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# **The Role Of Mobile And Cloud - Based Learning In Expanding Educational Access For Sustainable Development In Flood Prone Regions Of Nigeria.**

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## **ABSTRACT**

This paper presented the role of mobile and cloud -based learning in expanding educational access for sustainable development in Nigeria, with emphasis on states in Nigeria that are prone to seasonal flooding. It has been observed that activities are often stalled whenever the flood seasons sets in and as such pupils, students and higher education programme and activities are compelled to take a break until the tide gives way for normalcy. This has typically affected the learning outcomes and to lead to distorted academic calendar pattern and constituted to the out of school dropout . One way to solve this problem is the deployment of technology such as the mobile and cloud-based learning. This is to promote equal access and flexible learning among people of this region and beyond. This paper also highlighted the theories and principles necessitating the integration of mobile and cloud based learning for inclusivity, accessibility, and flexibility and finally, the various digital tools to be deployed and the procedure for content development were discussed.

**Keywords:** Cloud -based learning, flood Prone Regions, educational access

## **INTRODUCTION**

Statistics from UNESCO shows that in Sub-Saharan Africa, about 87 million children of primary school age are out of school, and over one-third of children who enrol drop out before completing primary education. (UNESCO Education for All Global Monitoring Report, 2023). Nigeria as a nation has also faced challenges like limited access to quality education and shortage of skilled teachers. These issues worsened due to socioeconomic disparities, with marginalized communities suffering the most. The situation is worsened by insufficient resources, outdated teaching methods, and inadequate infrastructure, hindering educational goals and socioeconomic development. Virtual learning is one of the learning modes that provide open access and flexibility for students who may have various commitments such as work, family, or other responsibilities. It provides students with the opportunities to learn at their own pace and time, making education more inclusive and adaptable to individual needs. The importance of this mode of learning to ensuring sustainable development in Nigeria cannot be overemphasized.

The emergence of scientific and technological breakthroughs that are geared towards addressing socioeconomic challenges. One of which is the innovative technologies designed such as the mobile

devices and cloud computing technologies to solve and enhance the gaps in African institutions of learning, especially in the developing countries. This is in line with the UNESCO Sustainable Development Goal (SDG4)). It is very obvious that our world presently has embraced everything digital since internet was invented. In 2000, more than 361 million people were online. In 2014 over 3 billion were online, which represent a growth rate of over 764 per cent. Presently, more than half of the world population is online. New information indicates that young people are leading the chart with 830 million young people which represent over 80 per cent of youth in 104 nations are online (International Telecommunication Union, 2017).

Nigeria as a nation can leverage on these technologies and innovations to advance the course of sustainable development across all sectors, especially in education. Agbarakwe and Uwadia (2024) encourage the use of e-learning and online learning platforms to support open, flexible and equal access for higher education for shared experiences and collaboration; even the SDG4 prescribes and demands access to inclusive and equitable quality education; and lifelong learning opportunities for all by 2030. It is therefore expedient that there is a collective effort to actualize this goal. This will in turn bring about the desired change that will better improve the teaching processes and products of learning in flood prone states through deploying mobile and cloud-based learning in her educational system.

**Statement of the Problem**

Man is endowed with the rational power and ability to subdue and overcome its environment. Challenges are bound to occur within, and it's surrounding, but the ability to provide sustainable solutions for survival is critical. Nigeria is a country blessed with so many natural resources and varied landscape; some regions are plane, dried while some are characterized by water log and are swampy by nature. These differences in geographical landscapes and occurrences determine to a great extent the economic activities and lifestyles of the people. Within the context of this review, some states in Nigeria will be used to show the impact of flood on the educational activities of the people.

**Table 1: Data on the impact of flood in some states in Nigeria**

State	LGA	Affected Household	Affected Individuals	Displaced Household	Displaced Individuals
ADAMAWA	DEMSA	1048	6288	499	2994
ADAMAWA	FUFURE	38	145	0	0
ADAMAWA	GIREI	39	195	0	0
ADAMAWA	LAMURDE	790	4490	170	940
ADAMAWA	MADAGALI	910	4550	0	0
ADAMAWA	NUMAN	1243	6687	402	2052
ADAMAWA	SHELLENG	240	1440	175	1050
ADAMAWA	YOLA NORTH	13	60	5	38
ADAMAWA	YOLA SOUTH	52	314	0	0
BORNO	BAMA	355	1598	0	0
BORNO	BAYO	86	738	16	148
BORNO	BIU	529	2769	1106	1396
BORNO	CHIBOK	183	991	18	102
BORNO	DAMBOA	2769	13291	0	0
BORNO	DIKWA	3221	13504	110	331
BORNO	GWOZA	23	144	3	16
BORNO	HAWUL	75	594	0	0
BORNO	JERE	11983	62710	8523	48073

BORNO	KAGA	959	4795	45	217
BORNO	KALA BALGE	1509	6127	977	1904
BORNO	KONDUGA	2489	12740	2489	12740
BORNO	KWAYA / KUSAR	231	1627	112	266
BORNO	MAFA	286	1584	6592	33582
BORNO	MAGUMERI	447	2231	189	1482
BORNO	MAIDUGURI M. C.	49651	250901	24902	128268
BORNO	MONGUNO	12222	47961	4412	7020
BORNO	NGALA	1572	7215	0	0
BORNO	SHANI	70	462	0	0
YOBE	BADE	1867	7937	53	268
YOBE	BURSARI	819	4239	442	2462
YOBE	DAMATURU	443	1373	133	476
YOBE	FIKA	865	2105	0	0
YOBE	FUNE	870	4394	221	1214
YOBE	GEIDAM	1065	6961	145	877
YOBE	GUJBA	462	2931	901	6307
YOBE	GULANI	1171	7116	150	77
YOBE	JAKUSKO	600	2923	378	1720
YOBE	KARASAWA	476	3065	188	1428
YOBE	MACHINA	751	1561	44	54
YOBE	NANGERE	251	1447	50	318
YOBE	NGURU	1026	2880	515	1547
YOBE	POTISKUM	505	1807	27	109
YOBE	TARMUWA	163	744	64	293
YOBE	YUNUSARI	318	2140	86	584
YOBE	YUSUFARI	1822	7233	255	1054

**Source:** <https://data.humdata.org/dataset/nigeria-nema-flood-affected-geographical-areasnorth-east-nigeria-flood-affected-geographical-areas>

From the data in the above, one can easily deduce that both economic and learning activities will be greatly affected. This is because within the period of displacement, members of the affected communities will be struggling to seek for safety and shelter while the teaching and learning activities suffers. *According to Daily Trust News; Saturday, 5 November 2022;*

*Apart from the disruption of transportation and food supply caused by the flood, it also impacts education. With schools submerged by the flood, many pupils and students were left stranded.*

The flood submerging many schools in communities in Delta and Bayelsa states are typical examples of setback for learners and which must be of utmost concern to the government and critical stakeholders. Daily Trust also reported that the Bayelsa State government, on October 3, shut down schools across the

state so that pupils and students would not drown in the rampaging floodwater as it happened in previous years. This is shown in the image below.



Figure 1 : Girls Secondary School, Kaiama, Kolokuma Opokuma LGA being overrun by flood water.

Source: <https://dailytrust.com/floods-disrupt-academic-activities-in-delta-bayelsa-others/>

The question that requires urgent response now becomes, with what technologies can the educational sector deploy to curb further academic calendar disruption and school shut down caused by seasonal flooding in this 21<sup>st</sup> century? Which this paper seeks to provide through the deployment of mobile and cloud – based learning technology.

## LITERATURE REVIEW

### Mobile Learning

Mobile learning, which is an advanced form of e-learning technique whereby wireless technology and smart devices constitutes the major tools used in learning and impartation in education; these devices have functionality of computer, DVD player, MP3 player, gaming system all wrapped in one smart device. They are learning tools with high potential in classrooms activities and outdoor learning with enhanced productivity. Huge number of learners today is having possession of Smartphone like android and iPhones.

The extensive use of mobile devices among youth for communication, connectivity, and collaboration raises an insight into identifying their thoughts for its use to enhance learning. It has gained immense relevance in the lives of students and youths globally today The study conducted by Agbarakwe and Amadi in 2019 to investigate students perception on the use of mobile devices for learning revealed that students showed positive perception towards mobile devices' usage for learning and appreciably disagree that owning a mobile device could negatively affect their studies and most students have standard Smartphone, laptops and preferred mobile almost everywhere and at home. Some basic features for promoting mobile learning are;

- Accessibility: Learning content is accessible from virtually anywhere.
- Personalization: Tailored learning paths can be created based on individual needs.
- Interactivity: Features such as gamification and multimedia integration enhance engagement.
- Collaboration : Cloud platforms facilitate real-time collaboration and communication among learners and educators.

### **Cloud Computing**

Nigeria as a country has a road map to maintain in order to root out its inefficiencies, showcase its potentials and adjust any anomaly, especially in the direction of cloud computing and the educational innovation. Cloud computing, which is referred to as the delivery of different services through the Internet, either remotely in the cloud or in a virtual space, can be successfully integrated into the Physics curriculum. (Agbarakwe & Ntaka, 2021). Cloud computing describes the complex system of interdependent servers that work together to ensure cloud services are provided to the users.

The cloud is a sole determinant to innovative moves, because it is the reason students would become more entrepreneurial and will refuse to surrender to the world power towards science and technology. Cloud computing is a description of an internet based activity that gives room for internet servers to be networked and then allow centralized data storage and online access to computer resources and services (Inyang- Abia, 2014). It creates hostage services over the internet, as such cloud computing ensures storage, assessing of data and programme over the internet, instead of a computer.

### **Benefits of Mobile and Cloud-Based Learning**

- Improved accessibility: Mobile and cloud-based learning break down geographical barriers, making education accessible to remote and underprivileged areas. Tools like Google Classroom and Microsoft Teams provide seamless access to learning resources, enabling global education.
- Cost-Effectiveness: Cloud-based solutions eliminate the need for expensive physical infrastructure, making education more affordable for institutions and students alike.
- Scalability: With cloud-based systems, educational institutions can scale resources to accommodate growing numbers of learners without significant investment in physical resources.
- Flexibility: it provides learners the opportunities to learn at their own pace and time, while accommodating diverse lifestyles and commitments.
- Enhanced Engagement: Interactive features such as quizzes, videos, and discussion forums increase learner participation and retention rates.

## **THEORIES SUPPORTING THE DEPLOYMENT OF MOBILE AND CLOUD -BASED LEARNING IN EDUCATION**

### **Theory of Connectivism and Pedagogical implication for the Digital Age :**

Connectivism was proposed by George Siemens and Stephen Downes in 2005. This theory emphasizes the role of technology and networks in shaping how we acquire knowledge. Connectivism aligns and fosters collaboration, flexibility, and resource-rich environment when using digital platforms.

### **Tenets of Connectivism theory include:**

- Learning as a Network Process: Knowledge exists in networks of information, individuals, and resources. Learning occurs by navigating and contributing to these networks.
- Diversity of Opinions: Learning thrives on diverse perspectives, encouraging critical thinking and innovation.
- Knowledge is Dynamic: Information evolves rapidly, and learning involves staying current by continuously updating one's knowledge base.
- Decision-Making as a Learning Process: In the digital age, the ability to decide what information is relevant and credible is a critical skill.
- Tools and Technology as Extensions of the Mind: Technology is integral to learning, enabling access to vast resources and facilitating communication across networks.
- Information and technology are connected through nodes of network

### **The Technology Acceptance Model (TAM)**

- Technology acceptance model was propounded by Fred Davis in 1989, is a theoretical framework that explains user acceptance of technology. It emphasizes two key factors that influence adoption, which are perceived ease of use (PEOU) and perceived usefulness (PU). In the context of mobile and cloud-based learning, TAM provides valuable insights into how learners and

educators adopt and interact with these technologies. Below are key implications, supported by references.

### **Implications of TAM on Mobile and Cloud-Based Learning**

- Designing User-Friendly Interfaces (Perceived Ease of Use) Simplified, intuitive interfaces are essential for encouraging adoption. Mobile learning apps and cloud platforms should prioritize user-friendly designs to reduce the learning curve. Eg Platforms like Duolingo and Google Classroom succeed due to their accessible and straightforward interfaces. Studies indicate that usability significantly impacts learners' satisfaction and continued use of educational technologies (Park, 2009).
- Demonstrating Value in Learning Outcomes (Perceived Usefulness): Users are more likely to adopt mobile and cloud-based learning if they perceive it as enhancing their learning outcomes or efficiency. Eg, the ability to access resources anytime and anywhere makes cloud platforms highly useful for flexible learning. Research by Venkatesh and Bala (2008) emphasizes that users' belief in the utility of a system strongly predicts their willingness to adopt it.
- Ensuring Reliability and Accessibility: The success of mobile and cloud-based learning depends on the consistent availability of resources and minimal technical disruptions. For example, platforms must be optimized for low bandwidth and offline use to accommodate diverse user conditions, especially in remote or developing areas. Studies highlight that technical reliability and accessibility are critical for sustained adoption in mobile and cloud-based learning environments (Al-Hujran et al., 2013).
- Fostering Positive Attitudes through Training and Support: Providing training and technical support to users can enhance their confidence and positive attitudes toward technology adoption. Workshops for educators on integrating cloud tools like Microsoft Teams or Moodle into classrooms. Training interventions have been shown to reduce anxiety and improve technology acceptance among educators and students (Teo, 2011).
- Integrating Social and Collaborative Features: Social interactivity and collaboration features foster engagement and perceived usefulness, making mobile and cloud-based learning platforms more appealing. Peer discussions and collaborative projects on cloud platforms like Padlet or Edmodo. A study by Venkatesh et al. (2012) expanded TAM with social influence, emphasizing the role of collaboration in technology adoption.
- Addressing Cultural and Contextual Factors: Cultural attitudes toward technology and education influence the adoption of mobile and cloud-based learning. Localized content and culturally relevant examples can increase the perceived usefulness and ease of use. Hofstede's cultural dimensions have been linked to variations in technology acceptance across regions (Straub et al., 1997).
- Incorporating Feedback Mechanisms: Platforms that enable learners to track progress and receive feedback are perceived as more useful. Learning management systems (LMS) with analytics dashboards for tracking learning outcomes. Evidence have shown that feedback mechanisms improve user engagement and technology adoption in educational settings (Davis et al., 1989)

### **Social Constructivist Theory and Its Implications on Mobile and Cloud-Based Learning**

Social Constructivist theory was influenced by theorists like Lev Vygotsky. This theory of learning posits that learning is a social process where knowledge is constructed through interaction, collaboration, and cultural context. In the digital age, mobile and cloud-based learning environments provide platforms that align with social constructivist principles, enabling collaborative and contextualized learning.

#### **Basic Tenets of Social Constructivism**

- Learning as a social activity, so Knowledge is co-constructed through social interactions with peers, instructors, and communities.
- The Role of Language and Communication: Language acts as a primary tool for mediating thought and learning, facilitating the exchange of ideas.

- Zone of Proximal Development (ZPD): Learning occurs within a zone where learners can perform tasks with guidance, eventually achieving independence.
- Scaffolding: Teachers or more knowledgeable peers provide temporary support to help learners program

### **Pedagogical Implications of Social Constructivism for Mobile and Cloud-Based Learning**

- It facilitates collaborative learning through features like group chats, discussion forums, and real-time co-editing. Research has shown that Google Docs and Microsoft Teams enable students to work collaboratively on assignments and other tasks.
- Enabling Peer-to-Peer Interaction: Learners can engage in peer feedback, discussions, and knowledge-sharing using mobile and cloud technologies. Social media platforms like Edmodo allow learners to form study groups and exchange ideas.
- Scaffolding through Adaptive Learning: Mobile apps can provide tailored guidance through scaffolding, helping learner's bridge gaps in understanding. Adaptive platforms like Khan Academy offers personalized feedback and step-by-step problem-solving guides.
- Contextualizing Learning through Mobile Technology: Mobile devices support contextualized learning by providing access to real-world scenarios, augmented reality (AR), and location-based applications. AR-based learning apps to Google Expeditions enable learners to explore real-world environments virtually.
- Building Communities of Practice: Cloud-based platforms enable the creation of learning communities where users share expertise and collaborate. Platforms like Moodle and Canvas support forums, wikis, and shared resource libraries. Wenger's (1998) concept of Communities of Practice aligns with social constructivism by emphasizing shared learning goals.
- Encouraging Active Participation: Mobile learning apps engage students in active problem-solving, discussion, and interactive activities. Gamified apps like Quizlet can encourage learners to co-create and share flashcards, fostering active involvement.

### **Engagement-Based Theory and Its Implications for mobile and cloud based learning**

Engagement-based theory emphasizes that active involvement, emotional commitment, and meaningful interaction with content, peers, and instructors are critical for effective learning. This theory has evolved from educational psychology and focuses on creating learning environments that captivate and sustain learner interest. Engagement-Based Theory has evolved through the contributions of multiple scholars and research areas, particularly in educational psychology and instructional design. In online instruction, engagement is particularly vital due to the potential for distractions and feelings of isolation.

#### **Tenets of Engagement-Based Theory**

1. Cognitive Engagement:
  - Deep processing of information through critical thinking and problem-solving.
  - Students actively relate new knowledge to existing schemas.
2. Behavioral Engagement:
  - Active participation in learning activities such as discussions, quizzes, or group projects.
  - Consistent attendance and submission of assignments.
3. Emotional Engagement:
  - Positive feelings such as interest, enthusiasm, and a sense of belonging.
  - Reducing anxiety and frustration by creating supportive environments.
4. Social Engagement:
  - Interaction with peers and instructors fosters collaboration and a sense of community.

#### **Implications for Online Instruction**

- Designing Interactive Content: Use multimedia, quizzes, simulations, and gamification to maintain cognitive and behavioral engagement. Interactive videos with embedded quizzes on

platforms like Edpuzzle or H5P. Interactive elements increase focus and encourage deeper cognitive processing (Mayer, 2005).

- Fostering Emotional Connections: Create a supportive online environment where learners feel connected to the instructor and peers. Personalized feedback, synchronous video discussions, and instructor presence in forums. Social and emotional engagement reduces dropout rates in online learning (Rovai, 2003).
- Encouraging Collaborative Learning: Use tools that enable group work, peer feedback, and discussions to promote social engagement. Platforms like Padlet, Slack, or Microsoft Teams for collaborative projects. Collaborative activities foster a sense of community and improve retention.

### **Challenges in Mobile and Cloud-Based Learning**

1. Digital Divide: Not all students have access to mobile devices or reliable internet connectivity, creating inequities in educational opportunities.
2. Data Privacy and Security: Cloud-based platforms store sensitive student and institutional data, which may be vulnerable to breaches if not properly secured.
3. Technical Issues: Dependence on technology can lead to interruptions caused by software bugs, device malfunctions, or network outages.
4. Adaptability: Educators and students may struggle to adapt to new technologies, necessitating ongoing training and support.

### **How can Cloud-based technology be deployed for learning in Flood Plain Regions**

Deploying cloud-based learning in floodplain regions presents unique challenges due to the area's susceptibility to natural disasters, unreliable infrastructure, and potential connectivity issues. However, with thoughtful planning and the use of appropriate technologies, effective solutions can be implemented. Below are steps and strategies to deploy cloud-based learning in floodplain regions:

1. Infrastructure Development: To ensure uninterrupted access to cloud-based learning in flood-prone areas:
  - Establish resilient internet infrastructure: Utilize satellite internet and mobile networks to provide connectivity where traditional infrastructure might fail during floods.
  - Deploy solar-powered or portable communication towers:
  - Solar-powered systems ensure connectivity even when electricity supply is disrupted.
2. Offline Access to Educational Resources: Cloud systems can integrate offline functionality to accommodate areas with intermittent connectivity
3. Use mobile apps with offline capabilities: Platforms like Google Classroom, Moodle, or Khan Academy offer downloadable content that can be accessed without an internet connection.
4. Sync data periodically: When connectivity is restored, students can sync their progress to the cloud.
5. Localized Data Centres: To reduce latency and dependency on distant servers; it is advisable to deploy edge computing solutions, place small, localized servers in floodplain regions to store frequently used educational materials.
6. Ensure server resilience: Use flood-resistant enclosures or deploy servers in elevated or secure locations.
7. Durable Learning Devices: Equip learners and educators with robust devices designed for challenging environments:
8. Community-Based Learning Hubs: Establish learning hubs in safe areas to serve as centralized locations for digital learning:
9. Training and Capacity Building: For effective implementation;
  - Train teachers and community leaders
  - Provide workshops on using cloud-based tools and managing disruptions caused by flooding.
  - Create community support networks



- Flexible and Resilient Curriculum
  - Design educational content to adapt to disruptions:
10. Partnerships and Funding: Collaborate with stakeholders to ensure sustainability via
- Government support, Seek funding and policy backing for resilient education initiatives,
  - Partner with organizations specializing in disaster relief and technology deployment, Leverage funding opportunities from international organizations such as UNESCO or the World Bank.

### **DIGITAL TOOLS AND ITS UTILIZATION FOR ONLINE COURSE DELIVERY**

Due to the daily transformation in technological product and processes, both the learners and the facilitators require professional training when it comes to promoting open access and equal flexible learning experiences. This is to adequately adapt and deploy these technologies for enhanced efficiency and effectiveness in learning.

Below are some of the digital tools that can be deployed for effective online course delivery:

- Google Classroom
- Moodle
- Canvas
- Google tools like Google forms, Google Docs and Calendar
- Inshot
- Zoom
- Whatsapp
- Massive Open Online Courses (MOOCs)

### **LEARNING MANAGEMENT SYSTEMS (LMS):**

LMS offers opportunities for learners and instructors by enabling personalized e-learning and integrating online resources with traditional face-to-face teaching techniques. Digital platforms serve as a central hub for various educational activities, from content delivery and assessment to student engagement and collaboration

Google classroom, Canvas, Moodle, and many others are some learning management systems and platforms that can effectively promote both online and offline instruction. For the effective and successful integration of mobile and cloud based learning into the learning structure, the following are required;

- i. Robust LMS
- ii. Course content design and development
- iii. Internet connectivity
- iv. Accessibility and connectivity
- v. System usability and maintenance and
- vi. The provision of technical support systems.

### **Courseware Development for Online Course Delivery**

Courseware development involves a team of people or experts such as:

- Subject Matter experts,
- Instructional designers,
- Videographers,

### **CONCLUSION**

The concepts mobile learning and cloud based learning are often fit into one square because of its compatibility and functional applications. Mobile learning (m-learning) refers to educational experiences delivered via mobile devices such as smartphones and tablets, offering a flexible alternative to traditional classroom-based education. Cloud-based learning relies on cloud computing to host, manage, and deliver educational resources, enabling students and educators to access materials from any location with an

internet connection. The role and benefits inherent in the integration and deployment of these technologies cannot be overemphasized

## SUGGESTIONS

1. A proactive measure should be taken to acquire and install the appropriate digital devices and servers for the deployment of cloud computing based learning in flood prone region in Nigeria.
2. All stakeholders including the e-tutors and facilitators should be equip with the requisite skills and competency to drive the mobile and cloud -based learning
3. Support services and Centre's should be created to provide instant feedback and resolve of any complaint by the students and other users of the facility
4. Internet connectivity should be designed to allow students access to networks within their locations
5. A customized hand held devices should be provided for all registered students to ensure flexible equal access and inclusive learning.

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