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Impact of Mobile Technology and Use of Big Data in Physics Education During Coronavirus Lockdown

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Abstract: The speed of spread of Coronavirus Disease 2019 led to global lockdowns and disruptions in the academic sector. The study examined the impact of mobile technology on physics education during lockdowns. Data were collected through an online survey and later evaluated using regression tools, frequency, and an analysis of variance (ANOVA). The findings revealed that the usage of mobile technology had statistically significant effects on physics instructors' and students' academics during the coronavirus lockdown. Most of the participants admitted that the use of mobile technologies such as smartphones, laptops, PDAs, Zoom, mobile apps, etc. were very useful and helpful for continued education amid the pandemic restrictions. Online teaching is very effective during lock-down with smartphones and laptops on different platforms. The paper brings the limelight to the growing power of mobile technology solutions in physics education.

Key words: coronavirus; mobile technology; smartphone; physics education; remote learning

1 Introduction

The sudden Coronavirus Disease 2019 (COVID-19) brought big disruptions and many devastating effects on the education sector. Despite several international efforts to limit the coronavirus pandemic, the epidemic showed no indications of abating. The world witnessed an exponential increase in COVID-related mortality. For instance, as of August 13, 2020, the number of COVID-19 deaths had risen to more than 747 568 and over 20 million cases worldwide[1].

Several draconian measures were put in place by authorities across the world to halt the transmission of the disease, including total lockdown of states and closure of schools in more than 160 countries across the globe. The closure of schools due to COVID-19 in many countries impacted knowledge dissemination[2] and education development. Indeed, the coronavirus pandemic has become one of the biggest storms that have confronted the world education system for centuries. The adverse consequences of COVID-19 on the education sector were severe, including disruptions in academic programmers, teaching and learning, academic calendars, staff development, and research. Even jobs in the education sector were not spared as many educational institutions were forced to resize their workforce, while some others implemented pay cut policies because of the coronavirus crisis. Virtual education has become a new normal worldwide, but unequal access to supportive technologies, particularly in developing countries, poses a serious challenge to remote teaching and learning. The use of mobile and computer technology was critical in the fight against COVID-19. Understanding of COVID-

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19 dynamics, including prediction of current and future COVID-19 realities, was provided by computer software and modelling. Furthermore, people used a variety of mobile applications and platforms to work, request, or render services from home. Mobile tracing apps and drones were used in some countries to monitor compliance with COVID-19 restrictions, while robots assisted authorities in fumigating hospital wards, public places, and schools to prevent the spread of COVID-19. Given the widespread adoption and use of mobile technology in the academic world, particularly among students and educators[3], the current study looks into the impact of mobile technology solutions on physics education during the coronavirus lockdown.

2 Literature Review

Despite the development of vaccines, the threat of COVID-19 remains, and many schools in some countries remain closed. The United States was at the top of the list as of August 13, 2020, with over five million cases and over 169 000 deaths[1]. The number of cases has continued to rise around the world, including in Madagascar, which previously claimed a breakthrough in COVID-19 treatment using a herbal cure (COVID Organics (CVO)). However, many countries in Africa, America, Asia, and Europe, including China, have begun to relax some of the COVID-19 restrictions, and businesses are reopening, but schools in most countries remain closed as of August 13, 2020. Given the rapid spread of COVID-19 and its negative effects on education, human health, and other activities, numerous studies are underway in an effort to discover clinical vaccines for the disease and provide answers to several arising questions from the COVID-19 pandemic. Unfortunately, there was no scientifically approved cure for Coronavirus Disease as of January 2022, but vaccination campaigns for vaccine acceptance were ongoing. Some countries, such as Australia, continue to maintain strict COVID-19 regulations as of the first quarter of 2022, resulting in the denial of access to some tennis athletes to Australia, which opens in January 2022.

2.1 Coronavirus and education

The education industry is still one of the sectors that has suffered as a result of the pandemic[4]. Unplanned school closures as a COVID-19 mitigation measure have caused significant damage to the education sector. Schools remained closed in most parts of the world as of August 13, 2020, because COVID-19 deaths and cases were still on the rise. There are growing fears that prolonged school closures will be even more damaging to students, teachers, parents, and educational institutions. According to Onyema et al.[4], the coronavirus pandemic has had an impact on teaching and learning, educational jobs, research, educational opportunities for disadvantaged people, academic calendar and school programmes, access to learning facilities such as laboratories, staff professional development, education funding, and other school characteristics. Figure 1 (Source: UNESCO, 2020; statista.com, 2020.) depicts UNESCO's report on the impact on students as of March 23, 2020. This means that nationwide closures kept 1 380 344 914 students from attending school[5–7]. It would take several years for the education sector, particularly in developing countries, to fully recover from the negative effects of COVID-19.

2.2 Mobile technology and education

Mobile techs have become almost indispensable for today[8]. A study by Onyema et al.[9] identified mobile devices, machine learning algorithms, wearable devices, augmented reality, cloud computing, simulation, artificial intelligence, robotics, IoT, 5G, 3-D printing, and brain computing as the major emerging technologies that are capable of influencing the processes and outcomes of education in the 21st century.

According to Moraes et al.[10], mobile phones are a necessity for instructors' and students' daily lives. Gromik[11] stated that educators and students are able to use mobile devices to create digital materials directly from their surroundings and to access educational resources. Onyema et al.[9] found that several features of mobile devices, coupled with their availability and portability, make them vital tools for learning. According to Onyema et al.[12], the use of

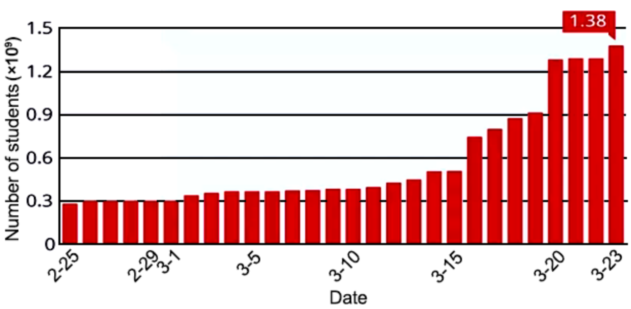

Fig. 1 Number of students affected by nationwide school closures globally as of March 23, 2020.

smartphones and other handheld devices facilitates accessibility to online education platforms, particularly during pandemics or unplanned school closures. The emerging trend towards remote education is likely to further increase the pedagogical importance of mobile technologies in both physics education and other disciplines.

The study is practical based as can be seen in the method of data collection and the quality of responses and findings. It truly reflects the answers given by the respondents who participated in this study. Also, it highlights the role played by mobile technology in physics education during the lockdown. Future work has been included in the conclusion section. The study can be replicated in other parts of the world especially in other developing countries to ascertain the challenges they face in using mobiles during the COVID-19 lockdown especially for physics education.

2.3 Big data in education

The way administrators, professors, and students communicate is changing as a result of big data. It has an impact on how colleges recruit and evaluate potential students, as well as how instructors provide services to present students. Furthermore, new technologies and developments are opening up new possibilities for the use of big data in education in the future.

(1) Future-oriented planning

Administrators will have more information to make estimates for future enrolment and judgments about admitting prospective students as data collecting and analytics tools improve. This can aid an educational institution's growth and resource planning, not just for the business as a whole, but for specific programmers and degrees.

(2) Professorial empowerment

Any big data in education endeavors must include a strategy to improve faculty digital literacy. Professors can use web resources, textbooks, e-books, and school software tools to construct a tailored curriculum using big data. Furthermore, automation will allow professors to create assignments and tests using tools like learning management systems (LMS). Professors will have more time to focus on classroom education as a result of this.

(3) Developing new prospects

Artificial intelligence, the capacity to link to Internet of things (IoT) devices, and the inclusion of virtual, augmented, and mixed reality in curricula are all current and future digital developments. These innovations and technologies can help students achieve better outcomes, have better experiences, and be more engaged by facilitating tailored learning and interventions. They will also help to accelerate the rise of big data.

Technologies such as 5G cellular networks and blockchain will underpin the future of big data. These technologies will provide academic institutions the foundation they need to deal with growing traffic, improve mobile data capabilities, and keep student records safe.

(4) Benefits of big data in education

Professors may use big data analysis to discover areas where students struggle or excel, understand their particular requirements, and build tailored learning techniques. It also gives pupils the option of picking their own educational pathways. Big data analysis, for example, may reveal that traditional in-person learning techniques cause issues in a student's performance. The statistics might also show that the student excels at online learning. In this case, a professor or adviser can assist the student in selecting a programme or course that is more appropriate for their learning style.

Students feel empowered to link their academic experiences to their interests as a result of a more individualized approach to education. This not only accelerates their academic development but also opens doors to potential professional success.

Administrators can also use big data analytics to investigate student dropout rates. Administrators may design programmes and methods to promote student retention by understanding the core causes of students leaving college.

2.4 Physics education

Physics is one of the fundamental sciences that has aided in the advancement of technology for centuries. Many physicists around the world are making significant contributions to finding solutions to many global problems. Physics concepts can be found in everyday life, and the technology side of physics makes modern lifestyles easier than they were many years ago[13]. Physics is one of the most important sciences in technology and essential for progress[14]. Physics is generally seen to be tough and abstract by students, especially those with a lack of mathematical understanding of many ideas in physics.

According to Elby[15], a large number of students do not develop the necessary conceptual understanding to solve physics problems, but often try to memorize only mathematical formulas. Similarly, the results of a study by Uwizeyimana et al.[13] found that there is a close link between students' learning difficulties in physics and the use of traditional teacher-centered approaches in teaching physics. Jegede and Julius[14] summarized the problems of physics education to include curriculum content, teaching methods, and teaching materials.

However, recent events show that physics education, like many other disciplines, is experiencing constant changes and challenges as a result of technology evolution and the recent coronavirus pandemic. These changes are changing approaches to the teaching and learning of physics, including content formulation and delivery, teacher methodology, nature of laboratories, and methods of examination and supervision. Many countries across the world are fast adopting technologies to enhance more students' participation and engagement in classrooms. For instance, Nigeria's National Policy on education clearly shows that the country would devote a larger part of her educational expenditure to science and technology (NPC, 2004). Ramma et al.[16] presented the Pedagogical Technological Integrated Mediums (PTIM) template of educational technology in physics as seen below in Fig. 2.

Some of the activities in the multiloop learning model presented in Fig. 2 incorporate components of the formative evaluation, allowing students to prepare for the introduction of additional ideas in the class[16]. To attain productivity, modern physics teaching and learning requires a pattern that encourages the confluence of content, pedagogy, and technology (CPT), as well as the engagement of the teacher, student, parents, and community.

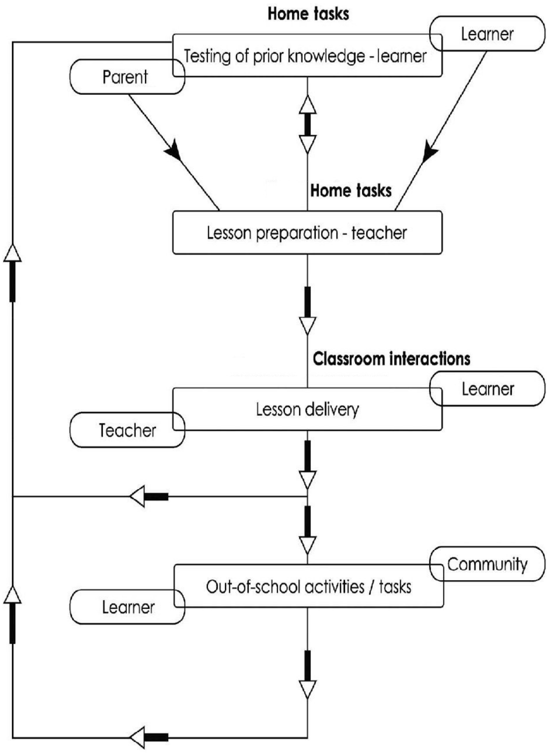

Fig. 2 Paradigm for physics lectures using a multiloop[16].

3 Material and Method

Structured questionnaires were the most frequently used data collection tool. Participants included physics professors and students from four different Nigerian tertiary institutions. Two hundred students from various schools responded to the survey questions online (Coal City University, Enugu; University of Nigeria, Nsukka; and Enugu State College of Education, Technical). The sample was chosen using a basic random sampling procedure. Participants were asked to rate their level of agreement or disagreement with the questions using a four-point linker scale: Strongly Agree (SA)-1, Agree (A)-2, Strongly Disagree (SD)-3, and Disagree (D)-4. The questionnaires included demographic information as well as information about the study's purpose. Two research methodology experts from Tai Solarin University of Education in Nigeria examined the content validity of the research instrument.

4 Result

4.1 Reliability test

The internal consistency of 30 items was measured using Cronbach's Alpha. The reliability index of 0.94 was judged to be adequate for reliability test.

4.2 Participants' bio

Table 1 represents the gender distribution of the participant. The age range of the participants is shown in Table 2. According to the data, 71.5 percent of those surveyed were between the ages of 18 and 25, 15.5 percent were between the ages of 26 and 33, and 13.0 percent were aged 34 and over. Table 3 shows the designations of the participants.

Table 1 Gender distribution of the participants.

Gender	Frequency	Learners' percent (%)	Valid percent (%)	Cumulative percent (%)
Female	106	53.0	53.0	53.0
Male	94	47.0	47.0	100.0
Total	200	100.0	100.0	–

Table 2 Age distribution of the participants.

Age	Frequency	Learners' percent (%)	Valid percent (%)	Cumulative percent (%)
18–25	143	71.5	71.5	71.5
26–33	31	15.5	15.5	87.0
34 and above	26	13.0	13.0	100.0
Total	200	100.0	100.0	–

Table 3 Designation of participants.

Designation	Frequency	Learners' percent (%)	Valid percent (%)	Cumulative percent (%)
Educator	56	28.0	28.0	28.0
Student	144	72.0	72.0	100.0
Total	200	100.0	100.0	–

4.3 Regression analysis and interpretation

Predictors: Usage of mobile technology

Table 4 shows the R and R^2 values, as well as the corrected R square and standard error. The simple correlation is depicted by the multiple correlation coefficient (R-value), which is 0.561 (the "R" column), showing a modest degree of connection. The R^2 value (the "R square" column) indicates how much variance in the dependent variable predictor factors can explain. The model matches the data gathered from the sampled physics teachers and students because of the value of 0.315, offering an optimistic estimate of how well the model fits the population. The corrected R square of 0.238, which seeks to adjust R square to better represent the model's goodness of fit in the population, also supports this. In this case, 23.8% of the dependent variable can be explained by the independent variables.

Independent variables: Physics educators, physics students, and students' attitude.

Dependent variable: Utilization of mobile technology.

Table 5 summarizes the results of an analysis of variance (ANOVA). Statistics terms include the sum of squares, degree of freedom (DF), variance, regression, and residual. The regression output provided information about the variation that the model could account for. The sum of the regression and residual information is the total output. The model accounted for the majority of the variance in the dependent variable because the regression sum of squares values (35.528) were greater than the remaining sum of squares values (77.347). The model did justice to this because of the obvious residual sum of squares 77.347. The relevance value is 0.000 (i.e., $p = 0.000$), which is less than 0.05, indicating that there is a statistically significant difference, as shown in Table 5.

Table 4 Model summary.

Model	R	R square	Adjusted R square	Std. error of the estimate
1	0.561	0.315	0.238	0.657

Table 5 ANOVA result.

Model	Sum of squares	DF	Mean square	F	Sig.
Regression	35.528	20	1.776	4.111	0
Residual	77.347	179	0.432	–	–
Total	112.875	199	–	–	–

Dependent variable: Usage of mobile technology.

Independent variables: Educators, and students' educational activities, and students' attitude.

Table 6 shows how T-statistics were used to determine the importance of each variable in the model. T values significantly less than -2 or greater than $+2$ are used to assess relative significance. Physics instructors and students both have T values greater than $+2$, with 2.493 and 2.114, respectively. Physics students have a T value of 1.853, which is less than $+2$. The preceding statement demonstrates that all explanatory variables are equally important in evaluating the impact of mobile technology on physics educators' and students' lives.

During the COVID-19 lockdown, educational programmes were suspended, as were students' attitudes toward instructional practices. Because the regression sum of squares values (35.528) was greater than the residual sum of squares values (77.347), the model explained the majority of the variation in the dependent variable. The model did justice to this because of the residual sum of squares (77.347). The independent variables did an excellent job of explaining the variance

Table 6 Coefficient of parameters to evaluate the performance.

Designation	Unstandardized coefficient		Standardized coefficient	T	Sig.	95.0% confidence interval for B	
	B	Std. error	Beta			Lower bound	Upper bound
(Constant)	2.088	0.659	–	3.171	0.002	0.789	3.388
Educator	0.212	0.085	0.194	2.493	0.014	0.044	0.380
Student	0.222	0.105	0.248	2.114	0.036	0.015	0.430
Students' attitude	0.136	0.073	0.192	1.853	0.065	–0.009	0.280

in the dependent variable because the F statistic has a minor significance value of 0.000, which is less than 0.05. This implies that there is a connection between the variables.

In the second column, the predictor variables are listed. The values for the regression model that explains the dependent variable using the independent variable can be found in the coefficient table. These are the 95 percent confidence intervals for the coefficients. Table 7 shows that all of the alternative hypotheses, H1, H2, and H3, were rejected. This suggests that the use of mobile technology has a statistically significant impact on the instructional activities of physics instructors and students during the COVID-19 lockout, as well as students' attitudes toward academic activity. The findings are consistent with those of Alzougool and Almansour[17], who discovered that using a mobile device benefited both students and instructors. The findings were also consistent with those of Iqbal and Bhatti[18] and Onyema et al.[19], who discovered that mobile phones have interesting features that are appealing to learning. However, our findings contradict those of Ifeanyi and Chukwuere[20], who discovered that many students have difficulty accessing information on their mobile devices.

4.4 Barriers that inhibit the use of mobile technologies for physics education during the coronavirus lockdown

The barrier that inhibited physics mobile tech use for physics education was examined using Principal Axis Factoring (PAF) with Promax rotation. Upon first assessment of the R-matrix, it was clear that a significant percentage of the coefficients were more than 0.30. The Kaiser-Mayer-Olkin (KMO) index was 0.79, which was higher than the required value of 0.6[21], and the Bartlett's Test of Sphericity[22] was statistically significant ($\chi^2 = 565.89, p = 0.001$), suggesting that the data were eligible for factor analysis. The initial analysis found three components with Eigenvalues greater than 1, each accounting for 34.370 percent, 20.848 percent, and 8.375 percent of the variation (as shown in Table 8). The scree plot, on the other hand, shows an obvious break after the third component (as shown in Fig. 3), indicating a possible three-factor answer. The first detected component with an eigenvalue more than 1.0 and variables with a factor loading of 0.5 or higher can be used as a cut-off for acceptable loadings[23], since they are useful in determining the minimal loading required to make up an item[24]. Following the best practices of item retention outlined at the outset, twelve items were retained for the final analysis with three latent factors. Five items (school policy, poor facilitation, functionality issues, small size screen, and time constraints) were loaded on Factor 1, another five items (accessibility and availability, data cost, poor digital skills, bad network, and constant power failure) were loaded on Factor 2 and the other two items (privacy issues and adaptation issues) were loaded on

Table 7 Hypotheses testing.

Hypothesis No.	Variable name	p-value	Statistically significant	Null hypothesis accept/reject
H1	Educator	0.014	Yes	Reject
H2	Student	0.036	Yes	Reject
H3	Students' attitude	0.065	Yes	Reject

Table 8 Total variance explained.

Factor No.	Initial eigenvalue			Extraction sum of squared loadings			Rotation sum of squared loadings
	Total	Variance (%)	Cumulative (%)	Total	Variance (%)	Cumulative (%)	Total
1	4.124	34.370	34.370	3.692	30.768	30.768	3.324
2	2.502	20.848	55.218	2.084	17.369	48.137	2.495
3	1.005	8.375	63.593	0.529	4.405	52.542	2.340
4	0.883	7.360	70.953	–	–	–	–
5	0.705	5.873	76.825	–	–	–	–
6	0.586	4.884	81.709	–	–	–	–
7	0.536	4.469	86.179	-	–	–	–
8	0.427	3.557	89.735	–	–	–	–
9	0.381	3.177	92.912	–	–	–	–
10	0.339	2.828	95.740	–	–	–	–
11	0.311	2.593	98.333	–	–	–	–
12	0.200	1.667	100.000	–	–	–	–

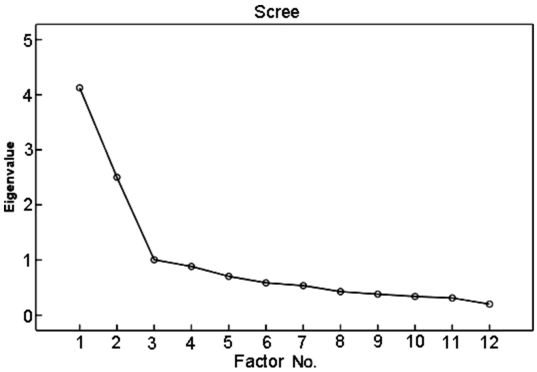

Fig. 3 Scree plot.

Factor 3 (as shown in Table 9). The study supports the findings of an earlier study by Onyema[12], which found that bad networks, school policies, and electricity problems limit EdTech use.

5 Discussion

The results indicate that laptops, e-readers, MP3 tablets, and other portable tools had a statistically significant effects on the attitudes of students towards their educational activities during the coronavirus pandemic lockdown. Responses reveal the positive influence of mobile tech on physics instruction, including access to internet and online educational resources, communication with colleagues and teachers, participation in online classes/e-learning, content/assignment preparation and submission, research and knowledge sharing, checking school updates, e-examinations, registration and payment of fees, group discussion and meetings, and social interactions. Respondents believed that smartphones and videoconferencing tools such as Zoom, GoToMeeting, Google Meet, CISCO, WebEx, Bluejeans, and Slack aided their educational activities during the COVID-19 lockdown, and it also greatly influenced the attitudes or commitment of students towards their academic activities during the coronavirus lockdown as proven in this study.

Table 9 Standardized factor loadings from the exploratory factor analysis on barriers.

Item	Standardized factor loading		
	Factor 1	Factor 2	Factor 3
School policy	0.907	–	–
Poor facilitation	0.798	–	–
Functionality issue	0.646	–	–
Small size screen	0.597	–	–
Time constraint	0.432	–	–
Accessibility and availability	–	0.844	–
Data cost	–	0.792	–
Poor digital skill	–	0.768	–
Bad network	–	0.471	–
Constant power failure	–	0.420	–
Privacy issue	–	–	0.711
Adaptation issue	–	–	0.653

Furthermore, positive and favorable responses were recorded on the perception of mobile tools. Most students admitted that they find it easy and pleasurable using their mobile technologies for educational activities. However, participants also expressed their concerns about several barriers, including bad networks, functionality issues, small screen size, data cost, and constant power failures to the application of mobile devices in education. Consequently, there is a need for education authorities to put measures in place to address the various concerns raised in our study to enable educators and students maximize the potential benefits of mobile phone and other related techs.

6 Conclusion

In this study, the authors found that for the growing of education industry during the lockdown and in COVID-19 situation, online teaching is very effective. The study highlights the growing need for technology-based education. The findings show that mobile technology solutions were very useful to physics educators and students during the coronavirus pandemic lockdown. We will do more studies in the future to examine the application of IoT enhanced devices in physics tutoring. The findings revealed that the usage of mobile technology had statistically significant effects on physics instructors' and students' academics during the coronavirus lockdown. Most of the participants admitted that the use of mobile technologies such as smartphones, laptops, PDAs, Zoom, mobile apps, etc. were very useful and helpful for continued education amid the pandemic restrictions.

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