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Internet Skills as a Measure of Digital Inclusion among Mathematics Education Students: Implications for Sustainable Human Capital Development in Nigeria

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Abstract

Global technology penetration reports have consistently indicated high levels of digital technology adoption among Nigerian students. Considering that mathematics education students are being trained to manifest proficiency in vital areas of communication, information technology, critical thinking, leadership, teamwork, problem solving and entrepreneurship, the imperative of emphasizing the place of digital skills in their education is more relevant now than ever. Consequently, this study adopts a survey research design to provide detailed background information of component indicators of digital literacy among a sample of 215 Mathematics Education students drawn randomly from a Federal University in North Central, Nigeria. The Digital Access Index (DAI) and the Measure of Internet Skills (MOIS) were used as standardized measures of digital inclusion, with data analyzed using mean, standard deviation and simple charts. The findings of the study indicate that the status of digital inclusion among mathematics education students in Nigeria is high. The implications of this outcome for sustainable human capital development were discussed. Evidently, the level of internet skills revealed in this study is an indication that despite existing context in Nigeria, youths will continue to negotiate and chart their way to political participation and economic success.

Keywords: Digital Inclusion, Digital Literacy, Internet Skills, Human Capital, Sustainable Development, Mathematics Education.

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Introduction

Mathematics education, as a profession, is an intersection of mathematics pedagogy with the nature of mathematics as a discipline, which focuses on teacher education, design, implementation and effects of curriculum and instructional interventions, and contemporary developments in learning theories and technology. At the higher education level, Nigerian universities are to produce mathematics teachers with the knowledge, skills and attitudes that will enable them to contribute to the growth and development of their communities in particular and the nation in general (Iji & Abah, 2017). Mathematics education programmes are to encourage the spirit of enquiry, creativity and entrepreneurship in teachers, and to enhance the skills of teachers in the use of new technologies and in contributing to the economic growth of the country (Abah, 2016). Presently, mathematics education 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). This is because the current era, appropriately tagged “information age”, altered the world’s perspective of standard in politics, economics and other

aspects of life including education. Iji, Abah and Uka (2013) rightly observe that an information economy is where the productivity and competitiveness of units or agents in the economy (be they firms, schools, regions or nations) depend mainly on their capacity to generate, process and apply efficiently knowledge-based information. Indeed, the economy of the present era is one in which information is both the currency and the product.

Consequently, 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 mathematics education students to succeed and prosper (Iji, Abah & Anyor, 2017). Educational institutions must rethink what, but even more importantly, how and where students learn (Innovation Unit, 2014). The level of penetration of information and communication technology (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 (Iji & Abah, 2016).

Despite the spread of ICT all over the globe, there are concerns of increasing marginalization of groups of people, resulting in a digital divide between individuals, household, businesses and geographic areas at different socio-economic levels with regard both to their opportunities to access ICTs and their use of the Internet for a wide variety of activities (OECD, in Jaeger, 2012). This level of access and usage of ICTs is related to socio-economic parameters such as gender, age, ethnicity, income, disability, level of education, family structure and geography. The digital divide encompasses a global divide (between developed and developing countries), a social divide (between individuals within a nation), and a political divide (between those who use the technology to be part of the political processes and those who do not) (Jaeger, 2012). Evidently, it is inclusive of other dimensions of everyday life, such as the political, the economic, the cultural and the social ones, with these different dimensions relating to each other in very complex ways.

The two key issues arising from the existence of the digital divide are digital literacy and digital inclusion. Digital or ICT literacy has been defined as the usage of digital technology, communication tools, and/or networks to access, manage, integrate, evaluate and create information in order to function in a knowledge society (International ICT Literacy Panel, in Australian Council for Educational Research – ACER, 2016). Broadly, ICT literacy combine aspects of technological expertise with concepts of information literacy, and extend to the inclusion of way in which digital information can be transformed and used to communicate ideas. This digital competence is a key foundation of lifelong learning which embraces the critical, collaborative, creative use of new technologies for employability and societal inclusion (ACER, 2016). Digital literacy is seen by most as the capacity to navigate and adapt to a changing environment, with one axis viewing literacy as a cognitive ability or as a social practice, and the other axis ranging from views that these “new” literacies are not new, to the belief that digital literacy introduces both new technological and ethical elements (Hadziristic, 2017).

The term digital inclusion has been used to articulate the policy, research and practical efforts to look beyond issues of access to computers and the Internet and toward a more robust understanding of the skills, content and services needed to support individuals, families and communities in their abilities to truly adopt computers and the internet (Rhinesmith, 2016). Broad definitions of digital inclusion often encompass areas of access, technology literacy, relevant content and services, motivation, skills and trust (Leep, 2016). Reder (2015) reports that one widely used definition which appeared in the Building Digitally Inclusive Community Framework states that:

Digital inclusion is the ability of individuals and groups to access information and communication technologies. Digital inclusion encompasses not only access to Internet but also the availability of hardware and software; relevant content and services; and training for the digital

literacy skills required for effective use of information and communication technologies. (Reder, 2015, p.4)

In the same vein, the Federal Communications Commission – FCC (2017) adopts the definitions provided by the National Digital Inclusion Alliance which defines digital inclusion as:

The activities necessary to ensure that all individuals and communities, including the most disadvantaged, have access to and use Information and Communication Technology (ICT). This includes five elements: 1) affordable, robust broadband internet service; 2) internet-enabled devices that meets the needs of the users; 3) access to digital literacy training; 4) quality technical support; and 5) applications and online content designed to enable and encourage self-sufficiency, participation and collaboration. (FCC, 2017 p.3)

It is also worthy to note that the context of these definitions implies that digital inclusion must evolve as technology advances and recognizes that access to and use of ICTs is an essential element for participation in society, democracy and economy. The context also establishes that digital equity is the ultimate outcome of full digital inclusion, with focused action and investments to eliminate historical, systematic and structural barriers that perpetuate disadvantaged individuals and communities (FCC, 2017). Digital equity recognizes the moral obligation to harness ICT to address the needs of disadvantaged individuals, communities, neighbourhoods, community-based organizations and small businesses.

Presently, the deep penetration of digital technologies into the fabric of society have boosted growth, expand opportunities and improved service delivery, resulting in a high level of connectivity between people, businesses and governments. At the heart of the current force of change is the Internet, linking people to unimaginable quality of data (Agbo-Egwu, Abah & Anyagh, 2017). The number of internet users has become more than tripled in the past decade with the quantity of accessible data enjoying an annual increase of 4300%, spreading towards a milestone of 35 Zettabyte by the year 2020 (World Bank, 2016; and Computer Science Corp, 2012). This global trend cuts across both developed and developing countries, including Nigeria.

Nigerians are increasingly becoming technology enthusiasts. Statistics available at the Nigerian Communications Commission (NCC) as at February 2018 put the number of phone subscribers in the country at over 149 million, with a high percentage of users accessing information via smart phones and other handheld devices (Nigeria Communications Commission - NCC, 2018). Twinpine Network (2017) report that Nigeria was the most mobilized country in the world, ahead of India and South Africa, with 40% mobile penetration and 30% smart phone penetration rate. Nigerians spend an average of 193 minutes on smart phones daily across all media, the Twin pine Network report added. This category of users comprises young adults, mostly undergraduates of Nigerian higher educational institutions, including students of mathematics education.

The amazing level of digital penetration in Nigeria, however does not imply that mathematics education students as digital natives are fully deriving optimum educational, economic and social benefits from digital technologies. This is because each societal system interprets digital literacy according to the inner structures and imperatives in differential discourses, with the connotations of digital literacy in economy differing from those in the educational system. While the economy stresses the importance of digital literacy as a factor of production and urges to close IT- skills gaps which could reduce productivity, the educational discourse points out dimensions of digital literacy which are beyond the pure instrumental usage of IT (Gapski, 2007). For mathematics education students, this comprises personal evolvement by creating digital expressions, self-reflexive and ethical dimensions of digital literacy. Thus, the ability of these students to achieve effective and sustainable processes of empowerment may be what matters ultimately.

While access remains a primordial condition for the use of ICTs, once barriers of access are diminished, inequalities regarding skills, and usage patterns remain (Marien & Prodnik, 2014). In the end, poor and rich alike might have access to the Internet as obtainable on a campus-wide

cloud network (Iji, Abah & Anyor, 2018), but only a privileged few are able to turn to the internet as an asset, a lifestyle and an incentive (Witte & Mannon, in Marien & Prodnik, 2014). Differences in skills, attitude and support networks lead to segmented usage patterns and substantial discrepancies in the ability of students to develop capital-enhancing usage patterns. The impressive numbers from statistics on ICT penetration can create an illusion that, by having access to digital technologies, people automatically know how to use them. People tend to assume that if they own a digital device and know how to use certain applications, then they already have all the necessary skills for personal and professional life (ECDL Foundation, 2016). However, surveys conducted in some countries considered to be digitally advanced revealed that gaps exist between self-perceived and actual levels of digital skills. Even young people, who are falsely assumed to be “digital natives”, usually under perform in practical tests (ECDL Foundation, 2016).

Many studies on technology penetration in Nigeria attest to the increasing number of Nigerians harnessing the power of digital technologies. However, barriers in affordability, broadband, and investment, have relegated the country to the background among the Commonwealth of nations. Specifically, mobile subscribers in Nigeria uses services relatively less than other African countries like Rwanda, Kenya and South Africa even though Nigeria is now the largest economy in Africa and has the largest mobile market in the continent (GSMA, 2015). In terms of skills and digital literacy, which reflect the human capital endowment of a country, Siemens (2017) reports that Nigeria still lags behind South Africa and Kenya. These statistics cut across digital training, digital tools usage and skills.

Other individual research efforts, particularly targeted at the higher education sector, corroborate the low levels of digital literacy in Nigeria. For instance, Adetimirin (2012) reports that the use of ICT by undergraduates was considerably low, with better levels recorded for higher level students. This indicates that frequent use of ICT would improve ICT skills and the longer the duration of its use, the better the skills possessed. Similar outcomes were obtained by Oladunjoye and Benwari (2014) who report that ownership of laptops among undergraduate students are more with students from families having high socio-economic status and that students in urban setting are more exposed to computer study centers than those from rural settings.

In the same vein, a survey of ICT competencies among students in teacher preparation programmes at a Nigerian University reveals that student ICT usage was low, particularly the use of internet and e-mail (Danner & Pessu, 2013). Details from the survey reports indicate that although there was no significant difference in the ICT competency among students according to gender and academic year/level, there was a positive relationship to acquisition of formal computer training. Danner and Pessu (2013) also report that lack of access to computers and internet connectivity within the campus presents a serious problem in the use of ICT applications. This later challenge was, however, reviewed to be less demanding years on in the work of Iji *et al.* (2017). The study by Iji *et al.* (2017) reveals that the private cloud services delivered by public universities have been increasingly influencing the way mathematics education students study and do research, thereby positively altering their views, perspectives and disposition towards their discipline.

Relatedly, Omar and Ralim (2015) undertake a study of the relationship between internet usage and digital inclusion of women entrepreneurs. The multiple regression analysis deployed in the study uncovered that internet usage skills were the number one contributors to the digital inclusion of women entrepreneurs, along with motivation for using the internet and frequency of accessing internet applications. The results also show that women entrepreneurs’ internet skills enable them to retrieve information, communicate online and conduct e-transactions (Omar & Rahim, 2015).

An obvious gap in numerous empirical works from within Nigeria is the lack of explicit methodology and haphazard measurement of ICT literacy, particularly among students of higher education. What is mostly obtainable is vague frequency counts of access to digital technologies without recourse to depth of use and mastery. This present study set out to bridge this chasm by adopting a standardized measure of digital skills. This approach seeks to provide detailed

background information of the component indicators of digital literacy in order to arrive at a more generalizable empirical conclusion.

Considering the fact that mathematics education students are being trained to manifest proficiency in vital areas of communication, information technology, critical thinking, leadership, team work, problem solving and entrepreneurship (Iji & Abah, 2017), the imperative of emphasizing the place of skills in their education is more relevant now than ever. Within the fluctuations and uncertainties of the higher education terrain in Nigeria (Abah, 2017), what is the status of digital inclusion among mathematics education students? Specifically, what is the level of internet skills among students of mathematics education in Nigeria? What are the ramifications of these skills in the context of human capital development in Nigeria? These pertinent questions form the basis for this study.

The following specific research questions guided this study

- 1 What is the status of digital inclusion among mathematics education students in Nigeria?
- 2 What is the level of internet skills among mathematics education students in Nigeria?

Methodology

This study adopts survey research design to investigate the internet skills of mathematics education students in Nigeria. The target population comprises 823 students enrolled in the three Bachelor of Science (Education) programmes of mathematics education in a Federal University in North Central Nigeria. A sample of 120 mathematics education student was randomly selected across programme options and levels of study.

Two instruments were used for data collection in this study. The first is the Digital Access Index, adapted from the Access sub-index of the Australian Digital Inclusion Index (Thomas *et al.*, 2016). The Digital Access Index was used to establish the status of digital inclusion among mathematics education students in answer to research question one.

The second instrument is a full adoption of the Measure of Internet Skills (MOIS) developed and validated by a team of Dutch and UK researchers (Van Deursen, Helsper & Eynon, 2014). The MOIS is a theoretical, empirically and cross nationally consistent framework consisting of five types of digital skills: Operational, Information Navigation, Social, Creative and Mobile skills. The operational skills scale comprises 10 items, the information navigation skills scale comprises of eight items, and the social skills scale comprises six items. The creative skills scale consists of eight items while the mobile skills scale consists of three items. All items are measured on a five-point Likert-type scale with answer formats that ranged from “Not at all true of me” = 1 to “Very true of me” = 5 (Van Deursen, Helsper & Eynon, 2014). For an entire group of respondents, a Likert-type scale mean of 3.0 and above indicate high levels of internet skills while a mean below 3.0 indicate low levels of internet skills. It is important to note that the information navigation items are all negatively formulated and thus the eight items of this subscale are reverse-coded during data analysis.

Mean and standard deviation were used to answer questions two using data obtained from the MOIS instruments. Research question one was answered by using simple percentages. Additional pie charts and bar charts were employed to present the key components of the Digital Access Index.

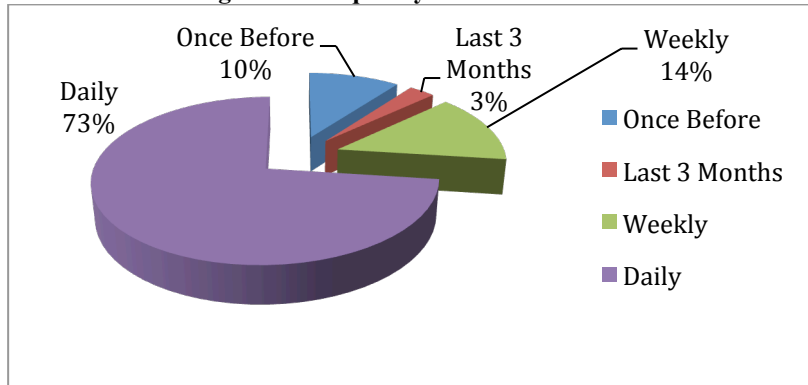
Results

The results of this study are presented according to the research questions.

Research Question One

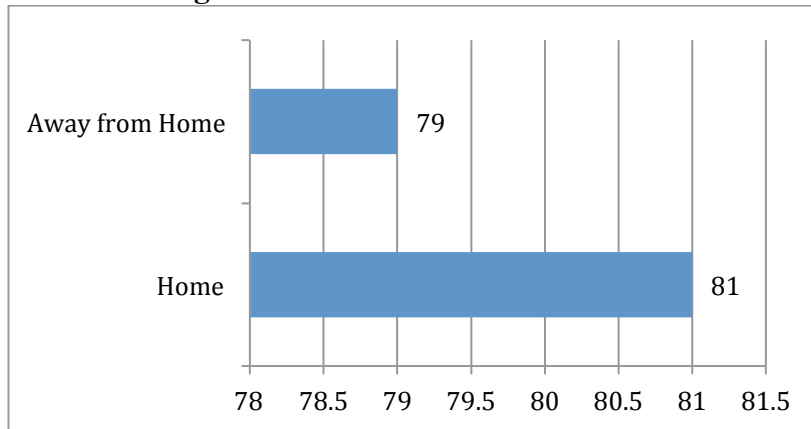
What is the status of digital inclusion among mathematics education students in Nigeria?

Figure 1: Frequency of Internet Access



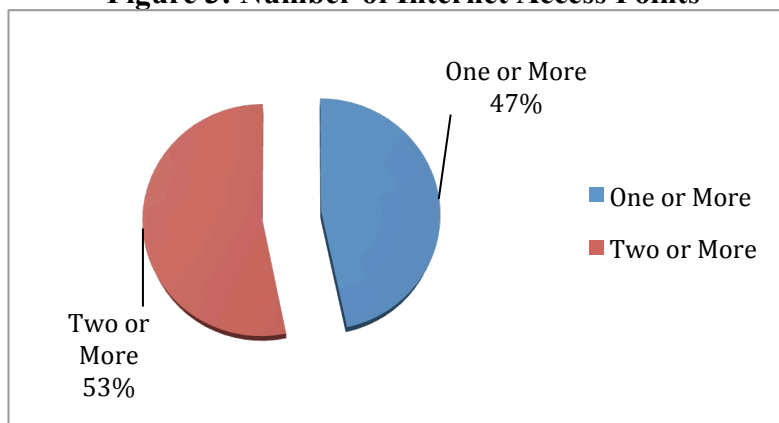
The results displayed indicate that 73% of mathematics education students access the Internet daily across a wide variety of devices.

Figure 2: Location of Internet Access



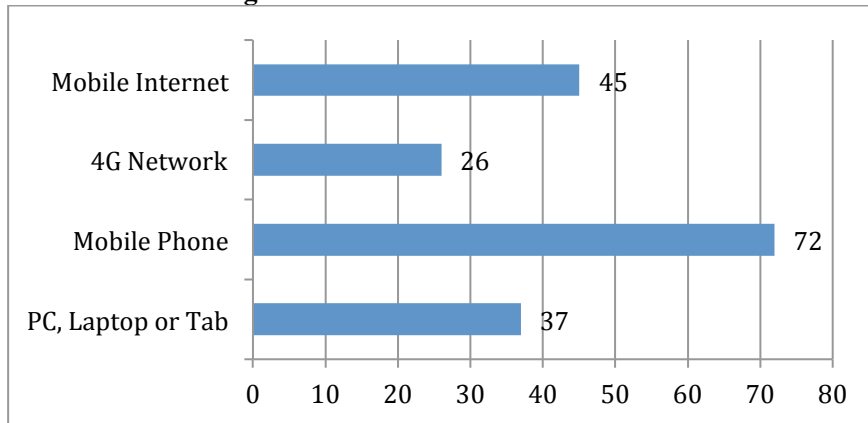
The data shown in Figure 2 reveals that a high number of mathematics education students have access to the Internet at home and away from home.

Figure 3: Number of Internet Access Points



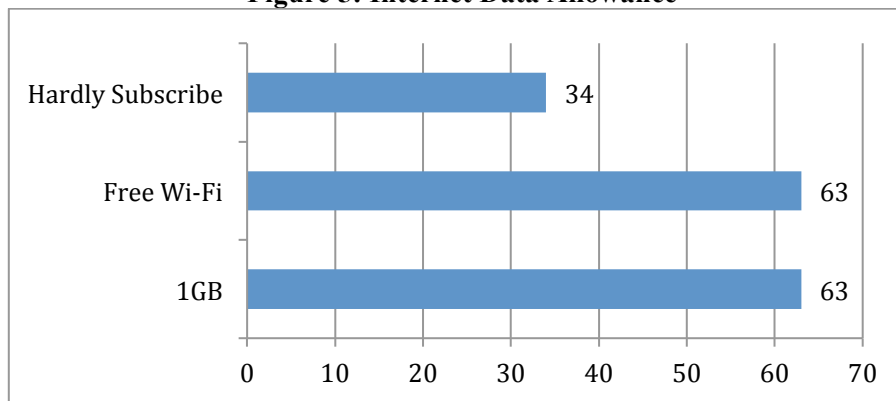
The pie chart in Figure 3 shows that 47% of mathematics education students have access to the Internet via at least one access point while 53% uses two or more access points.

Figure 4: Devices for Internet Access



The results in Figure 4 show that a large proportion of mathematics education students access the Internet via their mobile phones (i.e. smartphones).

Figure 5: Internet Data Allowance



The bar chart in Figure 5 shows that equal number of mathematics education students (63) have monthly data allowance of over 1GB and access to the free Wi-Fi on the campus.

Research Question Two

What is the level of internet skills among mathematics education students in Nigeria?

The Measure of Internet Skills (MOIS) instrument for this study yields a grand mean of 3.76 which is above the decision benchmark of 3.0. This outcome indicates that the level of internet skills among mathematics education is high. Tables 1 to 5 show a breakdown of this high level of internet skills according to the five components of the MOIS.

Table 1: Mean and Standard Deviation of Mathematics Education Students' Operational Skills

S/No.	Items	Mean	SD
1	I know how to open downloaded files	4.36	1.07
2	I know how to download/save a photo I found online	4.37	1.05
3	I know how to use shortcut keys (e.g. CTRL-C, CTRL-S, CTRL-V)	4.28	1.08
4	I know how to open a new tab in my browser	4.23	1.16
5	I know how to bookmark a website	3.87	1.36
6	I know where to click to go to a different webpage	4.26	1.19
7	I know how to complete online forms	4.12	1.20
8	I know how to upload files	4.15	1.12
9	I know how to adjust privacy settings	3.86	1.22
10	I know how to connect to a wide Wi-Fi network	4.16	1.20
Cluster Mean		4.17	-

The data in Table 1 yields a cluster mean of 4.17 which is above the decision benchmark of 3.0, indicating a high level of internet operational skills among mathematics education students in Nigeria.

Table 2: Mean and Standard Deviation of Mathematics Education Students' Information Navigation Skills

S/No.	Items	Mean	SD
1*	I find it hard to decide what the best keywords are to use for online searches	3.34	1.47
2*	I find it hard to find a website I visited before	3.50	1.51
3*	I get tired when looking for information online	3.07	1.52
4*	Sometimes I end up on websites without knowing how I got there	3.06	1.60
5*	I find the way in which many websites are designed confusing	2.99	1.55
6*	All the different website layouts make working with the internet difficult for me	3.42	1.47
7*	I should take a course on finding information online	3.07	1.51
8*	Sometimes I find it hard to verify information I have retrieved	3.27	1.40
Cluster Mean		3.22	-

*Items are Reverse-Coded

The results in Table 2 show that although mathematics students in Nigeria sometimes find the way in which many websites are designed confusing (Reverse-Coded Mean for Item 5 is 2.99), overall, they possess a high level of information navigation skills (Cluster Mean = 3.22)

Table 3: Mean and Standard Deviation of Mathematics Education Students' Social Skills

S/No.	Items	Mean	SD
1	I know which information I should and shouldn't share online	4.06	1.20
2	I know when I should and shouldn't share information online	3.99	1.25
3	I am careful to make my comments and behaviours appropriate to the situation I find myself online	4.09	1.23
4	I know how to change who I share content with (e.g. friends, friends of friends or public)	4.12	1.15
5	I know how to remove friends from my contact lists	4.42	1.05
6	I feel comfortable deciding who to follow online (e.g. on services like Twitter, Tumblr or Instagram)	4.04	1.28
Cluster Mean		4.12	-

The data in Table 3 shows that the cluster mean for the social skills sub-scale is 4.12. Considering that 4.12 is above the decision benchmark of 4.12, the results clearly indicate that mathematics education students possess high social skills.

Table 4: Mean and Standard Deviation of Mathematics Education Students' Creative Skills

S/No.	Items	Mean	SD
1	I know how to create something new from existing online images, music or video	3.41	1.40
2	I know how to make basic changes to the content that others have produced	3.29	1.37
3	I know how to design a website	2.59	1.51
4	I know which different types of licenses apply to online content	2.94	1.45
5	I would feel confident putting video content I have created online	3.35	1.36
6	I know which apps/software are safe to download	3.68	1.27
7	I am confident about writing a comment on a blog, website or forum	3.70	1.27
8	I would feel confident writing and commenting online	4.01	1.18
Cluster Mean		3.37	-

The results in Table 4 show that mathematics education students in Nigeria have difficulty in web design (Mean for Item 3 is 2.59) and in knowing which different types of licenses apply to online content (Mean for Item 4 is 2.94). Despite these shortcomings, the cluster mean of 3.37 for the creative skills sub-scale is above the decision benchmark of 3.0. This implies that the level of creative skills among mathematics education students in Nigeria is high.

Table 5: Mean and Standard Deviation of Mathematics Education Students' Mobile Skills

S/No.	Items	Mean	SD
1	I know how to install apps on a mobile device	4.30	1.13
2	I know how to download apps to my mobile device	4.53	0.96
3	I know how to keep track of the costs of mobile apps use	3.75	1.38
	Cluster Mean	4.19	-

The data in Table 5 reveals that mathematics education students in Nigeria are at their best when it comes to mobile skills. This is obvious from the cluster mean of 4.19 which is the highest obtained among the five skills-set measured by the MOIS.

Discussion

The outcomes of this study reveal that the status of digital inclusion among mathematics education students in Nigeria is high. When taken together, these findings show a high rate of mobile communication technology penetration among the students. This particular observation emanating from this study is consistent with many other empirical works which have maintained that there is an upward surge in the level of digital technology usage among Nigerian students (Anyor & Abah, 2014; Iji *et al.*, 2017; Iji *et al.*, 2018). The fact that 73% of mathematics education students in Nigeria access the Internet daily, mostly from the comfort of their homes via a monthly data allowance of over 1GB affirms the assertion by GSMA (2015) that Nigeria has the largest mobile market in Africa. The details shown in Figures 4 and 5 reveal that there is increasing affordability of Internet access for Nigerian students over the years since the works of Adetimirin (2012) and Oladunjoye and Benwari (2014). Such increase in access may be attributed to improvement in broadband and mobile communication technology in Nigeria in recent times (World Bank, 2016; Twinpine Network, 2017; Nigerian Communications Commission, 2018). Similarly, the growing adoption of campus-wide educational cloud services (Wi-Fi) by universities in the country has added another channel of internet access and affordability for students (Iji & Abah, 2016; Iji *et al.*, 2018).

A key factor in the upward trend in digital inclusion in Nigeria is the rapidly changing social dynamics among youths and adults in the country. There is an increasing dependence on digital technologies in everyday life, both in professional and private lives of Nigerians who are now more attuned to the social media than ever before (Abakpa, Abah & Agbo-Egwu, 2018). Such dynamics account for the statistics displayed in Table 3 which reveals high levels of social media skills among mathematics education students. Aided by the ubiquity of smartphones and improved connection speed, students are becoming highly engaged in social discourse, civil activism and social political participation (Alkamai, 2017; Edegoh, Asemah & Ekanem, 2013; and Chinedu-Okeke & Obi, 2016). Mathematics education students feel comfortable deciding who to follow on social media services like Twitter, Tumblr and Instagram.

The findings show that mathematics education students in Nigeria are digitally creative. However, they seem to be deficient in skills required for designing and hosting websites. Obviously, web design requires special training that are beyond the computer science components of the mathematics education curriculum. This deficiency, although not unique to Nigeria as a country, raises the need for students in higher educational institutions to develop personal interest and talent in software development (Chutel, 2016; CcHUB, 2017). With business executives ranking talent behind only broadband internet and mobile technology as a key driver for growth in the ICT sector (CcHUB, 2017), it is important that this talent gap is filled for the Nigerian technology sector to reach its full potential. The dismal mean rating for Item 3 in Table 4 implies that a number of mathematics education students may be graduating with the right academic scores but without the relevant web development skills needed in the technology sector. Software skills training available from many private firms in the country can be harnessed by the critical mass of talented young people who are struggling to find jobs in other industries (Jackson, 2015). To take advantage of available training opportunities, students must be ready to go the extra mile in

personal time management and investment in extra-curricular studies. Hence, in the view of the Model of Digital Literacy (Murray & Perez, 2014), the students must endeavor to cross the bridge between personal and academic use of technology and so gain technological prowess through structured learning experience.

The overall measure of Internet skills from this study is the grand mean score of 3.76 which indicate high levels of internet skills among mathematics education students in Nigeria. when considered in the light of the existing specifications, this outcome translates to easy access to internet at home as well as to at least one of computer (PC), laptop, tablet, smartphone and 4G network devices (Figures 3 and 4). Similarly, the findings of this study, particularly as deduced from Tables 1 to 5, indicate that mathematics education students in Nigeria are digitally engaged to transact as well as use interactive content to communicate in new ways. The students are thus said to be at the Digital Literacy stage of the Digital Inclusion Pathway in which they systematically develop their uses of ICTs and proficiency in solving problems with them (Reder, 2015). Through exploring, building and participating on the Internet, the students are expected to grow into engaged and empowered users ready to find and create value (Surman *et al.*, 2014).

Implications for Sustainable Human Capital Development in Nigeria

Nigeria, as a country, is blessed with enormous natural and human resources. Nigeria remains the most populous in Africa, the seventh globally, with an estimated population of over 198 million (National Population Commission, 2018). Over the last 50 years, the Nigeria's urban population has grown at an average annual growth rate of more than 6.5% without commensurate increase in social amenities and infrastructure. With larger proportion of Nigeria's population comprising young people, youth unemployment rate is presently at 33.1% (Trading Economics, 2018). Across board, Nigeria's unemployment stands at 18.8% as at the third quarter of 2017 (National Bureau of Statistics, 2017). These statistics indicate that Nigeria has an uphill task in growing and sustaining its economy to cater for its increasing population.

Rebasing of the economy in 2014 gave appropriate weight to job creating parts of the economy, such as banking, the Nollywood film industry and ICT that have been growing fast in recent years. The ICT sector contributing 9.61% to GDP (2014) – over \$50 Billion – has become a pillar of the Nigerian economy and its fastest growing sector (National Information Technology Development Agency – NITDA, 2016). ICT presently facilitates the creation of a more diversified economy through significant impact and strategic addition of value to other sectors of the economy. Initiatives adding value through ICT have created jobs and boosted innovation in Nigeria. NITDA (2016) reports that Nigeria's ICT sector has attracted over USD 6 Billion in Foreign Direct Investment (FDI) and has continued to drive inclusive and sustainable national growth and development. The recent visits to Nigeria by chief executives of global technology giants like Google, Facebook and Microsoft attests to the potential wealth the growing levels of digital inclusion in the country holds.

Considering the fact that ICT is critical to developing an inclusive and prosperous knowledge economy, the NITDA has been saddled with the responsibility of spearheading the ICT for Development (ICT4D) Strategic Action Plan. The National Strategic ICT4D Plan was developed through a multi-stakeholder process involving the participation and contribution of all sectors of the economy and society. Education is an essential tool for achieving sustainability within the Nigerian ICT sector. In this sense, Education for Sustainable Development (ESD) entails giving people knowledge and digital skills for lifelong learning to help them find new solutions to their environment, economic, and social issues (McKeown, 2002). Such educating for a more sustainable future in its broadest sense includes improving quality basic education, reorienting education to address sustainability, improving public awareness, and providing training to many sectors of the society (UNESCO, 2005). Within this perspective, the mathematics education students considered in this study are trainee-teachers whose skills and intellectual development will have immeasurable ripple effect spreading across diverse sector of the Nigerian economy.

Evidently, the role of institutions of teacher education in impacting digital skills to address sustainability is a pivotal one. To begin with, these institutions have the responsibility and potential to bring changes within educational systems that will shape the knowledge and skills of future generations. Through the provision of amiable atmosphere for better digital inclusion, teacher-education institutions, such as the one involved in this present study, serve as key change agents in transforming education and society, making possible a more sustainable future (UNESCO, 2005).

Not only do teacher-education institutions educate new teachers, they update the technological knowledge and digital skills of in-service teachers, create teacher-education curriculum, provide professional development for practicing teachers, contribute to textbooks, consult with local schools, and often provide expert opinion to regional and national ministries of education (UNESCO, 2005). One of the areas that require improvement in the service delivery efforts of universities, as indicated by the findings of this study, is the training of software developers to close the gap created by shortage of experts in web design and programming. Likewise, as recommended by Iji *et al.* (2017), the ICT directorates of public universities must wake up to the challenge of epileptic internet service delivery by building a consistent maintenance culture to sustain efficient cloud service delivery system. More access points are to be made available everywhere on campus, even around students' hostels to support efficient mobile learning.

The evidences revealed in the findings of this present study indicate that the investment growth effect of ICT on the productivity of Nigeria is positive and significant. This implies a necessity of a higher level of human capital for a significant ICT impact on labour productivity (Lovric, 2012). Human capital comprises a set of factors such as education, experience, training, intelligence, energy, work habits, trustworthiness, and initiative that affect the value of a worker's marginal product (Frank & Bernanke, 2007). As seen throughout this study, time investment in education by students and investment in education by government stand to contribute to human capital development (Shuaibu & Oladayo, 2016). The ICT infrastructure put on ground by higher educational institutions in Nigeria provides ample opportunity for students and graduates to partake in various economic activities that are important components of societal development, and contributes immensely to the living standard of people (Iji & Abah, 2017). Shuaibu and Oladayo (2016) maintain that Nigeria should continually seek to improve institutions, promote good governance, increase output and provide adequate technological infrastructure in order to sustain human capital development efforts. Such call is imperative since regions of higher level of investment, particularly in higher education, tend to have larger concentration of ICT sector firms, including provision of ICT services and manufacture of ICT devices and equipment (Izushi & Huggins, 2004). In addition, there is a clear indication that the level of human capital in an economy advances with the growth in the vital role ICT plays in enabling human capital development (Oluwatobi, Olurinola & Taiwo, 2016).

The status of digital inclusion observed by this study suggests that students can develop the spirit of entrepreneurship and become gainfully self-employed in different areas of the ICT sector. Ayoola-Ainjobi and Akinseye (2016) assert that such entrepreneurial engagements, even while in school, are able to put food on students' tables, meet their basic needs, and drastically reduce poverty level in the country. Web design and hosting, creating applications, and provision of other knowledge-based services by students, as indicated by the high level of digital skills observed in this study, serve as avenues for empowerment and economic sustenance (Onwumere & Adigwe, 2017). This level and quality of access to ICT infrastructures plays an important role in determining the country's technological innovation and technical efficiency (Campisi, De Nicola, Farhadi & Mancuso, 2013; Batalla-Busquets & Myrthianos, 2015).

Sustainability has been considered to be a paradigm for thinking about a future in which environmental, societal, and economic considerations are balanced in the pursuit of development and improved quality of life (McKeown, 2002). The results of this study imply students and youths in Nigeria are equipped with the right social media skills to chart the course of political governance

in the country. The level of digital inclusion and internet skills established by this study can be seen as an appraisal of the potential of ICT as a tool for participatory democracy in Nigeria (Unwuchola, Adinlewa & Udeh, 2017). Electoral stakeholders, especially the electorates, now have ubiquitous access to online services which have democratized the electoral effects as they offer citizens opportunities for more engagement in the political process. In what has come to be termed “digital democracy”, the use of social media and other digital enterprises are becoming important tools for mobilizing youth, and for facilitating, encouraging, and building their capacity to take their rightful part in the development of modern democracy (Kundiri & Umar, 2017; Edinyang, Odey & Gimba, 2015). With the current level of digital inclusion in the country, the future of Nigeria’s economic and social transformation rests on the ability to effectively translate the large youthful population of the country into a demographic dividend. Through social media platforms like Facebook, Instagram, WhatsApp and YouTube, Nigerian youths now have access to political information and can interact directly with political candidates (Abdu, Mohamad & Muda, 2016; Uzochukwu & Ekwugha, 2014). The utility of these platforms was specifically acknowledged by President Buhari at his inauguration on May 29, 2015 while thanking “thanking those tirelessly carried the campaign on social media”(Odeyemi & Mosunmola, 2015). Evidently, the internet skills covered in this study are an indication that despite existing unfavourable context in Nigeria, youths will, however, continue to negotiate and force their way to political participation and economic success.

Conclusion

Nigeria is fast growing into a huge technology hub as evidenced by several reports on broadband and digital technology penetration in the country. The outcomes of this study have added to this body of evidence that despite explosion in population without commensurate improvement in critical social amenities, the ICT sector of the economy holds great promises for sustainable human capital development in Nigeria. Specifically, this study has established a high level of digital inclusion among mathematics education students in Nigeria along with intangible internet skills that could be deployed in sustainable entrepreneurial outfits and laudable social platforms. Despite the robustness of this study, future studies in this area may focus on the state of software development capability of higher education students in Nigeria in view of the shortage of web designing skills already noted in the study. Similarly, the translation of the digital skills exposed by this study to measurable economic indices among higher education students could be a promising suggestion for further study.

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