Geospatial Assessment of e-learning Preparedness in Nigerian Educational System: A Case of Secondary Schools.

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This paper deployed geospatial techniques in mapping e-learning preparedness index (EPI) of Secondary Schools across 37 States in Nigeria. Dataset of three e-learning factors (EFs) specifically technology, infrastructure and human capital disaggregated into six indicators namely: teachers' computer literacy (TCL), teachers' educational qualification (TEQ), power availability (PA), computer access (CA), laboratory availability (ALab) and library availability (ALib) were sourced from Nigeria Bureau of Statistics' archive. Simple percentages and map algebraic algorithm in ArcGIS 10.8 Software with weights of 0.226 for CA, PA (0.225), TCL (0.220), TEQ (0.218), ALab (0.192) and ALib (0.008) generated from principal component analysis varimax rotation component score coefficients in SPSS 22 constituted the main analytical frameworks. The finding showed that about 70.89% variations in EFs were explained by the first component. Spatially, 8 States were ranked Very High (EPI = 0.78 - 0.92) and 10 States ranked High (EPI = 0.71 - 0.78). Besides, 6 States ranked Moderate (EPI = 0.64 - 0.71); 7 States ranked Low (EPI = 0.56 - 0.64) while; 6 States ranked Very Low (EPI = 0.42 - 0.56) as seen in the attached model. The findings offer stakeholders priceless opportunities for knowledgeable policy decisions to heighten e-learning in the country.

***Keywords**: geospatial; e-learning**;** preparedness; index; states*

1 Introduction

In a globalised world, there is nostalgia among policy makers and critical stakeholders in educational sector on the delivery of uninterrupted qualitative education at all levels. This is as a result of conscious evolution of stylish systems, novel, flexible and conducive atmospheres to facilitate knowledge exchange across the world aided by information and communication technologies (ICT) (Alajmi et al., 2020). Emphasis is therefore placed on the blend of conventional and contemporary approaches in knowledge, values as well as skills dissemination and acquisition. Among the contemporary and innovative approaches that have revolutionise knowledge, skills and attitudinal exchange globally is the emergence of electronic learning (e-learning).

Presently, lessons, instructions, training, school management as well as scholarship activities in scores of educational establishments have been facilitated by mainstreaming ICT in service delivery (Ouma et al, 2013; Djeki et al., 2022). There is also plausible alignment of e-learning inventiveness with Goal No 4 of the United Nations' Sustainable Development Goals (SDGs). The goal placed renewed emphasis on "inclusive and equitable quality education and promotes lifelong learning

opportunities for all" (Alegre Associates, UNICEF Nigeria, EdIntersect and The Presidency, 2021).This justifies Nigeria's effort with the reappraisal of the outmoded 2010 National Policy on ICT in Education to keep pace with the current realities while creating targets for improvement as well as utilisation of ICT in the area in 2019.

The reviewed and approved guiding principle articulates the vision and mission for ICT in education, after which it disaggregates the policy thrust into seven (7) focal points namely: human capital development, infrastructure, research and development, awareness and communication, governance, financing as well as monitoring and evaluation (Federal Ministry of Education [FME], 2019). Notwithstanding this stride, the need for sizeable degree of preparedness on the part of the Nigerian educational system in general and secondary schools in particular cannot be over-emphasised. This is to facilitate fruitful mainstreaming of ICT into the educational system in addition to it recognition as educational support as well as instructional device.

However, e-learning is the utlisation of ICT-enabled infrastructures, interactive media solutions, human capital and frameworks through dynamic information superhighways in the provision of qualitative education (Ouma et al, 2013; Ejimonye et al., 2021; Djeki et al., 2022). Basak et al (2017) equates e-learning to remote learning where educators can effectively interrelate with pupils and students seamlessly in the realisation of common educational goal. The implication is that e-learning not only boost interaction between educators and learners but connects instructional activities with learning processes (Ejimonye et al., 2021). Arghya et al (2020) enumerated core e-learning devices to include computers (hardware, operating systems and software), ancillary devices (video cameras, microphones, projectors, tables, electronic boards, lecture notes in soft copies). They all facilitate effective knowledge exchange as well as interfacing between instructors and learners.

E-learning comes with diverse merits including making teaching and learning easily accessible and readily available to all categories of learners and at their comfort (Amarneh et al., 2021). Worthy of note, however, is the fact that e-learning cannot be constrained by space and time which means students and pupils can receive lectures from their educators and teachers at anyplace at any given point in time (Ana et al., 2020). However, despite the copious gains linked with e-learning, the merits can only be fully harnessed when it is efficient vis-à-vis the preparedness of the educational system. In Nigeria, the preparedness of the educational system was stripped naked by the 2020/2021 lockdown occasioned by the then ravaging COVID-19 pandemic.

Educational institutions at all levels were shut down to avert COVID-19 transmission (Egolum, 2021) while only few private tertiary institutions were run via e-learning. Public secondary schools across the country were worst hit as there is no proof that they were operational not to mention e-learning (Wellington and Clarence, 2021). Now that the global war against COVID-19 pandemic seems to have been won through pharmaceutical and non pharmaceutical approaches (Ullah et al., 2022), it is unclear when another debacle that will result in shutting down of schools loom (United Nations Children's Fund, 2021). To bolster the resilience of educational sector to external shock

akin COVID-19 lockdown, the Nigerian Government directed the implementation of e-learning at all levels of education in all the 36 states and Federal Capital Territory (FCT) (Ejimonye et al., 2021). But how prepared are each state in terms of e-learning implementation?

Unraveling the extent of e-learning preparedness across the 36 states and FCT therefore depends on routine assessment using reliable indicators and emerging frameworks including geospatial techniques. At the tertiary level, copious studies have been carried to ascertain the degree of e-learning preparedness. Olutola et al (2018) assessed the deployment of e-learning resources by students undertaking post secondary educational training in Katsina State, Nigeria and found that socio-demographic profiles of students had no significant statistical effect on the use of e-learning resources. Obi et al (2018) investigated the viewpoint of medical students in Nigeria on e-learning preparedness and found that about 37.1% were prepared to embrace e-learning. Nwagwu (2020), Dumbiri and Nwadiani (2020), Oyediran et al (2020), Adeoye et al (2020), Kuliya and Usman (2021) and Eli-Chukwu et al (2022) among others also contributed to e-learning debate in post-secondary institutions.

At the secondary school level, Wellington and Clarence (2021) reported that under Covid-19 pandemic, e-Learning approach was the most beneficial educational tool for secondary schools in Nigeria. Olanrewaju et al (2021) acknowledged deficiency in ICT governance framework, poverty, critical infrastructure (power supply and weak mobile network for internet connection) as key constraints to e-learning in secondary schools located in rural areas of Nigeria. Eze et al (2021) noted that the challenge posed by the COVID-19 lockdown on the Nigeria secondary school education could have been averted if Nigeria's ICT policy on education and e-learning had been fully implemented. Osakuade and Joseph (2022) reported that despite e-learning effectiveness during the COVID-19 era, there was grave challenge in terms of accessibility to ICT infrastructure and internet with huge disparity between private and public secondary schools in Ondo State, Nigeria.

However, regardless of the extensiveness of empirical debate on e-learning, there is dearth in literature on how geospatial techniques can be deployed to assess the level of preparedness of secondary schools in Nigeria. Geospatial techniques particularly geographic information system (GIS) has been an emerging and veritable framework with broad application capabilities. Geospatial techniques are computer-based information systems for capturing, storing, retrieving, analysis and display of geographic information referenced to specific geographic area and coordinate system (Ibanga, 2018). Geospatial techniques can be used to map wide range of global socio-economic, environmental, political, cultural and developmental indicators and issues. Datasets from diverse sources including e-learning preparedness can be easily integrated and analysed to support policy and decisions using GIS and geospatial techniques.

Besides, a number of approaches in assessing e-learning preparedness have been proposed. These include second-order psychometric-based structural equation modeling (Alem et al., 2016), Delphi model (Al-araibi et al., 2019), Simple Additive

Weighting (SAW) and Analytical Hierarchy Process (AHP)-based Promethee-Topsis techniques (Andayani et al., 2020) as well as Aydin & Tasci model (Firmansyah et al., 2021). Each of these models evaluates e-learning preparedness using sets of indicators ranging from self-competence, self-directed learning, motivation, finance, usefulness, technology, innovation and people. Studies utilising map algebraic-based geospatial techniques in EPI assessment also seems to be lacking in sub-Saharan Africa in general and Nigeria in particular. There is therefore the compelling necessity to undertake a state-level assessment of e-learning preparedness in secondary schools in Nigeria. The paper also hypothesised the absence of statistical significant correlation between the e-learning preparedness of secondary schools across 37 States in Nigeria. These will facilitate identification of policy gaps, challenges and opportunities for effective e-learning implementation to boost the resilience of educational system.

2 Theoretical and Conceptual Frameworks

2.1 Technology Organization Environment Theory: This paper is situated within the technology organization environment (TOE) theory accredited to the works of Tornatzky and Fleischer in the early 1990s. The underlying principle of TOE rest on the fact that e-learning to a large extent is a function of the operational environment in addition to institutional style in accepting and integrating technological innovations (Tornatzky and Fleischer, 1990). Ejimonye et al (2021) argued that individual components of TOE have inherent constraints and prospects within the context of embracing along with utilising emerging technology. Within the context of this research, the efficiency and success of e-learning in secondary education across the 36 states and FCT in the country will largely be dependent upon the overall perception and level of familiarity about e-learning. This calls for openness, proper coordination and synergy among the students, parents, educational administrators, teachers, government and other critical stakeholders in the system to facilitate effective e-learning kick-off and its sustainability.

2.2 Conceptual Framework

Whenever reference is made to the preparedness educational system on e-learning in any debate, vital issues that come into mind especially within the context of emerging economies like Nigeria are the level of technology, available infrastructure and existing human capital. Technology is a key driver of e-learning and without it, the much anticipated outcome cannot be realized (Andayani et al., 2020). Laptop and desktop computers and accessories, multimedia devices, etc therefore forms major backbone for effective e-learning implementation (Alem et al., 2016). Besides, e-learning also depend on functional infrastructure (Firmansyah et al., 2021). Without uninterrupted power (electricity) supply for instance, no electronic device can be operated irrespective of their level of sophistications except it has in-built energy source. Also, well educated, technically skilled and trained personnel are also needed to operate diverse e-learning systems (Al-araibi et al., 2019).

This research is carried out as anticipatory strategy towards mitigating future interruptions in educational system as well as for policy evolution in boosting resilience

vis-à-vis sustainability of e-learning. Further conceptualisation of e-learning preparedness lies in the framework of assessment and indicators used. The e-learning preparedness index (EPI) deployed in this research is similar to the remote learning readiness index (RLRI) initiated by the United Nations Children's Fund (2021). The EPI deploys multiple pointer approach that assesses the preparedness of each state in Nigeria to adopt e-learning as adaptation strategy to exposure and vulnerability to shutting of schools and on-site classes.

Based on TOE model, EPI is built on three e-learning factors (EFs) specifically technology, infrastructure and human capital. The EFs is further disaggregated into six indicators namely: teachers' computer literacy (TCL), teachers' educational qualification (TEQ), power availability (PA), computer access (CA), laboratory availability (ALab) and library availability (ALib). The uniqueness of EPI rests on the fact that is straightforward and can be and replicated easily. It is also sustainable capable of supporting routine appraisal with latest datasets, posses strong analytical competency and can be applied to all level of education. The capacity as well as potentials of each state to effectively deploy e-learning is ranked on the scale of zero to one (0-1) using the EPI values. Higher values indicate high level of preparedness while lower values signify low level of preparedness. States, EFs and indicators that need urgent actions, for instance, to scale-up policies and programme improvement can easily be identified.

3 Methodology

In order to apply geospatial techniques in assessment and mapping e-learning preparedness in secondary schools across the 36 states and FCT in Nigeria, dataset of three EFs namely technology, infrastructure and human capital were used. The three EFs were disaggregated into six indicators including TCL, TEQ, PA, CA, ALab and library availability (ALib). The dataset were all sourced from statistical documents published by the Nigeria Bureau of Statistics (NBS) between 2017and 2019. The details of the dataset are presented in Table 1. The second dataset used was the administrative map of Nigeria showing 36 states and FCT. It was sourced from Open Street Map Database and used to show the location of the study area and for mapping.

The analytical procedures entails a cautious recognition and choice of suitable indicators to reflect the three EFs in the overall assessment and mapping e-learning preparedness in secondary schools across the 36 states and FCT in Nigeria and techniques. Data analysis were carried out using simple percentages, principal component analysis (PCA) and map algebraic algorithm while Statistical Package for Social Sciences (SPSS) version 22 and ArcGIS 10.8 constituted the main analytical software used. Map Algebra is an effortless as well as influential geospatial analytical framework suitable for diverse category of geographical analysis and mapping (Environmental Systems Research Institute [ESRI], 2021).

It is a geospatial functionality that facilitates the integration of several individual data layers (indicators) in the same coordinate system into a composite layer by multiplying the value of each indicator by their respective weights. Map algebraic operation is statistically well suited for the development of EPI and is executed using the formula presented in equation 1:

$EPI = (I_1 * w_1 + I_2 * w_2 + I_3 * w_3 + \ldots + I_n * w_n)$ - - - - - (1)
Where *I* is indicators of e-learning preparedness while *w* is the weight of each indicator.
Table 1: Percentage Indicators of E-learning Preparedness in Secondary Schools in Nigeria

S/ No	State	Teachers' Computer Literacy	Teachers' Educational Qualification	Power Availability	Computer Access	Laboratory Availability	Library Availability
1	Abia	75.1	72.0	72.0	63.0	57.0	56.0
2	Adamawa	59.1	79.0	42.0	32.0	19.0	20.0
3	Akwa-Ibom	84.4	65.9	76.0	60.0	71.0	78.0
4	Anambra	85.1	78.4	79.0	80.0	73.0	81.0
5	Bauchi	75.3	81.6	32.0	26.0	11.0	13.0
6	Bayelsa	69.3	67.1	73.0	64.0	40.0	34.0
7	Benue	64.0	80.9	54.0	49.0	42.0	46.0
8	Borno	56.8	81.0	50.0	34.0	24.0	21.0
9	Cross-River	76.6	77.0	59.0	48.0	63.0	63.0
10	Delta	74.5	74.3	75.0	63.0	63.0	51.0
11	Ebonyi	75.7	79.4	57.0	65.0	48.0	51.0
12	Edo	71.3	64.7	69.0	55.0	51.0	46.0
13	Ekiti	85.7	82.9	90.0	75.0	68.0	78.0
14	Enugu	71.3	84.3	67.0	73.0	67.0	70.0
15	FCT-Abuja	86.6	85.1	86.0	70.0	58.0	63.0
16	Gombe	69.0	72.8	43.0	37.0	18.0	22.0
17	Imo	83.9	82.1	60.0	55.0	57.0	62.0
18	Jigawa	64.8	78.3	20.0	21.0	8.0	15.0
19	Kaduna	79.8	74.7	74.0	60.0	57.0	53.0
20	Kano	66.9	75.6	70.0	51.0	39.0	42.0
21	Katsina	70.1	72.9	60.0	45.0	48.0	51.0
22	Kebbi	64.2	69.9	61.0	51.0	34.0	29.0
23	Kogi	76.8	76.7	46.0	41.0	32.0	37.0
24	Kwara	78.8	78.8	72.0	58.0	42.0	46.0
25	Lagos	87.7	71.5	98.0	86.0	69.0	70.0
26	Nasarawa	68.4	75.7	65.0	57.0	43.0	41.0
27	Niger	67.5	73.8	62.0	49.0	36.0	36.0
28	Ogun	85.0	76.3	97.0	91.0	74.0	78.0
29	Ondo	79.5	80.9	85.0	65.0	63.0	69.0
30	Osun	86.5	72.9	71.0	56.0	41.0	50.0
31	Oyo	86.6	80.9	84.0	71.0	67.0	66.0
32	Plateau	66.7	80.0	70.0	65.0	53.0	48.0
33	Rivers	85.1	71.1	82.0	62.0	50.0	51.0
34	Sokoto	61.9	76.0	53.0	56.0	35.0	39.0
35	Taraba	52.6	73.9	45.0	41.0	32.0	29.0
36	Yobe	63.9	78.4	51.0	44.0	20.0	21.0
37	Zamfara	65.9	80.0	54.0	44.0	33.0	35.0

Source: Nigeria Bureau of Statistics (2017- 2019)

However, several weighting approaches have been suggested including equal weighting, regression analysis, public opinion, benefit of the doubt approach, unobserved component models, budget allocation, public opinion, AHP, conjoint analysis, expert judgment and PCA/factor analysis among others (Gan et al., 2017). Each of these weighting approaches has its own advantages and limitations. This research however utilised PCA/factor analysis in the weighting of all the e-learning preparedness indicators. The advantages of PCA/factor analysis over others are that it decreases the danger of assigning weights to indicator twice and good for ordering uncategorized indicators (Siddique et al., 2021; Rai and Shrivastava, 2022).

PCA/factor analysis is a statistical technique deployed primarily to either reduce large volume of data to manageable size or uncover the underlying configuration within the dataset. The rationale for deploying PCA/factor analysis in this research was to generate weights from the first varimax rotated component matrix (Coulibaly et al, 2015:290) that were used in EPI assessment. To map the EPI, the six indicators were linked to attribute database (state layer) in Arc Map 10.8 and mapped separately. Single output map algebraic algorithm was executed using raster calculator with weights of 0.226 for CA, PA (0.225), TCL (0.220), TEQ (0.218), ALab (0.192) and ALib (0.008). The output resulted in the final EPI map of Nigeria which was classified using Jenk natural break classification system.

Jenks classification segregates the categories retaining lowest variation inside individual category in addition to highest variation among the categories (Olokeogun and Kumar, 2022). Five point scale of “Very High” “High”, “Moderate”, “Low and Very Low” were adopted in classifying the final EPI layer and the category with lowest pixel values were designated very low EPI whereas that with the highest pixel values were denoted very high EPI. In other words, the fractal intervals used to categorise each state according to the various levels of e-learning preparedness is as follows:

1. Very low e-learning preparedness - *0.42 - 0.56*
2. Low e-learning preparedness - *0.56 - 0.64*
3. Moderate e-learning preparedness - *0.64 - 0.71*
4. High e-learning preparedness - *0.71 - 0.78*
5. Very high e-learning preparedness - *0.78 - 0.92*

4 Results and Discussion

4.1 Correlations between the e-learning preparedness indicators

The main focus of the formulated hypothesis centered on the absence of statistical significant correlation between the e-learning preparedness indicators of secondary schools across 37 States in Nigeria. Factor analysis (FA) with PCA algorithm in SPSS 22 was deployed. However, in order to establish the suitability of the dataset, Kaiser-Meyer-Olkin (KMO) was used while Bartlett's Tests assessed the correlation between the e-learning indicators and the result is shown in Table 2. Thus, at 95% confidence level, the dataset was confirmed sufficient and robust for FA/PCA to be executed based on the KMO of 0.755. This finding aligns with that of Reddy et al (2021) who reported that KMO coefficient of 0.5-1 is acceptable for PCA to be executed.

Likewise, with p-value from Bartlett's Tests being less than 0.001, the null hypothesis was rejected and the alternate accepted. This is further buttressed by the strength of the correlation as seen in Table 3 where TCL for example was highly correlated with PA (R = 0.695), CA (R = 0.654), ALab (R = 0.690) and ALib (R = 0.755). Similarly, ALib had strong correlation with PA (R = 0.822), CA (R = 0.855) and ALab (R = 0.969) The implication of this finding is that statistical significant correlation existed between the e-learning preparedness indicators of secondary schools across 37 States in Nigeria. Similar significant correlation between the evaluated indicators had earlier been reported by Ebitimi and Ibanga (2020) and Asli (2022) among others.

Table 2: Result of Kaiser-Meyer-Olkin and Bartlett's Test of Dataset Adequacy

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		**0.755**
Bartlett's Test of Sphericity	Approx. Chi-Square	248.844
	df	15
	Sig.	0.000

Table 3: Correlation Matrix[a]

Indicators	***Teachers' Computer Literacy***	***Teachers' Educational Qualification***	***Power Availability***	***Computer Access***	***Laboratory Availability***	***Library Availability***
Teachers' Computer Literacy	1.000					
Teachers' Educational Qualification	0.032	1.000				
Power Availability	0.695	0.117	1.000			
Computer Access	0.654	0.015	0.918	1.000		
Laboratory Availability	0.690	0.017	0.859	0.882	1.000	
Library Availability	0.755	0.068	0.822	0.855	0.969	1.000

[a] Correlation significant at 0.01 confident level(2-tailed test)

Again, the extent of variability of each e-learning preparedness indicator concerned was assessed by measure of their communalities based on Ebitimi and Ibanga (2020). The result (Table 4) is a pointer to the fact that the entire initial communalities equated 1.0 portraying an ideal association between individual e-learning preparedness indicator/factors. Similarly, the extraction communalities signified forecast of the comparative variability of each e-learning preparedness indicator estimated by the

components. This implies that while *TCL* is capable explaining about 66.8% of the variance in e-learning preparedness, TEQ can explain up to 99.3%. Similarly, *PA* can elucidate 89% variation in e-learning preparedness, *CA (*88.2%), *ALab (*92%) and *ALib (*92.6%). This result agrees with previous finding of Putra et al (2018) who asserted that values of extraction communalities greater than 0.5 are excellent qualifiers in assessment of adequacy of the sample.

Table 4: Communalities of e-learning preparedness indicators

Indicators/Factors	**Initial**	**Extraction**
Teachers' Computer Literacy (%)	1.000	0.668
Teachers' Educational Qualification (%)	1.000	0.993
Power Availability (%)	1.000	0.890
Computer Access (%)	1.000	0.882
Laboratory Availability (%)	1.000	0.920
Library Availability (%)	1.000	0.926

Furthermore, relying on Kaiser rule which specifies the extraction of *eigenvalues* that is 1 and above during component extraction iteration (Amit et al 2021), two principal components constituted the extracted solution as seen in Table 5 and Figure 1. As it could be seen, it is clear that the first two components were able to explain up to about 87.97% variations in EFs were explained by the first component. But since the first component largely explained 70.89% variations in EFs with about 29.11% of the variance unaccounted for, it was adopted for the assessment of EPI. This decision corroborates earlier findings by Nuñez-Alonso (2019) and Tolenkhomba et al (2021) who stated that first extracted component normally champions the explanation in the variability of the variables.

Table 5: Components and total variance explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.254	70.892	70.892	4.254	70.892	70.892	4.253	70.884	70.884
2	1.024	17.074	87.966	1.024	17.074	87.966	1.025	17.082	87.966
3	.411	6.852	94.818						
4	.221	3.679	98.497						
5	.070	1.173	99.670						
6	.020	.330	100.00						

Extraction Method: Principal Component Analysis.

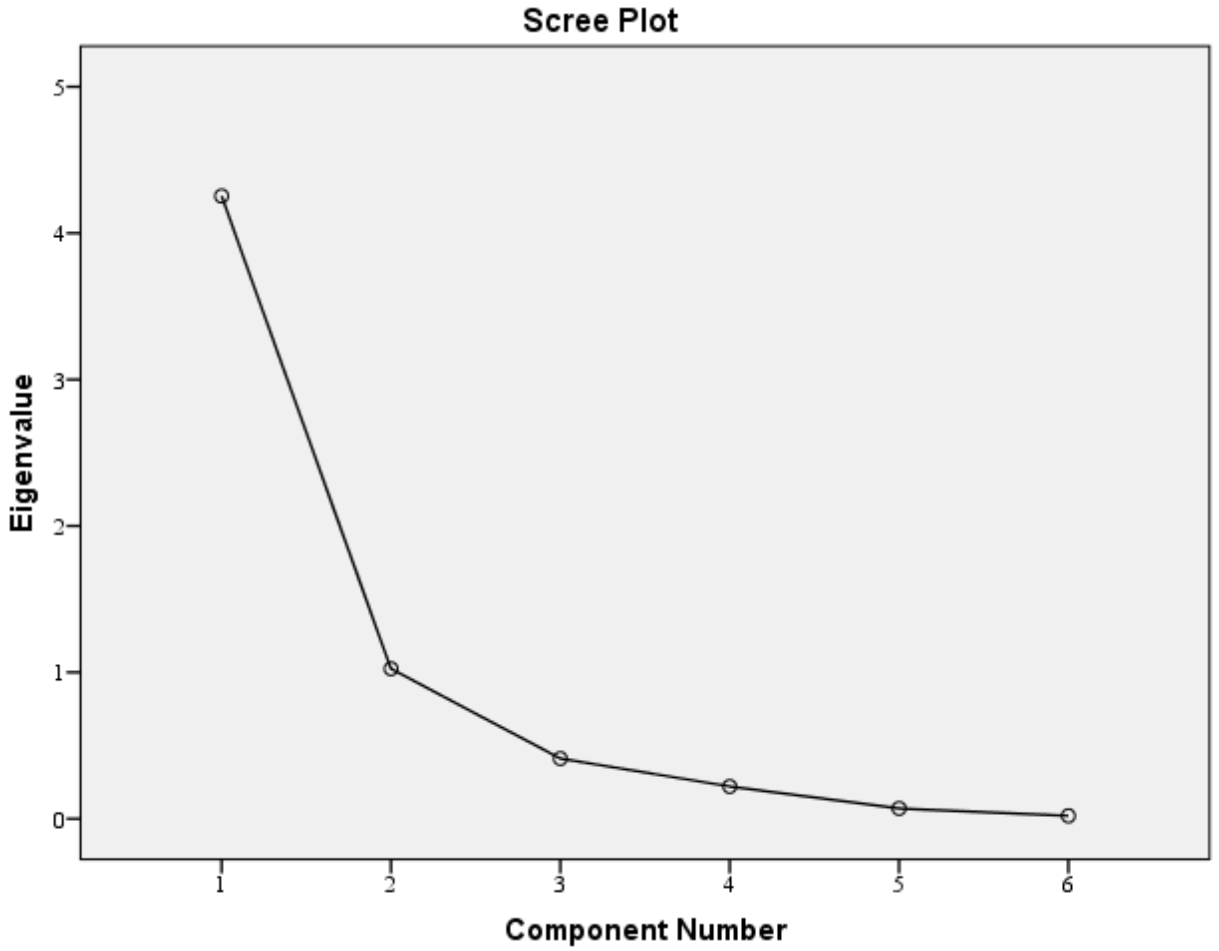

Figure 1: Scree plot showing relationship between eigenvalues and component number

4.2 E-learning preparedness index mapping

The cardinal motivation for this paper was to demonstrate how geospatial techniques can be deployed in mapping e-learning preparedness index (EPI) of secondary schools across 37 States in Nigeria. The result of the *varimax* rotation component score coefficients used as weights is presented in Table 6. Based on the *varimax* rotation component score coefficients (VRCSC), it could be inferred that the need for sufficient access to computers and related multimedia devices (televisions, smart phones, etc.) are crucial in e-learning (VRCSC = 0.226 or 22.6%). This finding is particularly factual in the sense that computers were among the e-learning resources that highly facilitated knowledge exchange among senior secondary schools students in Delta State during the Covid-19 school closure (Isagba and Onyeike, 2022).

Power availability became the second most vital indicator of e-learning preparedness with VRCSC of 0.225 or 22.5% while the literacy level on the use of computers and other digital devices was the third vital e-learning indicator based on VRCSC of 0.220 or 22%. Sadly, unstable energy access (power supply) and low capacity of teachers/staff to deploy existing ICT infrastructure and to transform education delivery has continued

to dominate debate on the drawbacks to effective deployment of e-learning in secondary schools in Nigeria (Alegre Associates, UNICEF Nigeria, EdIntersect and the Presidency, 2021). Other significant indicators of e-learning in secondary schools in Nigeria include educational qualification of teachers (VRCSC = 0.218 or 21.8%), availability of well equipped laboratory (VRCSC = 0.192 or 19.2%) and availability of functional and well stocked library (VRCSC = 0.008 or 0.8%).

Table 6: **Component Score Coefficient Matrix**

E-learning Indicators/Factors	Component	
	1	2
Teachers' computer literacy (%)	0.220	0.071
Teachers' educational qualification (%)	0.218	0.972
Power availability (%)	0.225	-0.128
Computer access (%)	0.226	-0.022
Laboratory availability (%)	0.192	-0.002
Library availability (%)	0.008	0.091
Extraction Method: Principal Component Analysis.		
Rotation Method: Varimax with Kaiser Normalization.		

Thus, deploying the VRCSC in Table 6 as weights, EPI of secondary schools across 37 states in Nigeria was mapped and the result is presented in Figure 2. Spatially, secondary schools in eight states namely: Lagos, Oyo, Ogun, Ondo, Ekiti, FCT-Abuja, Anambra and Enugu were ranked Very High (EPI = 0.78 - 0.92). Also, and 10 states in Nigeria including Abia, Akwa Ibom, Delta, Ebonyi, Imo, Kwara, Osun, Kaduna, Plateau and Rivers were ranked High based on the EPI range of 0.71 - 0.78). In contrast, six states specifically: Bayelsa, Cross River, Edo, Kano, Katsina and Nassarawa were ranked Moderate as a result of EPI range of 0.64 - 0.71. Besides, seven states (i.e. Benue, Koggi, Kebbi, Niger, Sokoto, Yobe and Zamfara) were ranked Low (EPI = 0.56 - 0.64). Also, the EPI class interval of 0.42 - 0.56 graded Adamawa, Bauchi, Borno, Gombe, Jigawa and Taraba as states with Very Low EPI.

This finding shows that majority of secondary schools in South West Geopolitical Zone in Nigeria are fully prepared for e-learning owing to the blend and very high access to the six e-learning indicators. The rationale for this may not be unconnected to high level of awareness and utilisation on e-learning on the part of students and teachers in secondary schools in the zone as reported by Adetona et al (2021), Bada and Jita (2021) and Olowo (2021). For instance, Adetona et al (2021) study showed that about 88% of the study participants were fully aware of e-learning, 87.7% had utilised e-learning resources for classes, 70% for homework, 38% for test and 15.2% science-related practicals.

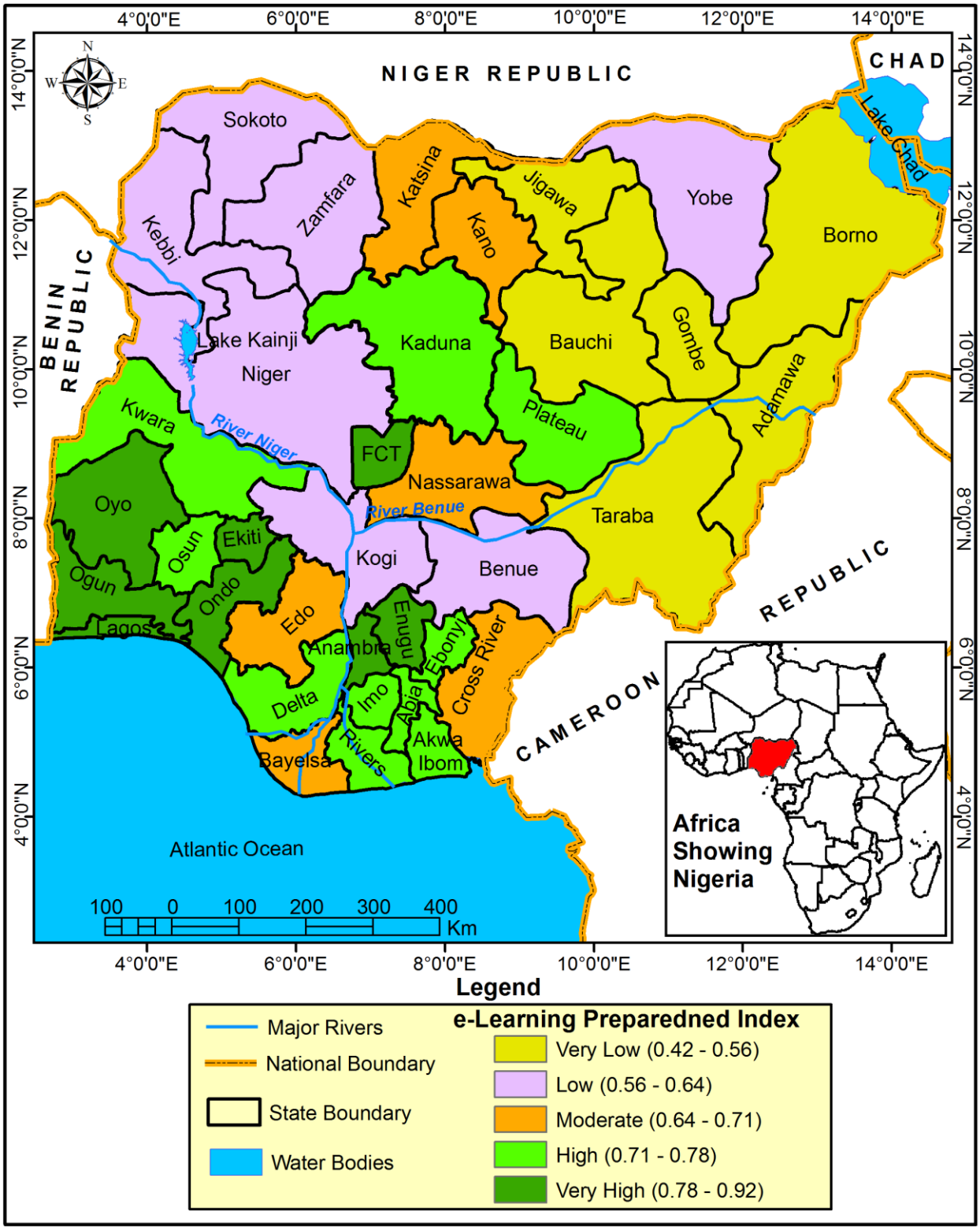

Figure 2: E-learning preparedness index of secondary schools in Nigeria

Olowo (2021) also reported that 60% of students in secondary schools in Oyo State already had sufficient knowledge about e-learning, 63% had took active part in it while

government policy particularly massive deployment of electronic media (radio and television) was decidedly effective based on the response on 63% of the respondents. Bada and Jita (2021) finding indicate that most secondary schools in Ondo State have already been provided with desktop computers to facilitate e-learning. In contrast, majority of the states in the North East Geopolitical Zone in Nigeria have very low EPI. Their very low EPI may be linked to the instability, environment and development challenges in the zone. These include elevated banditry activities, Islamic extremism, terrorism, insurgency, climate change-induces conflicts and herdsmen clashes among others.

Olaniyan and Okeke-Uzodike (2021) reported that excluding the ecological damage, insecurity and banditry activities has led to the destruction of 22,022 public schools, 18,117 residential buildings and over 218 settlements in the zone. In this atmosphere, policies and programmes on basic education including e-learning cannot be effectively implemented (AlfayoBoh, 2021; Jacob et al., 2021; Ogunode and Kolo, 2021; Ogunode and Kolo, 2021). In Adamawa for instance, school infrastructure including library, laboratory, computer labs, internet connections (ICT base) and power stations among others have been vandalised and destroyed by bandits and Boko Haram insurgency (Hanafi, 2021). These are critical infrastructures that form the foundation for successful e-learning implementation.

5 Conclusions

The study focused application of geospatial techniques in mapping e-learning preparedness index (EPI) of secondary schools across 37 States in Nigeria. Statistical significant association existed between the e-learning preparedness indicators in secondary schools across 37 States in Nigeria. Access to computer, availability of power and teachers' computer literacy emerged as among the most vital indicators of e-learning preparedness. About 70.89% variations in EFs were explained by the first component. Spatially, 8 States were ranked Very High (EPI = 0.78 - 0.92) and 10 States ranked High (EPI = 0.71 - 0.78). Besides, 6 States ranked Moderate (EPI = 0.64 - 0.71); 7 States ranked Low (EPI = 0.56 - 0.64) while; 6 States ranked Very Low (EPI = 0.42 - 0.56). Very high EPI is driven by high level of awareness on the concept particularly in the southwest states in Nigeria.

Very low EPI was noticed among the states in the north east zone characterised by environment and development challenges including insecurity. The suitability of the dataset, indicators and robustness of the analytical prowess offered by geospatiaI and multivariate statistical techniques offers unimaginable solutions for EPI mapping and assessment. E-learning is not only innovative educational framework but capable of promoting flexible, uninterrupted and engaging knowledge exchange that will drive sustainable development and the need for consider and adoption cannot be over-emphasised. States with low EPI should new approaches for full e-learning implementation. There also the need for massive investment in infrastructure, human capital and ICT while states with high EPI should keep up the tempo. The findings offer stakeholders priceless opportunities for knowledgeable policy decisions to heighten e-learning in the country.

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