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Educational Cloud Services and the Mathematics Confidence, Affective Engagement, and Behavioral Engagement of Mathematics Education Students in Public University in Benue State, Nigeria

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This study investigated the impact of cloud services on mathematics education students' mathematics confidence, affective engagement, and behavioral engagement in public universities in Benue State, Nigeria. Ex-post facto research design was adopted for the study. The instrument for the study was the researcher-developed Cloud Services Mathematics Attitude Scale - CSMAS (Cronbach Alpha Coefficient = 0.92). The CSMAS 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. In-depth analysis of data revealed that there is a positive high level of impact of cloud services on the mathematics confidence (cluster mean = 2.85), affective engagement (cluster mean = 2.87) and behavioral engagement (cluster mean = 2.92) of mathematics education students in public universities in Benue State. The t-test analysis of mean attitude ratings established a statistically significant difference between the public universities; as well as male and female students. The outcome of this study has shown that the adoption of cloud services for augmenting learning results in strong positive mentality and confidence among mathematics education students in public universities in Benue State.

Education has always been considered as a means through which a society communicates its norms, values, and morals to her young ones to ensure active participation in the society (Iji, Abah & Uka, 2013). Education imparts knowledge, teaches skills, and instills attitudes to the recipients (Ifenkwe, 2013). Singh (1991) maintained that in its widest sense, education is at a cross-roads of societal development and knowledge, and importantly, of dynamic change processes and the capacities to make choices.

Education is at the center of social and economic development because it provides knowledge and skills, encourages new behavior, and increases individual and collective empowerment. Edukugho (2012) observed that educational institutions exist to impart high-level skills to a reasonable proportion of the workforce; develop the intellectual capability of individuals; and engage training of competent, honest, patriotic and responsible professionals needed virtually in all spheres of human endeavor. Intellectual institutions are knowledge generators, centers of innovation, and importantly, service centers for their communities, facilitating and promoting change and development.

Mathematics education is a field of study concerned with the tools, methods and approaches that facilitate the practice of teaching and learning mathematics. Mathematics education, particularly at the higher education level, prepares students for quantitative and symbolic reasoning and advanced mathematical skills through general education, services, and major and graduate programs. Odili (2012) argued that mathematicians can be categorized into two groups: mathematics educators and professional mathematicians. The mathematics educator is concerned with curriculum development, instructional development, and the pedagogy of mathematics. Mathematics education basically prepares students to become innovative mathematics instructors, professionally prepared to communicate mathematics to learners at all levels.

Mathematics educators see mathematics not simply as a body of knowledge or an academic discipline but also as a field of practice. According to Kilpatrick (2008) this is because they are concerned with how mathematics is learned, understood, and used as well as what it is, they take a comprehensive view. Mathematics education looks beyond applications to ways in which people think about mathematics, how they use it in their daily lives, and how learners can be brought to connect the mathematics they see in school with the mathematics in the world around them.

Present-day mathematics education is reactive and future-oriented. It actively promotes innovation amid dynamically evolving social needs (Singh, 1991). Education has risen to become the fulcrum on which the competitiveness of the nation in the global community rests. Higher education, therefore, must be tailored towards success in communities and workplaces. To attain success, emphasis must be placed on higher education that develops in the individual a high sense of global awareness; financial, economic and business literacy; civic literacy; and technological prowess (Partnership for 21st Century Skills, 2002). This calls for efficient integration of modern technology in strategies for communicating knowledge in general, and mathematics education in particular, to a new generation of students.

Cloud Use

One of the specific ways technologies 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 centers 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 downloading 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, may be influenced.

Attitude itself is defined as the positive or negative emotional disposition towards a subject (Gomez-Chacon & Haines, 2008). It represents an emotional response, beliefs regarding the subject, and behavior towards the subject. Specifically, mathematics attitude has been described as aggregated measures of liking or disliking mathematics, a tendency to engage in or avoid mathematical activities, a belief that one is good or bad at mathematics, and a belief that mathematics is useful or useless (Neale, 1969 as cited in Chapman, 2003). It refers to the way one uses general capacities that are relevant for mathematics—such as mental openness, flexibility when seeking solutions to a problem, reflective thinking—aspects which are all more closely related to cognition than affect (Palacios, Arias & Arias, 2014). Attitudes are learned; they are moldable and may change with experience of the stimulus objects and with rules or institutions (Binder & Niederle, 2007).

Engendering positive attitudes in mathematics education students is an implicit objective of many mathematics education programs. Over the years the disposition of students towards mathematics has been very discouraging (Saritas & Akdemir, 2009). This has been linked to the myth that mathematics is difficult and hardly needed in life careers (Okafor & Anaduaka, 2013). Also, the fact that employment anxiety among higher education students has been on the increase has contributed to the negative attitude of mathematics education undergraduates towards the discipline.

Gaining insights into student 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? Specifically, how has the educational cloud affected the mathematics confidence and the affective and behavioral engagement of mathematics education students? Would its impact on attitude of mathematics education students be associated with gender?

Literature Review

Mathematics is an aid in representing and attempting to resolve problem situations in all disciplines. It is an interdisciplinary tool and language (Moursund, 2014). Mathematics education concerns the activity or practice of teaching mathematics (Ernest, 2014). According to O'Brien (2002) mathematics education is a good school of thinking. Doing mathematics entails building the right attitude for problems, ranging from simple to more complicated ones. One of the aims of mathematics education is to develop in society the general attitude of customization of mathematical principles to satisfy human needs (Dudley, 2010).

Students' attitudes toward mathematics reflect 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).

Attitudes towards mathematics have been described as inclinations and predispositions that guide an individual's behavior in mathematics (Mohamed & Waheed, 2011). Learners form views about their own competence and learning characteristics, which have considerable impact on the way they set goals, the strategies they use, and their achievement (Zimmerman, 1995). Chamberlin (2010) posited that attitude towards mathematics comprises components such as mathematics confidence, affective engagement, and behavioral engagement.

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; 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 & Barmby, 2010). In the mathematics classroom, engaged students are actively participating, genuinely valuing, and reflectively involved in deep understanding of mathematical concepts, applications, and expertise (Attard, 2012). 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). Subject motivation is often regarded as the driving force behind learning. Interest in, and enjoyment of, mathematics is a relatively stable orientation that affects the intensity and continuity of engagement in learning situations, the selection of strategies, and the depth of understanding.

Students are active participants in the learning process, constructing meaning in ways shaped by their own prior knowledge and new experiences. Behavioral engagement in mathematics refers to students' disposition to manage their own learning by choosing appropriate learning goals, using their existing knowledge and skills in mathematics to direct their learning, and selecting learning strategies appropriate to the task in hand (OECD, 2004). To do this they must be able to establish goals, persevere, monitor their progress, adjust their learning strategies as necessary, and overcome difficulties in learning. According to Abd-Wahid and Shahrill (2014), behavioral engagement is expressed in dimensions such as attentiveness, diligence, time spent on task, and non-assigned time spent on task. Behavioral engagement draws on the idea of participation; includes involvement in academic, social, or extracurricular activities; and is considered crucial of achieving positive academic outcomes and preventing dropping out (Fredricks & McColskey, 2012).

Another perspective in the literature considers attitude towards mathematics as being unique. Palacios et al. (2014) mentioned that attitude towards mathematics also refers to the valuation, the appraisal, and the enjoyment of mathematics, underlying the affective facet more than the cognitive one. Attitude towards mathematics is a predisposition to respond favorably or unfavorably to mathematics. This perspective, according to Abedalaziz, Jamaluddin and Leng (2013) implies that attitudes possess cognitive (beliefs, knowledge, and expectations), affective (motivational and emotional), and performance (behavior or actions) components. In this regard, some works have found that students with better attitudes towards mathematics have higher perceptions of the utility of mathematics, denoting intrinsic motivation towards study (Perry, 2011); they have a better mathematical self-concept (Hidalgo, Maroto & Palacios, 2005); they are more confident they can learn mathematics (Rusinov, 2012), and, especially, they display approach behaviors towards mathematics (Fennema & Sherman, 1976 in Pierce et al., 2007).

Several attempts to measure attitude towards mathematics have shed further light on the components of attitude. In a review by Palacios et al. (2014), it was observed that these components started out as broad aspects such as pleasure and fear of mathematics. These subscales were considered the extreme poles of the same continuum, leading to the introduction of factors like enjoyment of mathematics, value of mathematics, mathematical motivation, and utility of mathematics. One vital contribution in identifying constituents of attitude towards mathematics came from Tapia and Marsh (2004). Their Attitude Towards Mathematics Inventory (ATMI) attempts to assess six aspects of attitude: confidence (i.e., self-concept, anxiety, utility), the value of mathematics, motivation, the enjoyment of mathematics, parents' expectations, and teachers' expectations.

Attitudes toward mathematics have the potential to be modified. Larsen (2013) observed that the learning environment, teacher quality, and meaningful teaching methods have been considered as factors of change in studies on modification of attitude. This implies that the introduction of technological tools into the learning environment to aid teaching and learning of mathematics has the potential to influence the way students view mathematics. A study by Dix (1999) generated results that support the efficacy of technological tools in modifying students' attitude towards mathematics. The study observed that the use of computer-based technology in mathematics does appear to positively influence student motivation. But the extent to which specific computer technologies improve students' attitude towards mathematics education enjoys little coverage in the body of available literature. The role of cloud services, in particular, on students' attitude towards mathematics education in Nigerian public universities is yet to be verified.

Despite speculated claims, the subject of gender difference is of grave concern with no clear-cut answer as to the questions of sex disparities in mathematics (Halpern, Benbow, Geary, Gur, Hyde & Gernsbacher, 2007). After considering evidence from studies of infants, children, and adults, Spelke (2005) maintained that available data yields little support to these claims. The psychologist added that although research on older children and adults has revealed differences between the performance of males and females on specific cognitive tasks, her research provides no evidence for sex differences in overall aptitude for mathematics at any point in development. She further expounded that research on selected groups of highly talented students reveals some disparities in performance on speeded tests of quantitative reasoning, but highly talented male and female students also show equal abilities to learn mathematics.

Fatade, Nneji, Awofala, and Awofala (2012) hold a different perspective. They assert that mathematics is considered a male dominated domain from which females tend to shy away. Males tend to "show a natural positive attitude to school mathematics while females display negative attitude" (p.105). The researchers concurred that the negative attitude is situated in the stereotypical belief which is a common phenomenon in Nigeria. Another perspective on mathematics attitudinal difference between males and females lies in school type. In this view, a cross-sectional study by Norton and Rennie (1998) on single-sex and co-educational school dichotomy indicated that there was no significant difference between the attitude towards mathematics among male and female students in co-educational schools. But there were small variations on the scales measuring effects relating to grade level and school type. The general observation, however, was that, overall, boys have more positive attitudes toward mathematics than girls.

In another study to investigate the attitude towards mathematics of male and female students in Nigeria, Adebule and Aborisade (2014) arrived at the conclusion that attitude of students towards mathematics did not depend upon sex. The researchers recommended that sex should not to be considered as a factor influencing attitudes of students towards mathematics and that teachers should teach mathematics freely among all category of students. This outcome is in agreement with the work of Lindberg, Hyde, and Petersen (2010), which held that due to cultural shifts in recent years, the gender gap is closing. A close review of the trend indicates that the common denominator in the dynamics of educational change in recent times is computer technology. What does this blend of technological innovations into instructional strategies portray for mathematics education? How does this trend impact on the attitudes of students towards mathematics?

When technological tools are introduced into mathematics instruction directly or indirectly, Dix (1999) found that differences in attitude between male and female students are significant. Longitudinal changes in attitude reveal a significant positive change in male attitude towards mathematics. Male students were more willing to experiment with technology. Pierce and colleagues (2007) while testing their attitudinal scale, also established that boys have statistically significant positive scores than girls for attitude to learning with technology.

A study by Ursini and Sanchez (2008) sought to compare changes in girls' and boys' attitude towards computer-based mathematics. The longitudinal comparison spanning three years showed attitudinal change in students subjected to technology augmented mathematics instruction. Significant gender differences favoring boys were found in attitudes towards mathematics for the group using technology. Similarly, this present study extends the blend of technological tools, such as the educational cloud in mathematics education, to observe the attitudinal impact on both male and female students in public universities in Benue State.

Pierce and colleagues (2007), in an attempt to develop scale for monitoring students' attitudes to learning mathematics, polled 350 students from 17 intact classes across 6 secondary schools in Victoria, Australia. The intent of the study was to authenticate the Mathematics and Technology Attitude Scale (MTAS). The MTAS was built from a cross-section of items meant to cover five attitude subscales, namely, mathematics confidence (MC), confidence with technology (TC), attitude to learning mathematics with technology (MT), affective engagement (AE), and behavioral engagement (BE). Reliability analysis yields satisfactory Cronbach's alpha value for each subscale (MC, 0.87; MT, 0.89; TC, 0.79; BE, 0.72 and AE, 0.65), indicating a strong or acceptable degree of internal consistency in each subscale. The results of the study indicate that students gave maximum possible MT scores. In every school, most students agreed rather than disagreed that it was better to learn mathematics with technology. The researchers also established a statistically significant difference between attitude towards mathematics of boys and girls. A breakdown of scores by gender reveals that boys have higher scores than girls for each sub-scale except for BE. The differences are greatest for TC and MC, with MT and AE demonstrating less difference. In interpreting all the gender differences, the researchers noted that only a few girls actually expressed negative responses to any of the factors, but there were more highly positive responses from the boys. Whereas boys may experience learning mathematics more positively simply because technology is present, some girls may value it when they feel it has the potential to compensate for self-perceived shortcomings. Although the work of Pierce, et al. (2007) refined an important attitude scale, it failed to streamline the aspect of technology which elicits the positive attitude in students. This present work intends to narrow the technology integration to the utilization of cloud services. Also, the target sphere of this study is the university environment where individualistic learning approaches are encouraged.

Wu (2013) embarked on a study to observe the difference between the learning behavior and attitude of students before and after exposure to the IT education environment of a cloud computing service. The study applies a quasi-experimental design on 110 fifth grade students who were selected from Tunglo Elementary School in Miaoli County, Taiwan. Fifty-five of the students were placed in an experimental teaching class spanning four weeks with one period per week. Before and after the four weeks of 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 outcome indicates 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.

In addition, 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 employed a system analysis and implementation design, was 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 forums, 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 program 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.

From the review of literature, it is clear that different forms of technological innovations enjoy different affective acceptance. This points to the fact that human-computer interaction is a complex phenomenon and that the attitudes and feelings involved with the relationship are not easy to identify. As the role of computer technology expands in the global society, it is imperative that educators become aware of the anxiety of integration among students. Several researches considered so far indicate a high likelihood that students’ attitude towards subject area like mathematics are generally boosted with the adoption of computer technology. However, as observed throughout this review, the body of available literature holds little evidence of usage of technological tools such as educational cloud services in specific areas of study like mathematics education. This present work on the impact of cloud services on students’ attitude towards mathematics education in public universities in Benue State intends to bridge this gap.

Method

Questions

The following research questions guide the study:

1. To what extent do cloud services affect mathematics confidence of mathematics education students in public universities in Benue State?
2. To what extent do cloud services affect the affective engagement of mathematics education students in public universities in Benue State?
3. To what extent do cloud services affect the behavioral engagement of mathematics education students in public universities in Benue State?
4. Which gender’s attitude towards mathematics was more affected due to cloud services

among mathematics education students in the public universities in Benue State?

Hypotheses

The following research hypotheses were formulated and 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.

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 was comprised of all mathematics education students in public universities in Benue State. The target population size was 1807 students. The sample included 328 mathematics education students drawn from the two out of the three public universities in Benue State. The two selected institutions were chosen based on 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 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 et al., 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, behavioral 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 in 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 CSMAS 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 behavioral engagement sub-scale, and 0.92 for the summated CSMAS.

Data was collected and analyzed using both descriptive and inferential statistics. The research questions were answered using mean and standard deviation. The benchmark for decision on each item of CSMAS is a mean of 2.50, indicating that a mean of 2.50 and above imply acceptance while a mean value below 2.50 implies rejection. 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

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.

Research Question Two

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

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 Three

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

Table 1
Mean Attitude Ratings 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

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

Research Question Four

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

The result 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 favor 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 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

Table 3

Mean Attitude Ratings of Behavioral 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

Table 4

Mean Attitude Ratings of Male and Female Mathematics Education Students in 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		

Table 5

t-test Analysis of Mean Attitude Ratings 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 $\alpha = 0.05$

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 $\alpha = 0.05$

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 indicates 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.

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 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 provide 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 in, 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 have illuminated the fact echoed by Attard and Curry (2012) that cloud services in particular, and technology integration in general, affect 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 a high level (cluster mean = 2.92) of behavioral engagement among mathematics education students in public universities in Benue State. This is in agreement with Fredricks and McColskey (2012), who observed that behavioral 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' behavioral engagement as expressed in dimensions outlined in Abd-Wahid and Shahrill (2014): 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 translates to a 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 for a certain gender of students. The Mean Attitude Score for female mathematics education students is higher than that of their male counterpart, though both genders 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 a 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 a negative attitude. Ursini and Sanchez (2008), in a longitudinal comparative study, also found significant gender difference in attitudinal change favoring 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 MTAS. Keen observation and scrutiny of the body of evidence in favor 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 have lent 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, Ezoem, and Ekene (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. In a similar vein, Adebule and Aborisade (2014) recommended that sex should not be considered as a factor influencing attitudes 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 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, is 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 favor 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, as opposed to 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 work of Oyeleye, Fagbola, and Daramola (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.

Conclusion

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' attitudes toward mathematics education in the attitudinal component areas of mathematics confidence, affective engagement, and behavioral 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-centered 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 experiences by continuously leveraging on available cloud services, benefitting 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-around 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 systems. 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 establishment 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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