the present work in its direct usage of cloud services in instruction. Also, the allocation of user accounts to students for cloud access is a similarity shared by both works. However, students used for the study are from a lower level education, and the subject of interest was IT education. This present work intends to poll the impact of using cloud services on the attitude of mathematics education students in public universities towards the subject of mathematics.

The work of Johnson and Hiran (2014) presented at the International Conference on Science, Technology, Education, Arts, Management and Social Sciences (iStEAMS) held at the Afe Babalola University, Ado-Ekiti in May, 2014, drew a comparative line for universities in Nigeria. The Ghana-based survey was designed to elicit information from a target population comprising IT administrators, faculty and students from four selected tertiary institutions. The sample for the study comprises of 50 respondents randomly drawn from among IT administrators, faculty and students in the four selected tertiary institutions. Structured questionnaire containing both open and closed-ended questions were used to obtain data on the usage, benefits and the constraints of cloud computing technology in higher educational institutions in Ghana. Data analysis for the study was carried out using frequencies, percentages and pie charts. Majority of the respondents constituting 76% said that their institutions do not use any cloud service model while the rest of the respondents (24%) said their institutions use at least one of the cloud service models. Out of the respondents whose institutions used at least one (1) cloud service model, the percentage of respondents according to service models are: SaaS: 40%; PaaS: 30%; IaaS: 22%; and none: 8%. This present research is in line with the work of Johnson and Hiran (2014) in its emphasis on all the cloud service models available to mathematics education students. Although the researchers sampled opinions from across several schools, their study was not field-specific. The specific impact of the services on students was not ascertained.

A recent study of students from two Nigerian universities by Olibe, Ezoem, and Ekene (2014) underscore the extent of awareness of available virtual learning channels in Nigeria. The researchers employs a descriptive survey design on a sample of six hundred and forty (640) 300 level students in the only two public universities in Anambra State. The study used a researcher-developed checklist titled “Students Virtual Learning Awareness Questionnaire” (SVLAQ). The study used frequencies and percentages in analyzing data obtained with the SVLAQ. The findings of the study indicate students were mostly aware of virtual learning channels such as educational blogs, online libraries, online self-paced course contents with inter-linkage support, and other alternative learning channels provided via connections to cloud networks. The study also noted a surprising incongruence in male and female students’ awareness of what constitutes virtual learning, with female students having more knowledge of virtual learning than male students. Olibe et al (2014) recommended that lecturers need to incorporate virtual activities in curriculum delivery, task design processes and outcomes, teaching pedagogies, and measurements of actual learning. The work elaborately identified aspects of educational content assessed through available network services as covered by this present research on cloud utilization in public universities in Benue State. But the researchers drew their sample from across different disciplines, not expounding what the said awareness of virtual learning holds for individual fields of study such as mathematics education.

In a similar vein, Oyeleye, Fagbola and Daramola (2014) carried out a study to investigate the impact and challenges of the adoption of cloud computing by public universities in the southwestern part of Nigeria. A sample of 100 IT staff, 50 para-IT staff and 50 students each was selected from 10 public universities in the southwest. The researchers adopted a descriptive survey for the study. The study employed a structured questionnaire titled “The Evaluation of the Impact and Challenges of Cloud adoption and Use on Universities in Southwestern Nigeria.” The instrument has a Cronbach Alpha reliability coefficient of 0.89. Frequency and percentage distributions were used to analyze collected data. The outcome of the study indicated a mere 10% adoption of cloud computing by Nigerian public universities, with the service model distribution represented as PaaS: 20%, IaaS: 10%, and SaaS: 70%. This distribution corroborates the report of Johnson and Hiran (2014) that the highest numbers of cloud consumers subscribe to SaaS. Still, this study fall short of specifics, not relating how students utilize the services directly in their course of study.

In another study, Adeyeye, Afolabi and Ayo (2014) in a study canvassing for enhanced academic standards affirmed that cloud networks are commonplace in Nigerian tertiary institutions and act as a good platform for distributing and disseminating instructional materials. The study, which employs a system analysis and implementation design, is a detailed presentation of the development of a virtual campus in Covenant University, Ota, Nigeria. All the students of the school’s College of Science and Technology (CST) have access to personal computers, with 70% having personal laptop (PCs). Students access the university cloud via wireless access points (hotspot zones) connected through a backbone network of fiber optics. The work seeks to improve quality through online provision of learning resources based on Free Open Source Software (FOSS), wired and wireless access to contents, discussion forum, and mail services. The researchers recommend efficient propagation of similar systems in higher educational institutions in Nigeria to reduce students' idle time and get them engaged in productive academic discourse. The study, however, left out the use of any programme within CST to test the efficacy of the virtual campus. Another obvious discrepancy between the work of Adeyeye et al (2014) and this present study is the fact that the target school is a private university. This present work is subject-area-specific (mathematics education) and draws its sample from the domain of public universities.

Methodology

Ex-post facto research design was adopted for this study. The study was conducted in Benue State. The State is located in North Central region of Nigeria. The population of the study comprises all mathematics education students in public universities in Benue State. The target population size was 1807 students. The sample comprises 328 mathematics education students drawn from the two out of the three public universities in Benue State having operational cloud service delivery systems. Proportionate stratified random sampling was used to select 82 mathematics education students from the State University and 246 mathematics education students from the Federal University, resulting in a total sample size of 328. The instrument for data collection in this study was the Cloud Services Impact Questionnaire (CSIQ). The CSIQ is a researcher-developed instrument which comprises four (4) sections, A, B, C and D. Section A, tagged Basic Information, is meant to elicit responses on mathematics education students' institution, sex and study option. Section B is a checklist tagged Computer Devices Used in Accessing Cloud Services. The checklist contains the various computer devices available among students for connecting to cloud services when in a Wi-Fi hotspot. Section C of CSIQ provides responses on the frequency of usage of cloud services among mathematics education students. The item elicits response ranging from Very Frequent, Frequent, Fairly Frequent, to Not Frequent.

Section D is an attitude scale tagged Cloud Services Mathematics Attitude Scale (CSMAS). The CSMAS is a mathematics attitude scale adapted from a set of existing mathematics attitude scales including Modified Fennema-Sherman Mathematics Attitude Scale (Doepken, Lawsky, & Padwa, 1993), Mathematics and Technology Attitude Scale (Pierce, Stacey & Barkatsas, 2007), and Attitudes to Technology in Mathematics Learning Questionnaire (Fogarty, Cretchley, Harman, Ellerton & Konki, 2001). The CSMAS consists of 40 items, structured on a four-point scale of Very High Impact (VHI), High Impact (HI), Low Impact (LI), and Very Low Impact (VLI). The items of the CSMAS cover basic components of mathematics attitude such as mathematics confidence, behavioural engagement, and affective engagement. Positive items were scored 4, 3, 2, and 1, for VHI, HI, LI, and VLI respectively. The scoring for negative items are reversed after the order 1, 2, 3, and 4, for VHI, HI, LI, and VLI respectively.The validation of the instrument for this study was done by two experts in Mathematics Education and one expert in Measurement and Evaluation. To ensure reliability, the CSIQ was trial-tested on 50 mathematics education students at a conventional university within Nigeria's North Central region. Results obtained from the trial testing were subjected to reliability analysis yielding a Cronbach's alpha coefficients of 0.80 for the mathematics confidence sub-scale; 0.83 for the affective engagement sub-scale; 0.89 for the behavioural engagement sub-scale; and 0.92 for the summated CSMAS. Data were collected and analyzed using both descriptive and inferential statistics. The research questions were answered using simple percentages, pie charts, mean, and standard deviation. The research hypotheses were tested at 0.05 level of significance using the t-test.

Results

The presentation of data analysis and interpretation for this study was done according to the research questions and followed by related hypotheses.

Research Question One

What are the computer devices readily available among mathematics education students for accessing cloud services in public universities in Benue State?

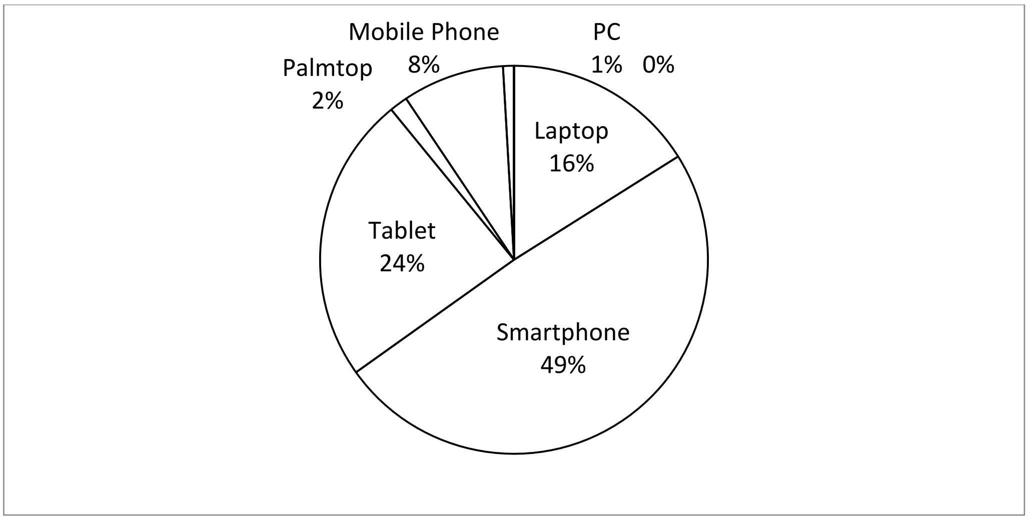

Figure 5: Computer devices used in accessing cloud services

Figure 5 shows that smartphones (49%), tablets (24%) and laptops (16%) are the prevalent computer devices readily available among mathematics education students for accessing cloud services. This shows a high level of penetration of hand-held devices over café-type personal computers (1%) which used to be the norm.

Research Question Two

How frequent do mathematics education students of public universities in Benue State make use of available cloud services?

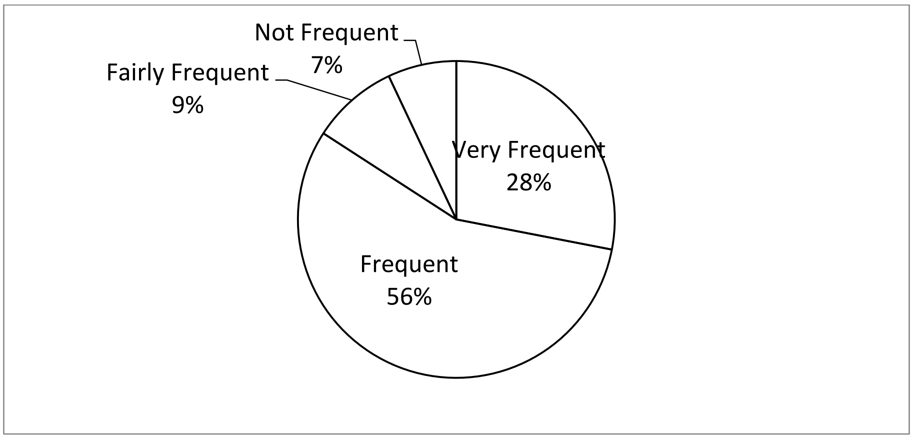

Figure 6: Frequency of usage of cloud services

Figure 6 indicate that a high percentage of mathematics education students (56% and 28%) frequently access cloud services.

Research Question Three

To what extent do cloud services affect mathematics confidence of mathematics education students in public universities in Benue State?

In Table 1, the result shows that there is a high level of impact of cloud services on the mathematics confidence of mathematics education students in public universities in Benue State, considering the high cluster mean of 2.85 for the sub-scale, as compared to the benchmark of 2.50.

Table 1. Mean attitude scores of mathematics confidence of mathematics education students in public universities in Benue State

S/No.	Items	Mean	SD	Remark
1	I am sure that I can learn mathematics using cloud services.	2.63	1.09	High
2	Mathematics is hard for me even with the use of cloud services.	3.13	1.03	High
3	I find mathematics frightening even with cloud services.	2.78	1.00	High
4	I know I can handle difficulties in mathematics with the aid of cloud services.	3.47	0.87	High
5	It takes me longer time to understand mathematics than the average person even with the aid of cloud services.	3.81	1.01	High
6	I'm not the type to do well in mathematics.	2.91	0.70	High
7	I am proud of my abilities in mathematics when aided with cloud services.	2.92	1.12	High
8	I have a mathematical mind which is enhanced with the aid of cloud services.	2.71	1.05	High
9	I find mathematics confusing even with the aid cloud services.	2.41	0.86	Low
10	Most subjects I can handle OK, but I only manage to endure mathematics even with cloud services.	3.03	0.92	High
11	I know I can do well in mathematics by using cloud services.	2.85	1.21	High
12	I know cloud services are important but I don't feel I need to use them to learn mathematics.	2.48	0.81	Low
13	I can get good grades in mathematics with the aid of cloud services.	2.88	0.97	High
	Cluster Mean	**2.85**		**High**

Research Question Four

To what extent do cloud services affect the affective engagement of mathematics education students in public universities in Benue State?

Table 2. Mean attitude scores of affective engagement of mathematics education students in public universities in Benue State

S/No.	Items	Mean	SD	Remark
1	I like using cloud services for mathematics.	2.54	1.13	High
2	In using cloud services to study mathematics, you get your answers correct as rewards for your efforts.	2.79	1.01	High
3	Cloud services aid my interest in learning new things in mathematics.	3.05	0.97	High
4	I find many mathematics problems interesting and challenging with the aid of cloud services.	3.06	0.72	High
5	Learning mathematics through cloud services is enjoyable.	3.01	1.05	High
6	I get a sense of satisfaction when I solve mathematics problems with the aid of cloud services.	2.58	0.71	High
7	I feel good about using cloud services to study mathematics.	2.92	1.13	High
8	Mathematics is more interesting when using cloud services.	2.77	1.00	High
9	I have never been excited about mathematics even with cloud services.	2.94	0.82	High
10	I like the idea of exploring mathematical methods using cloud services.	2.61	1.18	High
11	I always look forward to using cloud services to study mathematics.	2.82	1.15	High
	Cluster Mean	**2.87**		**High**

The results in Table 2 indicate that the affective engagement of mathematics education students in public universities in Benue State is highly impacted by the utilization of cloud services. This was established by the cluster mean attitude score of 2.87 for the affective engagement sub-scale, which is higher than the benchmark of 2.50.

Research Question Five

To what extent do cloud services affect the behavioural engagement of mathematics education students in public universities in Benue State?

Table 3. Mean attitude scores of behavioural engagement of mathematics education students in public universities in Benue State

S/No.	Items	Mean	SD	Remark
1	If I can't solve a mathematical problem, I use cloud services to try out different ideas on how to solve the problem.	2.73	1.15	High
2	I always try to do assignments with the help of cloud services.	3.21	0.92	High
3	Cloud services make me versatile in mathematics.	2.75	0.95	High
4	When studying mathematics using cloud services, I often think of new ways of solving mathematics problem.	2.80	1.01	High
5	I think using cloud services waste too much time in the learning of mathematics.	3.03	1.18	High
6	When learning mathematics with the aid of cloud services, I try to understand new concepts by relating them to things I already know.	2.80	1.02	High
7	Using cloud services to study mathematics makes it easier for me to do more real life applications.	3.16	1.05	High
8	When I cannot understand something in mathematics, I always use cloud services to search for more information to clarify the problem.	2.65	0.83	High
9	Having cloud services to do routine work makes me more likely to try different methods and approaches.	3.14	0.92	High
10	Using cloud services in mathematics is worth the extra effort.	2.86	0.99	High
11	When I study for a mathematics test using cloud services, I try to work out the most important parts to learn.	2.87	0.84	High
12	I prefer to study mathematics by myself, without using cloud services.	2.66	1.17	High
13	When I study mathematics using cloud services, I try to figure out which concepts I still have not understood properly.	3.34	0.89	High
14	If I have trouble in understanding a mathematics problem, I go over it again using cloud services until I understand it.	2.74	1.14	High
15	When I study mathematics with the aid of cloud services, I start by working out exactly what I need to learn.	2.04	0.94	Low
16	I find reviewing previously solved problems using cloud services to be a good way to study mathematics.	3.27	1.02	High
	Cluster Mean	**2.92**		**High**

The results shown in Table 3 indicate a cluster mean attitude score of 2.92 for the behavioural engagement sub-scale which is higher than the benchmark of 2.50. This implies that cloud services highly affect the behavioural engagement of mathematics education students in public universities in Benue State.

Research Question Six

Which gender's attitude towards mathematics was more affected due to cloud services among mathematics education students in the public universities in Benue State?

Table 4. Mean attitude score of male and female mathematics education students' public universities due to the use of cloud services

Gender	N	Mean Attitude Score	Remarks
Male	202	2.782	High
Female	126	2.956	High
Mean Difference		0.174	
Total	328		

Results in Table 4 shows that the mean attitude score of male mathematics education students is 2.782 while that of female mathematics education students is 2.956. Although both male and female mathematics education students scored reasonably high across the CSMAS, a mean difference of 0.174 in favour of female mathematics education students was observed.

Research Hypothesis One

There is no significant difference in the mean response of mathematics education students on how cloud services affected students' attitude towards mathematics education in the public universities in Benue State.

Table 5. t-test analysis of mean attitude scores of mathematics education students from the two public universities

Public University	Mean	N	DF	t-calculated	p-value
Federal University	2.822	246			
			326	5.629	0.000*
State University	3.025	82			
Total		328			

*significant at α = 0.05

Table 5 shows that the p-value of 0.000 affirms that there is a significant difference in the mean response of respondents on how cloud services affected students' attitude towards mathematics education in the public universities in Benue State, hence the null hypothesis is rejected at 0.05 level of significance. Eyeballing the cluster mean attitude scores of both educational institutions indicate that mathematics education students from the State University are more impacted by cloud services than their counterparts from the Federal University.

Research Hypothesis Two

There is no significant difference in the mean response of mathematics education students on how cloud services affected male and female students' attitudes towards mathematics education.

Table 6. t-test analysis of mean attitude scores of male and female mathematics education students

Gender	Mean	N	DF	t-calculated	p-value
Male	2.782	202			
			326	2.893	0.004*
Female	2.956	126			
Total		328			

*significant at α = 0.05

From the results in Table 6, the p-value of 0.004 which is less than 0.05 indicates that there is a significant difference in the mean response of respondents on how cloud services affected male and female students' attitudes towards mathematics education. The null hypothesis was therefore rejected at 0.05 level of significance.

Discussion

The results displayed in the pie chart in figure 5 indicated that mathematics education students often access online cloud services using smartphones (49%), tablets (24%), laptops (16%) and mobile phones (8%). The high percentage of students using smartphones and tablets to access educational cloud services is a pointer to the changing technological landscape which is rapidly enabling the ability to learn on-the-go. This is as established by as related study by Anyor and Abah (2014) who maintained that a great number of students (70%) deploy smartphones for mobile learning. Smartphones are distinguishable from the less powerful mobile phones in their high specification in terms of 3G to 4G network access, Wi-Fi, Frontal VGA camera, QWERTY keyboard, and compatibility with a wide range of applications such as Microsoft Office, email, PDF readers, and digital encyclopedia. The data in figure 5 agrees with the Device Usability Aspect of educational technological integration put forward by Kenny, Park, Van Neste-Kenny, Burton and Meiers (2009). Most educational content accessible in the cloud are designed for physical, technical and functional components of devices which provides more psychological comfort for users.

One of the outcomes of this study as presented in the pie chart in figure 6 is the high frequency of usage of cloud services by mathematics education students. Due to great ease of use, students are increasingly depending on cloud sourced educational contents. This finding agrees with Bavelier, Green and Dye (2010) who rightly observed that high frequency of technology utilization in education is becoming pervasive. This high frequency of usage of cloud services, according to Mills (2014), strengthens specific cognitive strategies in young adults. The results displayed in Table 1 suggest that cloud service utilization among mathematics education students exerts a high level of impact on the mathematics confidence of the students. This finding implies cloud service adoption is helping mathematics education students overcome their psychological barriers in doing well in mathematics. Cloud services thus enhance the students' natural aptitude in mathematics and raise their belief in their capability to achieve a successful outcome. The high extent of impact of cloud services on the students' mathematics confidence observed in this study is in agreement with the research findings of Abd-Wahid and Shahrill (2014) and the assertion by Rusinov (2012) that review of good class notes using cloud-sourced contents boosts self-confidence in mathematics. Cloud services avails students the opportunity to utilize free interactive platforms on the Internet, assuring them of their ability to handle difficulties in mathematics. This practice of studying mathematics with online help develops students' mentality towards mathematics education and improves their self-worth, not only in the discipline, but in life as a whole. As reported in Table 2, mathematics education students' affective engagement is highly impacted by the adoption of cloud services (cluster mean = 2.87). This is an indication that the students react well to cloud services utilization as an external incentive to develop personal interest and enjoyment of mathematics. This outcome is in line with the results presented by Barkatsas, Kasimatis and Gialamas (2009) who affirmed that specific technology use in mathematics education is associated with strongly positive levels of affective engagement. Augmentation of mathematics education with cloud services therefore leads to a relatively stable orientation that affects the intensity and continuity of engagement in learning situations, the selection of strategies and the depth of understanding. The observations of this present study has illuminated the fact echoed by Attard and Curry (2012) that cloud services in particular, and technology integration in general, affects how students react to schooling, teachers and peers, influencing their willingness to become involved in school work. This also agrees with Dix (1999) who upheld that the use of computer-based technology in mathematics does appear to positively influence student motivation.

This study has revealed that cloud services positively affect mathematics education students' disposition to manage their own learning by choosing appropriate learning goals and selecting learning strategies appropriate for mathematical tasks. The results displayed in Table 3 indicate that cloud services utilization engenders high level (cluster mean = 2.92) of behavioural engagement among mathematics education students in public universities in Benue State. This is in agreement with Fredricks and McColskey (2012) who observed that behavioural engagement draws on the idea of participation and involvement in learning processes and is considered crucial for achieving positive academic outcomes. The finding of this study reveals that adoption of educational cloud services by mathematics education students yields high impact on the students behavioural engagement as expressed in dimensions outlined in Abd-Wahid and Shahril (2014) such as attentiveness, diligence, time spent on task and non-assigned time spent on task. Cloud services enable mathematics education students to put in a great deal of practice to perfect their mathematical skills which in turn translate to positive attitude towards their field of study. This outcome from this study also agrees with the work of Shechtman, Cheng, Lundh and Trinidad (2012) who emphasized that a fine blend of technology in mathematics instruction delivery raises the level of commitment of learners. Cloud services, as observed in this present study, encourage mathematics education students to develop sound study strategies and try various approaches and methods of solving mathematical problems.

The analysis of results presented in Table 4 adds commensurately to the debate on repeated priming of mathematics as negatively stereotyped on certain gender of students. The Mean Attitude Score for female mathematics education students is higher than that of their male counterpart, though both gender display strong positive attitudes towards mathematics education. The weight of this difference in attitude towards mathematics education was further subjected to rigorous hypothesis testing as shown in Table 6. The t-test analysis established a statistically significant difference in the impact of cloud services on students' attitude towards mathematics education between male and female mathematics education students in public universities in Benue State. The implication of these results is that female students tend to better perceive their ability to study mathematics education than male students, particularly with cloud services as means of instructional augmentation. This study which agrees with the works of Wong and Hanafi (2007) and Sanders (2006) reveals that female students are more responsive to technological innovation in mathematics education than their male counterparts.

This outcome is obviously in conflict with several traditional studies which upheld mathematics as a male-dominated field of study. In this vein, this finding is in sharp contrast to Fatade et al (2012) who maintain that males tend to show a natural positive attitude to school mathematics while females display negative attitude. Ursini and Sanchez (2008) in a longitudinal comparative study also found significant gender difference in attitudinal change favouring boys when students are subjected to technology augmented mathematics education.

Similarly, Pierce et al (2007) reveal that boys have higher scores than girls for each sub-scale of their newly developed Mathematics and Technology Attitude Scale (MTAS). Keen observation and scrutiny of the body of evidence in favour of the male gender reveals that unlike the present study, most of these studies are based on subjects at the early childhood and lower levels of education where gender disparities are predominant. However, on the other side of the gender debate to which the findings of this study has lend weight, are a series of deeper psychological enquiries such as the one by Spelke (2005) who concluded that highly talented male and female students show equal abilities to learn mathematics. This finding also supports the results of Olibe et al (2014) who reported that female students have more knowledge of virtual learning than male students. Lindberg et al (2010) relatedly held that due to cultural shifts initiated by increasing levels of technology penetration in recent years, the gender gap is closing. Towing a similar path, Adebule and Aborisade (2014) recommended that sex should not be considered as a factor influencing attitude of students towards mathematics and that teachers should teach mathematics freely among all categories of learners. The higher rate of impact of cloud services among female mathematics education students observed in this study could be a pointer to a new demographical structure of technology adoption. Female students who are at the receiving end of the gender complex are now gradually looking up to available means of supporting their mathematics learning. With time, the need to look out for gender disparity in mathematics education may disappear altogether. This line of reasoning has also been suggested by Bergeron (2011) who observed that women are most likely to adopt new technology when it is social, relevant, and seamlessly improves their day-to-day efforts as obtained in mathematics education.

A comparison of the extent of impact of cloud services on students' attitudes towards mathematics education between public universities in Benue State turned out in favour of the State University. The results presented in Table 5 indicate the Mean Attitude Score of mathematics education students in the State University as 3.025 against that of Federal University which is 2.822. The implication of this outcome is that mathematics education students from the State University, a State Government owned university, are more impacted by the utilization of cloud services than their counterparts from the Federal Government owned Federal University. This difference unveils several complex underlying issues bordering on service delivery by the ICT directorates of the educational institutions. This finding agrees with the earlier reported work of Oyeleye et al (2014) who found only 10% efficiency in adoption of cloud computing by public universities in Nigeria. Most of the efficient cloud services delivery systems reported in available literature such as that by Adeyeye et al (2014) are predominantly hosted by private universities.

This finding has suggested that the State University offers better cloud-based services, particularly in terms of infrastructure as a service (IaaS) available unto students, as evidenced in the level of impact on mathematics education students' attitudes. Technical factors such as distribution of wireless access points within a campus, power supply to access points, bandwidth and strength of broadband, and maintenance of service equipment by staff of the ICT directorate, determine the quality of service students get.

Conclusions

Insights into students' attitudes and beliefs are the most important and crucial steps in understanding how the learning environment for mathematics education is affected by the introduction of digital technology. The private cloud services delivered by public universities in Benue State have been increasingly influencing the way mathematics education students study and do research, thereby altering their views, perspectives and disposition towards their discipline.

This study has specifically established a substantial impact of the utilization of cloud services on students' attitude toward mathematics education in the attitudinal component areas of mathematics confidence, affective engagement and behavioural engagement. Cloud services adoption results in strong positive mentality and self-worth among mathematics education students. It also leads to students feeling good, thinking hard and actively participating in their own mathematics learning.

Obviously, allowing students' choice in the mathematics education process is an important element of engagement and sends important messages relating to power and control. The choice of cloud services by mathematics education students as a sort of technological augmentation has opened up rich avenues to develop highly engaging, student-centred mathematical activities and tasks. Engagement in mathematics occurs when students are procedurally engaged during the course of learning and beyond, as they enjoy learning and doing mathematics, and they view beyond the classroom. These outcomes have been revealed to be positively impacted by the utilization of cloud services by mathematics education students in public universities in Benue State, Nigeria.

Recommendations

The following recommendations are made based on the findings of this study:

i. Students of mathematics education should seek deeper and more enriched learning experience by continuously leveraging on available cloud services, benefiting from several online mathematical communities and developing themselves in life-sustaining skills.

ii. Mathematics educators should incorporate emergent technologies like the educational cloud in their instructional design to flexibly support the teaching and learning process and improve students. More instructional aids can be cued from the World Wide Web (WWW) via educational institution-hosted cloud services for all round pedagogical development.

iii. The ICT directorates of public universities should wake up to the challenge of epileptic service delivery by building a consistent maintenance culture to sustain efficient cloud service delivery system. More access points should be made available everywhere on campus, even around students' hostels, to support efficient mobile learning.

iv. The management of public universities in Benue State in particular, and Nigeria in general, should make a concerted effort targeted at improving the deployment of technological infrastructure in their institutions. The commitment on the part of schools' management can only translate to flexible ways of doing things and effective approaches to teaching and learning by faculties and students.

v. The federal and state governments must make more funds available to public universities for technological development and state-of-the-art service delivery. Only a sustained sponsorship from the government can improve the status of Nigerian universities in global ranking.

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