Navigating the Post-Pandemic Era: Student Preferences and Barriers to Digital Education in Nigerian Universities

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Abstract: This study investigates on-campus students' preferences for continuing digital learning, particularly for technical subjects like Mathematics, and examines the factors influencing these preferences. Access to quality education in Nigeria is often hindered by financial constraints, but digital learning offers a cost-effective means of enhancing accessibility. Before the COVID-19 pandemic, digital learning was primarily confined to distance education programs; however, the pandemic necessitated its extension into on-campus settings. To maximize the effectiveness of digital education, it is crucial to align it with students' preferences, as these significantly influence learning outcomes. Using an analytical survey design with 314 participants and employing Chi-square and Binary Logistic Regression analyses, the study reveals a significant preference for blended learning formats that combine digital and in-person instruction. Despite having the necessary technology, the affordability of internet services remains a major barrier. The study underscores the importance of aligning digital education with students' preferences for successful adoption and recommends that government and institutions collaborate with internet service providers to ensure affordable, reliable connectivity on campuses. These measures are essential for enhancing educational accessibility and equity in Nigeria and similar contexts.

Keywords: Africa, Blended learning, Digital education, Face-to-face learning, Post-pandemic

1 Introduction

The COVID-19 pandemic triggered an urgent and widespread shift from face-to-face (F2F) to digital learning across higher education institutions in Africa, exposing both the potential and the challenges of digital education in this context [32]. Prior to this shift, digital education—defined as the use of tools such as the internet, smartphones, and online learning platforms—had been largely confined to distance learning programs with minimal integration into on-campus education [2, 7]. Despite its advantages in delivering education conveniently and cost-effectively without geographical limitations [6, 40], digital education was not widely adopted in African institutions until the pandemic necessitated its rapid expansion.

To maximize the effectiveness of digital education, it is crucial to align it with students' preferences, as these significantly influence learning outcomes. Research, including the Best Colleges [12] online learning survey, has demonstrated that considering students' preferences leads to more efficient and effective learning experiences [6, 19]. These preferences are shaped by various factors, including demographic characteristics and the availability of technological resources [6]. Therefore, understanding and integrating these preferences into the design of educational programs is essential for providing an education delivery system that meets students' needs.

This study examines on-campus students' willingness to continue using digital learning by investigating their preferences and the factors influencing these preferences, particularly for technical subjects like Mathematics. Applying the Digital Divide Theory and the Technology Acceptance Model (TAM), the research focuses on undergraduate students' learning mode preferences in Mathematics within South-West Nigeria, a region where access to quality education is critically limited due to financial constraints [33]. While digital education presents a promising solution for enhancing educational access [24, 36], the technical nature of Mathematics poses specific challenges for digital learning. Developed countries have addressed these challenges with advanced technologies, such as pen-based tools [26].

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However, such innovations are less common in developing countries, potentially limiting the effectiveness of digital learning in these regions.

Worthy of mention is the Transactional Radio Instruction (TRI), a method that has been successfully applied to teach mathematics and other subjects in low-resource settings, providing an example of how accessible, scalable education can be achieved through alternative technologies [13,23]. TRI combines radio broadcasts with interactive student activities, making it a valuable tool in regions where access to internet and digital devices is limited. This method has demonstrated success in remote areas, improving learning outcomes by providing an interactive, cost-effective learning experience for students [4]. The efficacy of TRI in these contexts underscores the potential for similarly accessible digital learning solutions in higher education, such as university-level mathematics courses in Nigeria, where access to the internet remains uneven.

The findings of this research will contribute to the ongoing discourse on education delivery in Nigeria, particularly regarding the potential for digital education to enhance the quality, accessibility, and cost-effectiveness of university education. Additionally, the study's insights will be valuable for universities aiming to increase student enrollment by offering flexible learning options, which are increasingly recognized as key factors in students' choice of educational institutions [10].

The paper is organized as follows: Section 2 explores the rationale for adopting digital education in tertiary institutions in Nigeria, discusses the current state of university education in the country, and reviews literature on teaching mode preferences and the factors influencing these preferences. Section 3 outlines the data used in the study and the statistical techniques employed. Section 4 presents the results and discussion. Finally, Section 5 concludes the study and offers recommendations.

2 Literature Review

2.1 Why Digital Education is Essential for Nigerian Tertiary Institutions

The persistent decline in Federal government funding for tertiary education in Nigeria, driven by inflation and the depreciation of the naira, has severely strained the sector's financial sustainability [25]. This funding shortfall hampers the achievement of the fourth Sustainable Development Goal, which is to provide quality education for all, regardless of circumstances. In response, the financial burden has increasingly shifted to the governing councils of tertiary institutions, relying on internally generated revenues. This has led to significant tuition fee increases across many institutions, with a sharp hike in 2023 further exacerbating the situation. Professor Osodeke, President of the Academic Staff Union of Universities, warned in a Channels Television interview on September 22, 2023, that this surge in fees could force half of the enrolled students to drop out.

Digital education presents a viable solution to these financial challenges. By increasing student enrollment without the need for additional infrastructure or staffing, digital education can enhance revenue streams for tertiary institutions while significantly reducing the overall cost of education [1,41]. This approach also ensures that all students have equal access to teaching resources, regardless of class size. Moreover, digital education offers flexibility, enabling financially disadvantaged students to work while studying, making it easier for them to afford tuition [10].

Additional arguments for adopting digital education include: (i) Sustaining the digital skills developed during the COVID-19 pandemic, ensuring that education continues uninterrupted during unforeseen circumstances. (ii) Providing an alternative learning platform during campus shutdowns due to student protests [16]. (iii) Adapting to the lifestyle of African youth, who increasingly spend significant time on smartphones, by extending learning beyond the traditional classroom and aligning with global best practices to make education more attractive and accessible [34].

2.2 Overview of the Public University Education System in Nigeria and Learning Modes

The public university education system in Nigeria is designed to ensure diverse representation across geopolitical zones. Admission criteria consider factors such as merit, quota system, educational disadvantage, and catchment areas, ensuring that each institution reflects a mix of income levels, intelligence, and ethnic backgrounds. Admissions are centrally managed by the Joint Admission Matriculation Board, applying uniform standards across all institutions. The education system follows a 6-3-3-4 structure: 6 years in primary school, 3 years in junior secondary, 3 years in senior secondary, and 4 years in tertiary education. Consequently, students typically begin their undergraduate studies at around 15 years of age, with no upper age limit for admission.

Learning modes in Nigerian public universities include face-to-face (F2F), remote, and blended approaches. Face-to-face learning requires physical presence in classrooms for all activities [30]. Remote learning, facilitated by

technology, allows students to complete courses without attending classes physically, using devices like personal computers, smartphones, and tablets [38]. Blended learning combines F2F and remote elements [39].

Prior to the 2020 pandemic, face-to-face instruction was the norm in Nigerian public universities. During the pandemic, blended learning was introduced, with remote lectures and face-to-face tutorials, exams, and lab work. Asynchronous methods were used for foundational courses, with materials shared on WhatsApp, Telegram, and Google Classroom. For other undergraduate courses, both synchronous and asynchronous modes were employed. Students in each course followed a single learning mode per semester, with Mathematics courses featuring remote lectures and face-to-face tutorials and exams.

2.3 Theoretical Perspectives and Empirical Evidences on Factors Influencing Students' Preferences for Learning Modes

Understanding students' preferences for learning modes can be enriched by several theoretical frameworks. The Digital Divide Theory addresses how disparities in access to technology impact students' engagement with different learning modes. This theory suggests that varying levels of technological access can significantly affect students' ability to effectively participate in remote and digital learning [20].

The Technology Acceptance Model (TAM) posits that users' acceptance of technology is influenced by their perceptions of its ease of use and perceived usefulness. [29] applied TAM to propose that students' satisfaction with previous e-learning experiences and their perception of the usefulness of e-learning platforms are crucial for their willingness to continue using these platforms. Similarly, [31] found that institutional support and perceived enjoyment were more significant predictors of students' preferences than the technology and internet facilities or the ease of use of the technology.

Blended Learning Theories advocate for combining face-to-face and online learning elements to enhance educational experiences [18]. [39] highlighted successful implementations of blended learning models that integrate in-person and digital interactions to provide a flexible and effective learning environment.

Empirical research on students' preferences for learning modes shows diverse results. [17] found no strong preference between remote and face-to-face (F2F) learning among their survey participants. Conversely, [22] observed that students in Hong Kong, despite their technological proficiency, preferred F2F learning over remote methods.

In contrast, studies from Africa offer a different perspective. [32] noted that Zimbabwean students in rural areas were particularly enthusiastic about using WhatsApp for learning during the pandemic. Similarly, [6] reported that about 70% of distance learning students in Ghana preferred blended learning. [39] previously documented successful blended learning models at institutions such as Chicago Virtual Charter School and Hoosier Academy. The limited preference for online learning during the COVID-19 pandemic in certain regions may be attributed to challenges such as inadequate technology access, mental health issues [15], and insufficient online support [5].

Technological factors are also critical. [11] identified the high cost of digital tools as a significant barrier to technology adoption. [3] emphasized the importance of ease of internet access for effective online teaching. [21] similarly found that internet access significantly influences students' decisions to engage with digital learning.

Additional factors influencing learning mode preferences include the duration of time spent in school [37], the quality and accessibility of study materials, interactions with staff and peers, and logistical considerations [10]. Gender, age, and mode of study preferences also play a role [30].

3 Materials and Methods

3.1 Data Collection

The study was conducted at one of the oldest public universities in Nigeria, situated in the South-West region. During the pandemic, the university implemented a blended learning mode exclusively. This approach involved remote instruction for all lecture components, while tutorials and practical sessions were conducted face-to-face (F2F). Following the pandemic, the university relaxed these restrictions, allowing lecturers to choose between blended and F2F modes for classes with fewer than 200 students. However, large classes continued to be taught using the blended mode, and all examinations were conducted F2F.

The target population for this study included students who experienced face-to-face learning in the session before COVID-19, and blended learning in the session during the pandemic. The study focused on a 200-level Mathematics course, with the understanding that students who failed or deferred the course could re-register in subsequent sessions.

Therefore, the target group consisted of students in either the 300 or 400 levels. The participants were from four different majors: Education, Environmental Design Management (EDM), Science, and Technology.

To determine the sample size, the proportion estimation formula proposed by [27] was applied:

$$n = \frac{\frac{z^2 p(1-p)}{e^2}}{1 + \frac{z^2 p(1-p)}{e^2 N}}, \tag{1}$$

where N represents the target population of $1,677$, e is the error margin of 0.05, $z = 1.96$, and $p = 50\%$. This formula yielded a required sample size of 314 students.

Ethical considerations were rigorously adhered to, ensuring that respondents' anonymity and privacy were maintained throughout the data collection process. No identifying information was collected, and no direct contact with respondents was made. The study involved a survey design where participants were presented with a questionnaire via Google Forms, and the survey link was shared with relevant student forums through WhatsApp. Participation was entirely voluntary, and all respondents were fully informed about the purpose of the study, and assured of the confidentiality of their responses before completing the forms. The survey was administered from April 10, 2023 to May 15, 2023 and was concluded once 314 valid responses were received.

The questionnaire was divided into two sections: Section A gathered demographic information, including sex, age, major, and level of study. Section B focused on technological factors, which were crucial given that students only had access to blended learning during the pandemic. According to [9], most public institutions had internet facilities due to Federal Government interventions and non-governmental aid. Consequently, Section B included questions about technology and data accessibility, essential for engaging in digital learning via smartphones.

Table 1 outlines the demographic characteristics of the study participants. The sample comprised 50.6% males and 49.4% females. Most respondents were between the ages of 18 and $30(92.4\%)$, with a smaller proportion being below $18(1.3\%)$ or above $30(6.4\%)$. In terms of academic major, the largest group was from the Science discipline (48.7%), followed by Education (18.8%), Environmental Design Management (16.6%), and Technology (15.9%). The majority of respondents were at the 300 level (59.6%), with 40.4% at the 400 level.

Table 1: Demographic Characteristics of Respondents

Category	Group	Frequency (%)
Sex	Male	159 (50.6%)
	Female	155 (49.4%)
Age	Below 18	4 (1.3%)
	18-30	290 (92.4%)
	Above 30	20 (6.4%)
Major	Education	59 (18.8%)
	EDM	52 (16.6%)
	Science	153 (48.7%)
	Technology	50 (15.9%)
Level	300	187 (59.6%)
	400	127 (40.4%)

3.2 Data Analysis

Data analysis was performed using the Statistical Package for Social Sciences (SPSS) version 20. Univariate and bivariate analyses were conducted to evaluate the demographic and technological characteristics of participants, employing percentages, frequency distributions, and Chi-square tests. For a deeper understanding of the factors affecting students' preferences, a logit regression analysis was utilized. Statistical significance was determined at a p-value threshold of < 0.05.

Logit regression was used to examine the relationship between the categorical response variable (students' preferred learning mode) and various predictor variables. The model is defined as follows [30]:

$$P(Y = 1 | x_1, x_2, \cdots, x_k) = \frac{e^{\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_k x_k}}{1 + e^{\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_k x_k}}, \tag{2}$$

where $Y = \begin{cases} 1, \text{if Blended mode} \\ 0, \text{if F2F mode} \end{cases}$, k is the number of predictors and $x_1, x_2, \cdots, x_k$ are the predictors. The predictors in this context include demographic and technological factors that may influence students' choices of learning modes

4 Results and Discussion

Figure 1 reveals that 64% of students preferred the blended mode of learning, while 36% favoured the F2F approach. This preference underscores a significant inclination towards blended learning, reflecting its growing acceptance.
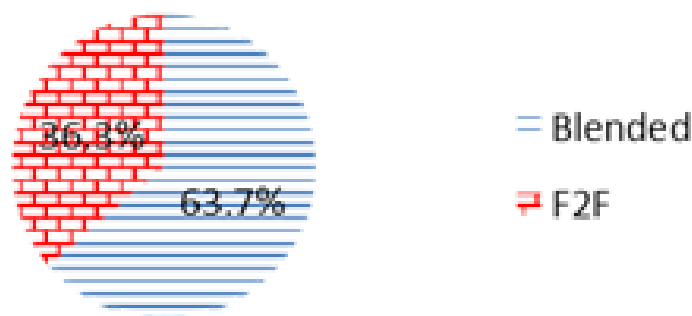

Fig. 1: Proportion of undergraduates who preferred digital learning

Table 2 illustrates the relationship between demographic characteristics and learning preferences. Students majoring in Education exhibited the highest preference for blended learning (75%), followed by those in Environmental Design and Management (68%), Science (63%), and Technology (50%). Younger students (below 30 years) also showed a stronger preference for blended learning. Despite these trends, the Chi-square analysis indicates that demographic factors such as sex, age, major, and level of study did not significantly impact students' learning mode preferences, as all *p*-values exceeded the 0.05 threshold. This suggests that while preferences may vary by demographic groups, these differences are not statistically significant. Table 3 highlights the impact of technological factors on learning preferences. The majority

Table 2: Cross tabulation of demographic characteristics by preferences

Category	Group	Blended (%)	F2F (%)	χ^2 p-value
Sex	Male	100 (62.9%)	59 (37.1%)	0.682
	Female	100 (64.5%)	55 (35.5%)	
Age	Below 18	2 (50.0%)	2 (50.0%)	
	18-30	189 (65.2%)	101 (34.8%)	0.983
	Above 30	9 (45.0%)	11 (55.0%)	
Major	Education	39 (75.0%)	13 (25.0%)	
	EDM	40 (67.8%)	19 (32.2%)	0.999
	Science	96 (62.7%)	57 (37.3%)	
	Technology	25 (50.0%)	25 (50.0%)	
Level	300L	125 (66.8%)	62 (33.2%)	0.690
	400L	75 (59.1%)	52 (40.9%)	

of students (83.4%) had access to the necessary technology for digital learning. However, 54.1% struggled with affording

internet data. Significantly, 91.5% of students who preferred blended learning had the required technology, compared to 69.3% of those who preferred F2F learning. The availability of technology was highly significant ($p < 0.05$), emphasizing that access to digital tools is a critical factor in favouring blended learning. The challenge of affording data also showed marginal significance ($p < 0.10$), indicating that while less influential than access to technology, it still plays a role in shaping learning preferences. Table 4 presents the logit regression results, reinforcing the findings from Tables 2 and

Table 3: Cross tabulation of technological factors by preferences

Category	Group	Blended (%)	F2F (%)	Total (%)	χ^2 p-value
Have Tech.	Yes	183 (91.5%)	79 (69.3%)	262 (83.4%)	0.000*
	No	17 (8.5%)	35 (30.7%)	52 (16.6%)	
Afford data	Yes	99 (49.5%)	45 (39.5%)	144 (45.9%)	0.086**
	No	101 (50.5%)	69 (60.5%)	170 (54.1%)	

*Significant at 5% level; **Significant at 10% level

3. The regression analysis demonstrates that demographic factors do not significantly drive learning mode preferences. Instead, technological factors—particularly having the necessary digital tools and affording data—are key determinants. Students equipped with technology and who can afford data are significantly more likely to prefer blended learning, as evidenced by the high odds ratios and significant p-values. The findings of this study highlight the importance of various

Table 4: Logit regression output

Factors	Category	Group	Odds ratio	Adjusted odds ratio	p-value	Confidence interval
Demographic	Sex	Female (ref.)		1		
		Male	-0.232	0.793	0.381	0.471 - 1.334
	Age	Below 18 (ref.)		1		
		18–30	-0.014	0.986	0.989	0.124 - 7.822
		Above 30	-0.489	0.613	0.675	0.062 - 6.038
	Major	Education (ref.)		1		
		EDM	0.319	1.375	0.490	0.556 - 3.403
		Science	-0.338	0.713	0.343	0.354 - 1.435
		Technology	-0.774	0.461	0.072	0.198 - 1.072
	Level	300L (ref.)		1		
		400L	-0.308	0.735	0.250	0.435 - 1.242
Technological	Have tech.	No (ref.)		1		
		Yes	1.792	6.001	0.000*	3.017 - 11.937
	Afford data	No (ref.)		1		
		Yes	0.590	1.805	0.026*	1.073 - 3.036

ref. means reference, *significant at the 5% level.

models and theories in understanding students' preferences for learning modes. The Digital Divide Theory emphasizes the gap between individuals with and without access to technology, which is crucial in the context of digital learning. The study's findings align with this theory, demonstrating that access to digital tools significantly influences students' choices between blended and F2F learning modes. TAM underscores the significance of perceived ease of use and perceived usefulness in the adoption of technology. This study supports TAM by showing that technological factors, such as the availability of digital tools and internet access, play a vital role in students' preferences. Furthermore, Blended Learning Theories, which advocate for integrating online and face-to-face components, are reflected in the preference for blended learning observed among students. Results show that the majority of participants had the necessary technology to engage with digital learning. This suggests a promising outlook for the effective and efficient uptake of digital learning in Nigeria.

The first objective of the study was to assess students' preferences for blended or F2F modes of learning in Nigerian public universities. Results indicated a preference for the blended mode, despite the F2F mode being established long before and digital learning being relatively new. This preference for blended learning could be attributed to the convenience, cost-effectiveness, and engaging nature of digital learning [14, 28]. This finding is consistent with [39], who

argued that digital learning represents the future of education. Similar preferences were observed by [32], who reported a positive reception of WhatsApp learning tools among Zimbabwean students, and [6], who found that approximately 70% of distance learning students in Ghana preferred blended learning. The current study's findings, however, contrast with those of [17] and [22], who found less inclination towards digital learning modes.

The study also highlights the importance of internet access in digital learning. A significant number of respondents reported difficulties in affording data, which notably influenced their choice of learning mode. Lack of access to necessary technologies can impede the success of digital learning. These results confirm [21], who reported that internet access is crucial for students' adoption of e-learning, and are consistent with [3], who identified internet access difficulties as a major barrier to digital teaching. [35] also emphasized that technological factors strongly impact students' attitudes towards digital learning. However, this study's findings contrast with [6], who did not find a significant effect of internet access on the preferred mode of study among distance learning students in Ghana.

Consequent upon these findings, the study recommends that the government take measures to improve internet access among public undergraduates to facilitate the successful implementation of digital learning. Service providers such as GLO and MTN, which already offer promotional packages for recreational activities, should be encouraged to expand their internet access offerings for educational purposes. Additionally, tertiary institutions could follow the recommendation given in [8] to partner with service providers to subsidize internet services on campuses.

5 Conclusions

The rapid transition to digital learning in Nigerian public universities, prompted by the COVID-19 pandemic, has revealed a significant shift in students' learning preferences towards blended modes. This study aimed to explore these preferences and understand the factors influencing them. In particular, the study provides insights into the factors that shape students' choices between blended and F2F learning modes. Results showed that the majority of students preferred the blended learning mode, which combines the flexibility of remote learning with the interactive elements of face-to-face instruction. This preference is attributed to the convenience, cost-effectiveness, and engaging nature of digital learning, which contrasts with the F2F approach that has been long established. However, the study also identified significant barriers to the widespread adoption of digital learning. Despite having the necessary technology, many students struggled with the high cost of internet data. This issue underscores the necessity for targeted interventions to enhance digital learning accessibility. The results suggest that addressing the digital divide and improving internet affordability are essential for the successful integration of digital learning in Nigerian universities. To address these challenges, several recommendations are proposed.

The study is limited by its focus on the South-West region of Nigeria, which may not fully represent the broader context of Nigerian public universities. Future research should consider expanding to include multiple institutions across different regions to provide a more comprehensive understanding of students' preferences. Longitudinal studies could also be conducted to track changes in preferences over time. Furthermore, exploring the impact of specific technological tools and internet service packages on learning outcomes could offer more detailed insights.

Acknowledgement

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