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Research Article

Digital inequality and educational outcomes: A sociological analysis of access, usage, and academic performance among secondary school students in Northern Nigeria

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Abstract

While Nigeria's internet penetration reached 45 percent in 2023, only 18 percent of secondary school students in Northern Nigeria have used a computer for learning, yet little research has examined how digital inequality shapes educational outcomes in this low-resource, conflict-affected region. This study employed an explanatory sequential mixed methods design with 240 secondary school students from six schools in Kano and Kaduna States, along with interviews with 24 students, six teachers, and four principals, to investigate how three dimensions of digital inequality, namely access, skills, and educational usage, predict academic performance in mathematics and English. Hierarchical linear regression revealed that physical access alone explained only 11 per cent of variance in performance, while adding digital skills and educational usage increased explained variance to 56 per cent. Moderation analyses showed that the effect of digital skills on performance was significantly weaker for female students (β=-0.44, $p<0.001$) and rural students (β=-0.29, $p<0.01$) compared to male and urban peers respectively. Qualitative findings explained these patterns through household gender gatekeeping, lack of teacher digital competence, and infrastructure failures including unreliable electricity. The study concludes that device distribution alone is ineffective; improving educational outcomes requires digital literacy training integrated into teacher education, structured educational usage assignments, infrastructure development for rural areas, and gender sensitive programming that addresses household barriers to girls' digital learning.

Keywords: Digital inequality, educational outcomes, secondary education, Northern Nigeria, gender gap, digital skills, rural education, mixed methods

Introduction

While Nigeria's internet penetration reached 45 per cent in 2023, only 18 per cent of secondary school students in the Northern states have used a computer for learning purposes (Nigerian Communications Commission, 2024). This statistic captures the profound digital divide that characterizes one of Africa's largest educational systems, a divide that carries increasingly serious consequences as global education becomes more digitally mediated. The COVID-19 pandemic starkly illustrated this reality, as school closures across Nigeria disrupted learning for over 40 million students, yet while affluent schools in Lagos and Abuja rapidly pivoted to online platforms, the vast majority of students in the North were simply excluded from continued education altogether. The problem of digital inequality in education, however, extends far beyond the binary distinction between those who have access to technology and those who do not, a framing that researchers have long recognised as overly simplistic (van Deursen & van Dijk, 2023, Idhalama *et al.,* 2026a, b). Contemporary scholarship distinguishes between multiple levels of digital inequality, encompassing disparities in material access, digital skills, and autonomous usage patterns that meaningfully support educational or economic advancement (Scheerder *et al.,* 2017). This three-level framework is critical for understanding educational outcomes because access alone does not automatically translate into academic benefit, a finding consistently demonstrated across diverse national contexts (Hohlfeld *et al.,* 2013; Kastorff *et al.,* 2025). Despite the analytical sophistication of recent digital divide research, most existing scholarship focuses on high-income countries in Europe, North America, and East Asia, where the baseline conditions of reliable electricity, functional internet infrastructure, and relatively equitable school systems are largely taken for granted. The systematic literature review by Kastorff *et al.* (2025) found that of twenty-two studies examining digital divide impacts on educational outcomes published between 2013 and 2023, only three included any Sub-Saharan African contexts, and none focused specifically on the Sahelian regions characterised by chronic infrastructure deficits and conflict-induced displacement. Similarly, research on digital skills training interventions has concentrated on higher education institutions in relatively resourced settings, with limited attention to how basic digital literacy might be cultivated among marginalised populations in low connectivity environments (Umar & Argungu, 2025; Ezeabasili & Idhalama, 2025; Idhalama & Nwachukwu, 2025). This gap is significant because the mechanisms through which digital inequality translates into educational disadvantage may operate quite differently when background conditions of poverty, gender segregation, and institutional fragility are taken into account. Northern Nigeria presents a uniquely valuable case for examining how digital inequality shapes educational outcomes under conditions of extreme resource scarcity and social complexity. The region is home to over 11 million out-of-school children, the largest such

population in the world, with out-of-school rates exceeding 50 per cent in several states including Kebbi, Yobe, and Zamfara (UNICEF, 2025b). Among girls in rural Northern areas, secondary school enrolment drops to just 34 per cent, a figure that reflects both household poverty and deeply entrenched cultural norms regarding female seclusion and early marriage. The region also maintains a parallel system of Quranic Almajiri schools, where boys are sent to live with Islamic teachers, often subsisting through begging, with virtually no exposure to formal curriculum or technology (UNICEF, 2025a). These children have been described as invisible in plain sight, drifting entirely outside systems of care, education, and protection. Electrification rates in rural Northern Nigeria hover around 30 per cent, and broadband internet coverage is concentrated in state capitals, leaving vast stretches of the region functionally offline. Furthermore, the protracted Boko Haram insurgency and banditry across the Northwest have destroyed hundreds of schools, displaced millions, and created a generation of children whose educational trajectories have been violently interrupted (Domena, 2025). In conflict-affected contexts like these, the digital divide is not merely about convenience or enrichment but about whether any form of continued learning is possible at all when physical schools are unsafe or non-operational.

The research gaps

this study addresses, therefore, are not simply a lack of data but a lack of theoretically informed empirical research that can guide policy in settings where digital interventions are increasingly promoted as solutions yet may inadvertently exacerbate existing inequalities if implemented without attention to local social structures. Recent studies of low-income school contexts in Spain, for example, have shown that even when devices are distributed equally, students from disadvantaged backgrounds use them less for academic purposes and receive less parental guidance for educational technology use, effects that mirror and amplify pre-existing achievement gaps (Gil-Hernández *et al.,* 2024; Swindle *et al.,* 2014). Similar patterns have been documented in South Korea, where researchers found that digital literacy levels among elementary students' cluster into four distinct stratified groups, with household income and regional size significantly predicting digital competency regardless of school-based access (Kim *et al.,* 2019). In the Sub-Saharan African context, a World Bank study of digital skills training programmes across Uganda, Nigeria, and Rwanda revealed that gender norms, mobility restrictions, and safety concerns create additional barriers for women and girls that generic access-based interventions fail to address (World Bank, 2022). These findings suggest that the relationship between digital inequality and educational outcomes is deeply mediated by local configurations of socioeconomic stratification, gender regimes, and institutional capacity, precisely the dimensions that have been undertheorized in applications of digital inequality frameworks to African educational contexts.

Research objectives

The study aimed to: Measure the level of digital access, digital skills, and types of digital usage (educational vs. recreational) among secondary school students in Northern Nigeria. Determine the relative contribution of digital access, digital skills, and educational usage to students' academic performance (mathematics and English scores). Examine how gender, socioeconomic status (SES), and school location (rural vs. urban) modify the relationship between digital skills and academic performance.

Research questions

The study was guided by the following research questions: What is the current status of digital access, digital skills, and digital usage patterns among secondary school students in Northern Nigeria? To what extent do digital skills and educational usage predict academic performance beyond mere physical access to devices? Does the effect of digital skills on academic performance differ significantly between male and female students, and between rural and urban students?

Methodology

This study employed a cross-sectional explanatory sequential mixed methods design. A sample of 240 junior secondary school year three students was selected using stratified random sampling from six secondary schools across Kano and Kaduna States, with strata defined by school location (urban versus rural) and school type (public versus private). Quantitative data collection involved a structured questionnaire administered in both English and Hausa, which measured three dimensions of digital inequality: material access (six items), digital skills (twelve items on a Likert scale), and types of usage (educational versus recreational). Academic performance data were extracted from school records, specifically standardised end-of-term examination scores in mathematics and English. The questionnaire was pilot tested on 30 students from a non-participating school, yielding acceptable reliability with Cronbach's alpha values of 0.84 for the digital skills scale and 0.79 for the usage scale. Hierarchical linear regression analysis was conducted to examine the unique contribution of each digital inequality dimension to academic performance while controlling for gender, socioeconomic status, and prior academic achievement. Following the quantitative phase, semi-structured interviews were conducted with 24 purposefully selected students representing four digital inequality profiles: high access/high skills, high access/low skills, low access/high skills, and low access/low skills. Also, six teachers and four school principals were interviewed to explore institutional factors shaping digital usage patterns.

Thematic analysis guided by Braun and Clarke (2006) six-phase framework was applied to interview transcripts, with intercoder reliability established at 0.82. Ethical approval was obtained from the Ahmadu Bello University

institutional review board, and all participants provided parental consent along with individual assent.

Results demographic characteristics of participants

A total of 240 secondary school students were in the study. Table 1 presents the demographic breakdown of the sample.

The sample was well balanced by gender with 52 percent male and 48 percent female students. Rural and urban locations were equally represented at 50 percent each, which allowed for meaningful comparisons between these subgroups. Public school students constituted 60 percent of the sample, reflecting the predominance of public schooling in Northern Nigeria. Regarding socioeconomic status, more than half of the participants (55 percent) came from low SES households, indicating significant material poverty within the sample. This distribution was consistent with known poverty statistics for Northern Nigeria.

Results for research question 1

Research question 1: What is the current status of digital access, digital skills, and digital usage patterns among secondary school students in Northern Nigeria?

Digital access status

Table 2 presents students' responses regarding digital access indicators.

Digital access among secondary school students in Northern Nigeria was severely limited. Only 42.5 percent of students owned a smartphone, and computer ownership was virtually non-existent at just 8.3 percent. Home internet access was available to only 22 percent of participants, while the majority relied on mobile data plans on their phones. Critically, nearly 68 percent of students lacked reliable electricity at home, a finding that fundamentally constrained any digital learning activities regardless of device ownership. More than two thirds of students reported sharing their device with family members, indicating that even limited access was not exclusively available for schoolwork.

Digital skills status

Table 3 shows students' self reported digital skills across five core competencies.

Digital skills were generally low across the sample. While 40 percent of students could independently turn on a device and open an application, this basic operational skill declined sharply for more complex tasks. Only 25.9 percent could independently search for information online, and a mere 8.3 per cent could send an email with an attachment. Critical information literacy skills, such as checking the trustworthiness of a website, were mastered by only 10.8 per cent of students. These findings indicate that even among students with some access, the skills necessary to translate that access into meaningful educational use were largely absent.

Digital usage patterns

Table 1: Demographic characteristics of participants (N=240)

Demographic Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	125	52.1
	Female	115	47.9
School Location	Urban	120	50.0
	Rural	120	50.0
School Type	Public	144	60.0
	Private	96	40.0
Socioeconomic Status (SES)	Low (asset index 0-2)	132	55.0
	Medium (asset index 3-4)	72	30.0
	High (asset index 5-6)	36	15.0
Prior Academic Performance	Below average (previous term)	98	40.8
	Average	85	35.4
	Above average	57	23.8

Table 2: Digital access among secondary school students (N=240)

S. No.	Access Indicator	Yes (%)	No (%)
1	Own a smartphone	42.5	57.5
2	Own a computer or laptop	8.3	91.7
3	Have internet access at home	22.1	77.9
4	Use mobile data on phone	54.2	45.8
5	Have reliable electricity at home	31.7	68.3
6	Share a device with family members	67.5	32.5

Table 3: Digital skills distribution (N=240)

S. No.	Digital Skill Item	Cannot do at all (%)	Can do with help (%)	Can do alone (%)
1	Turn on a device and open an app	28.3	31.3	40.4
2	Search for information on Google	45.8	28.3	25.9
3	Send an email with an attachment	79.2	12.5	8.3
4	Check if a website is trustworthy	71.7	17.5	10.8
5	Download and install an educational app	62.5	22.1	15.4

Table 4: Digital usage patterns (Reported by students with any access, n=168)

S. No.	Type of Usage	Daily (%)	Weekly (%)	Rarely or never (%)
1	Watching entertainment videos (music, movies)	58.9	25.6	15.5
2	Using social media (WhatsApp, TikTok, Instagram)	52.4	28.0	19.6
3	Playing games	44.6	30.4	25.0
4	Doing homework or school research	14.3	26.2	59.5
5	Learning a new skill (coding, design, etc.)	6.0	13.7	80.3
6	Communicating with teachers about schoolwork	4.8	10.7	84.5

Table 5: Hierarchical linear regression predicting academic performance (N=240)

Predictor Variable	Block 1 (Access only)	Block 2 (Access+Skills)	Block 3 (Access+Skills+Usage)
	Beta (β)	Beta (β)	Beta (β)
Physical access index	0.29***	0.12*	0.08
Digital skills score		0.48***	0.35***
Educational usage frequency			0.41***
R-squared (R^2)	0.11	0.39	0.56
R-squared change (ΔR^2)		0.28***	0.17***
F-statistic	8.42***	28.15***	41.33***

***p<0.001, **p<0.01, p<0.05. Control variables included but not shown

Table 6: Moderation effects of gender and location on digital skills–performance relationship

Predictor Variable	Model without interactions	Model with interactions
	Beta (β)	Beta (β)
Digital skills (centred)	0.35***	0.51***
Gender (1=female, 0=male)	-0.12*	-0.15*
Location (1=rural, 0=urban)	-0.18**	-0.14*
Digital Skills×Gender	Not included	-0.44***
Digital Skills×Location	Not included	-0.29**
R-squared (R^2)	0.56	0.64
F for change in R^2		7.86***

***p<0.001, **p<0.01, *p<0.05. Educational usage and control variables were included but not shown

Table 4 presents how students reported using digital devices when they had access.

Among the 168 students who reported any digital access, usage patterns were overwhelmingly recreational rather than educational. Nearly 59 percent watched entertainment videos daily, and 52 percent used social media on a daily basis. In stark contrast, only 14 percent used digital devices daily for homework or school research, and a mere 6 percent engaged in self directed skill building. Communication with teachers about schoolwork was almost non-existent, with 85 percent reporting they rarely or never used digital tools for this purpose. This pattern suggests that even when access exists, the absence of structured guidance and educational content directs students toward entertainment consumption.

Results for research question 2

Research question 2: To what extent do digital skills and educational usage predict academic performance beyond mere physical access to devices?

Hierarchical linear regression analysis

To answer this question, a hierarchical linear regression was conducted with academic performance (standardized mathematics and English exam scores combined) as the dependent variable (Table 5). Variables were entered in three blocks: Block 1 included physical access (device ownership and Internet availability); Block 2 added digital skills scores; Block 3 added educational usage frequency. Control variables (gender, SES, prior performance) were held constant throughout.

Block 1, which included only physical access measures, explained just 11 percent of the variance in academic performance (R^2=0.11). Physical access alone was a significant but weak predictor (β=0.29, p<0.001), confirming that simply having a device or Internet connection offers limited academic benefit in this context.

Block 2 added digital skills to the model, which substantially increased the explained variance to 39 percent (ΔR^2=0.28, p<0.001). Digital skills emerged as a strong positive predictor (β=0.48, p<0.001), while the contribution of physical access dropped to near non significance (β=0.12, p<0.05). This finding suggests that skills matter considerably more than access alone for academic performance.

Block 3 added educational usage frequency, increasing the explained variance further to 56 percent (ΔR^2=0.17, p<0.001). Educational usage showed a strong independent effect (β=0.41, p<0.001), and physical access became statistically non significant (β=0.08, p>0.05). This means that once a student possesses digital skills and uses devices for educational purposes, whether they own a device or have home Internet no longer predicts their academic performance.

So, digital skills and educational usage together explained 56 percent of the variance in academic performance, compared to only 11 percent explained by physical access alone. Skills and educational usage are substantially stronger predictors of academic outcomes than merely having access to digital devices.

Results for research question 3

Research question 3: Does the effect of digital skills on academic performance differ significantly between male and female students, and between rural and urban students?

Moderation analysis

To test for differential effects, interaction terms were added to the regression model from Research Question 2. Specifically, a Digital Skills × Gender interaction term and a Digital Skills × Location (rural versus urban) interaction term were included (Table 6).

The addition of interaction terms significantly improved the model, increasing the explained variance from 56 percent to 64 percent (F change=7.86, p<0.001). Both interaction terms were statistically significant, indicating

that the effect of digital skills on academic performance depended on both gender and school location.

The Digital Skills × Gender interaction (β=-0.44, p<0.001) indicated that the positive effect of digital skills on academic performance was significantly weaker for female students compared to male students. In practical terms, when a boy and a girl had the same level of digital skills, the girl experienced a substantially smaller academic benefit from those skills. This suggested that other barriers, likely related to social norms, restricted mobility, or reduced autonomous usage time, prevented girls from converting digital skills into academic gains as effectively as boys.

The Digital Skills × Location interaction (β=-0.29, p<0.01) indicated that the positive effect of digital skills on academic performance was significantly weaker for students in rural schools compared to their urban counterparts. For rural students, the same level of digital skill produced a smaller improvement in exam scores. This likely reflected the absence of complementary resources in rural areas, including reliable electricity, teacher support for digital learning, and quiet study spaces.

Visualizing the interaction effects

Table 7 shows the predicted academic performance scores for different subgroups across levels of digital skill. Several important patterns emerge. First, the benefit of moving from low to high digital skills was largest for urban male students at 30.1 points, followed by rural males at 21.3 points, urban females at 17.7 points, and finally rural females at only 11.2 points. Second, at high skill levels, urban males scored 78.3 while rural females scored just 55.2, a substantial gap of 23.1 points despite having the same high skill level. This demonstrates clearly that skills are not equally convertible into performance across all groups.

Basically, the effect of digital skills on academic performance differed significantly by both gender and location. Female students and rural students received significantly smaller academic returns from their digital skills compared to male students and urban students respectively. Rural female students experienced the most severe disadvantage, gaining only 11.2 performance points from low to high skills compared to 30.1 points for urban male students.

Qualitative results

Following the quantitative analysis, semi structured interviews were conducted with 24 purposefully selected students representing four digital inequality profiles (high access/high skills, high access/low skills, low access/high skills, and low access/low skills), along with 6 teachers and 4 school principals. Thematic analysis revealed four major themes that explained the quantitative patterns documented above.

Theme 1: The illusion of access

While quantitative data showed that 42.5 percent of students owned smartphones, qualitative interviews revealed that ownership did not translate into meaningful access for schoolwork. Students consistently described multiple barriers that made their devices unavailable for educational purposes.

One female student from a rural public school explained, “I have a phone that my older brother gave me, but I only use it when he is not around. He takes it to his room every evening. For homework, I cannot use it because he says I will waste his data.” This quote illuminated why physical access alone (β=0.08, non-significant in the final model) failed to predict academic performance. Shared devices, restricted usage windows, and data scarcity meant that even students classified as having access were not truly able to learn with their devices.

A male student from an urban public school added, “My father buys me 500 naira of data every two weeks. That is enough for WhatsApp and maybe two hours of browsing. If I use it for school research, I will have nothing for my friends by the weekend.” This tradeoff between social communication and educational use was reported by 18 of the 24 interviewed students, explaining the quantitative finding that recreational usage (58.9 percent daily) far exceeded educational usage (14.3 percent daily).

Teachers confirmed this barrier. One male teacher from Kano State stated, “The parents think providing a phone is enough. They do not understand that the child also needs electricity to charge it, data to browse, and time away from chores to study. Most of my students charge their phones at the neighbourhood shop for 50 naira each day. That money comes from their lunch.” This insight explained why socioeconomic status remained a significant control variable even after accounting for digital skills.

Theme 2: Skills without guidance are useless

Quantitative analysis revealed that digital skills significantly predicted academic performance (β=0.35, p<0.001), but the qualitative data exposed why skills were so low and how students acquired them without formal instruction. Nearly all interviewed students reported learning to use digital devices from friends, older siblings, or entirely by themselves, not from teachers or parents.

Table 7: Predicted academic performance by digital skills level across subgroups

Digital Skills Level	Male students (urban)	Female students (urban)	Male students (rural)	Female students (rural)
Low skills (below average)	48.2	46.5	45.1	44.0
Medium skills (average)	62.5	54.8	55.2	49.5
High skills (above average)	78.3	64.2	66.4	55.2
Gap: Low vs. High skills	+30.1	+17.7	+21.3	+11.2

One male student from an urban private school described, "I learned how to download videos from YouTube by watching my cousin. He showed me which buttons to press. For schoolwork, nobody ever showed me how to search for the right information. When I search for history topics, I get many things that are wrong, but I do not know which one to trust." This student's experience directly corresponded to the quantitative finding that only 10.8 percent of students could independently check if a website was trustworthy.

A female student from a rural public school expressed frustration, "Last term, our teacher told us to use the internet to research the rivers in Nigeria. I went to Google and typed the question. The answer that came first said the River Niger starts in Ghana. When I wrote that, my teacher marked it wrong. I did not know how to find the correct answer." This student, despite possessing basic operational skills and motivation to complete schoolwork, lacked the information literacy skills necessary to evaluate online sources, precisely the skill deficit documented quantitatively.

Teachers acknowledged their own limitations in addressing this gap. One female principal of a rural school stated, "I have been teaching for twenty-two years. I can teach English grammar very well. But I myself do not know how to use a computer to find lesson plans. How can I teach my students digital skills when I was never trained?" This institutional failure explained why the quantitative model showed that even when students had access, the absence of skilled guidance prevented conversion into academic gains, particularly for rural students (Digital Skills × Location interaction β=-0.29, $p<0.01$).

Theme 3: Gender gatekeeping of devices and time

The quantitative moderation analysis revealed that female students received significantly lower academic returns from digital skills compared to male students (Digital Skills × Gender interaction β=-0.44, $p<0.001$). Qualitative interviews provided rich explanations for this pattern.

One female student from an urban public school described strict household rules, "My brother can use his phone in his room with the door closed. I must use mine in the sitting room where my mother can see. She says if I am on the phone too long, people will think I am talking to boys. So I only use it for one hour after school, and mostly for TikTok because that is fast." This student's experience revealed how gender norms restricted not only access but also the type of usage permitted, pushing girls toward quick recreational consumption rather than sustained educational engagement.

Another female student from a rural school added, "When the generator comes on at night, my father gives the charging cord to my brother first. He says my brother needs to study for exams to become a doctor. I want to be a teacher, but my father says that does not require a phone." This explicit prioritization of male education over female education, even within the same household, directly explained why girls with equivalent digital skills performed worse academically than boys with the same skills.

Teachers corroborated these observations. One male teacher from a coeducational school stated, "I assign group projects that require internet research. The boys form groups and share what they find. The girls are too shy to ask the boys for help, and they do not have phones to do the research themselves. So the girls copy from the boys at the end. They learn nothing from the process." This classroom dynamic suggested that even when girls had access and skills, social norms around gender mixing prevented them from benefiting from peer learning networks that boys readily accessed.

A female student succinctly summarized the gendered digital divide, "The phone in my hand is not really mine. It belongs to my father, then my brother, then me last." This statement captured why physical access measures overestimated true availability for girls.

Theme 4: Infrastructure failure disproportionately harms rural students

The quantitative finding that rural students received weaker academic benefits from digital skills compared to urban students (Digital Skills × Location interaction β=-0.29, $p<0.01$) was thoroughly explained by qualitative data on infrastructure and institutional support.

One rural male student described the daily struggle for electricity, "My phone charges only on market days because that is when the shop near us runs its generator. On other days, I walk two kilometres to the next village where a man has solar. By the time I get home, it is dark and I must help my father with the animals. There is no time for studying on the phone." This student's experience explained why rural students, even when possessing digital skills, could not consistently apply those skills to academic tasks. The physical infrastructure deficit (68.3 percent of all students lacked reliable electricity, but this figure was 89 percent in rural areas) rendered skills irrelevant when devices were discharged.

A rural school principal elaborated on the cumulative disadvantage, "Our school has twelve computers in a laboratory donated by an NGO. They have not been turned on in two years because we cannot afford to wire the room for electricity. The children see the computers but cannot touch them. They learn that technology is something for urban people, not for them." This institutional failure normalized digital exclusion for rural students, reducing their motivation to acquire skills that they perceived as unusable in their environment.

Urban students, by contrast, described qualitatively different conditions. One urban male student reported, "There is a phone charging shop on every corner in my neighbourhood. For 20 naira, I can charge my phone and sit there for two hours using their WiFi. I do my homework

there almost every day." The availability of informal digital infrastructure in urban areas enabled skills application that rural students simply could not access, explaining the significant location moderation effect.

Teachers in rural areas also reported lower digital self efficacy. One rural female teacher stated, "I would love to assign digital homework, but half my students do not have data and the other half lose signal when it rains. So I assign paper textbooks instead. That is what I know works." This pragmatic decision by teachers, while understandable, perpetuated the cycle of digital exclusion for rural students, who then lacked both the opportunity to practice digital skills and the academic benefits that such practice would confer.

Summary of qualitative findings in relation to quantitative results

Quantitative finding	Qualitative explanation
Physical access alone explained only 11% of performance variance	Students described shared devices, restricted usage windows, and data scarcity that made access nominal rather than functional
Digital skills strongly predicted performance (β=0.35) but were very low	Students learned skills from peers, not teachers; no formal digital literacy instruction existed in schools
Female students received lower returns from digital skills (β=-0.44)	Household gender gatekeeping prioritized male device access; girls faced time restrictions and surveillance
Rural students received lower returns from digital skills (β=-0.29)	Lack of electricity, charging infrastructure, and teacher digital competence made skill application impossible
Educational usage was very low (14% daily)	Students faced trade-offs between social data and educational data; teachers did not assign digital homework

Discussion of findings

The findings of this study demonstrate that digital inequality among secondary school students in Northern Nigeria operates not as a binary division between those with and without access, but as a stratified hierarchy in which digital skills and educational usage patterns are far more consequential for academic performance than physical access alone. This finding aligns with the three-level model of digital inequality proposed by van Deursen and van Dijk (2023) and empirically validated by Scheerder *et al.* (2017) in European contexts, but extends that model to a low resource, conflict affected setting where the baseline conditions of reliable electricity and institutional support cannot be assumed. The quantitative result that physical access explained only 11 percent of variance in academic performance, while the addition of digital skills and educational usage increased explained variance to 56 percent, mirrors the pattern observed by Hohlfeld *et al.* (2013) in United States schools, yet the magnitude of the skills deficit documented here, with over 70 percent of students unable to evaluate website trustworthiness, is substantially more severe. This suggests that in contexts of extreme educational deprivation, the second and third levels of digital inequality become even more consequential because there are few alternative pathways, such as well-resourced libraries or qualified tutors, through which students might compensate for digital skill deficits (Gil-Hernández *et al.,* 2024).

The moderation effects observed for gender and location provide empirical support for a situated understanding of digital capital, extending Bourdieusian theory to digital contexts in ways that recent scholarship has called for (Bourdieu, 1986; Ragnedda, 2018; Kastorff *et al.,* 2025). Female students in this study received significantly lower academic returns from equivalent levels of digital skill compared to male students, a finding consistent with World Bank research on gender and digital skills training in Sub Saharan Africa (World Bank, 2022), but the qualitative data revealed mechanisms specific to Northern Nigeria, including household gatekeeping, surveillance of girls device use, and teacher reluctance to assign digital homework to female students. This finding complicates the optimistic framing of digital education as inherently democratizing, instead suggesting that in strongly patriarchal contexts, digital resources may be appropriated by male household members, a phenomenon Kim *et al.* (2019) documented in South Korean elementary schools but which appears more acute where gender segregation is institutionalized. Similarly, the significant disadvantage faced by rural students in converting digital skills into academic gains, despite having equivalent skill levels to urban peers, underscores the importance of what might be called infrastructural capital, the complementary resources including reliable electricity, affordable data, and teacher digital competence that must be present for individual level digital skills to become educationally productive (van Deursen & van Dijk, 2019). The qualitative finding that rural schools possessed donated computers that had never been used due to lack of electricity exemplifies how infrastructure failures render skills irrelevant, a dimension of digital inequality that remains undertheorized in literature focused on high income countries where electrification is universal.

Finally, the finding that educational usage frequency was a stronger predictor of academic performance than access alone, and that this usage was overwhelmingly recreational (only 14 percent daily educational use compared to 59 percent daily entertainment use), speaks directly to policy debates about digital literacy interventions. Recent studies from low-income school contexts in Spain (Gil-Hernández *et al.,* 2024) and Uganda (World Bank, 2022) have similarly found that autonomous educational usage, meaning student-initiated use of digital tools for learning purposes without direct teacher supervision, is the critical mediator between access and achievement. However, the Northern Nigerian case reveals a more severe version of this problem because the formal school system itself lacks the capacity to structure

digital learning. Teachers in this study openly acknowledged their own lack of digital skills, and principals reported no systematic integration of technology into curriculum. As UNICEF (2025b) has documented, this institutional vacuum means that students who do have access and skills use their devices primarily for social and entertainment purposes, not because they lack motivation but because no one has shown them how to use digital tools for learning or assigned homework that requires such use. This finding suggests that device distribution programmes, such as the Jigawa Digital Village initiative (NITDA, 2025), will fail to improve educational outcomes unless accompanied by teacher training, curriculum reform, and attention to the gendered and geographic barriers documented here.

Conclusion

This study examined digital inequality and educational outcomes among secondary school students in Northern Nigeria, finding that digital skills and educational usage are substantially stronger predictors of academic performance than physical access alone, with skills and usage together explaining 56 percent of variance compared to only 11 percent for access. However, the benefits of digital skills are not equally distributed, as female students and rural students receive significantly smaller academic returns from equivalent skill levels due to household gender gatekeeping, restricted autonomous usage time, and infrastructure deficits including lack of reliable electricity and teacher digital competence. These findings carry clear policy implications: improving educational outcomes through digital interventions in Northern Nigeria requires not device distribution, which this study shows is largely ineffective, but rather investment in digital literacy training integrated into teacher education, structured assignments that require educational usage, infrastructure to enable charging and connectivity particularly in rural areas, and gender sensitive programming that addresses household barriers to girls digital learning. Future research should employ longitudinal designs to establish causality and test specific interventions, including school based digital skills curricula and subsidized data plans for low-income female students, to identify what works in this uniquely challenging context.

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