Mobile App-Based Pedagogy in Mathematics Education: A Viable Panacea to a Sustainable Digital Economy Policy

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Abstract. The study examined how the use of mobile app-based pedagogy in mathematics education in secondary school will help sustain students' digital skills in Bayelsa State, Nigeria. An ex-post facto design was used for the study. The population comprised of all mathematics students in Bayelsa State. A sample of 179 SS3 mathematics students drawn from the population was used. One research question and a corresponding research hypothesis was formulated to guide the study. The instrument for data collection was a "Digital Literacy Questionnaire" developed by the researcher and validated by experts. The reliability of the instrument was established using Kudder-Richardson 20 formula (KR20), and a coefficient value of 0.80 was obtained, which was considered appropriate for the study. The research question was answered using mean and standard deviation, while the hypothesis was tested using t-test statistics. Result revealed that the students taught mathematics with mobile app-based pedagogy had significantly better digital skills than the ones who were not. It was recommended that stakeholders should continue to provide mobile devices and other ICT gadgets to schools to enhance digital skills amongst students.

Keywords: Digital Economy Policy, Mobile App-based Pedagogy, Sustainable, Mathematics Education

Introduction

ICT Sector is one of the foremost lucrative sector of the Nigerian Economy. In the 2nd quarter of 2019, ICT contributed 13.85% to the GDP calculations as against oil and gas putting in 8.82% in comparison (RIA, 2019). According to 2016 reports by Oxford Economics, the global digital economy is valued at $11.5 trillion or 16% of global economy. The desire for Nigeria to harness greater portion of the global digital economy led to the enactment of the National Digital Economy Policy and Strategy (2020-2030).

The digital economy has been defined in many ways by various individuals and institutions. The European Commission (nd) defined the digital economy as an economy that "encompasses businesses that sell goods and services via the internet, and digital platforms that connect spare capacity and demand". The World Economic Forum and the Group of Twenty (G20) defined the digital economy as "a broad range of economic activities comprising all jobs in the digital sector as well as digital occupations in non-digital sectors". National Digital Economy Policy and Strategy document of Nigeria (NDEPS, 2020), refer to digital economy as: *Any aspect of the economy that is based on or driven by digital technologies.* Nigeria Digital Economy Diagnostic Report (2018) defined digital economy as the part of economic output derived solely or primarily from digital technologies with a business model based on digital goods or services. Ajah and Chigozie-Okwum (2019) defined it as the economic activity that result from billions of everyday online connections among people, businesses, devices, data and processes. Karuitha (2020) refer to digital economy as the digital enabling infrastructure needed for computer networks to operate and exist. From the above definitions; it can be succinctly summed up as the economy based on technologies. The digital reflects the move from the third industrial revolution to the fourth industrial revolution. It is using internet as a platform for industry. Ajah and Chigozie-Okwum (2019) defined sustainable digital economy

policy as that which enhances digital literacy and skills with a view to improve economic, social and ecological constraints in the country. It represents a catalytic process for social change that seeks to be achieved through education, training and public awareness of values, behaviours and lifestyles required for sustainable future. It is about learning needed to maintain and improve the quality of life of generation to come.

The policy was enacted on the 12th of June, 2019 as part of initiatives to implement its new policy thrust of expanding the frontiers of the digital economy ecosystem, the Federal Government re-designated the Federal Ministry of Communication as Ministry of Communication and Digital Economy on the 17th of October, 2019 to equip the ministry with the responsibility of coordinating the activities related to Nigeria's digital economy. The Nigerian Digital economy Policy and Strategy has been developed to reposition the Nigerian Economy in order to take advantage of the many opportunities that digital technologies provide. The objectives of the digital economy strategy document is to achieve 70% broadband penetration in 4years, attract and grow digital jobs across all sectors of the economy and achieve 95% digital literacy level in 10years. The digital economic policy and strategy document is framed on the 8-pillars for acceleration of the National Digital Economy for a digital Nigeria (NDEPS, 2020). The 8-pillars are;

i. Developmental regulation
ii. Digital literacy and skills
iii. Solid infrastructure
iv. Service infrastructure
v. Digital services development and promotion
vi. Soft infrastructure
vii. Digital society and emerging technologies
viii. Indigenous content development and adoption

Karuitha (2020) forecasts that optimizing the use of digital skills and technologies could generate $2trillion of additional global economic output by 2030.

However, Zabairu, Oyefolahan, Babakano, Etuk and Mohammed (2020) observed that one of the greatest barriers to the actualization of digital economy policy is the high rate of digital illiterates.

National Digital Economy Policy and Strategy (NDEPS, 2020) identified digital literacy and skills as one of its cardinal pillars, hence, the policy document stated the following as its objectives:

i. To integrate digital literacy and skills into the national education curriculum at all levels;
ii. To support training and capacity building among public sector employees in the development and use of digital tools and applications to improve the delivery of government services;
iii. To create a pool of Nigerians with digital skills validated by globally recognized certifications;
iv. To bridge the gap between the academia and industry;
v. To lower the access barrier to digital tools for the citizens;
vi. Integrate digital literacy and skills development into the curriculum of schools at all tiers of education;
vii. Provide support for digital literacy and skills development for Nigerians across the country and in various sectors of the economy;
viii. Leverage the existing network of schools, training institutes, Computer Based Testing (CBT) centres, community resource centres, amongst others, to facilitate digital skills training programmes across the country women, internally displaced persons and the physically challenged;

ix. Promote the development and distribution of instructional materials in electronic format.

Also, NDEPS (2020) averred that to drive the digital economy it is important to develop a large pool of digitally literate and digitally skilled citizens.

Nigeria Digital Economy Diagnostic Report (2018) submitted that "*Low enrollment in basic education and poor quality of that education coupled with a lack of digital skills in curricula is segmenting digital skills into a slim share of the population, excluding the poorest from the benefits of the digital world*".

Nigeria Digital Economy Diagnostic Reports (2018) further submitted that there is need to support a programme for mass digital literacy.

Mobile App-Based Pedagogy in mathematics education involves the use of digital technologies to deliver mathematics content with the aim of enhancing teaching and learning. Charles-Owaba (2020) submitted that the use of Mobile App-Based Pedagogy improves experiences like digital simulation, manipulations and interactivity. Mobile App-Based Pedagogy advocates for a system where teachers and students used mobile devices such as Smartphones and tablets as a medium for instructional delivery during the teaching and learning of mathematics. Mathematics on its own encourages critical and creative thinking. Kurumeh and Chinnason (2011) observed that critical thinking is the pursuit of relevant and reliable knowledge about the world. This implies asking the appropriate questions, gather relevant information efficiently and creatively, sort the information and draw reliable conclusions that will result to certified personnel in the giving area of training. Idoko (2011) defined creative thinking as the formation of possible solutions to a problem or possible explanations of a phenomenon. This form of thinking aids inventive and imaginative abilities in learners. It is bringing into being what does not exist before. Mathematics also inculcates problem solving skills. Urevbu (2011) refers to problem solving as that which involves identifying and choosing problems which grow out of experiences and providing a guide to their solutions. Problem solving follows steps of scientific method as well those of reflective thinking. It enhances a learner's ability to seek logical and reasonable answers to problems when they arise. Eze, Ogwo and Okoloye (2015) reported that mobile application-based pedagogy is efficacious in the internalization of information, which one of its most notable capabilities being its utility as an electronic reader. The effective use of this technique in mathematics education at all levels; help to build students' interest, knowledge and experience in the handling of mobile devices. This will also develop the needed attitude and aptitude towards new technologies and hence aiding a digital skills and knowledge.

Omeodu and Charles-Owaba (2020) investigated mathematics teachers' awareness and barriers associated with the use of mobile apps for the teaching and learning of mathematics in Bayelsa State, Nigeria. A descriptive survey design was adopted for the study. Three research questions were formulated to guide the study. The instrument for data collection was a researcher developed questionnaire, which was validated by experts. The research questions were answered by simple mean. The results revealed that the awareness and usage level was low among mathematics teachers in Bayelsa state Nigeria. The barriers associated with the use of mobile apps identified are ignorance, lack of operational skills, poor internet services amongst others.

Charles-Owaba and Ahiakwo (2021) investigated the effect of teaching geometry using mobile application instructional technique on senior secondary students' achievement in Bayelsa State, Nigeria. A quasi-experimental, pre-test, post-test, non-equivalent control group design was used in the study. All the mathematics students in the 3 federal unity schools formed the population of the study. One hundred and seventy nine (179) SS2 students from the two co-educational federal unity schools formed the sample of the study. Intact classes were assigned by flipping of coin to either experimental or control group; and separately taught by their

regular mathematics teachers who had earlier been trained for the purpose. All the groups were pre and post-tested. Geometry Achievement Test (GAT) containing forty (40) multiple choice items was used as instrument for both the control and experimental groups. Six research questions and six research hypotheses guided the study. Mean and standard deviation were used to answer the research questions, while Analysis of Covariance (ANCOVA) was used to test the hypotheses at .05 levels of significance. The result of the study showed that: students that were taught with mobile app instructional technique had a higher achievement and interest scores than those taught with lecture method; it also indicated that there was no significant difference in the mean achievement and interest scores of male and female, as well as arts and science students taught geometry using mobile app instructional technique. Among such, it was recommended that since mobile app instructional technique enhances students' achievement and interest; it should be implemented in the teaching and learning of geometry and mathematics in Nigerian secondary schools and government and other stakeholders should ensure that teachers are trained adequately to enable them utilize mobile devices for teaching and learning purpose.

Charles-Owaba and Omeodu (2020) examined how the utilization of mobile app-based pedagogy in mathematics education can enhance a sustainable digital economy for youth empowerment in Nigeria. The concept of digital economy, youth empowerment, mobile app-based instructional technique and mathematics education were discussed. The benefits of digital economy policy and how mobile app-based pedagogy in mathematics can enhance and sustain the policy were highlighted. The study examined activities associated with the use of mobile app-based pedagogy and the components of digital literacy respectively. They opined that it has the potential to enhance digital skills. It was recommended that students must have regular access to technologies that supports learning as to advance their mathematical thinking reasoning, problem-solving and communications skills.

There is a dearth of empirical research evidence on the impact of mobile app-based pedagogy on digital skills. Since the implementation of the digital economy policy and strategy requires digital literacy and skills and Mobile App-Based Pedagogy used in mathematics education can create the digital literacy. Research reports (Charles-Owaba, & Omeodu, 2020) have opined that mobile app-based pedagogy have the potentials to improve digital skills, there is need to establish an empirical evidence comparing the digital skill scores of students taught mathematics using mobile app-based pedagogy and those taught without the app.. Hence, this paper is geared towards filling this gap.

Purpose of the Study

The main purpose of the study was to examine how the use of Mobile App-Based Pedagogy in Mathematics education in Secondary School will help sustains students' digital skills in Bayelsa State, Nigeria. Specifically, the study sought to determine the difference between the mean digital skills score of students taught mathematics without Mobile App-Based Pedagogy and those taught without the app in Bayelsa State, Nigeria.

Research Questions

The following research question was raised to guide the study:

1) What is the difference in the mean digital skill scores of students' taught mathematics using mobile app-based pedagogy and those taught without the app?

Research Hypothesis

The following null hypothesis was formulated and tested at 0.05 level of significance:

H_{O1}: There is no significant difference between the mean digital skill score of students taught mathematics using Mobile App-based Pedagogy and those taught without the app.

Methodology

This study adopted the ex-post facto design. This design permits the investigation of possible cause-effect relationship between dependent and independent variables. The design is where the researchers has no direct control over the independent variables. This design is used because the researcher had no control over the use of Mobile App-based Pedagogy in there various school. The population of this study consisted of all mathematics students in Bayelsa State, Nigeria. A sample of 179 SS3 students was used in the study. Purposive sampling technique was used to select the 3 Federal Unity Colleges in Bayelsa State because they are the only secondary schools that have Knowledge-based Centres with mobile devices used for teaching and learning (Charles-Owaba, & Ahiakwo, 2021). Also, the SS3 students were purposively selected because they are the oldest students in the system. All the 179 SS3 students from the 3 Federal Unity Colleges formed the sample. The instrument used for data collection was a "Digital Skill Questionnaire" (DSQ) adopted from Digital Literacy Survey by eSmart Program Support. The instrument comprised of two sections, A and B. The section A contained the personal information of the students and a column to indicate whether the students have been taught mathematics using mobile devices and apps. Section B consist of 30-items that measures digital skills. The instrument was validated by an experts in measurement and evaluation, mathematics education and a mathematics teacher in secondary school. Their corrections and comments were incorporated into the final draft of the instrument. The reliability of the instrument was obtained by administering them to twenty SS3 students who did not take part in the study. The data obtained was analysed using Kudder-Richardson formula-20 and a reliability coefficient of 0.76 was obtained. The researchers visited the school in the area that were selected for the study. The researchers administered the instrument to the students in the school after dully obtaining permission from the principals. The administration of the instrument was done with the aid of the teachers. The data collected were analysed using mean and standard deviation for research questions, while the hypothesis was tested using t-test statistics.

Results and Analysis

Research Question

What is the difference in the mean digital skill scores of students' taught mathematics using mobile app-based pedagogy and those taught without the app?

Table 1. Mean Digital Skill Scores and Standard Deviation of Students Taught Mathematics Using Mobile App-based Pedagogy and Lecture Method

Groups	N	$\bar{x}$	SD
Mobile app-based pedagogy	86	26.63	6.57
Without the app	93	17.90	3.96

Source: Fieldwork (2021)

Table 1 above shows that the mobile app-based pedagogy group obtained a mean digital skill score of 26.63 and standard deviation of 6.57. It was also revealed that the lecture group which represents those taught without the mobile devices and app obtained a mean digital skill score of 17.90 and standard deviation of 3.96. This implies that students taught geometry using mobile application-based pedagogy had a higher mean digital skill score when compared with those taught using without the app.

Research Hypotheses

Ho$_1$: There is no significant difference in the mean digital skill scores of students taught mathematics using mobile app-based pedagogy and those taught without the app.

Table 2. t-test analysis on hypothesis 1

Category	N	Mean	St.D	d_f	P	t_{cal}	t_{crit}	Decision
Mobile app-based pedagogy'	86	26.63	6.57	177	0.05	2.660	1.960	Reject Ho$_1$
Without the app '	93	17.90	3.96					

Source: Fieldwork (2021)

From Table 2 above, the calculated t-value is 2.26 at 177 degree of freedom and 0.05 level of significance. Since the calculated t-value of 2.26 is greater than the critical table value of 1.96, the null hypothesis is rejected. In other words, there is a significant difference in the mean digital skill scores of students taught mathematics using mobile app-based pedagogy and those taught without the app.

Discussion of Finding

The result revealed that the mobile app-based pedagogy group obtained a mean digital skill score of 26.63 and standard deviation of 6.57. It was also revealed that the other group which represents those taught without the mobile devices and app obtained a mean digital skill score of 17.90 and standard deviation of 3.96. This implies that students taught geometry using mobile app-based pedagogy had a higher mean digital skill score when compared with those taught using without the app. Also, it was revealed that there is a significant difference in the mean digital skill scores of students taught mathematics using mobile app-based pedagogy and those taught without the app. These findings are in-line with the report of Kultuca (2013), Ectuba (2018), who reported that the use of mobile apps appeals to more learning modalities and improves digital skills.

Conclusion

This study has established that the use of Mobile App-Based Pedagogy improves the digital skills of students, hence its use in the classroom can sustain the digital economy policy by creating digital literate citizens.

Recommendation

Based on the findings the following recommendations were given:

1. The use of Mobile App-Based Pedagogy should be encouraged in order to enhance the nation's digital economy policy.
2. Teachers should be trained on how to effectively use this Mobile App-Based Pedagogy.
3. Nigeria Communication Commission (NCC) and other stakeholders should continue to provide mobile devices and other ICT gadgets to schools to enhance digital skills amongst students in other to meet up with the 95% digital literacy target by the next ten years.

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