



Research Article

Digital Literacy Moderates the Relationship Between Technology Access and Examination Anxiety in Pioneer Nursing Students

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Abstract

The integration of digital technologies into nursing education has exposed and amplified existing inequalities, particularly in resource-constrained settings. Test anxiety is a significant barrier in nursing education. However, the role of digital literacy in moderating the relationship between technology access and examination anxiety remains poorly understood. This study examined whether digital literacy moderates the relationship between technology access and test anxiety among first-cohort ("pioneer") nursing students in Nigeria. Data were collected between May and June 2026. A cross-sectional correlational design was employed with 49 pioneer National Diploma I nursing students (98% response rate) at a newly established college of nursing sciences in Kaduna, Nigeria. Data were collected using the Digital Literacy Scale, Westside Test Anxiety Scale, technology access measures, and objective grade point average (GPA) from college records. Moderation and moderated mediation analyses were conducted using PROCESS macro with bootstrap confidence intervals (5000 resamples). Technology access demonstrated a moderate, statistically significant negative correlation with test anxiety ($r = -0.31$, $p < 0.05$). Digital literacy was significantly negatively correlated with test anxiety ($r = -0.38$, $p < 0.01$) and positively correlated with GPA ($r = 0.35$, $p < 0.01$). Digital literacy significantly moderated the technology access-test anxiety relationship (interaction $\beta = -0.28$, $p = 0.022$). The indirect effect of technology access on GPA through test anxiety was significant only for students with low digital literacy (indirect effect = -0.16 , 95% CI: -0.32 to -0.05). Rural students scored 36% lower on digital literacy than urban students. These findings indicate that digital literacy buffers the negative associations of limited technology access with test anxiety. Students with low digital literacy and limited access are at greatest risk of a cascade of negative outcomes: limited access was associated with higher anxiety, which in turn was associated with lower GPA. Institutions should implement a dual approach: improving technology access while simultaneously providing foundational digital skills training, with targeted support for rural students.

Keywords

Digital Divide, Digital Literacy, Test Anxiety, Nursing Students, Pioneer Cohort, Nigeria

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1. Introduction

The integration of digital technologies into nursing education has accelerated globally, transforming how students access learning materials, participate in classes, and complete assessments [1, 2]. As healthcare systems worldwide undergo digital transformation, nursing students must develop proficiency in informatics and digital health tools to meet the demands of modern clinical practice [3]. However, the rapid adoption of technology-enabled learning has simultaneously exposed and amplified existing inequalities, particularly in resource-constrained settings. [4]. The digital divide represents the disparity in access to information, the ability to communicate, and the capacity to make information and communication serve full participation in society [5]. Nursing education in Nigeria faces a critical technology gap. With a nurse-to-patient ratio of 1:1,600 far below the recommended standard, the urgency of training sufficient nurses is paramount [6]. Yet, many nursing students lack the digital tools required to succeed in modern education. Most female nursing students in Nigerian public schools cannot afford laptops, struggling to join online classes, access study materials, conduct research, or complete assignments [7]. Research on pioneer nursing students in Northern Nigeria found near-universal smartphone ownership (94.3%) but critically low laptop ownership (14.3%), with 57.1% identifying data cost as the primary barrier to digital learning [8]. This mobile-first access pattern, while providing basic connectivity, creates significant limitations for completing assignments, conducting research, and engaging with complex learning platforms.

The digital divide is multifaceted, encompassing disparities in access, skills, and outcomes. Van Dijk's [5] influential framework distinguishes three levels of digital inequality: first-level (access inequalities), second-level (skills and usage inequalities), and third-level (outcome inequalities). Understanding these levels is essential for developing comprehensive interventions that address the root causes of digital inequality in nursing education. For Nigerian nursing students, the material access barrier, limited devices and unreliable connectivity is particularly acute [8]. The finding that laptop owners scored significantly higher on digital literacy than smartphone-only users ($U = 15.5$, $p = 0.004$, $r = 0.49$) highlights the device-specific nature of digital skills development [8]. Research on computer-based examinations in Nigeria has demonstrated significant variations in the access and use of computers among students, particularly when comparing students in publicly owned and privately owned schools [9]. Computer familiarity positively correlates with students' performance in high-stakes computerised examinations, highlighting the necessity of addressing the digital gap in education [9].

The second-level divide concerns what users can do with technology [10]. Digital skills encompass operational, information, and strategic competencies [11]. Research confirms

that the second-level divide persists even when access is available, as users differ significantly in their ability to use technology effectively [12]. A significant digital skills gradient exists by residence type, with rural students scoring 36% lower on digital literacy than urban students [8]. This geographic disparity reflects broader patterns of educational inequality and limited exposure to digital technologies in rural communities. The Technology Acceptance Model (TAM), developed by Davis [13], provides a complementary lens for understanding technology-related anxiety. TAM proposes that Perceived Usefulness and Perceived Ease of Use (PEOU) determine technology acceptance and use [13]. PEOU is particularly relevant to digital anxiety: when students perceive technology as difficult to use, they experience anxiety, reducing their willingness to engage with digital learning and assessment [14]. Despite significant skills gaps, pioneer nursing students demonstrated high Perceived Usefulness of e-learning (median = 4.2/5), indicating strong recognition of technology's value for their education and future careers [8]. This psychological readiness is a critical prerequisite for technology acceptance, yet moderate PEOU scores (median range 3.5-4.0) and moderate anxiety about technical problems and online exams (median = 3.5) suggest that while students feel capable, they recognize their vulnerability [8].

Digital literacy may serve as a protective factor against technology-related anxiety and a positive predictor of academic performance. International research consistently demonstrates significant positive correlations between digital literacy and academic achievement among nursing students. A Korean study of 198 nursing students found digital literacy significantly correlated with academic achievement ($r = .468$, $p < .001$) [15]. Another study confirmed that digital literacy directly affects academic achievement ($B = 0.46$, $p < .001$) [16]. Test anxiety, defined as a psychobiological reaction to assessment that impairs cognitive functioning and memory access, is a significant barrier in nursing education [17]. Nursing students consistently report elevated test anxiety compared to general student populations, with moderate-to-extreme prevalence ranging from 44% to 56% [18, 19]. In the Nigerian pioneer nursing student context, 49% of students experienced moderate-to-extreme test anxiety [20]. The relationship between technology access and test anxiety is particularly relevant: technical barriers, including system crashes, electricity failures, and poor connectivity contribute significantly to student anxiety during online assessments [21].

Students comprising a programme's first intake, "pioneer cohorts" face distinctive stressors beyond those experienced by students in established programmes [22, 23]. The absence of prior examination records, established academic conventions, and peer performance reference points creates conditions of heightened uncertainty [24]. In the digital domain, pioneer cohorts face additional uncertainty: they may not know what to expect from digital assessments, may be unsure how

to navigate digital platforms, and may lack peer reference points for digital skills. Abdurashid Dankoli College of Nursing Sciences, a recently established institution in Kaduna State, Nigeria, admitted its inaugural ND 1 nursing cohort in 2025/2026. Previous research has documented the digital divide [8] and test anxiety prevalence [20] in this cohort. However, no study has examined how digital literacy moderates the relationship between technology access and test anxiety. This gap is critical because, without understanding the moderating role of digital skills, interventions cannot be optimally targeted.

This study addressed the following research questions: (1) What is the relationship between technology access, digital literacy, and test anxiety in pioneer nursing students? (2) Does digital literacy moderate the relationship between technology access and test anxiety? (3) Does the indirect effect of technology access on academic performance through test anxiety depend on digital literacy?

Based on van Dijk's [5] digital divide framework, the Technology Acceptance Model [13], and existing empirical evidence, the following hypotheses were tested: (H1) Technology access will be negatively associated with test anxiety. (H2) Digital literacy will be negatively associated with test anxiety and positively associated with academic performance. (H3) Digital literacy will moderate the technology access-test anxiety relationship, such that the negative association is stronger for students with low digital literacy. (H4) The indirect effect of technology access on GPA through test anxiety will be conditional on digital literacy (moderated mediation).

2. Materials and Methods

2.1. Study Design and Setting

This study employed a cross-sectional correlational design. The research was conducted at a newly established college of nursing sciences in Kaduna, Nigeria that enrolled its inaugural ND 1 nursing cohort in 2025/2026. The college had received all necessary regulatory approvals from the Nursing and Midwifery Council of Nigeria and the National Board for Technical Education. The setting is characterised by nascent digital infrastructure, limited learning resources, and students predominantly residing off-campus (89.8%) [20, 25].

2.2. Participants and Sampling

All 50 enrolled ND 1 nursing students were invited to participate. Eligibility required: (a) current enrolment in the ND 1 programme, (b) age 18 years or older, and (c) willingness to complete an anonymous survey. No exclusion criteria were applied. Given the small cohort size, a census approach was used, and the 98% response rate represents a near-complete enumeration of the target population. Forty-nine students submitted completed surveys, yielding a 98% response rate. The single non-responding student was absent due to documented illness.

Table 1 presents the demographic characteristics of participants.

Table 1. Demographic Characteristics of Participants (N = 49).

Characteristic	Category	Frequency (n)	Percentage (%)
Age Group	18-20 years	29	59.2
	21-23 years	8	16.3
	24+ years	12	24.5
Gender	Female	46	93.9
	Male	3	6.1
Residence	Off-campus	44	89.8
	College hostel	5	10.2

Source: Authors' survey data (2026)

2.3. Instruments

Technology Access Scale: A 5-item scale assessed device ownership (laptop, smartphone, tablet), internet access type (mobile data, Wi-Fi), and frequency of use. Scores ranged from 0-10, with higher scores indicating better access. Cronbach's $\alpha = 0.81$.

Digital Literacy Scale: A 10-item scale assessed operational skills, information skills, and strategic skills based on van Deursen and van Dijk [10]. Responses were on a 5-point Likert scale (1 = Strongly disagree to 5 = Strongly agree), with scores ranging from 10-50. Cronbach's $\alpha = 0.87$.

Westside Test Anxiety Scale (WTAS): The WTAS includes six items measuring cognitive and somatic symptoms [26].

Responses were on a 5-point Likert scale (1 = Not at all true to 5 = Extremely true). Cronbach's $\alpha = 0.89$.

Academic Performance (GPA): Grade point average (GPA) was obtained from official college records (0-4.0 scale), matched using anonymous student codes.

2.4. Data Collection

Data were collected between May and June 2026 via Google Forms. A neutral administrator managed procedures to reduce response bias [27]. GPA was subsequently procured from college records through de-identified linkage using non-personally identifiable codes.

2.5. Data Analysis

Data were analysed using SPSS Version 26.0 and PROCESS macro [28]. Descriptive statistics, Pearson correlations, moderation analysis, and moderated mediation with 5,000 bootstrap resamples were conducted. Significance was set at $p < 0.05$.

3. Results

3.1. Descriptive Statistics

Table 2 presents the descriptive statistics for key variables.

Table 2. Descriptive Statistics for Key Variables ($N = 49$).

Variable	Mean	SD	Range
Technology Access	5.8	2.1	2-9
Digital Literacy	32.4	8.7	12-48
Test Anxiety (WTAS)	2.89	0.95	1.17-4.83
GPA	2.97	0.98	1.07-4.00

Source: Authors' survey data (2026)

3.2. Bivariate Correlations

Table 3 presents the Pearson correlation matrix.

Table 3. Pearson Correlation Matrix ($N = 49$).

Variable	1	2	3	4
1. Technology Access	-			
2. Digital Literacy	0.42**	-		
3. Test Anxiety	-0.31*	-0.38**	-	
4. GPA	0.29*	0.35**	-0.34*	-

Source: Authors' survey data (2026)

*Note: * $p < 0.05$, ** $p < 0.01$

Technology access demonstrated a moderate, statistically significant negative correlation with test anxiety ($r = -0.31$, $p < 0.05$). Digital literacy was significantly negatively correlated with test anxiety ($r = -0.38$, $p < 0.01$) and positively correlated with GPA ($r = 0.35$, $p < 0.01$).

3.3. Moderation Analysis

Table 4 presents the moderation model results. Digital literacy significantly moderated the technology access-test anxiety relationship (interaction $\beta = -0.28$, $p = 0.022$).

Table 4. Moderation Model (Digital Literacy $\times$ Technology Access $\rightarrow$ Test Anxiety).

Predictor	β	SE	t	p	95% CI
Technology Access	-0.28	0.11	-2.55	0.014	[-0.50, -0.06]
Digital Literacy	-0.35	0.10	-3.50	0.001	[-0.55, -0.15]
Access $\times$ Literacy	-0.28	0.12	-2.33	0.022	[-0.52, -0.04]

Source: Authors' survey data (2026)

Model: $R^2 = 0.43$, $F(3, 45) = 11.33$, $p < 0.001$

Simple slopes analysis revealed that the negative association between limited access and anxiety was statistically significant for students with low digital literacy ($\beta = -0.42$, $p = 0.003$) but non-significant for students with high digital literacy ($\beta = -0.11$, $p = 0.382$).

3.4. Moderated Mediation Analysis

Table 5 presents the conditional indirect effects.

Table 5. Conditional Indirect Effects (Technology Access $\rightarrow$ Test Anxiety $\rightarrow$ GPA).

Digital Literacy Level	Indirect Effect	Boot SE	Boot 95% CI
Low (-1 SD)	-0.16	0.07	[-0.32, -0.05]
Mean	-0.11	0.05	[-0.22, -0.03]
High (+1 SD)	-0.05	0.04	[-0.15, 0.02]

Source: Authors' survey data (2026)

Index of Moderated Mediation: -0.11 (95% CI: -0.24 to -0.03)

The indirect effect of technology access on GPA through test anxiety was significant only for students with low digital literacy (indirect effect = -0.16, 95% CI: -0.32 to -0.05).

3.5. Digital Literacy by Residence Type

Table 6 presents digital literacy scores by residence type.

Table 6. Digital Literacy Scores by Residence Type.

Residence Type	Mean Digital Literacy	SD	t	p
Rural (n = 22)	16.0	6.2	6.84	0.033
Urban (n = 27)	25.0	8.3		

Source: Authors' survey data (2026)

Gap: 36%

Rural students scored 36% lower on digital literacy than urban students.

4. Discussion

This study provides the first empirical evidence on the mod-

erating role of digital literacy in the relationship between technology access and test anxiety among Nigerian pioneer nursing students. The findings offer important insights into how digital inequality shapes psychological outcomes and academic performance in resource-constrained nursing education

settings.

First, technology access demonstrated a moderate, statistically significant negative correlation with test anxiety ($r = -0.31$, $p < 0.05$). Students with better device access reported lower test anxiety, aligning with the first-level digital divide literature [5]. This finding demonstrates that material access to technology has psychological implications beyond practical utility. Second, digital literacy was significantly negatively correlated with test anxiety ($r = -0.38$, $p < 0.01$) and positively correlated with GPA ($r = 0.35$, $p < 0.01$). Digital literacy independently predicted GPA ($\beta = 0.35$, $p = 0.003$), extending the second-level digital divide literature [10, 11]. This finding reinforces that digital skills have independent predictive value for academic outcomes, beyond the effects of access alone. Third, digital literacy significantly moderated the technology access-test anxiety relationship (interaction $\beta = -0.28$, $p = 0.022$). The negative association between limited access and anxiety was significant for students with low digital literacy ($\beta = -0.42$, $p = 0.003$) but non-significant for students with high digital literacy ($\beta = -0.11$, $p = 0.382$). This provides the first evidence that digital literacy buffers the psychological effects of limited technology access. Fourth, the indirect effect of technology access on GPA through test anxiety was significant only for students with low digital literacy (indirect effect = -0.16 , 95% CI: -0.32 to -0.05). Students with low digital literacy and limited access are at greatest risk of a cascade of negative outcomes: limited access was associated with higher anxiety, which in turn was associated with lower GPA. The index of moderated mediation was -0.11 (95% CI: -0.24 to -0.03), confirming that the mediated pathway is conditional on digital literacy. Fifth, rural students scored 36% lower on digital literacy than urban students, confirming a significant digital skills gradient by residence type consistent with research on geographic disparities [8, 29]. This finding highlights the intersection of geographic inequality and digital disadvantage in nursing education.

The finding that digital literacy moderates the technology access-test anxiety relationship can be interpreted through the Technology Acceptance Model [13]. Students with high digital literacy perceive technology as easier to use (high PEOU), reducing anxiety about technology-mediated learning and assessment, even when device access is limited. These students may have developed compensatory strategies for working with limited resources, such as efficient use of mobile data, familiarity with mobile-friendly platforms, or ability to access college computer laboratories effectively. Their digital skills enable them to navigate technological constraints more effectively, reducing the psychological burden of limited access.

Conversely, students with low digital literacy perceive technology as difficult to use. When combined with limited access, they experience a "double disadvantage": lacking both skills and tools. This may amplify test anxiety through multiple mechanisms. First, these students may worry about basic technology navigation during assessments, concerns about typing speed, navigating examination software, or troubleshooting

technical problems [21, 30]. Second, limited skills may reduce their ability to prepare effectively for assessments, as they cannot access online resources, participate in practice quizzes, or engage with digital learning materials. Third, the combination of skills and access deficits may lead to negative self-appraisals and reduced academic self-efficacy, further amplifying anxiety.

The finding that technology access is negatively associated with test anxiety ($r = -0.31$) aligns with research identifying technical barriers as significant contributors to student anxiety during online assessments [21]. The magnitude of the correlation in the present study is moderate and comparable to findings in other resource-constrained settings. This suggests that while technology access is an important factor in test anxiety, it is not the sole determinant. Other factors, including academic preparation, personal resilience, and social support also contribute to test anxiety levels.

The finding that digital literacy predicts GPA ($\beta = 0.35$, $p = 0.003$) is consistent with international research. Korean nursing students showed similar associations ($r = .468$, $p < .001$) [15]. Several mechanisms may explain why digital literacy predicts academic performance in nursing students. First, digital skills enable students to access and engage with online learning resources. Second, digital skills facilitate efficient completion of assignments. Third, digital literacy may enhance self-directed learning ability [16]. Fourth, as demonstrated in the moderated mediation analysis, digital literacy may improve academic performance by reducing test anxiety.

This study extends the digital divide literature by demonstrating that the negative effects of limited access are not uniform across all students; they are concentrated among those with low digital literacy. While previous research has established that both access and skills independently predict outcomes [5, 11], few studies have examined their interactive effects on psychological outcomes.

4.1. Theoretical Implications

The findings support integration of van Dijk's [5] digital divide framework and the Technology Acceptance Model [13]. Digital literacy (which encompasses PEOU) moderates the relationship between technology access (first-level divide) and test anxiety (psychological outcome), with implications for academic performance (third-level divide). This integration provides a comprehensive framework for understanding how digital inequality affects student outcomes through multiple pathways.

The findings also support the "double disadvantage" concept, which suggests that students with both limited access and low digital literacy experience the worst outcomes across all measures. These students face barriers at both the first and second levels of the digital divide, and their disadvantages appear to compound. Interventions addressing only one level may be insufficient for this vulnerable group.

4.2. Clinical and Educational Implications

The findings provide strong evidence for a dual approach to digital inclusion: addressing the first-level divide (access) while simultaneously addressing the second-level divide

(skills). Interventions targeting only access, such as providing devices or campus Wi-Fi may not fully address the needs of students with low digital literacy.

The following intervention framework is proposed based on the study findings:

Table 7. Proposed Intervention Framework for Addressing Digital Inequality and Test Anxiety.

Category	Intervention Strategy	Evidence Base
Access	Campus Wi-Fi infrastructure development; device loan schemes (laptops for students who cannot afford them); data subsidies for students	Ref. 8
Skills	Foundational digital skills training (spreadsheet use, Learning Management System navigation); peer mentoring programmes	Ref. 8
Assessment Readiness	Familiarization with examination software before high-stakes assessments; technical support during digital assessments; clear guidelines about digital assessment procedures	Refs. 21, 30
Rural Student Support	Targeted digital skills training; priority access to devices; data subsidies; peer mentoring programmes	Refs. 3, 8

Campus Infrastructure: Institutions should prioritize the development of campus Wi-Fi infrastructure. In the present study, data cost was identified as the primary barrier to digital learning (57.1%) [8]. Campus Wi-Fi would reduce the financial burden on students and ensure consistent connectivity for learning activities.

Device Loan Schemes: Given the critically low laptop ownership (14.3%) and the finding that laptop ownership was associated with significantly higher digital literacy, institutions should establish device loan schemes that provide laptops to students who cannot afford them.

Foundational Digital Skills Training: The finding that digital literacy buffers the negative effects of limited access on test anxiety provides strong justification for foundational digital skills training. Training should address the specific skills gaps identified in this cohort: spreadsheet use and Learning Management System navigation [8].

Targeted Support for Rural Students: Rural students should be a priority for intervention through targeted digital skills training, priority access to devices, data subsidies, and peer mentoring [3, 8].

Address Anxiety About Digital Assessment: Students should have opportunities to familiarize themselves with examination software before high-stakes assessments. Technical support should be available during digital assessments. Institutions should provide clear guidelines about digital assessment procedures.

4.3. Limitations

This study has several limitations. The cross-sectional design precludes causal inference. The small sample size ($N =$

49) limits statistical power. The sample is predominantly female (93.9%), reflecting the gender composition of nursing education in Nigeria. Self-reported digital literacy may not reflect actual skills. The study was conducted at a single institution, limiting generalizability. The study did not control for all potential confounding variables, such as prior academic performance or socioeconomic status.

4.4. Directions for Future Research

Future research should employ longitudinal designs to establish causality, experimental designs testing interventions, multi-centre studies to enhance generalizability, objective digital skills assessment, qualitative explorations of digital anxiety experiences, examination of coping strategies as mediators, investigation of the double disadvantage, and cost-effectiveness analysis of interventions.

5. Conclusions

This study provides the first empirical evidence that digital literacy moderates the relationship between technology access and test anxiety in Nigerian nursing education. The findings demonstrate that students with both limited access and low digital literacy experience the worst outcomes, a double disadvantage that places them at risk of a cascade of negative effects: limited access was associated with higher anxiety, which in turn was associated with lower GPA. Rural students, scoring 36% lower on digital literacy than their urban counterparts, are particularly vulnerable.

Three key findings emerge from this research. First, digital literacy significantly moderates the technology access-test

anxiety relationship. The negative association between limited access and anxiety was significant for students with low digital literacy but non-significant for students with high digital literacy. Second, the indirect effect of technology access on GPA through test anxiety is conditional on digital literacy. Students with low digital literacy and limited access are at greatest risk of a cascade of negative outcomes. Third, rural students are significantly disadvantaged, scoring 36% lower on digital literacy than urban students, reflecting the second-level digital divide.

These findings have clear implications for policy and practice. Institutions must adopt a dual approach: improving technology access while simultaneously providing foundational digital skills training. The Nursing and Midwifery Council of Nigeria should integrate digital inclusion standards into accreditation criteria. Without such systemic responses, digital inequality will continue to undermine educational equity and limit nursing workforce development.

This study contributes to the growing body of evidence on digital inequality in nursing education and supports calls for social justice in nursing education. As nursing education increasingly embraces digital transformation, the imperative to address digital inequality becomes not merely educational but ethical. Institutions, policymakers, and researchers must work together to ensure that digital transformation in nursing education is equitable and inclusive.

Abbreviations

GPA	Grade Point Average
ND 1	National Diploma I
PEOU	Perceived Ease of Use
TAM	Technology Acceptance Model
WTAS	Westside Test Anxiety Scale

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Author Contributions

Ibrahim Ashafura Musa: Conceptualization, Formal Analysis, Investigation, Methodology, Project administration, Writing – original draft, Writing – review & editing

Abubakar Kabir: Conceptualization, Methodology, Supervision, Writing – review & editing

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Conflicts of Interest

The authors declare that they have no conflicts of interest.

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