Engineering Students' Virtual Learning Challenges during COVID-19 Pandemic Lockdown: A Case Study

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***Abstract*—As a result of the pandemic lockdown, most Faculty, Staff, and students in Nigerian universities were unable to learn online because of irregular power and internet unavailability. As a major concern to the Nigerian Deans of Engineering, a study was commissioned by the Deans to identify the extent of the problem with a view to identifying the research and development areas and proffer an indigenous solution to the problems identified. This paper discusses the results of an online survey administered during the lockdown to a stratified sample size from the over 80,000 engineering students' population in Nigeria. The initial results showed that there is need to develop some form of a cost-effective but modular and mobile integrated boosted internet-ready power system suitable for teaching, learning and research which is always-on both day and night for learning.**

Keywords—Virtual learning, Internet, Power Supply, Pandemic, Lockdown, Engineering students

I. Introduction and Motivation

Globally, the COVID-19 pandemic disrupted the educational system, as most countries around the world temporarily closed all their educational institutions to contain the spread of the disease. As a result, education delivery changed dramatically, with the distinctive rise of e-learning, whereby teaching is undertaken remotely and on digital platforms. However, developing countries including Nigeria are faced with the challenge of shifting from the traditional teaching method to e-learning during the pandemic. The challenges arise as a result of the varying degree of preparedness of the institutions, lack of infrastructure, paucity of funds and policies issues in the Nigeria education sector. Beyond these challenges and despite the immense benefits of the e-learning platforms available for students, including access to coursework from anywhere at any time, there are several other problems that may hinder participation of students during organised virtual learning programme. This phenomenon is not peculiar to Nigeria or Africa but worldwide. Several studies have been carried out corroborating the problems and importance of virtual learning especially during the Pandemic lockdown.

The impact of the lockdown enforcement was discussed by Favale et al. [1] on the Politecnico di Torino campus network in Italy as social distancing and lockdown measures modified people's habits, and the internet gained a major role in supporting remote working, e-teaching, online collaboration, gaming, video streaming. Profound effects on healthcare system including medical training and education in India were observed by Upadhyaya et al. [2] as a large number had problems in completing their dissertations and 96% had concerns about mental health. Similarly, Kapasia [3], using online survey assessed the impact of lockdown amidst COVID-19 on undergraduate and postgraduate learners of various colleges and universities of West Bengal. They found out that around 70% of learners were involved in e-learning. Most of the learners used android mobile phones for attending e-learning and students faced various problems related to depression, anxiety, poor internet connectivity, and unfavorable study environment at home. Also in India, Malhotra et al. [4] reported the conduct of a "zero-patient contact virtual practical exit examination" for orthopaedic residents with clinical cases prepared in a digital presentation format. The impact of the COVID-19 pandemic was observed by Caruana et al. [5] on the well-being, practice, and progression of all trainees in cardiothoracic surgery in the United Kingdom and they found that the deviation may require an extension in their planned training time. Also, Rajhans et al. [6] reported how COVID-19 pandemic lockdown impacted training in India.

It was noted by Croxton [7] that the use of virtual learning is an emerging topic in the theory of education and practice and some of the benefits of virtual learning include flexible participation and convenience [8]. Also, Obringer [9] affirmed

that learning experience could be enhanced if technology is effectively used. The use of virtual learning can improve the achievement of a student, provide access to learning, increase efficiencies of learning, and reduce costs. It will also enhance ability to learn and provide opportunity to prepare them for a globally competitive workforce as observed by Weller [10].

While these studies identified some challenges and benefits, they did not address the peculiarities in Nigeria and many African countries as it affects power and internet facilities.

The objective of this study was to identify the problems encountered by students in participating in organised virtual learning programmes using engineering students as a case study with a view to recommending a cost-effective way to solve these problems leading to effective use of sustainable virtual learning platform. The choice of engineering students as a case study was motivated by the complexity of engineering programmes. Many engineering courses require the use of laptops which requires energy to power them. For example, computer-aided design, computer-aided engineering, laboratory practical, simulation and modelling, computational fluid dynamics, artificial intelligence, and web development cannot be effectively done on smartphones. These problems need to be solved to reduce disruptions in academic calendar. This research will answer the following research questions:

1. What are the virtual learning challenges faced by students during the COVID-19 pandemic?

2. What is the indigenous engineering solution that is cost-effective to overcome the virtual learning challenges?

3. Will the indigenous engineering solution be affordable to the students?

4. How will such indigenous solution impact engineering education in Nigeria and Africa at large?

METHODOLOGY

To provide answers to the research questions, an online survey was created and grouped into relevant sections, as follows:

a. To identify the virtual learning challenges faced by students during the COVID-19 pandemic, data of the participating universities and the student profile such year of study, location of online studies and gender were collected. Also, respondents were required to enumerate the challenges as well as proffer their solution.

b. The cost-effectiveness of the indigenous engineering solution was evaluated based on responses relating to the computing device, alternative source for charging, preferred internet service provider, packaging and transportation preference.

c. To identify the affordability of the solution, the research profiled the student's financial capacity exemplified by their financial support through scholarship and sponsors as well as disposable income

d. As regards to the impact of the indigenous solution on engineering education in Nigeria and Africa at large, the questionnaire sought the opinion of the students on how power and internet connectivity challenges could be solved in the location of their study and the impact on their education.

A. Sampling Plan

The population data used in this study is based on the report of NUC [11] on students' enrollment and the Committee of Deans of Engineering and Technology of Nigerian Universities (CODET) statistics. There was a total of 1,727,782 students enrolled in Nigerian Universities in 2017, out of which 960,417 were males and 750,717 females. Today, there are 171 universities in Nigeria out of which 65 offer engineering programmes. CODET [12] estimates that there are about 80,000 engineering students in these 65 universities.

The sampling plan used in this study was a hybrid of clustering by geography and stratified by students' year of study. However, because of the COVID-19 lockdown some elements of convenience sampling were adopted. The participating Deans were requested to create 5 strata based on students' year of study, namely, Year 1, Year 2, Year 3, Year 4 and Year 5. An online survey was carried out to identify the virtual learning challenges faced by students during the lockdown from April to August 2020. The bulk of the responses were received when there was a total national lockdown between April and June 2020 in Nigeria.

B. Survey Analysis

A survey instrument consisting of 17 items was developed with a stratified sample size by level of study and administered to the students online. A total of 5,166 students responded largely during the national total lockdown. The survey data as reported by CODET [13] were analysed using Minitab®19.2020.1 and Microsoft PivotTable®

II. RESULTS AND DISCUSSIONS

A. Profile of Respondents and Participating Universities

A total of 44 of the 65 engineering universities participated in the survey with the largest number of respondents from the South-West Zone followed by the South-East and North-Western zones as shown in Table I. The 3rd year students topped the groups that responded followed by the 2nd year and interestingly the 5th year (final year) students in that order.. Table I shows the respondents by the year of study.

TABLE I. PARTICIPATING STUDENTS BY YEAR OF STUDY

Zones	Year 1	Year 2	Year 3	Year 4	Year 5	Others	Total
North-Central	41	59	75	50	62	27	**314**
North-East	66	180	188	181	82	31	**728**
North-West	59	53	147	136	216	213	**824**
South-East	99	174	240	122	213	46	**894**
South-South	86	93	177	103	117	6	**582**
South-West	210	518	418	297	324	57	**1824**
TOTAL	**561**	**1077**	**1245**	**889**	**1014**	**380**	**5166**

Engineering programmes in Nigerian universities are dominated by the males and this is reflected in the gender ratio of the respondents with the Males to Females ratio being 4:1 as shown in Figure 1. It is noted, as depicted in Table II, that the

computing devices used by engineering students include laptops since smartphones alone cannot meet the requirements for many engineering courses such as computer-aided design and computer-aided engineering. The use of smartphones is still limited to web-based virtual learning. Power requirement therefore for engineering students must include its use for charging laptops. Table II shows that laptops make up about one-quarter of the computing devices owned by engineering students.

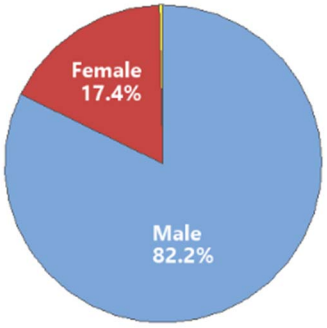

Fig. 1. Respondents by Gender

TABLE II. COMPUTING DEVICES OF RESPONDENTS

Zones	PC	Laptop	None	Smart Phone	Total	%
North-Central	1	135	7	152	295	5.7
North-East	2	92	17	518	629	12.2
North-West	1	250	4	582	837	16.2
South-East	3	204	9	749	965	18.7
South-South		60	14	487	561	10.8
South-West	8	589	20	1262	1879	36.4
Grand Total	15	1330	71	3750	5166	100
Percentage	**0.3**	**25.7**	**1.3**	**72.7**	**100**	

B. *Challenges Faced by Students*

Virtual learning challenges faced by students in Nigeria were largely power supply such as: irregular power supply, poor quality power supply and poor internet connectivity. These are shown in Table III. Power related challenges dominated the challenges. A power solution for students will go a long way to address virtual learning challenges. Table IV shows that students resorted to the assistance of friends, use of generators, wait for the startup of public places such as Hotels, Schools, Churches, and Mosques to charge their computing devices.

For internet, the service providers are dominated by three providers, namely, MTN, Glo and Airtel as shown in Figure 2. The MTN tops the three followed by Airtel and Glo. Therefore, a solution that has the capability to access these three internet sources will improve the probability of getting connected to the internet by more than 90% as no service Provider can meet the national demand of students.

TABLE III. CHALLENGES FACED BY RESPONDENTS

Zone	Internet	Other	Power	Total
North-Central	7	13	275	295
North-East	11	19	599	629
North-West	14	13	810	837
South-East	14	17	934	965
South-South	11	8	542	561
South-West	46	85	1748	1879
Grand Total	**103**	**155**	**4908**	**5166**

TABLE IV. COMPUTING DEVICE RECHARGING ALTERNATIVES

Zones	Generator	Friends	Public	School	Total
North-Central	96	103	67	29	295
North-East	79	188	278	84	629
North-West	120	243	338	136	837
South-East	169	376	351	69	965
South-South	92	288	146	35	561
South-West	568	714	421	176	1879
Grand Total	1124	1912	1601	529	5166

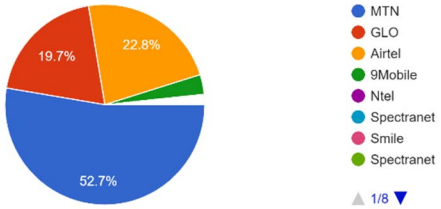

Fig. 2. Preferred Internet Service Provider

C. *Financial Capability of Student*

The ability of students to purchase a given solution is a source of concern. Only 10% of the students receive some form of financial assistance for their study as depicted in Figure 3. The 3rd year students appear to be more financially stable and the 1st year students are worse-off as shown in Table V. The sponsors of their education are largely civil servants, traders and the middle-class professionals as shown in Table VI. The disposable income for many the students' populations is quite low; barely enough for subsistence signifying the low disposable income of the students.

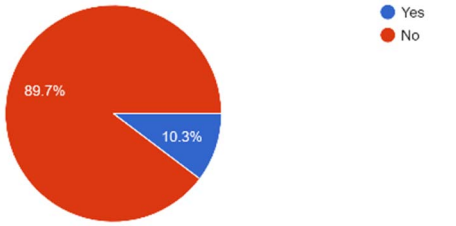

Fig. 3. Students on Some Form of Financial Assistance

TABLE V. SCHOLARSHIPS BY LEVEL OF STUDY

Study Level	No	Yes
1st Year	92.69	7.31
2nd Year	88.49	11.51
3rd Year	87.39	12.61
4th Year	92.46	7.54
5th Year	90.24	9.76
Postgraduate	90.26	9.74

TABLE VI. OCCUPATION OF SPONSORS

Occupation of Sponsors	Percentage
Civil Servants	22.87%
Businesspersons	13.94%
Traders	12.62%
Engineers	12.45%
Retired	8.76%
Teacher/Lecturers	7.36%
Farmers	6.75%
Public Servants	3.33%
Pastors	2.80%
Doctors	2.10%
Accountants	1.58%
Lawyers	1.05%
Bankers	0.88%
Others	3.51%
TOTAL	100.00%

Figure 4 shows the monthly data usage and Figure 5 shows the monthly upkeep allowance of students. Depending on the Service Provider data plan, more than one-third of the students use about $5 monthly translating to between 4.5GB to 9.5GB of data if they only spend their upkeep allowance on data. The data on upkeep allowance in Figure 5 seems to corroborate this projection. Given that 40-50% of the upkeep allowance is used for data, the students cannot maintain the level of data consumption.

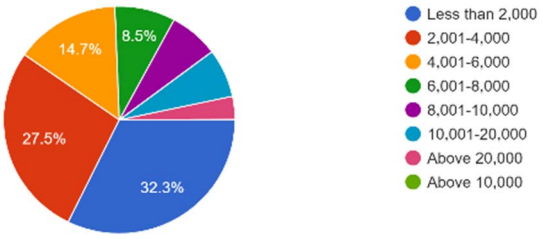

Fig. 4. Data Usage By Respondents

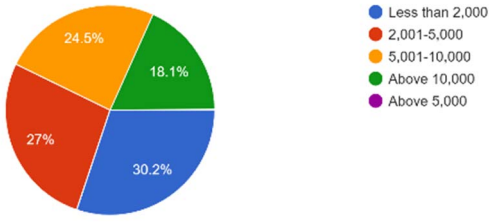

Fig. 5. Students upkeep allowance per month

The research attempted to find out from the students the value they will place on a solution to the virtual learning challenges they are facing and how much they will be willing to pay for the solution. From the responses shown in Figure 6, most of the students, 87.4%, can afford to pay about $50. The rest of the students will be willing to pay between $50 and $125 for the solution. About 2% will be willing to pay beyond $125. The interesting thing about the students' answer is that they placed a great value to the solution to their challenges to as high as half of their disposable income.

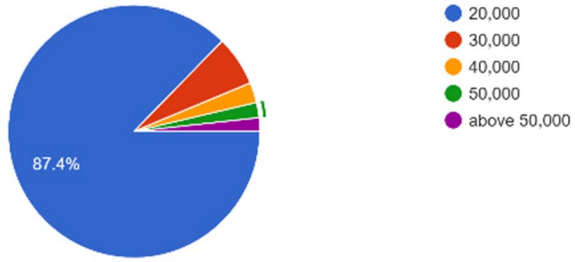

Fig. 6. Perceived Ability to Pay for a Solution

D. *Student Solution & Packaging*

One of the objectives of this study was to collate the views of the students on the type of solution they will require. It was clear that students would like to resolve the problem of power and internet in one solution. Students recommended a solution that will combine the power solution and the internet facility in one piece. Figure 7 shows that over 80% of the respondents will like the power and internet solution to be combined and the rest will want to have the power and internet solution separate.

With regards to packaging, it should be small enough to be carried in their school bag. Figure 8 shows the opinion of the students. Most students subscribe to a mobile solution as against fixed location solution. They were as follows:

In the School Bag	51%
Fixed in study location	38%
Create a special container	9%

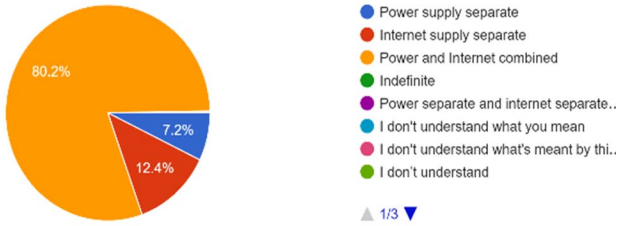

Fig. 7. Packaging of Solution

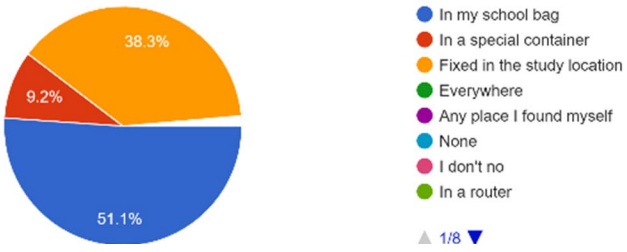

Fig. 8. Transportation of Solution

The solution to these virtual learning problems will have far reaching impact on engineering education in Nigeria and Africa. Some of these impacts are:

i. Capacity to teach weak students thereby reducing dropouts due to flexible participation and convenience,
ii. Laboratory exercises can be performed anytime thus increasing laboratory availability especially where laboratory facilities are scarce,
iii. Regional industry collaboration will be enhanced,
iv. Inter-university collaboration among students across universities in Nigeria and Africa will also be enhanced.
v. Enabling online examination which will reduce academic calendar disruptions,
vi. Industry experts teaching agreed topics in Faculty/College of engineering programmes to leverage their industry experience will be much easier to implement,
vii. Mentorship by industry experts to support engineering education in Faculty/College of Engineering through membership of both the Departmental and Faculty/College Academic Boards will be enhanced,
viii. Development of training videos and clips with Nigerian industry content can be used in the classrooms to illustrate science and engineering theories, principles, and practice and
ix. Opportunities for the development of software for online connection to laboratory equipment, machines etc. will increase.

CONCLUSION AND RECOMMENDATIONS

This study revealed that students' virtual learning challenges were two-fold, irregular and poor-quality power supply on one hand and on the other hand, poor quality and expensive internet data. It is also clear that despite the low disposable income of students they place a high value to the solution to these challenges. The students are also eager to be a part of the solution but must be affordable at below $100. The solution to these virtual learning problems will have far reaching impact on engineering education in Nigeria and Africa

It is therefore recommended that the engineering family in Africa should constitute themselves to solve these problems working with industry. The solution must be cost-effective, modular, mobile integrated, with boosted internet-ready un-interrupted power system suitable for teaching, learning and research.

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REFERENCES

[1] T, Favale, F. Soro, M. Trevisan, I. Drago, M. Mellia, "Campus traffic and e-Learning during COVID-19 pandemic", Computer Networks, Computer Networks, 2020, 176 107290, Elsevier

[2] G. K. Upadhyaya, V. K. Jain, K. P. Iyengar, M. K. Patralekh, A. Vaish, "Impact of COVID-19 on post-graduate orthopaedic training in Delhi-NCR", Journal of Clinical Orthopaedics and Trauma, https://doi.org/10.1016/j.jcot.2020.07.0180976-5662/, 2020

[3] N. Kapasia, P. Paul, A. Roy, J. Saha, A. Zaveri, R. Mallick, B. Barman, P. Das, P. Chouhan, "Impact of lockdown on learning status of undergraduate and postgraduate students during COVID-19 pandemic in West Bengal, India", Children and Youth Services Review 116, 2020, 105194, https://doi.org/10.1016/j.childyouth.2020.105194

[4] R. Malhotra, D. Gautam, J. George, D. Goyal, M. T. Ansari, "Conducting orthopaedic practical examination during the Covid-19 Pandemic," Journal of Clinical Orthopaedics and Trauma 11 (2020) S448eS455, https://doi.org/10.1016/j.jcot.2020.07.002, Elsevier

[5] E. J. Caruana, A. Patel, S. Kendall, S. Rathinam, "Impact of coronavirus 2019 (COVID-19) on training and well-being in subspecialty surgery: A national survey of cardiothoracic trainees in the United Kingdom", The American Association for Thoracic Surgery https://doi.org/10.1016/j.jtcvs.2020.05.052, Elsevier

[6] V. Rajhans,, U. Memon, V. Patil, A. Goyal, "Impact of COVID-19 on academic activities and wayforward in Indian Optometry", J Optom. (2020), https://doi.org/10.1016/j.optom.2020.06.002

[7] Croxton, R.A.,. "The role of interactivity in student satisfaction and persistence in online learning". MERLOT Journal of Online Learning and Teaching, 10(2), pp.314-325

[8] Feldman, P. "Higher education leaders share challenges of the sector". JISC. Available at:https://www.jisc.ac.uk/blog/higher-education-leaders-share-challenges-of-the-sector-27-jun-2016, Accessed 29 Jul. 2017

[9] Obringer Lee Ann, (2002), How E-learning Works, Available: http://www.howstuffworks.com/elearning1. htm

[10] Weller, M., Virtual learning environments: using, choosing and developing your VLE. Abingdon: Routledge, 2007

[11] National Universities Commission (NUC), "Nigerian University System Statistical Digest", April 2018, Abuja, Nigeria

[12] Committee of Deans of Engineering and Technology of Nigerian Universities (CODET), "Statistics of Graduating Engineering Students in 2017-2018, Unpublished, 2019.

Committee of Deans of Engineering and Technology of Nigerian Universities (CODET), "Engineering Students Virtual learning Challenges during COVID-19 Pandemic Lockdown", accessed at https://docs.google.com/forms/d/1IUEXCW4I6SDOeFAlU9fU3fjh0m5Ehyk-7xuoDo0k_Bo/edit on September 8, 2020.