EXPLORING THE LANDSCAPE FOR DIGITAL EDUCATION: OBSERVATIONS FROM KENYA, NIGERIA, AND SENEGAL

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EXECUTIVE SUMMARY

As school systems throughout the world pivoted to distance learning approaches in response to the COVID-19 pandemic, the need for alternative approaches to reach and engage with students was accentuated. The need for these alternate approaches will be an important component of countries' toolkits as they strive to strengthen their resilience in the face of future crises.

Digital learning is an increasingly important form of distance learning. Having the infrastructure, access to devices, and digital literacy needed to make digital learning viable and equitably accessible will be crucial in the coming years. This report provides a digital landscape review for Kenya, Nigeria, and Senegal, examining the contextual factors that affect digital learning integration into education systems. The report goes on to provide a series of actionable recommendations designed to support these countries' efforts to make digital learning a viable option that is accessible to all children including the most marginalized.

For each of the three countries the report looks at (I) information, communications, and technology (ICT) for education policies and plans to understand the landscape for technology in education and the government's priorities, (2) existing physical resources needed for implementing and integrating technology in education (technology infrastructure, access to and use of technology devices, software, (3) human resources and capacity (technological literacy, digital education pedagogical knowledge, and ICT-related teacher training efforts), (4) conclusions and recommendations. We share our conclusions and recommendations below.

GENERAL CONCLUSIONS

- All governments reviewed had some form of ICT policy. Kenya and Nigeria have specific policies and plans on ICT in education but not Senegal.
- Kenya is the only country that sets a specific yearly budget for its ICT in education initiatives (e.g., Digital Literacy Program for primary levels and ICT-related initiatives for the secondary levels).
- Countries have made great strides in expanding electrification in recent years but rural households and poorer areas lag behind urban and better off areas. All three countries have taken steps to open up their power industry through privatization and diversification of their power sources (e.g., solar technology and geothermal power).
- Reliability of electricity remains an issue in all three countries. Power outages is an ongoing problem especially in Nigeria. Nigeria has the longest hours (6 to 8 hours) of no power per day.
- Cost of electricity per kWh in Kenya and Senegal is higher compared to the world average. While Nigeria may have a slightly lower per kWh cost compared to the world average, its long hours of power outages and Nigerians' reliance on diesel generators result in higher electricity costs for households and businesses.
- In all three countries, the Internet can be accessed via fixed broadband or the mobile broadband network with the majority of the users using mobile broadband network to access the Internet.

- While 3G and 4G network access and coverage has increased in the last few years, adoption and use of mobile Internet has not because the current cost of data remains unaffordable to the majority who make less than the national average income.

- Over the past two decades, China has become a major developer and investor in Africa's telecommunications industry with Chinese companies building substantial portions of 3G, 4G and fiber optic networks and or supplying middle boxes within countries' internet infrastructure.

- Clear digital divides exist on the availability of needed infrastructure, and access to and use of devices based on gender, geography, education and income levels, and disability status. COVID-19 and the economic challenges it brought may affect and increase the gap in the foreseeable future.

- There are existing government, non-government, and private company initiatives on education technology. All three countries have a number of innovative indigenous EdTech companies.

- All three countries have some form of digital training for teachers, but more in-depth, systematic, and ongoing training and support are needed on basic digital literacy skills, online safety skills, and on integration of technology into their teaching.

RECOMMENDATIONS

- Work with the relevant ministries to understand how to build on and support government initiatives and investments that are already specified in each country's EdTech or ICT policies.

- Understand where decision-making on ICT for education policy, support, and implementation lies to better design and implement demand-driven projects and programs. For example, in Kenya, the national government drives and implements the ICT for education programs. That is different from Nigeria, where the state and local governments decide and implement the ICT policies set by the federal government.

- Partner with key stakeholders (e.g., government ministries, power and telecommunications companies) and study financing, maintenance, and sustainability of alternative power sources and network coverage for remote areas to develop sustainable strategies that can increase demand and know-how among users. Addressing the affordability issue of services is a good first step.

- Find ways to work with or build on existing technology network infrastructure.

- Support efforts to evaluate existing programs for effectiveness and document lessons learned since there have been limited to no systemic, on-going, or in-depth monitoring of EdTech programs.

- Build on or extend effective existing government or non-government programs that have proven reach and efficacy to serve the most marginalized students.

- Engage with local private EdTech companies to build on and support in-country expertise.

- Support effective local private EdTech companies to make their products and services more accessible and affordable to a larger number of schools, teachers, and students including the most marginalized and underserved.

- Work with key stakeholders to study, define, set standards, and measure digital literacy skills of target population. Having set digital literacy standards can help guide the government and other organizations design programs, measure their effectiveness and monitor progress being made toward achieving national digital literacy targets.

- Invest in pre-service and ongoing in-service trainings and materials that strengthen digital literacy skills (including digital safety) of school administrators and educators.

- Incentivize teacher adoption of ICT in their teaching and acknowledge that teachers will need additional planning and prep time to integrate technology into their teaching and so, they should be compensated accordingly.

- Develop materials that can strengthen digital literacy skills among education support staff, parents, caregivers, and students. Digital literacy including digital safety are requisite skills as more and more people go online.

INTRODUCTION

This review looks first at the information, communications, and technology (**ICT) for education policies and plans** to understand the landscape for technology in education and the government's priorities. It then looks at the **physical resources** and **human resources** needed for implementing and integrating technology in education.

Under physical resources, this review examines the country's technology infrastructure (electricity, phone network, Internet networks) and access to and use of technology devices and software. Below is some common terminology that we will reference throughout this document.

- **Technology infrastructure** refers to electricity coverage and reliability and to Internet access obtained through mobile broadband networks (e.g., phone data via 3G, 4G, or 5G network) and/or fixed broadband networks (e.g., cable modems, digital subscriber line [DSL], and fiber connections).
- **Technology devices** refers to mobile phones, computers (laptops and desktop), and tablets. There are three types of mobile phone devices in current use: basic mobile phones for calling; feature phones with texting, multimedia, a simple Web browser, an operating system, and GPS capabilities; and smartphones with advanced operating systems, GPS, faster Internet speeds, and the basic capabilities of a tablet or computer. All three phones can be used for educational purposes, but with different functionalities and capabilities (Morris and Farrell, 2020). Many apps are designed for smartphones or feature phones, but some educational multimedia content that uses Java-based applications and is stored on micro memory cards can be played back on feature phones offline (Morris and Farrell, 2020).
- **Software** refers to learning management systems (e.g., Moodle, Google Classroom), productivity software (e.g., Microsoft Office), educational mobile phone apps (e.g., Worldreader, Duolingo), and social media and communications platforms (e.g., Facebook, WhatsApp).

Exhibit 1. Types of phones and their uses

TYPE OF PHONE	USES
Basic mobile phone	Call only
Feature phone	Call and text Access multimedia content (e.g., videos) Access the web Use GPS
Smartphone	Video calls Text, send, and receive photos and multimedia messages Access, receive, and send multimedia content (e.g., videos) Access the web Use GPS Use all kinds of apps (e.g., games, mobile payment)

Under human resources and capacity, this review examines technological literacy (knowledge on how to use devices) and pedagogical knowledge (familiarity with approaches or methods on how to best teach digital content). Technological literacy is distinct from digital literacy. UNESCO defines digital literacy as

the ability to access, manage, understand, integrate, communicate, evaluate, and create information safely and appropriately through digital technologies for employment, decent jobs, and entrepreneurship. It includes competences that are variously referred to as computer literacy, ICT literacy, information literacy, and media literacy (UNESCO 2018). Building on UNESCO's definition, USAID defines digital literacy in the recently published Digital Literacy Primer as "the ability to access, manage, understand, integrate, communicate, evaluate, and create information safely and appropriately through digital devices and networked technologies for participation in economic, social, and political life" (Sthanumurthy, et. al. 2022). There have been many and varied national and regional efforts to define, develop, and implement digital literacy frameworks. For example, in Kenya's Basic Curriculum Framework, digital literacy encompasses traditional literacies and computer literacy (UNESCO 2018). In the absence of a standard definition and measure for digital literacy, this review will instead look at studies and reports that discuss ICT-related teacher training efforts in each country to understand existing capacity or lack of technological literacy and pedagogical knowledge among teachers.

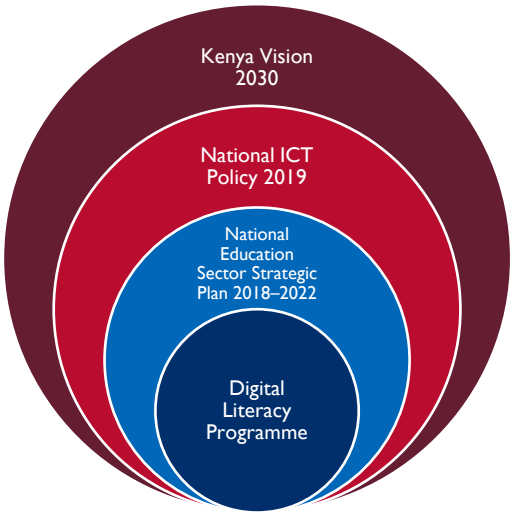
Digital content includes material accessed through a learning management system (i.e., Google Classroom), educational mobile phone apps (i.e., educational programming), social media and communications platforms, or other digital content viewed or listened to through the phone (i.e., audio or video programming).

KENYA

ICT FOR EDUCATION POLICIES, PLANS, AND PROGRAMS

Four key policy and plan documents mention and emphasize Kenya's commitment to ICT education at the national level:

Exhibit 2. Kenya's ICT-related policies



1. **Kenya Vision 2030** was launched in 2008 by former President Mwai Kibaki. This vision outlines the country's long-term goals to become a globally competitive country and reflects the country's alignment with the global Sustainable Development Goals (SDG). One of the vision's goals (under its Social Pillar) is to upgrade the country's ICT capacity by developing its ICT infrastructure, providing schools with necessary devices, and training its educators to integrate ICT into their teaching and learning.
2. The **National ICT Policy** of 2019 was first drafted in 2006 and revised in 2019 to support Kenya Vision 2030. It details the country's plan to provide universal access to ICT infrastructure across Kenya.
3. The **National Education Sector Strategic Plan (NESSP)** of 2018–2022 describes the Ministry of Education, Science, and Technology's (MoEST) plan to provide quality and inclusive education, training, and research for sustainable development. Part of this strategic plan is to integrate ICT into teaching, learning, and assessment at the primary and secondary levels and in adult and continuing education, establish open distance and e-learning in university education, and upgrade existing infrastructure for assistive/adaptive technology for persons living with disabilities.
4. The **Digital Literacy Program** of 2016 (DigiSchool) is a key government initiative that reflects the implementation of the policies and priorities outlined in the NESSP. The program, which is led by the Ministry of Information, Communications, and Technology, works with primary schools countrywide to install devices and introduce primary school children to the use of digital technology and communications in learning.

While the Kenyan government remains committed to "embracing digital technology and harnessing its full potential" (President Uhuru Kenyatta 2021), the COVID-19 crisis revealed how much more needs to be done to address longstanding problems, including the digital divide in technology device and infrastructure access between urban and rural students, and educators' lack of pedagogical skills needed to integrate technology into their teaching. The digital divide was compounded by pandemic-related school closures.

Digital Master Plan 2022–2030 (Kenya ICT Authority 2022)

The ICT Authority developed and launched the Digital Master Plan in April 2022 to serve as a single point of reference for all government ICT plans and to ease coordination and management in achieving Kenya Vision 2030. This document is largely informed by the National ICT Policy of 2019 and is anchored in four pillars:

- Digital Infrastructure
- Digital Services and Data Management
- Digital Skills and Digital Innovation
- Digital Business

Under Digital Infrastructure, 52,000 km of national fiber optic cable for government networks and 48,000 km for private networks will be constructed to provide reliable and affordable connectivity to education institutions, health institutions, metro areas, government offices, county wards, rural areas, businesses, and homes. Proposed digital infrastructure projects include:

- 25,000 hotspots in public installations, rural areas, businesses, and public spaces
- Establishment of regional ICT infrastructure hub and sustainable power plan for ICT installations through green energy plants
- Establishment of government digitization centers and platforms to house a total of 5 billion government records that will be digitized by 2030

Under Digital Services and Data Management and Digital Skills and Digital Innovation, the following initiatives were listed:

- Develop and implement a strategy to capacitate 20 million Kenyans on digital literacy
- Create 1,450 community training centers and 290 constituency hubs in five years
- Set up electronic plants to manufacture and assemble laptops and supply 1.2 million laptops to schools
- Train 350,000 teachers in the use of technology
- Connect 40,000 schools with sustainable Internet

SPENDING ALLOCATIONS FOR ICT

A close look at the Government of Kenya's (GoK) expenditure on ICT and education provides a clear picture of its commitment to the vision and goals that the policies and plans set.

The GoK continues to invest in technology to improve digital literacy skills and expand digital infrastructure to facilitate access to affordable broadband connectivity. While the GoK's expenditure on

education dropped slightly in 2020 (5.08 percent of GDP vs. 5.306 percent in 2018), key ICT programs such as the Digital Literacy Program continued to be funded. For the 2020 budget, the GoK allocated a total of KES 14.9 billion (about US$131 million) for the ICT sector, which included an allocation of KES 800 million (about US$7 million) for the Digital Literacy Program and an additional KES 300 million (about US$2.6 million) for 1,000 ICT interns to support digital learning in schools (PwC 2020). For the 2021 budget, the total allocation for the Digital Literacy Program, including ICT integration in secondary schools, went up to KES 1.09 billion (about US$9.6 million) (Kenya National Treasury and Planning Budget Statement 2021). For digital learning to reach all learners in Kenya and connect everyone with broadband Internet by 2030, the estimated cost is KES 398 trillion (US$3.5 billion)[1] or about KES 39.8 trillion (US$350 million) per year for 10 years (Yao et al. 2021).

TECHNOLOGY INFRASTRUCTURE

ELECTRICITY

The GoK owns 70 percent of KenGen, which generates 70 percent of Kenya's electricity. The remaining 30 percent of Kenya's electricity is generated by independent power producers, mainly operators of small-scale hydro, geothermal, biomass, and fuel oil plants (Power Africa 2021). The GoK owns 100 percent of KETRACO (Kenya Electricity Transmission Company), which plans, designs, owns, operates, and maintains the high voltage electricity transmission grid and regional power interconnectors that form the backbone of the National Transmission Grid (KETRACO website 2022). Kenya Power, which is 50 percent owned by the GoK, is the only electricity distribution company. It works with the state-owned Rural Electrification Authority to expand rural electrification by connecting public facilities (mostly primary schools) and "last mile" homes (last mile homes are those that are historically challenging to connect to the main power lines because of their location) (Power Africa 2016).

As of 2021, roughly 75 percent of the country had access to electricity (African Development Bank Group 2021). A greater proportion of urban residents had electricity (90.8 percent) than rural residents (61.7 percent) (World Bank 2019). Since 72 percent of Kenyans reside in rural areas, there are still an estimated 12.5 million rural Kenyans and 1.3 million urban Kenyans, who are without electricity (author's calculation based on data from World Bank 2019 and Kenya Population and Housing Census 2019).

Exhibit 3. Access to electricity in Kenya, urban and rural

Data source: World Bank 2019 and Kenya Population and Housing Census 2019 (total population about 47.5 million in 2019).

To achieve universal electricity access for all homes, businesses, and public facilities by 2022, Kenya has also been working on off-grid solutions (e.g., solar technology and geothermal power) that are eco-friendly and affordable. As of 2018, nearly 10 million Kenyans were meeting their basic electricity needs

[1] Exact amount is US$3,509,030,000 based on the Excel tool provided in Annex A of UNICEF's Policy Brief: How Much Does Universal Digital Learning Cost?

with off-grid solar products (Lighting Africa World Bank Group 2018). Under the Digital Literacy Program, out of 22,258 public primary schools that have electricity, 3,239 are using solar power (DigiSchool 2021). The World Bank Kenya Off-Grid Solar Access Project (KOSAP) will provide 207 secondary schools with solar electrification (KOSAP 2022).

While there is improved electricity coverage in rural areas in the last decade, uptake and consumption remain low (Blimpo and Cosgrove-Davies 2019). One reason for the low uptake in rural areas is cost. The cost of electricity for rural households—KES 24.18 (US$0.211) per kWh—is above the world average KES 15.51 (US$0.1386) and is the fourth highest in Africa (Global Petrol Prices 2021). Another reason for the low uptake is the lack of reliability. Kenya has had three nationwide blackouts since 2018, with the most recent one in January 2022 (Otieno 2022). Any business enterprise in Kenya, on average, has 6.7 power outages per month (Maende and Alwanga 2020). In 2020–2021, the average duration customers were off supply per outage as measured by the Customer Average Interruption Duration Index (CAIDI) was 4.03 hours (Kenya Power 2021). International best practice is less than 2.5 hours. The high rate of power loss indicates that much more needs to be done to improve the reliability of electricity supply to customers (Energy and Petroleum Regulatory Authority 2020). This lack of reliable electricity coupled with the high cost makes it challenging for households, especially in rural areas, to access and engage in digital learning.

INTERNET NETWORKS

In Kenya, the Internet can be accessed via the mobile broadband network or via fixed broadband. The National Optic Fibre Backbone (NOFBI) is a project aimed at ensuring Internet connectivity in all of Kenya's 47 counties. The GoK, through loans secured from Chinese government-owned banks (e.g., China's Export Import Bank and Exim Bank), funded this project. The Ministry of ICT provides oversight, and the National ICT Authority acts as its implementing agency. Phase 1 of the project, which connected 28 counties out of 47, was contracted out to two Chinese companies (Huawei Technologies and ZTE) and a French company (Sagem). Huawei was granted an automatic extension of its contract to begin Phase 2 of the project, which added 1,600 kilometers of fiber optic cable, of which 1,200 had been completed at the time of reporting. To date, fiber optic cable has been installed in all 47 counties (Kenya ICT Authority 2021).

MOBILE BROADBAND NETWORK

Kenya privatized and opened its telecom sector in 2000. It currently has several telecommunications companies that are privately owned. The three major operators are Safaricom, the largest mobile operator, which is partially owned by the government (35 percent ownership share); Airtel Kenya, the second largest mobile operator, which is owned by Bharti Airtel (an Indian multinational company); and Telkom Kenya, which is also partially owned by the government (40 percent ownership share).

Kenya has made excellent progress in increasing mobile broadband network coverage, with 96 percent of its population covered by a mobile broadband network that ranges from a 2G network to a 4G network. Ninety-four percent of its population has access to a 3G mobile network and 77 percent of the population has access to a 4G mobile network (ITU 2020). However, mobile Internet penetration is only at about 27 percent (GSMA 2019), which means that adoption and use of mobile Internet has not kept pace with the increase in network access and coverage.

Most mobile phone apps, whether for social networking (e.g., Facebook), e-commerce, text, audio, or video messaging (e.g., WhatsApp), or educational use (e.g., accessing the Kenya Education Cloud website via web browser app), run better on 4G-enabled devices because they need high data transfer rates to run smoothly. "Lite" versions of an app (e.g., Facebook Lite) can run on 3G-enabled devices.

There are three barriers to mobile Internet penetration. The first is the cost of 3G or 4G-enabled mobile phones. Second is the cost associated with mobile downloads. While the cost to download 1.5 GB of data, KES 1,338 (US$11.75), is lower than the median global download cost of KES 2,106 (US$18.50),[2] this rate is unaffordable for Kenya's general population (GSMA 2021). The third barrier is the lack of digital literacy needed to effectively access mobile Internet content (GSMA 2021).

At 17.15 Mbps (Speedtest February 2022), Kenya's average download speed is on the lower end (Ang 2021). Global download speed (for 138 countries) ranges from 5.43 Mbps to 133.51 Mbps, with a global median download speed of 29.91 Mbps. Within the African region, South Africa has the highest download speed at 32.26 Mbps (Speedtest February 2022). For online learning that requires watching and sending videos and video conferencing during synchronous sessions, users need at least 25 Mbps. For reference, a research study of more than 750,00 students in the United States recommended a download speed of 25 Mbps per student (not per household) for online learning and engagement to be effective (CoSN 2021).

FIXED BROADBAND

In 2020, Kenya had 674,191 fixed broadband subscriptions, representing only 1.25 percent of its population (World Bank 2020), indicating that fixed broadband is still at an early stage of development (Kelly and Dunand 2021). Fixed broadband subscriptions remain low because affordability is a major barrier. The average monthly cost of fixed broadband with 5 GB of data in Kenya is KES 6,568 ($57.72) when adjusted for purchasing power parity.[3] This cost is higher than the world median of KES 4,934 ($43.40) (ITU 2020).

While subscribers in Kenya pay more for fixed broadband, this does not mean they experience faster download speeds. Worldwide download speeds range from 1 to 300 Mbps. At 8.86 Mbps (Speedtest February 2022), Kenya's average download speed is considered to be on the very low end (Ang 2021).

TECHNOLOGY DEVICE ACCESS

MOBILE PHONE OWNERSHIP

In 2017, 80 percent of adults in Kenya owned a mobile phone; 50 percent owned a basic phone, 30 percent owned a smartphone, and 20 percent of adults had no phone (Silver et al. 2019).

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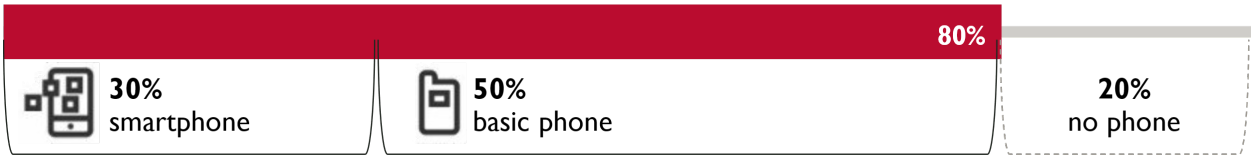
[2] Costs quoted for 1.5GB data are corrected for purchasing power parity (ITU 2020).

[3] Five GB of data is equivalent to one of the following activities: sending and receiving 10,000 emails or instant messages with attachments, 10 hours of watching standard definition streaming videos, 80 hours of listening to online radio, 20 hours of Skype video calls, or viewing about 3,000 web pages (Ken's Tech Tips 2019).

Exhibit 4. Percentage of adults by type of phone owned in Kenya (2017)



Note: Percentages based on total sample.
Source: Spring 2017 Global Attitudes Survey. Q64 & Q65.
Pew Research Center

Penetration level is calculated by expressing the number of devices as a percentage of the total national population. As of 2021, the penetration levels of feature phones and smartphones stood at 67.9 percent and 53.4 percent, respectively (Communications Authority of Kenya 2022).

COMPUTER, LAPTOP, AND TABLET OWNERSHIP

For digital learning to be effective, continuity of learning outside of school is critical; access to a computer or laptop ensures learning. An estimated 8.8 percent of households (12.1 million households in total) have a desktop computer, laptop, or tablet. The difference in computer/tablet ownership in urban and rural households is stark, at 3 percent of rural households (7.4 million) and 18 percent of urban households (4.7 million) (Kenya Population and Housing Census 2019).

EQUITABLE ACCESS TO DIGITAL TECHNOLOGY DEVICES AND INFRASTRUCTURE

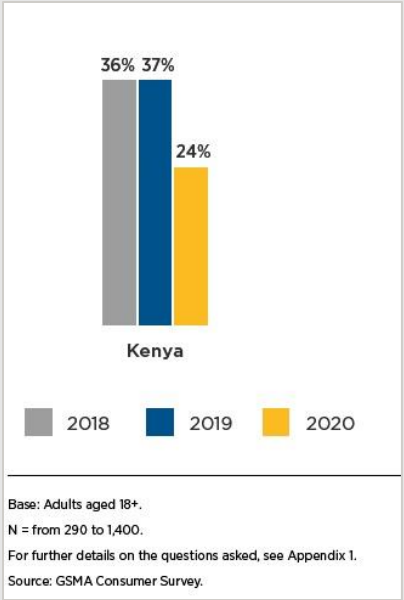
Equitable access to digital devices (e.g., mobile phone or a tablet) and technology infrastructure are crucial in making sure that digital learning is reaching all students, especially the most marginalized. The learning crisis brought about by the COVID-19 pandemic exposed wide gaps between Kenya's goals in the National Education Sector Strategic Plan (NESSP) and the reality it faces in implementing digital learning.

A. GEOGRAPHIC DIVIDES

Rural-urban gap refers to how much less likely a person living in a rural area is to use mobile Internet than a person living in an urban area (GSMA 2021).[4] Urban areas tend to have better access to both digital technology infrastructure and devices than rural areas. That said, because of falling device prices, smartphone ownership in rural areas increased about 10 percent between 2018 and 2020 (GSMA 2021). The rural-urban gap for smartphone ownership narrowed from approximately 20 percent in 2019 to about 15 percent in 2020. Similarly, the rural-urban gap for mobile Internet use also narrowed, dropping from 37 percent in 2019 to 24 percent in 2020. However, the rural-urban gap remains a significant issue that should be addressed because mobile Internet is a critical pathway to digital inclusion for the underserved (GSMA 2021).

[4] Rural-urban gap is calculated using the following formula: (percent of urban users) – (percent of rural users) / (percent of urban users) (Source: GSMA 2021)

Exhibit 5. Rural-urban gaps in mobile Internet use (2018–2020)

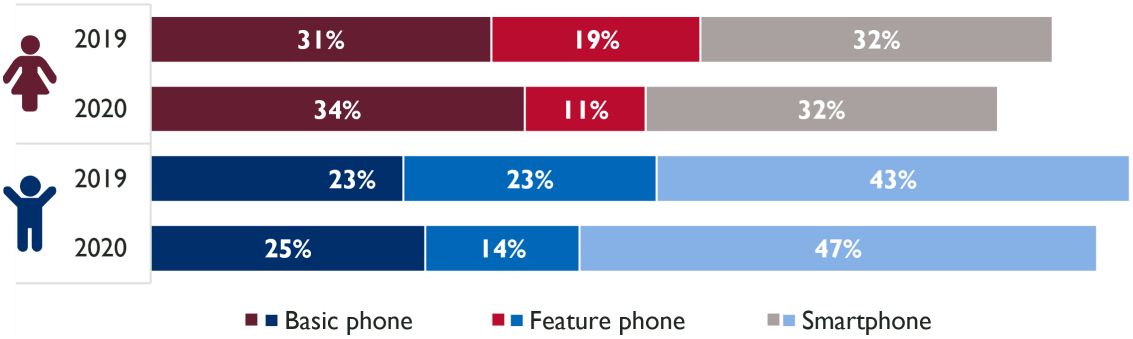


B. GENDER DIVIDES

Fewer women (86 percent) than men (92 percent) own a mobile phone in Kenya (GSMA 2021). Between 2019 and 2020, overall mobile phone ownership declined by 5 percent for women compared to just 3 percent for men. Smartphone ownership among men increased while smartphone ownership among women remained constant. The study also revealed that households prioritized men's use of smartphones over women during the COVID-19 pandemic so men could seek new work opportunities, stay socially connected, and watch sports (GSMA 2021).

Exhibit 6. Mobile device ownership and mobile Internet use by gender in Kenya (2020)

Exhibit 7. Mobile device ownership by gender (2020)

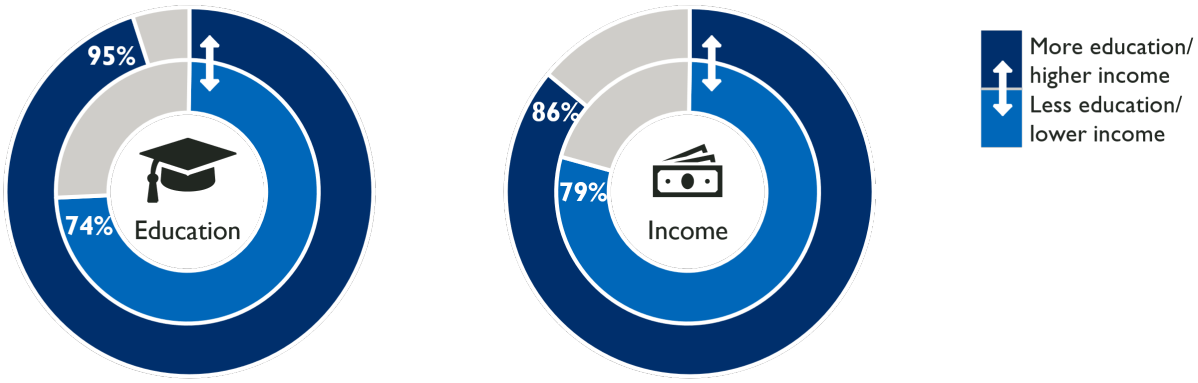


The gap in access to mobile phones and use of mobile Internet is more pronounced among women in Kenya. In low and middle-income countries, women are 15 percent less likely than men to use mobile Internet. For women, barriers in accessing mobile Internet include difficulties with reading, writing, and digital literacy skills, and a lack of family approval (GSMA 2021). Kenya was the only country out of the eight LMIC countries surveyed where the gap in mobile Internet use widened, from 34 percent in 2019 to 42 percent in 2020.[5] Women's Internet usage on mobile phones remained flat over this period while use increased for men. Forty-two percent of male mobile phone users and 39 percent of female mobile phone users are aware of mobile Internet but have not used it. According to them, the cost of a mobile Internet-enabled handset is a major barrier to mobile Internet adoption (GSMA 2021). To address the affordability barrier, Safaricom, Kenya's biggest telecoms operator, partnered with Google in 2020 to offer one million affordable smartphones at a cost of KES 5,400 (US$47.50) (Miriri 2020).

C. ECONOMIC DIVIDES

Mobile phone ownership in Kenya is higher among people with more education and higher income. Ninety-five percent of people with more education, compared to just 74 percent of people with less education, own a mobile phone.[6] Eighty-six percent of higher-income people, compared to just 79 percent of lower-income people, own a mobile phone (Pew Research 2018).

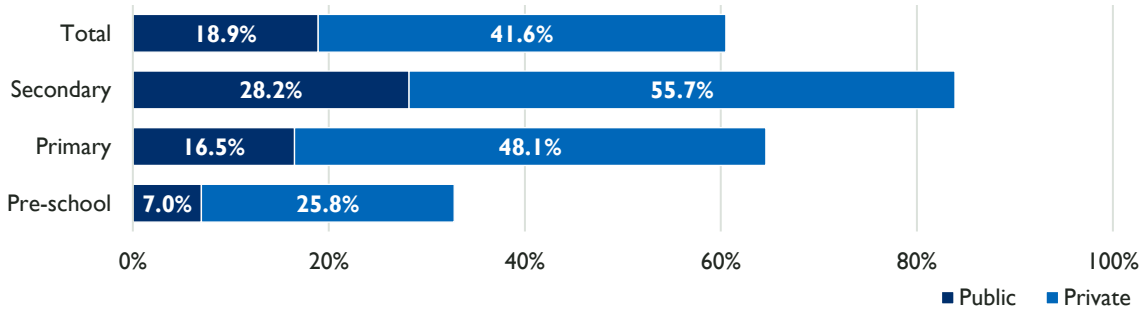
Exhibit 8. Mobile device ownership by education and income (2018)



Another clear divide is between households that have children in private schools and households that have children in public schools (Uwezo 2020). A telesurvey conducted in 42 of the 47 counties in Kenya that reached 3,735 households with a total of 10,281 schoolchildren found a substantial and statistically significant gap in device access between learners in private schools and public schools (Uwezo 2020). This finding echoes similar digital divides that have been documented even in high-income countries.[7]

[5] The seven other LMIC countries were Algeria, Mozambique, Nigeria, Bangladesh, India, Pakistan, and Guatemala (GSMA 2021).
[6] The lower or less education category is below secondary education and the higher or more education category is secondary or above.
[7] For example, findings from a survey by Microsoft (2020) in England found that when schools closed at the start of the pandemic, just 1 percent of public primary schools were able to provide hardware for pupils to take home compared to 38 percent of private schools. In secondary schools in England, just 7 percent of public secondary schools are able to provide devices for students versus 20 percent of private schools.

Exhibit 9. Access to digital learning by school type and schooling level (Uwezo 2020)



D. ACCESS FOR PEOPLE WITH DISABILITIES

People with disabilities face inequalities and additional barriers in accessing the Internet, devices, and specialized assistive technology. While the National ICT Policy stated that the GoK will provide an ICT environment fully accessible to people with disabilities, in reality, people with disabilities in Kenya still struggle to access basic information online or via local apps, since these platforms were not developed with accessibility in mind (Okite 2021). Affordability is another barrier people with disabilities face because of their lower income and expenses related to their disability (GSMA 2021). A survey of people with disabilities in Kenya found that 82 percent owned a mobile phone vs. 93 percent of people without disabilities—a 12 percent disability gap in ownership (GSMA 2019). [8]

[8] Disability gap is calculated using the following formula: (percent non-disabled mobile owners/users – percent mobile owners/users with disabilities) / percent non-disabled mobile owners/users) (Source: GSMA 2020)

Exhibit 10. Mobile ownership and access by people with and without disabilities

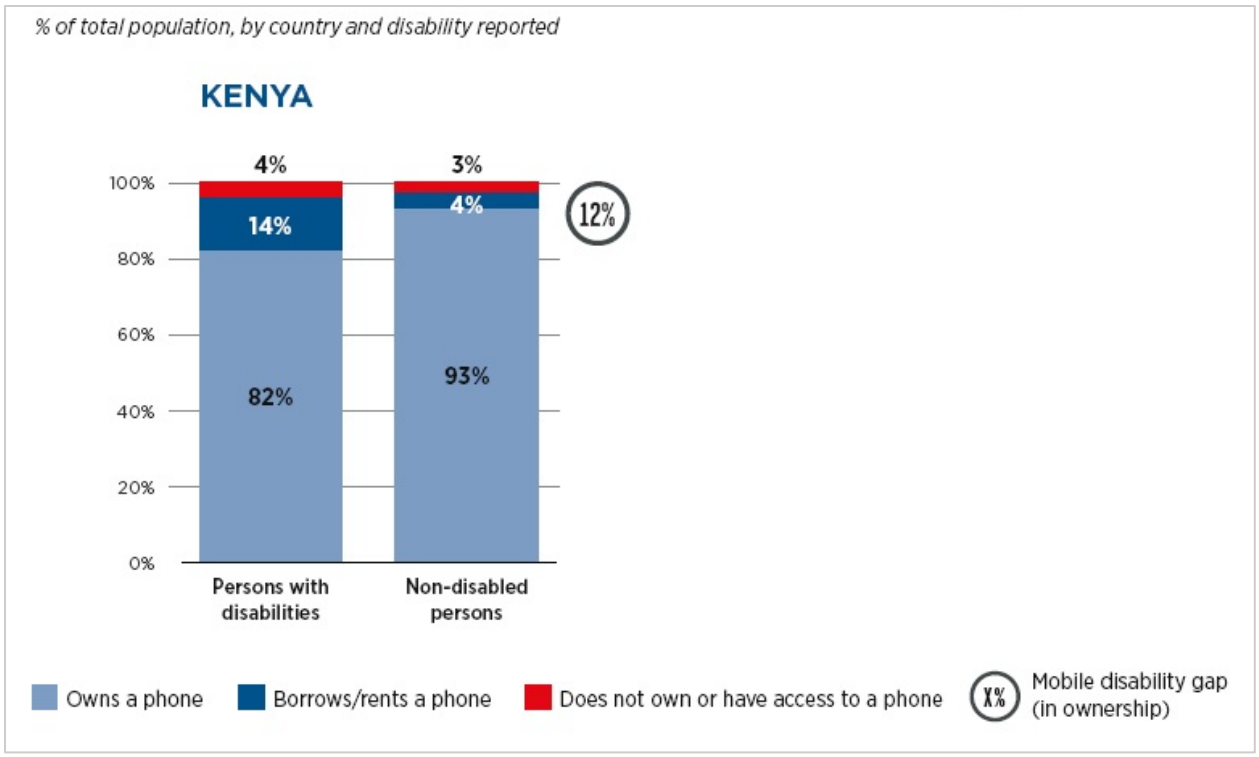
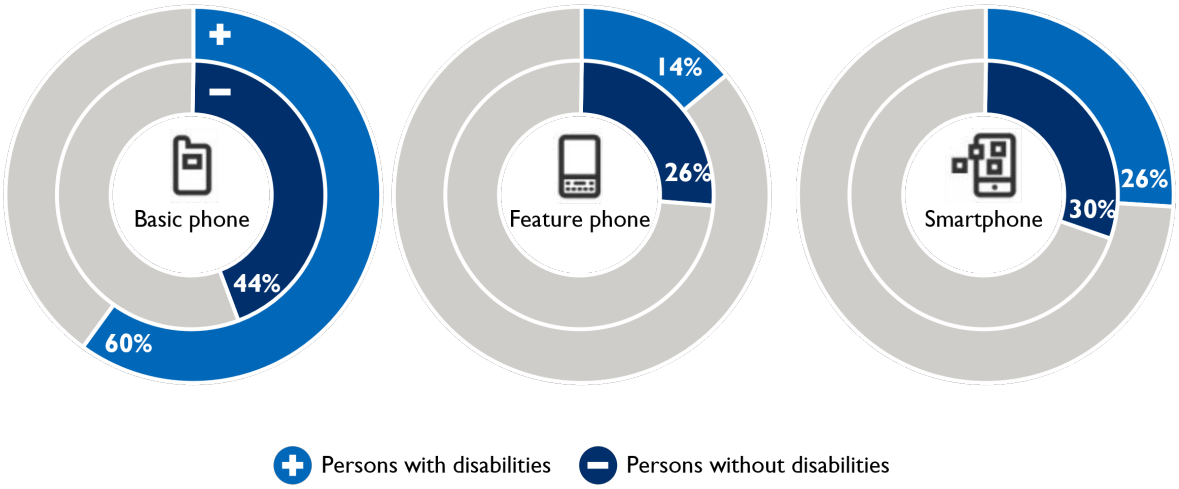
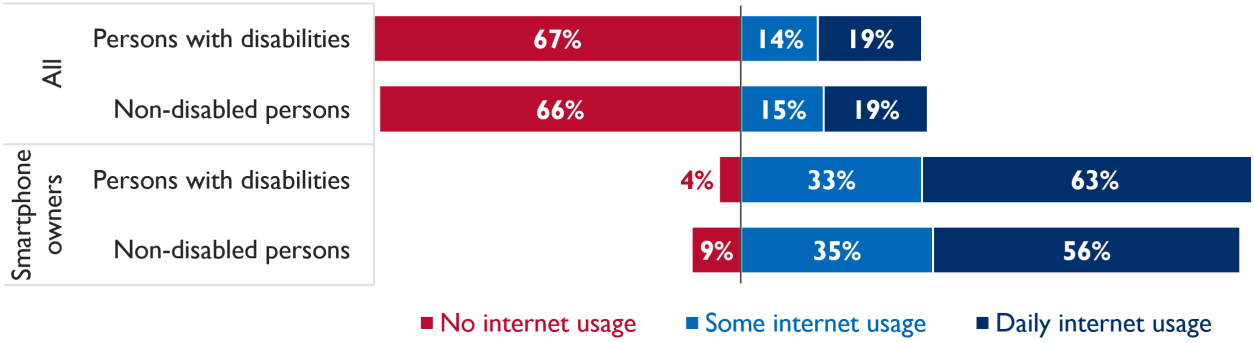


Exhibit 11. Type of mobile phones owned by owners with and without disabilities



The same GSMA study on the mobile disability gap found that people with disabilities use mobile Internet with similar frequency to non-disabled people. However, among smartphone users, people with disabilities have a higher daily usage of mobile Internet (63 percent) than non-disabled people (56 percent) (GSMA 2019).

Exhibit 12. Mobile Internet usage by mobile users with and without disabilities



In 2021–2022, the GoK allotted KES 1.2 billion (about US $10.6 million) for people living with severe disabilities. It also allotted KES 200 million (about US$1.76 million) for the National Development Fund for people living with disabilities. The total allotted amount makes up 3.8 percent of the total national budget (KES 3.66 trillion, or US$32.30 billion) (Deloitte 2021). However, there was no mention of whether the funds will be used to help people with disabilities better access and use technology.

TECHNOLOGY DEVICE AND SOFTWARE ACCESS IN LEARNING INSTITUTIONS

GOVERNMENTAL PROGRAMS

DEVICE ACCESS IN PRIMARY SCHOOLS

Kenya's Digital Literacy Program (originally called the Laptop Project) aims to integrate technology in teaching and learning in the basic education system. The following GoK agencies are in charge of the program (Digischool 2021):

- Ministry of Education, Science, and Technology (MoEST) – provides policy guidelines for the project
- Kenya Institute of Curriculum Development (KICD) – develops content
- Teacher Service Commission – trains teachers
- Kenya Power and REA – electrifies schools
- Ministry of Industrialization – sets up local plants to assemble devices
- ICT Authority – provides learning devices to schools and coordinates implementation

A pilot of the Digital Literacy Program was conducted in 150 Kenyan public primary schools, which includes three schools in each of the 47 counties (141 schools) plus nine special needs schools. The first phase of implementation (2016–2018) started with students in Grades 1–3 in 21,638 public primary schools (93 percent of the total public primary schools) (Kenya Basic Education Statistical Booklet 2019). The second phase of the project (2019 to 2022) targeted all students in Grades 4–6. The third phase of the project, which has not started, will target Grades 7 and above (Digischool 2021).

Since electricity is a prerequisite for schools to implement the Digital Literacy Program, the ICT Authority and the Ministry of Energy and Petroleum are working to ensure that schools have power

connections. As of 2021, 22,258 (95.6 percent) public primary schools were connected to electricity. Of those schools, 3,239 (about 14.6 percent) were using solar power (DigiSchool 2021).

The program provided teachers with digital devices (laptops, scanners, and printers); learner digital devices (laptops and tablets); projectors; servers for program content; digital wireless routers; grid or solar power; device storage and charging stations; and assistive and specialized technology for students with special needs (Barasa 2021).

The program had delivered 1.169 million devices at the time of reporting (Kenya ICT Authority 2021). While most of the devices were bought from China, the Kenyan government also had 100,000 tablets assembled locally. To strengthen local manufacturing, the GoK chose Jomo Kenyatta University of Agriculture and Technology (JKUAT) and Moi University to oversee the production and supply of digital devices (DigiSchool 2021). JKUAT collaborated with Inspur (a Chinese company), Intel, and Microsoft to launch its locally assembled Taifa laptops in 2015. At present, JKUAT produces and sells low-cost Taifa laptops and tablets.[9]

While the numbers and data provided by the GoK look substantial in terms of the country's provision of technology devices for education purposes, especially in primary schools, studies among a sample of schools found that access was not sufficient for teaching and learning with digital technologies and devices. An online survey of 351 urban (54.7 percent) and rural (45.4 percent) primary school teachers (Murithi and Yoo 2021) found that:

- 82.9 percent of teachers had a reliable power supply, though 80 percent of the teachers did not have sockets and power extension cables for connecting devices to electricity
- 87.7 percent of government primary schools lacked Internet connectivity
- 70 percent of government teachers did not have projectors as a part of the shared devices
- 73.5 percent of the teachers didn't have access to government-furnished laptops[10]
- 55.8 percent of learners had access to a tablet (teacher reported)

The insufficient supply of technology became clear with the onset of the COVID-19 pandemic and public schools were found to be least prepared to support digital learning (Uwezo 2020). The study (Uwezo 2020) found that platforms used, such as KICD's online learning management system (also called the Kenya Education Cloud), were not accessible without an Internet connection and, at a minimum, a smartphone or a tablet with at least 64 GB storage (DLP Guidelines 2016). Only 10 out of 100 digital learners accessed digital KICD materials (Uwezo 2020). The most favored platform that teachers use to reach their learners is WhatsApp. Even then, only 27 out of 100 learners accessed materials sent by schools through WhatsApp. The inability to afford smartphones and Internet connectivity were two of the main challenges reported to accessing online content (Uwezo 2020).

[9] Taifa laptops retail at KES 41,500 (US$365) and Taifa Digital Learning School tablets retail at KES 19,500 (US$172) (JKUAT Industrial Park 2021).

[10] One possible reason for this is under DLP's Phase 1, Standard 1/Grade 1 students and teachers were the primary targets and beneficiaries; thus, other grade level teachers may not have had access to the devices (The Nation 2018).

DEVICE ACCESS IN SECONDARY SCHOOLS

While primary schools have the government-run Digital Literacy Program to support their ICT needs, secondary schools, at present, rely on the Secondary Education Quality Improvement Project (SEQIP). This project is funded by the World Bank and seeks to improve student learning in secondary education and the transition from primary to secondary education. The project has sub-components that focus on improving school infrastructure and enhancing teacher professional development for select schools (World Bank 2022). The project provides ICT equipment and IT laboratories to schools and facilitates a mobile phone-based teachers' peer learning group strategy for building the capacity of teachers (SEQIP 2017).

In 2020–2021, out of a total of KES 68,689 million (US$602 million) allotted for secondary education, only KES 149 million (US$1.3 million or .22 percent of the total budget) was allotted for ICT integration in secondary schools, including providing ICT infrastructure and integrating ICT skills in the delivery of the interactive learning process, school management, digital curriculum, and promoting e-learning in public secondary schools (Kenya Department of Treasury 2021). The amount allotted for secondary education is just one seventh of the amount allotted for the Digital Literacy Program (KES 800 million, about US$7 million). In fact, a study that surveyed the status of ICT infrastructure of secondary schools in Meru County (an urban county) reflects this reality. The study found that many secondary schools in Meru County did not have adequate and functional ICT facilities, which hinders ICT teaching and learning (Bariu 2020).

SOFTWARE ACCESS IN GOVERNMENT SCHOOLS

Most government schools in Kenya are not provided with the resources and funding for software licenses, which has resulted in schools using pirated software (Burns 2019). To address this issue, in 2018/19, the Kenyan education sector ensured that all ICT equipment in basic education institutions of learning and its offices were loaded with legal Microsoft software (Kenya government 2021). Interestingly, the National ICT Policy 2019 states that the government aims to promote the use of open-source software in public administration and prefers it over proprietary formats. To encourage the use of open-source software, the Kenya Education Network Trust (KENET) is tasked with providing support to schools (public and private universities, research institutions, government institutions, hospitals, and medical colleges) in the use of open-source software like Moodle, a learning management platform, and BigBlueButton, a Web conference platform.

CONTENT DEVELOPMENT

Developing good digital content entails having in-country know-how and adequate budget to fund the development. To develop in-country know-how, the government established the Kenya Institute of Curriculum Development (KICD) to oversee curriculum materials in basic and tertiary education. The KICD developed a Basic Education Curriculum Framework in 2016 with the vision of having "an engaged, empowered, and ethical citizen." One of the curriculum reform's purposes is to "enable young people to cooperate with their peers around the world through enhanced digital literacy and mastery" (Kabita and Ji 2017). The KICD is in charge of developing, producing, and disseminating educational programs through various channels such as radio, TV, and the Kenya Education Cloud (KEC). The KEC is a repository of all digital materials developed and curated by the KICD that teachers and students can access. The Kenya GPE COVID19 Learning Continuity in Basic Education Project is working to make KEC interactive content accessible via basic and feature mobile phones (GPE 2020).

Most of the content in the KEC is in English except the materials for teaching Kiswahili. The KEC hosts the following content:

- Interactive digital content for Grades 1–4 in primary school and Forms 1–4 in secondary school. Topics include agriculture, math, science, English, Kiswahili, hygiene and nutrition, art, music, Christian religion education, computer studies, business studies, physics, chemistry, biology, geography, government, and home science.
- On-demand radio content for select grade levels.
- Educhannel TV lessons.
- Open educational resources (e.g., health literacy content from UNESCO, math activity games from BrainPop).
- Adapted interactive digital content for Grade 1 and 2 learners with hearing and visual impairment.
- Accessible digital textbooks for Grade 1 produced as part of a pilot for UNICEF's Accessible Digital Textbooks for All Initiative.[11]
- Online courses for teachers on topics such competency-based curriculum (CBC), CBC learning areas, ICT integration, and health literacy. These courses are on the Elimika site.

Digitizing at least 30 percent of the curricula is the lowest threshold for learning to be considered a blend of digital/online and traditional (Allen, Seaman, and Garrett 2007 as cited in UNICEF 2021). Digitizing 30 percent of the curricula for school-age children and youth under 25 costs an estimated US$37.5 million per country (UNICEF 2021). The approved budget for KICD for 2020–2021 is KES 791 million (about US$7 million), half of the budgeted amount in 2019–2020 (KES 1.4 billion, or US$12.6 million) (Kenya Department of Treasury 2021).

NONGOVERNMENTAL PROGRAMS

DEVICE ACCESS

Aside from GoK initiatives, several nongovernmental organizations support digital learning at the primary and secondary levels by providing technology infrastructure and devices. Below is a list of ongoing initiatives.

[11] The GoK worked with UNICEF Kenya to pilot the use of an accessible digital textbook in the country. The digital textbooks were developed for learners who are deaf or hard of hearing, blind or have low vision, and learners with intellectual disability (UNICEF 2019). This UNICEF initiative brings together writers, publishers, teachers, organizations of persons with disabilities, technology developers, MoEST representatives, and other stakeholders to ensure the development of the standards and guidelines needed to produce textbooks and learning materials in accessible digital formats (UNICEF 2022).

Exhibit 13. Sample of NGO programs in Kenya

PRIVATE ORGANIZATION OR NONGOVERNMENT ORGANIZATION	PROGRAM NAME	DESCRIPTION	ACCOMPLISHMENTS
Computers for Schools Kenya (CFSK)	DigiTruck project	CFSK: A charitable nongovernmental organization established in 2002. DigiTruck: A program to deliver digital and entrepreneurial skills to remote communities through mobile digital classrooms housed in solar-powered 40-foot cargo containers. It is in partnership with Huawei and Close the Gap, a Belgium-based non-profit organization.	CFSK: More than 400,200 personal computers to more than 12,010 public secondary and primary schools and technical institutes, teacher training colleges, medical training centers, and several universities. DigiTruck: More than 1,500 youth trained in different counties in Kenya.
inAble		A non-profit organization established in 2009, inAble partners with schools that serve learners with low vision in Kenya to implement its computer programs.	More than 8,000 blind and visually impaired students and teachers had been provided with assistive technology computer skills training. Established eight assistive computer technology labs in six special schools for the blind.
Safaricom		Kenya's major telecommunications company subsidized access to education content produced by Eneza, an EdTech company, Longhorn Publishers, and Viusasa.	Provided free access to all primary and secondary school students studying from home during the pandemic.
Tunapanda	TunpandaNET	A non-profit social enterprise that works to bridge digital divides by providing low-cost community wireless network through its TunapandaNET project.	More than 600 students reached.
USAID and DFID funded with implementing partners RTI, WERK, Worldreader, Dalberg-Global Development Advisors	Tusome National Tablets Program that is integrated into the Tusome Early Grade Reading Activity	A program that provides tablets to instructional coaches to use when they visit and coach teachers on how to improve primary literacy outcomes.	More than 1,200 instructional coaches provided with tablets and a target total of more than 7 million children to be reached

SOFTWARE ACCESS

In line with the aim of the Kenyan government to "Buy Kenya, Build Kenya," the government prefers to buy Kenyan-produced devices, software, and solutions to foster an innovation and start-up ecosystem (National ICT Policy 2019). It is therefore no surprise that Kenya is home to software platform start-ups that seek to shape the use of technology in education. Below is a list of companies that are developing software and content for education:

Exhibit 14. Sample of EdTech companies in Kenya

PRIVATE ORGANIZATION OR NONGOVERNMENT ORGANIZATION	ABOUT THE ORGANIZATION	NUMBER OF LEARNERS USING THE SERVICE	LANGUAGE USED ON THEIR PLATFORM
BRCK	An EdTech company that built Moja Wi-Fi. BRCK provides a suite of hardware and software connectivity tools that address the challenges (e.g., unreliable power) of deploying Internet connectivity solutions in emerging markets like Kenya. BRCK also provides a dedicated education channel on the Moja Network where ministries of education and private content providers can distribute approved digital curricula. It developed Kio Kit, a portable digital classroom with a "Wi-Fi hotspot, a small server packed with educational content and 40 tablets that can be charged wirelessly and work in the roughest conditions in rural schools" (Secorum in The Guardian 2017).	More than 200 Kio Kits sold to communities in 14 counties	English
eKitabu	An ebook provider that aims to drastically reduce the price of textbooks in Kenya by building a digital library with thousands of titles. It offers eKitabu e-reader apps and open.ekitabu.com. Part of its service is providing customized education software.	10,000 students with disabilities in special needs schools with the support of Kenya's MoEST (UNICEF 2017)	Includes books in English and Kiswahili. Also produces sign language video storybooks.
e-Limu	An EdTech company that provides online and offline educational resources such as exam prep and lessons based on the Kenyan curriculum. Content is accompanied by images, animations, and videos to make learning fun. It has a literacy app that combines local stories with a range of exercises to improve reading and writing for children aged 5–7. It also offers teacher training courses.	500,000	English: Website and content Kiswahili: Kiswahili subject test content
Eneza	An EdTech company that provides users (aged 9–18 years old) with educational assessments and lessons through the Web, SMS, and Android platforms. Eneza partnered with Safaricom in March 2016 to launch Shupavu 291 to provide quizzes and search topics of interest. Students can also access Wikipedia without the Internet.	8 million+	English: Website and content Kiswahili: Kiswahili subject test content
Kytabu	An EdTech company that provides education technology solutions and relevant digital content to African learning institutions and their students to support their learning objectives. It deploys a mobile-based information management system for learning institutions and a mobile-first learning management system with digital content for students that is affordable, accessible, and relevant to them.	No information	English
Longhorn Publishers e-Learning Platform	The digital product of Longhorn Publishers Limited. The platform delivers personalized eLearning items in various digital formats and tracking of students' performance.	No information	English
M-Shule	An SMS knowledge-building platform that helps organizations deliver learning, evaluation, activation, and data tools across East Africa.	20,000 households	English

PRIVATE ORGANIZATION OR NONGOVERNMENT ORGANIZATION	ABOUT THE ORGANIZATION	NUMBER OF LEARNERS USING THE SERVICE	LANGUAGE USED ON THEIR PLATFORM
onebillion	A non-profit organization based in London that builds comprehensive, scalable educational software for children in and out of school.	No information	English
Worldreader	A non-profit organization that provides people in low- to middle-income countries with free access to a library of digital books via e-readers and mobile phones.	500,000 readers per month	English and Kiswahili

Source: Data come from the company's website unless cited otherwise.

TECHNOLOGICAL AND PEDAGOGICAL KNOWLEDGE OF TEACHERS

TEACHER TRAINING

PRIMARY AND SECONDARY SCHOOL TEACHERS

In addition to having the necessary infrastructure, devices, and software in place, having a competent teacher who understands how to use technology to teach, engage, and challenge students is key to making digital learning effective. The GoK is committed to building teachers' technological literacy and pedagogical practices through the Digital Literacy Program. Beyond the number of teachers trained, there is limited information on the kinds of training and long-term support and mentoring Kenyan teachers receive to adopt and transition smoothly from classroom teaching to teaching with technology.

Below are the numbers of educators MoEST has trained:

- 218,760 (37 percent) of public primary school teachers had participated in the Digital Literacy Program training as of 2019. The training was on foundational digital literacy (Kenya Department of Treasury 2019).
- 9,000 teachers were trained on ICT integration to implement Kenya's competence-based curriculum.
- 40 ICT champions from public teacher training colleges were selected and trained in 2019/2020.
- 156 ICT champions in five counties (Mandera, Marsabit, Wajir, Garissa, and Lamu), 31 ICT in education national master, and 19 champions were trained in 2019/2020.
- 1,000 interns, who are ICT graduates or ICT with education graduates, were recruited in 2020/21 for on-the-job training to support ICT integration in teaching and learning in primary schools.

Aside from the MoEST, the Computers for School Kenya Institute of ICT, a nongovernmental organization, has also trained well over 100,000 tutors, subject teachers, heads of institutions, and educational administrators in public primary and secondary schools.

While the policy and strategy papers stressed the importance of integrating ICT into teaching and learning, implementing this has been challenging because of inadequate facilities, lack of teacher capacity,

and teacher perceptions that ICT is time-consuming and requires additional work (Murithi and Yoo 2021). In a survey of 351 public urban and rural primary school teachers, teachers reported that (Murithi and Yoo 2021):

- They received basic computer training as part of their teacher training course (77.7 percent)
- They had not received in-service training on technology integration (66.4 percent)
- They perceived computers as necessary, but they could not plan and integrate technology in their lessons (58.4 percent)
- Technology can help them be more organized and enable student-centered learning to take place (98.9 percent)
- ICT is time-consuming and they would need more time allocated in the school timetable for successful integration (52.7 percent)

Among secondary school teachers, there is a growing general acceptance and understanding of technology. While this is a positive development, it may not translate into proficiency or actual use of technology for planning or teaching (Burns 2019). Apart from skills training, teachers need ongoing professional development that will help them transition from using a highly passive model of instruction to more innovative and student-centered pedagogies like collaborative or project-based teaching. Aside from teachers, education officials and school leaders (principals) also need ongoing professional development and support in how to use technology to fulfill their professional role in supporting the integration of technology into teaching and learning (Burns 2019).

UNIVERSITY TEACHERS

Kenya has seen an increase in the number of students pursuing a university degree in the last two decades. While there was also an increase in the number of universities and middle-level colleges, they are not enough to cater to the increased demand for education. To fill this gap, eight public universities and five private universities have embraced e-learning. The University of Nairobi and Kenyatta University are public universities that have well-established e-learning departments. The University of Nairobi pioneered distance education in Kenya in the 1960s with its teacher training correspondence course (Kibiku, Ochieng, and Wausi 2020).

Some of the challenges faced by universities in implementing e-learning include instructors' lack of technical competencies and content creation skills and a lack of e-learning benchmarks to be able to set and evaluate the quality of digital content developed (Kibiku, Ochieng, and Wausi 2020). That said, there are a number of individual Kenyan instructors/professors who are forging ahead and creating innovative digital content and delivering digital learning. Below are examples of the work done by professors as documented by the International Network for Advancing Science and Policy and funded by the British Council (2021).

Exhibit 15. Sample of e-learning programs at Kenyan universities

NAME OF UNIVERSITY	DEPARTMENT	DIGITAL CONTENT DEVELOPED
United States International University - Africa (Private)	Department of Computing	Recorded lectures with PowerPoint presentations uploaded to YouTube and the university's learning management system

NAME OF UNIVERSITY	DEPARTMENT	DIGITAL CONTENT DEVELOPED
Africa Nazarene University (Private)	Institute of Open and Distance Learning	Lecture videos uploaded to the university's learning management system, YouTube or shared via WhatsApp. Videos are followed by live chats.
University of Nairobi (Public)	School of Open and Distance Learning	Lecture videos on YouTube, correspondence with students via comments section, email, or WhatsApp.
Jomo Kenyatta University of Agriculture and Technology (Public)	Department of Telecommunication and Information Engineering	Used open-source Arduino to teach engineering, computer science, and technology students. Arduino is combined with Tinkercard, a free easy-to-use application for 3D design, electronics, and coding, for students to engage in practical sessions without being on campus.
Kenya Methodist University (Private)	Department of Information Science	Developed interactive content that includes video recordings of lectures, curated links, and activities embedded in live online sessions. All materials are hosted on the university's learning management system.
Tangaza University College (Private)	Institute of Social Transformation	Developed two toolkit apps ("Conflict Resolution and Transformation" and "Peace and Conflict Reporting") for access on a mobile phone. Students can download and access much of the content offline.
Strathmore University (Private)	All faculties and schools	Has a robust e-learning system and offers online courses across different disciplines.
University of Nairobi (Public)	School of Mathematics	Together with the University of Sheffield, UK, developed the SOMAS learning platform on Moodle to allow students to receive randomly generated problems to solve.
Technical University of Kenya (Public)	School of Architecture and Spatial Planning	To help students engage in practical studio work, tools such as Archicad is combined with interactive studio content for training in architectural design on Moodle.

Source: From "Creating digital content and delivering digital learning in African universities," International Network for Advancing Science and Policy, 2021.

NIGERIA

ICT FOR EDUCATION POLICIES, PLANS, AND PROGRAMS

In 2019, the Government of Nigeria launched the **National Digital Economy Policy and Strategy 2020–2030** with the aim of developing the digital technology sector. The intention is to diversify the economy and move away from dependence on the oil and gas sector. There are eight pillars for accelerating development of the digital economy:

- Developmental Regulation
- Digital Literacy and Skills
- Solid Infrastructure
- Service Infrastructure
- Digital Services Development and Promotion
- Soft Infrastructure
- Digital Society and Emerging Technologies
- Indigenous Content Development and Adoption

Out of the eight, the two most relevant to supporting the education sector in implementing digital learning are the Digital Literacy and Skills pillar and the Solid Infrastructure pillar. The Digital Literacy and Skills pillar encompasses a policy mandate to integrate digital literacy and skills into the national curriculum for all grade levels. It also calls for training and capacity-building of educators and training institutes and all Nigerians, including children, women, internally displaced persons, and persons with disabilities (Federal Ministry of Communications and Digital Economy 2019). The Solid Infrastructure pillar details policy objectives and implementation strategies to facilitate broadband Internet development and to increase its use and access (Federal Ministry of Communications and Digital Economy 2019).

To achieve the objective of universal broadband access, the National Broadcasting Commission rolled out the **National Broadband Plan for 2020–2025**. The plan seeks to deliver data download speeds across Nigeria at a minimum of 25 Mbps in urban areas and 10 Mbps in rural areas. Effective coverage should be available to at least 90 percent of the population (around 185.5 million people) by 2025 at a price not more than Naira 390 (US$0.94) per 1 GB of data (i.e., 2 percent of median income or 1 percent of minimum wage). The plan is ambitious, given the capital requirements, which are estimated at a range of US$3.5–5 billion (about N 1.5–2.1 trillion) (NCC 2019).

In the same year, 2019, the **National Policy on ICT in Education**, originally drafted in 2010, was reviewed and updated. The updated policy covers the following areas:

- Human Capital Development
- Infrastructure
- Research and Development

- Awareness and Communication
- Governance
- Financing
- Monitoring and Evaluation

While the Federal Ministry of Education is charged with policy formulation and setting, maintaining, and monitoring standards in the Nigerian education sector, the implementation of ICT in education rests heavily on state and local governments (Federal Ministry of Education 2019).

The **National Implementation Guidelines for ICT in Education** (February 2019) build on the National Policy in ICT in Education and provide details on the activities, deliverables, responsible agencies, timeline, and key performance indicators for implementing ICT in education.

SPENDING ALLOCATIONS FOR ICT

The Nigerian government expenditure on education for 2020 was 5.61 percent of the total budget, a 2 percent drop from 2019 (7.03 percent) and a 5.4 percent drop from 2015 (11.047 percent) (World Bank 2021). While the **National Implementation Guidelines for ICT in Education** describe the strategies for financing, which includes allocating at least 5 percent of education annual capital budget to ICT in education and intensifying the use of creative financing models such as public-private partnerships, there is limited funding for use of technology in education. Nearly all ICT in education initiatives are led by NGOs, startups, and international organizations (Dele-Ajayi and Taddese 2020).

TECHNOLOGY INFRASTRUCTURE

ELECTRICITY

Nigeria's electricity sector is comprised of six privately owned generation companies, 11 privately-owned distribution companies, and one federally managed transmission company. The Nigerian Electricity Regulatory Commission (NERC) is an independent regulatory body that oversees the power industry (NERC 2021). Nigeria is dominated by thermal (80 percent) and hydro (20 percent) power sources (ITA 2021).

The privatization of the electricity sector began in 2001 with the goal of establishing an efficient electricity market in Nigeria (NERC 2021). However, at present, about 85 million Nigerians—43 percent of the population—do not have access to grid electricity. This makes Nigeria the country with the largest energy access deficit in the world (World Bank 2021).

Because of poor public investment over several years, the country's energy supply infrastructure has not kept pace with the country's population growth (Olaniyan et al. 2018). Despite being an oil-rich country, Nigeria continues to suffer from a lack of reliable power, which is a significant constraint for citizens and businesses and results in annual economic losses estimated at US$26.6 billion (N 11 trillion), 2 percent of GDP (World Bank 2021). The lack of reliable power is a major hindrance in implementing ICT in education initiatives.

At the national level, the median number of hours of electricity received by households was about eight hours per day. Urban households tend to have longer hours with electricity (eight hours) than rural

households (six hours) on average. The North Central and South-East zones received the longest average hours (10 or more), while the North-East received the least (only four per day). Hours received by households in the Southern zones were also higher than for households in the northern zones (Olaniyan et al. 2018). With the limited number of hours of reliable power, most Nigerians rely on diesel generators.

To address Nigeria's power problems, especially the gap between urban and rural areas, the government, through the Rural Electrification Agency, has been actively commissioning electrification projects since 2014, using solar energy as the main source of electricity (ITA 2021). Aside from government initiatives, there's also the Scaling Off-Grid Energy (SOGE) Grand Challenge for Development, which is implemented in Nigeria under a partnership between U.S. Global Development Lab, Power Africa, USAID/Nigeria, FHI360, and Power for All. The partnership aims to provide 20 million households in Sub-Saharan Africa with access to modern, clean, and affordable electricity (Amaza 2018).

Like other countries in Sub-Saharan Africa, Nigeria has introduced some low-carbon energy technology applications, but these have not led to a substantial investment in renewable energy. Nigeria is investing mainly in energy generation from fossil fuels, which to date are still cheaper and more scalable than renewables (World Economic Forum 2021). In fact, the price of electricity in Nigeria, at US$0.057 (N23.70) per kWh for households and US$0.093 (N36.68) for businesses, is lower than the world average, which is US$0.138 (N57.39) per kWh for households and US$0.126 (N 52.40) for businesses (Global Petrol Prices 2021).

INTERNET NETWORKS

In Nigeria, the Internet can be accessed via fixed broadband or the mobile broadband network. Nigeria's telecommunications sector was fully deregulated in 2001. There are four major mobile network operators (MNOs) that provide services to over 99.5 percent of 184.7 million active lines (NCC December 2019) with 126 million of those lines (68 percent), connected to the Internet (2G+/3G/4G) (O'Peters 2021).[12]

MOBILE BROADBAND NETWORK

Nigeria's broadband penetration rate is 37.8 percent with mobile broadband connections accounting for approximately 99.8 percent of the broadband base, while fixed connections account for only 0.2 percent (Broadband Plan 2020). [13]This is not surprising, since the majority of Nigerians access the Internet via their mobile phone (Oyelola 2021).

In terms of actual connected users, out of 97.5 million unique mobile subscribers,[14] around half also use mobile Internet services (GSMA 2018). Nigeria lags behind its regional peers in 4G adoption. The graph

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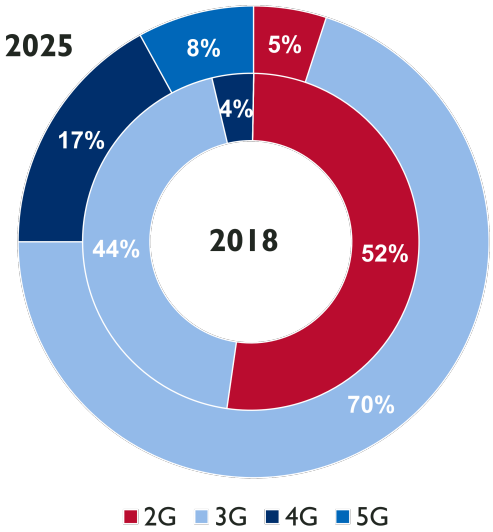
[12] The four mobile network operators are MTN, Globacom, Airtel, and 9Mobil. There were 184.7 million mobile subscriptions as of December 2019 distributed across the four network operators: MTN – 37.31 percent, Globacom – 28.05 percent, Airtel – 27.23 percent, and 9Mobile – 7.41 percent.

[13] In 2020, there were 65,313 fixed broadband Internet subscriptions out of a total population of 206.1 million—only .032 percent of Nigeria's population (World Bank 2020).

[14] A "unique mobile subscriber" is defined as an individual person that can account for multiple "mobile connections" (i.e., SIM cards) (GSMA, 2017).

below shows the percentage of Nigerians accessing 2G, 3G, 4G, and 5G networks in 2018 and the projected percentage of Nigerians accessing the different networks in 2025 (GSMA 2018).

Exhibit 16. Percent of Nigerians with access to mobile broadband network



Several hurdles have hindered broadband expansion and investment opportunities for the sector. Some of the major challenges that have affected the sector include long delays in the processing of permits; taxation at federal, state, and local government levels; multiple regulatory bodies; damage to existing fiber infrastructure as a result of cable theft, road works, and other operations; and right of way charges implemented by several state governments (ITA 2021). While mobile broadband penetration has increased in Nigeria with the deployment of 3G and 4G coverage, the results achieved in terms of end-user adoption has not matched expectations for a variety of reasons (e.g., access to and affordability of smartphone devices, quality of service and speed, access to services beyond major urban areas, access via public institutions such as schools, hospitals, ministries, departments, and agencies, limited availability of relevant content and e-government online services) (O'Peters 2021).

Mobile broadband affordability in Nigeria has significantly improved because of aggressive competition among the major operators (Broadband Plan 2020–2025). The cost of data in Nigeria skews lower than 155 other countries, including high-income and low-income countries (Ang 2020).[15] The cost to download 1.5 GB of data at N3,095 (US$7.45) is lower than the median global download cost of N7,686 (US$18.50) (ITU 2020). However, given the high-income disparities within Nigeria, Internet bundles remain largely unaffordable for the majority of people. Broadband services will need to become less expensive for 48 percent of Nigerians living below the median income to afford it (Broadband Plan 2020–2025).

Nigeria's mobile Internet download speed, at 17.76 Mbps, is also lower than the global average of 29.91 Mbps (Speedtest February 2022). Global download speed (for 138 countries) ranges from 5.43 Mbps to 133.51 Mbps. Within the African region, South Africa has the highest download speed at 32.26 Mbps

[15] Based on data from 155 different countries, the price for one GB of data ranges from USD$0.09 (India) to USD$27.41 (Malawi). Benin (USD$27.22), Chad (USD$23.33), and Botswana (USD$13.87) are the other three countries that have the most expensive price for one GB of data. (Ang 2020).

(Speedtest February 2022). The official broadband definition set by the U.S. Federal Communications Commission is a minimum of 25 Mbps for download speed. In addition, a research study of more than 750,00 students in the United States recommended a download speed of 25 Mbps per student (not per household) for online learning and engagement to be effective (CoSN 2021).

FIXED BROADBAND

In 2020, there were 65,313 fixed broadband Internet subscriptions out of a total population of 206.1 million (only .032 percent of Nigeria's population) (World Bank 2020). This very low number of fixed broadband subscribers may be due to Nigeria's fixed broadband service price, which is ten times the standard pricing for low- to middle-income countries (LMICs) (Broadband Plan 2020–2025).[16] The average monthly cost of fixed broadband with 5 GB of data in Nigeria is N39,935 (US$96.12) when corrected for differences in purchasing power parity. This cost is almost double the world median of N18,031 (US$43.40) (ITU 2020). Moreover, the average download speed for fixed broadband is only 10.39 Mbps (Speedtest February 2022), which is on the lower end of the global download speed range (1 to 300 Mbps) (Ang 2021).[17]

TECHNOLOGY DEVICE ACCESS

For digital learning to be effective, there must be continuity of learning, even outside of school and at home. For that to happen, access to the necessary technology device is essential.

MOBILE PHONE OWNERSHIP

Nigerians use their mobile phones to connect to the Internet more than other technologies. As such, mobile phones are the primary modality for creating, distributing, and consuming digital content and services across multiple sectors (GSMA 2018).

In 2017, 80 percent of adults in Nigeria owned a mobile phone, of which 32 percent owned a smartphone, 48 percent owned a basic phone, and 20 percent had no phone (Silver et al. 2019).

Exhibit 17. Percentage of adults by type of phone owned in Nigeria (2017)

To facilitate access to low-cost broadband devices, the government is incentivizing local manufacturing of devices. The goal is to have at least one locally assembled smart device by 2023, with the following

[16] Nigeria's fixed broadband services price was 22.08 percent of Gross National Income (GNI) per capita in 2020, 10 times above the standard pricing for developing countries. According to the United Nations Broadband Commission on Sustainable Development's Target 2 for 2025, entry-level broadband service in developing countries should not cost more than 2 percent of monthly GNI per capita, but Nigeria's fixed broadband pricing surpassed this by 20.8 percent. (O'Peters, 2021)

target prices: <US$50 (N 18,000) by 2023 and <USD$25 (N9,000) by 2025 (Broadband Plan 2020–2025).

COMPUTER, LAPTOP, AND TABLET OWNERSHIP

Based on information from a representative sample of 42,000 households, only 6.4 percent of households have a computer. The difference in ownership in rural and urban households is stark, with only 2.5 percent of rural households and 10.8 percent of urban households having a computer (DHS 2018).

EQUITABLE ACCESS TO DIGITAL TECHNOLOGY DEVICES AND INFRASTRUCTURE

Equitable access to technology infrastructure and digital devices (e.g., mobile phone or a computer) are crucial for digital learning to reach all students, especially the most disadvantaged and marginalized. The COVID-19 pandemic brought to light and exacerbated digital divides and geographic, gender, and economic divides in teaching and learning.

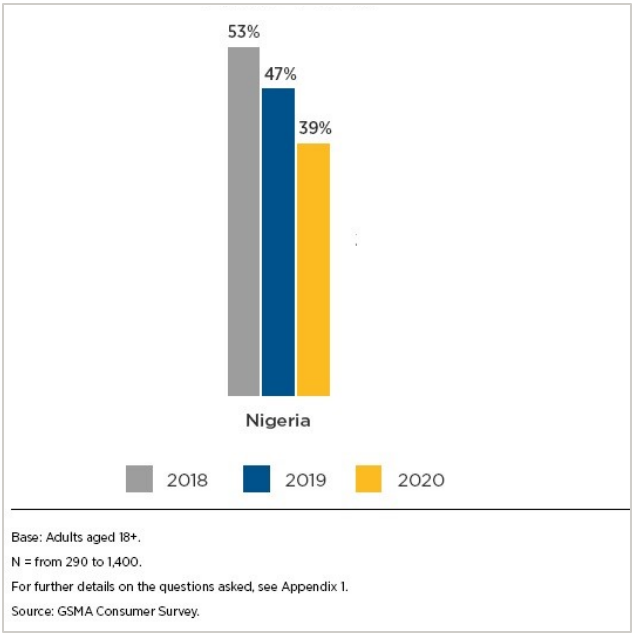
A. GEOGRAPHIC DIVIDES

Urban areas tend to have better access to both digital technology infrastructure and devices than rural areas. The rural-urban gap refers to how much less likely a person living in a rural area is to use mobile Internet than a person living in an urban area (GSMA 2021).[18] The rural-urban gap in Nigeria is significant in terms of access to technology devices and infrastructure:

- 81.7 percent of the urban population has access to electricity, while only 37.1 percent of the rural population has access to electricity (DHS 2018).
- 95 percent of urban households and 82 percent of rural households own a mobile phone (DHS 2018).
- There is a 39 percent rural-urban gap in mobile Internet use. This gap has been decreasing since 2018 (GSMA 2021). 18

[18] Rural-urban gap is calculated using the following formula: (percent of urban users) – (percent of rural users) / (percent of urban users) (Source: GSMA 2021)

Exhibit 18. Rural-urban gap in mobile Internet use



B. GENDER DIVIDES

The gender gap is the difference between how many men and how many women are mobile phone owners or mobile Internet users as a proportion of how many men are mobile phone owners or mobile Internet users.[19] The lower the percentage of women, the larger the gender gap (Iglesias 2020). In general, the gender gap in mobile phone ownership is smaller than the gender gap in mobile Internet use across all countries in the world (Amorighoye 2020), and Nigeria is no exception.

- The gender gap in mobile phone ownership in Nigeria is 4 percent, while the gender gap in mobile Internet use is 29 percent (GSMA 2020).
- 31 percent of urban women compared to just 6 percent of rural women use the Internet, while 55 percent of urban men compared to 25 percent of rural men use the Internet (DHS 2018).

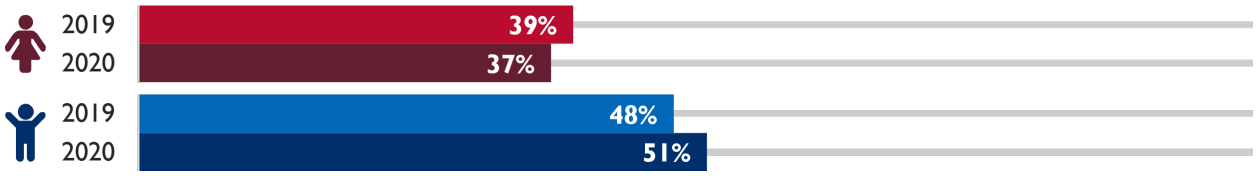
Exhibit 19. Mobile device ownership and mobile Internet use by gender in Nigeria (2020)

Between 2019 and 2020, women's smartphone ownership was negatively affected compared to men. While there was a slight increase in men's smartphone ownership, women's smartphone ownership dropped from 39 percent in 2019 to 37 percent in 2020. Based on anecdotal evidence obtained while

[19] Gender gap is calculated using the following formula: (Male owners/users (percent of male population) – Female owners/users (percent of female population)) / ((Male owners/users (percent of male population)) (Source: GSMA 2021)

GSMA was conducting its consumer survey, some women and men sold their handset to cope with financial stress brought about by the COVID-19 pandemic. The survey also revealed that households prioritized men's use of smartphones over women during the pandemic so men could seek new work opportunities, stay socially connected, and watch sports (GSMA 2021).

Exhibit 20. Smartphone ownership 2019–2020 by gender

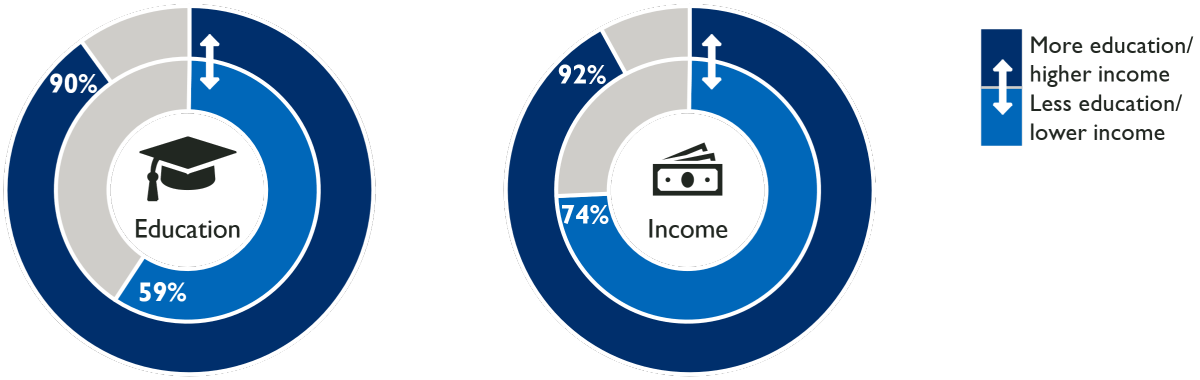


C. ECONOMIC DIVIDES

The proportion of women and men who own a mobile phone increases as education and wealth increase (DHS 2018). Women and men in the highest wealth quintile are much more likely to own a mobile phone than women and men in other wealth quintiles (DHS 2018). Research conducted by Pew Research Center also reflects these findings:

- 90 percent of people with more education compared to just 59 percent of people with less education own a mobile phone (Pew Research 2018).[20]
- 92 percent of people with higher income compared to just 74 percent of people with lower income own a mobile phone (Pew Research, 2018).

Exhibit 21. Mobile device ownership by education and income (2018)



Since there are no specific data linking wealth/income level with mobile Internet use, a closer look at how men and women use mobile phones for financial transactions (e.g., mobile banking, mobile payment) can provide some points of reference.

[20] The lower or less education category is below secondary education and the higher or more education category is secondary or above.

- Only 2 percent of women in the lowest wealth quintile use mobile phones for financial transactions, compared to 51.2 percent of women in the highest quintile (DHS, 2018).
- Only 3.9 percent of men in the lowest wealth quintile use mobile phones for financial transactions compared to 68.5 percent of men in the highest quintile (DHS, 2018).

A study that surveyed up to 554 public- and private-school students from 31 of 36 states in Nigeria provides insights into access-related challenges students from different socio-economic backgrounds face.[21] Schooling opportunities in Nigeria are correlated with income level and higher-income families are more likely to send their children to private schools (Azubuike, Adegboye, and Quadri 2021). Below are some findings from the study:

- A higher percentage of public-school students than private-school students reported access to digital tools as a challenge to distance learning.
- 54 percent of the public-school respondents versus 46 percent of private-school respondents reported facing challenges learning online. This difference is statistically significant.
- Students in government schools were more likely to report that accessing digital tools to learn online was their main challenge with learning. Other challenges reported were access to electricity, access to devices, phone credit for Internet data and poor Internet connections.

A separate study that looked at how COVID-19 has affected low-fee private schools (LFPS) found that private-school students in Nigeria were not able to access distance-learning opportunities either. Out of 100 LFPS parents surveyed by a non-profit organization,[22] only 25 parents had smartphones and only two parents had the data coverage to stay online (Niazi and Doorly 2020). Thus, in Nigeria's case, lack of access to technology infrastructure and devices are challenges that both private- and public-school students face.

D. ACCESS FOR PEOPLE WITH DISABILITIES

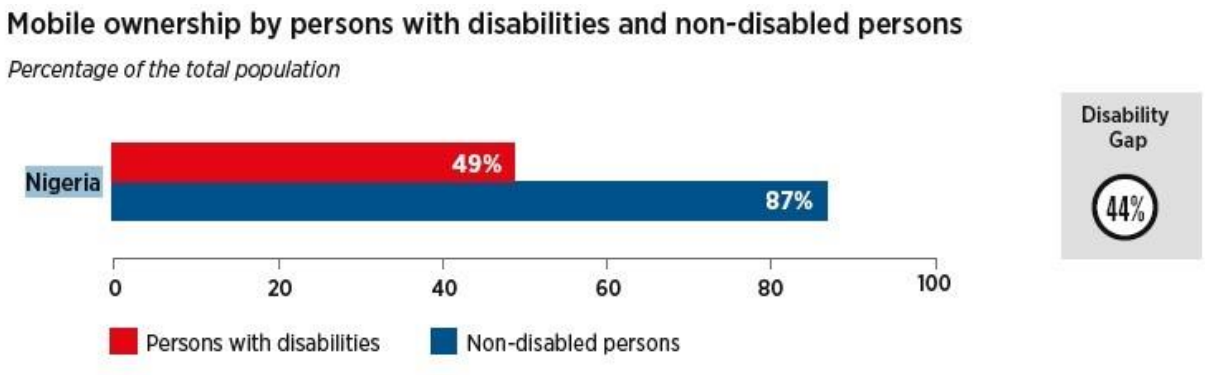
Nigeria's "Discrimination against Persons with Disabilities (Prohibition) Act 2018" seeks to safeguard the rights of persons with disabilities, but it has not been fully implemented (Martinez and Vemuru 2020). Similar to other countries in Sub-Saharan Africa, in Nigeria, people with disabilities experience poor educational outcomes because of the absence of adequate facilities, including accessible infrastructure, learning materials, and teachers trained in inclusive education. Assistive devices are expensive and not easily available, which limits the mobility and access to technology for people with disabilities (Martinez and Vemuru 2020).

[21] The sample included representatives from higher institutions, senior secondary schools, junior secondary schools, and primary schools. The study did not specify whether students from low-fee private schools (LFPS) were included in the sample and if so what proportion of the sample they represented. The inclusion or not of LFPS in the sample, which cater to low- and middle-income families could likely impact these statistics.

[22] SEED, a Nigerian non-profit that supports more than 700 LFPSs.

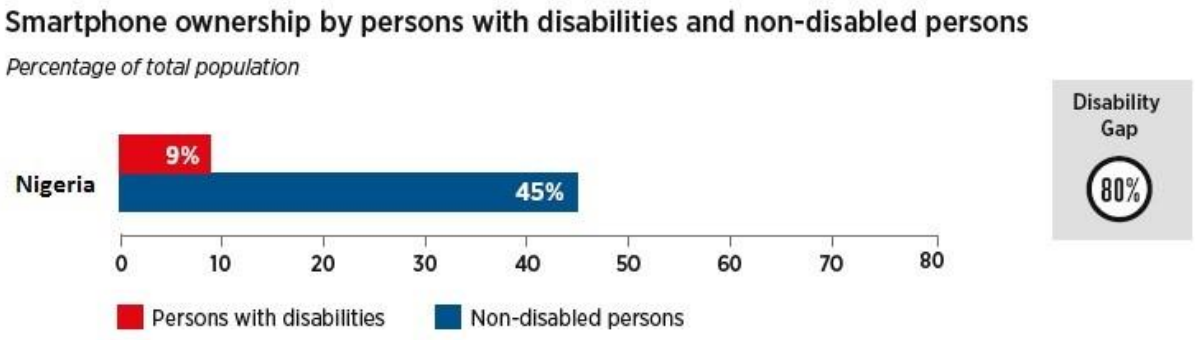
In terms of mobile ownership, compared to seven other LMICs surveyed, Nigeria has the largest disability gap[23] people with disabilities are 44 percent less likely to own a mobile phone and 80 percent less likely to own a smartphone than those without disabilities (GSMA 2020).

Exhibit 22. Mobile phone ownership by persons with and without disabilities



Source: GSMA Intelligence, 2019. Mobile ownership is defined as having sole or main use of a SIM card (or a mobile phone that does not require a SIM), and using it at least once a month. Based on survey results for adults aged 18 and over. n=35 to 436 for persons with disabilities and n=866 to 1942 for non-disabled persons.

Exhibit 23. Smartphone ownership by persons with and without disabilities



Source: GSMA Intelligence, 2019. A smartphone is a mobile phone with a touchscreen display, an advanced operating system (Android or iOS) and the ability to download apps from an online app store, such as Google Play or the App Store. Based on survey results for adults aged 18 and over. n=35 to 436 for persons with disabilities and n=866 to 1942 for non-disabled persons.

SPECIAL CONSIDERATION: OUT-OF-SCHOOL CHILDREN AND YOUTH

In thinking about access to technology infrastructure and devices, out-of-school children and youth in Nigeria deserve special attention. The country has around 10.5 million out-of-school children, of which about 69 percent come from the north (Adeniran and Castradori 2021), where various factors, including ongoing conflict, economic barriers, and socio-cultural norms and practices, discourage attendance in formal education, especially for girls (UNICEF 2022). Nigeria contributes approximately 20 percent of the total global out-of-school population (Amorighoye 2020). For digital learning to be equitable and

[23] Eight countries surveyed were Bangladesh, Brazil, India, Kenya, Mexico, Nigeria, Pakistan, and Uganda. Disability gap is calculated using the following formula: (percent non-disabled mobile owners/users – percent mobile owners/users with disabilities / (percent non-disabled mobile owners/users) (Source: GSMA 2020).

inclusive, the needs of out-of-school children must be seriously considered even if there are no data regarding their current access, use, and knowledge of technology.

TECHNOLOGY DEVICE AND SOFTWARE ACCESS IN LEARNING INSTITUTIONS

The COVID-19 pandemic and the spate of school attacks and student abductions in Nigeria (20 attacks on schools in 2021 alone) have forced schools to close and left many children unable to continue their education (UNICEF 2021). Like other countries worldwide, Nigeria, with help from the private sector, took action to provide distance learning when the pandemic started. Prior to the COVID-19 pandemic, Nigeria had not fully embraced technology in education at all levels (BudgIT 2021) because the implementation of ICT in education is dependent on each state and local government's initiative.

At the tertiary level, the current administration has provided funding intervention to enable all public tertiary education institutions to develop ICT infrastructure and support the migration to e-learning, including training 12,873 staff in tertiary institutions nationwide (Goong 2021). This is a timely response, since a survey revealed that while private organizations have provided a wider range of learning solutions to private and public-school students, only a few innovations are addressing tertiary education, teacher development, and training. Private universities have employed e-learning platforms during the pandemic, but most state-owned universities are still lagging behind the e-learning transition (TEP-NESG 2020).

In 2021, the Nigerian president also approved the establishment of two new universities of technology and the upgrade of four existing ones (Goong 2021). However, there is no mention of any technology-related plans for the primary and secondary levels.

Most of the ICT in education programs that are ongoing in Nigeria focus on providing software and digital content access and only a few programs, mostly state and local government initiatives, include the provision of hardware (e.g., mobile phones).

GOVERNMENTAL PROGRAMS

According to a survey conducted with 101 government officials across 22 of the 36 states and the Federal Capital Territory in Nigeria, 49 percent of the states reported that Internet-based learning platforms were created for students to learn. Other states used TV (77 percent) and/or radio (75 percent) programs to deliver lessons. Many states seem to have employed a mixed-media approach that includes both low-tech and high-tech alternatives. However, 75 percent of respondents reported a lack of resources for children (i.e., digital devices, Internet access, and electricity) as major challenges in helping students learn (TEP and NESG 2020).

The Federal Ministry of Education (FMoE) and the Universal Basic Education Commission set up the Nigeria Education Sector COVID-19 Response Strategy (FMoE 2020). This strategy includes plans for the Learn at Home Program and is aimed at minimizing learning loss during the pandemic. In partnership with educational technology companies, the FMoE launched virtual learning platforms (e.g., SchoolGate and MobileClassroom App) and provided links to e-learning resources that are developed locally (e.g., Hitch) and internationally (e.g., Khan Academy, Seesaw, Oracle, British Council, Oxford University Press) (TEP and NESG 2020).

Some state governments also implemented their own digital learning programs by working with funders or private partners to provide students with opportunities to continue learning remotely (FMoE 2022). Below is a list of state government-led programs:

Exhibit 24. Government digital learning programs

STATE	PARTNER/FUNDER	PROGRAM NAME AND DETAILS
Benue	Gamint Corporate Ltd.	BESEVIC: a state government-owned e-learning/virtual education and ICT resource center.
Borno	Vistern Partners	Mavis Talking Books and Mavis Education Model: seeks to reach 10,000 children (in the first phase) using the Mavis Talking Books and Mavis Education model. Funded by the Borno State Government through the Borno State Universal Basic Education Board (SUBEB).
Edo	World Bank (technical and funding support (US$75 million, about N 31 billion, over four years)	EdoBEST: provides learning materials such as study guides, interactive storybooks, questions, and audio lessons. In addition, teachers created more than 7,000 virtual classrooms. Lessons were accessed either through the student's older siblings' or parents' phones since the majority of the students do not own mobile devices (World Bank 2021).
Lagos	Microsoft represented by ATB Techsoft Solutions First Bank of Nigeria Robert and John Ltd. (Roducate) KaiOS Technologies Government of Lagos State, through the Ministry of Education and the Ministry of Science and Technology with the Global Education Media (Nigeria) Limited	Work From Home, Remote Teaching and Learning for Lagos State Secondary School Teachers: trains teachers to use mobile devices and computers to teach and assess students remotely. Provides e-learning solutions and devices to primary, secondary, and tertiary institutions. Devices are preloaded with a government-accredited curriculum that can be accessed offline. Distributed 20,000 KaiOS smart feature phones to help children in Lagos continue their education during lockdown. Lagos Schools Online is an online community portal for all public and private schools in Lagos state.
Ogun	Teach for Nigeria	Ogun Digital Classroom (Ogun Digiclass): focuses on educating primary and secondary school students, providing online capacity-building workshops for teachers and an online learning assessment for students.
Ondo		Ondo State eLearning: a learning portal that provides access to online courses for secondary schools, e-books on any subjects, prepared student lesson notes, and practice and preparation for computer-based tests and assignments.

NONGOVERNMENTAL PROGRAMS

There are a variety of ICT for education-related initiatives implemented by different NGOs and private corporations. However, the list below is limited to programs that were implemented from 2020 to the present and target a larger number of beneficiaries (1,000 and up).

Exhibit 25. Nongovernmental digital learning programs

NGO	PROGRAM NAME	DESCRIPTION	TARGET GROUP
Tech4Dev (in partnership with Microsoft)	Basic Digital Education Initiative (BDEI) – ongoing	An experiential learning computer education and STEM program	500,000 public school students between ages 8 and 18 across selected states in Nigeria
Tech4Dev (in partnership with the UK Foreign Commonwealth and Development Office)	Basic Digital Literacy for Rural Clusters in Northern Nigeria program – concluded in 2021	A program that seeks to increase the number of digital literate vulnerable populations and people living in underserved communities in Northern Nigeria	1,000 vulnerable people in 10 states in Northern Nigeria (Benue, Jigawa, Kwara, Kogi, Kaduna, Nasarawa, Niger, Plateau, Sokoto, and Zamfara states) Of the1,000, 50 percent vulnerable women and girls (aged 8–18; 45–65), 30 percent persons with disabilities (e.g., mobility, speech, polio), 20 percent other vulnerable groups

PRIVATE SECTOR-DEVELOPED SOFTWARE AND PLATFORMS

E-learning resources developed by local and international private sector organizations played an important role in supporting the FMoE's COVID-19 response strategy. The table below lists e-learning platforms developed in Nigeria, approved by the FMoE, and listed on the FMoE website:

Exhibit 26. E-learning platforms developed in Nigeria

E-LEARNING PLATFORM DEVELOPED IN NIGERIA	DESCRIPTION	TARGET GROUP	REACH
Hitch (a UNICEF partner)	A library of the world's best educational videos that focus on topics related to exams administered by the West African Examinations Council (WAEC) such as the West African Senior School Certificate Examination (WASSCE), a standardized test to confirm graduation from secondary school.	Teachers	40 public schools (Q2, 2021) 200 schools (Q3/Q4, 2021)
Mobile Classroom Application	An audio-visual learning application that is developed in Nigeria. (Note: The last post was a year ago.)	Learners in senior secondary and higher institutions	Potentially reaching all school learners in Nigeria since it is one of two online portals approved by the FMoE
National Open University	An online learning platform that offers courses by Nigeria's National Open University.	Learners at tertiary level	Students enrolled at the National Open University
SchoolGate	An online learning platform where students can take courses and	Learners of all levels	Potentially reaching all school learners in Nigeria since it is one of

E-LEARNING PLATFORM DEVELOPED IN NIGERIA	DESCRIPTION	TARGET GROUP	REACH
	educators can post and teach courses they developed.		two online portals approved by the FMoE
Teacher Development Program Resource Hub	An online library of videos for pre-service and in-service teachers to help them achieve better learning outcomes for their students.	Teachers	62,000 teachers

The table below lists international e-learning platforms that are approved by the FMoE and listed on its website. Content on these platforms is all in English.

Exhibit 27. International e-learning platforms approved by FMoE

INTERNATIONAL E-LEARNING PLATFORM	DESCRIPTION	TARGET GROUP
Aga Khan Foundation Resources for Educators	A curated listing of professional offline and online tips, resources, and recommendations to support educators.	Teachers
British Council	List of learning resources (in PDF format) for teachers, learners, and parents developed by the British Council.	Teachers and parents
CISCO	A comprehensive program that provides in-class and online courses, tools, and industry-recognized certifications.	Learners in tertiary level and above
IBM Digital-Nation Africa	A free, self-paced learning platform to empower youth with digital skills and tools.	Learners in tertiary level and above
Khan Academy	An online library of educational videos that teaches a range of subjects from K–12 subjects to early college courses.	Teachers and learners of all levels
Oracle Academy	An online free resources library for educators and learners that includes a range of forums, sites, and learning materials.	Teachers and learners in tertiary level and above
Oxford University Press	A library of online resources and materials published by the Oxford University Press. Resources were free to access during COVID-19 school closure but not anymore.	Teachers and learners at primary and secondary levels
Seesaw	A digital portfolio and an interactive learning platform where teachers can create multimedia experiences for their students.	Teachers and learners at primary and secondary levels
Springer Scientific Books	A library of online journals and books published by Springer, Palgrave, and Apress books.	Teachers and learners in tertiary level and above
UNESCO School Meet the Learner Approach (SMLA)	A series of videos posted on YouTube to teach literacy through non-formal education.	50,000 girls and women in Bauchi State

Aside from the e-learning platforms that are approved by the FMoE, Nigeria is also home to several EdTech companies and start-ups that focus on addressing students" learning gaps. Below is a list of Nigerian EdTech startups:

Exhibit 28. Nigerian EdTech startups

COMPANY NAME	DESCRIPTION	CONTENT LANGUAGE
AltSchool Africa	An EdTech company that is a sub-institution of TalentQL, a tech talent outsourcing company. It trains tech talents for free and then certifies them with a universally recognized certification.	English
Edukoya	An EdTech company that creates educational content and offers online tutoring for students and parents alike. It also offers test prep.	English
Edves	An EdTech company that brings schools online through its cloud-based platform.	English
FlexiSAF Edusoft	A school management software provider that serves teachers and students.	English
Mavis	Digital books that come with digital content and recorded educational content and are used by teachers and students. A total of 149 schools and 18,520 students reached.	Mostly in English except for materials that teach another language (e.g., English to Igbo, Spanish language)
Roducate	An EdTech company that has mobile learning applications with approved curriculum materials for primary, secondary, and select university courses. Roducate also provides schools with the ability to set up their digital platform within minutes.	English
Stranerd	An EdTech startup that gives A-level and university students an opportunity to learn and earn at the same time.	English
Teesas	An EdTech company that offers video classes and other digital educational materials for learners that are aligned to Nigeria's national curriculum.	English but also offers local language classes
ULesson	An EdTech company that provides live online classes, video lessons, and personalized support for primary and secondary school learners.	English

TECHNOLOGICAL AND PEDAGOGICAL KNOWLEDGE OF TEACHERS

TEACHER TRAINING

While the National Commission for Colleges of Education has specified that basic education teachers should be able to teach the ICT component of the basic education curriculum effectively to qualify for the Nigeria Certificate in Education, most teachers still lack the skills to use and integrate ICT into their teaching. In fact, there is a mismatch between the minimum standards set and how basic education teachers are being prepared in Colleges of Education (Egede and Asabor 2019). Teacher training and

development is not prioritized, especially in rural areas and marginalized communities (TEP-NESG 2020). It is therefore no surprise that current studies show that teaching, learning, and use of ICT at the basic education level are still very low because the majority of the teachers have not received adequate training on how to use and teach with technology (Egede and Asabor 2019).

Since implementation of ICT in education-related policies rests with state and local governments, it is also up to each state to provide ongoing training and support to its teachers to integrate ICT into their teaching. The table below lists state programs and the number of teachers trained.

Exhibit 29. ICT teacher training programs

STATE	PARTNER	PROGRAM NAME AND TRAINING PROVIDED	NUMBER OF TEACHERS TRAINED
Benue		Training for digital literacy skills and ICT knowledge in order to effectively use the Benue e-Learning/Virtual Education ICT Resources Center	Target number to train – 22,000 teachers and lecturers in public schools
Edo	World Bank (technical and funding support of US$75 million, about N 31billion, over four years)	EdoBEST – 10-day intensive teacher professional development training to help them use digital technology in delivering impactful lessons.	2,000 primary and secondary teachers for 2022
Lagos	Microsoft represented by ATB Techsoft Solutions	Work From Home, Remote Teaching and Learning for Lagos State Secondary School Teachers	18,000 secondary school teachers
Ogun	Google	Training for Computer Science teachers	1,500 secondary school teachers
	Bureau of Information Technology, Data Science Nigeria, Lead Resources, Computer Association of Nigeria, Nigeria Computer Society	Training in AI and Python Programming	2,000 secondary school teachers
Ondo	1Million Teachers	Training on tools of collaborations and communication for online learning.	2,000 primary and secondary school teachers

SENEGAL

ICT FOR EDUCATION POLICIES, PLANS, AND PROGRAMS

The **Plan for Emerging Senegal (PES)** is the new policy framework of President Macky Sall's government. It details Senegal's medium and long-term strategies to accelerate its economic and social development by 2035 (Senegal government 2022). The PES was the basis for the development of **Digital Senegal 2025 (Sénégal Numérique 2025)**, which embodies Senegal's ambition to be an innovative leader in the digital field in Africa. It aims to have the digital industry make up 10 percent of

Senegal's GDP by 2025 and create 54,000 direct and 162,000 indirect jobs. The plan also includes creating laws to lift restrictions for new market entries of Internet providers and strengthening regulations for essential infrastructure sharing among industry operators (Muller 2018). More importantly, one of its priorities is to promote innovative uses of digital technology in priority economic sectors by improving education and training (Senegal Numérique 2016–2025). Below are some of Digital Senegal 2025's targets.

Exhibit 30. Select Digital Senegal 2025 targets

INDICATOR	AS OF 2015	2025
Internet access	1 out 10 households	5 out of 10 households
Mobile broadband teledensity[24]	.54	.9

While Senegal does not have an ICT in education policy, EdTech is a key strategic priority for the Ministry of Education (Ministère de l'Education Nationale [MEN]) and features in the **2018–2030 Program for the Improvement of Quality, Equity and Transparency – Education/Training (Programme d'amélioration de la qualité, de l'équité et de la transparence – Education/Formation [PAQUET-EF]**) (Upadhyay 2020). According to the education sector plan, the government aims to use ICT to improve equitable access, the quality of teaching and learning, and sector governance (Upadhyay 2020). The three strategic EdTech objectives are:

- Build the capacity of all education personnel by (1) training them in the use of ICT and digital education resources; (2) promoting new training tools such as e-learning systems, distance learning tutorials, tablets, functional interactive whiteboards, and virtual classes
- Improve the learning environment in schools and universities through ICT
- Improve resource management through ICT

Given the promising results of distance education put in place to allow students to continue their education when schools were closed because of COVID-19, the Minister of Education also announced that the Ministry plans to build on its achievements by establishing a project for the development of distance learning. In addition, the Minister also plans to provide ICT training for teachers, principals, and school directors (Diouf 2020).

SPENDING ALLOCATIONS FOR ICT

For 2021–2025, Senegal has committed to allocate more than 20 percent of its national budget to education. At the World Education Summit organized by the Global Partnership for Education (GPE) in London in July 2021, the Minister of Education, Mamadou Talla, indicated that for 2021, 24.2 percent of the national budget was allocated to education, higher than the 20 percent recommended minimum set by the international community (Seneweb News 2021). The 2021 budget includes the creation of national integrated high schools that emphasize science and technology education (Faye 2021).

[24] Teledensity refers to the number of main telephone lines per 100 inhabitants within a geographical area. Effective teledensity reports fixed-line teledensity or mobile density—whichever is higher—in a particular geographical region (ITU, n.d.).

In addition, a 2018 World Bank-financed budget of US$41.1 million was allocated for the implementation of a national program to develop middle school sciences and mathematics teaching. This program included funding for a pilot to introduce technology-based mathematics and science teaching methods in 230 secondary and primary schools.[25] This and other ICT initiatives in Senegal have been welcomed by the government. Support and integration of technology into schools has generally been done on a small and ad hoc basis (World Bank 2018).

TECHNOLOGY INFRASTRUCTURE

ELECTRICITY

SENELEC is in charge of producing, transporting, distributing, and commercializing electricity throughout Senegal. The Government of Senegal is the majority shareholder with 90.58 percent of shares. SENELEC also works closely with the Ministry of Petroleum and Energy, which ensures the regulation and control of the power sector to make it both efficient and economically viable (Artacho 2021). The government passed a pair of bills in June 2021 to break SENELEC's monopoly, grant private firms access to power transmission and distribution networks, and create an independent regulator (Felix 2021). These reforms helped unlock a five-year grant of 331.7B CFA (USD$550 million) from the United States that will help build high-voltage power transmission lines and substations to boost access to electricity (Felix 2021).

A decade ago, Senegal suffered from severe power outages that crippled businesses and contributed to violent riots. Since then, it has made improvements to energy access and power reliability (The Conversation 2018). Senegal relies mostly on diesel-run power plants to produce its electricity. In recent years, it has made significant progress in developing renewable energy projects. Renewable energy sources now make up about 30 percent of the electricity the country produces. Senegal plans to continue developing clean energy sources to have a well-balanced and environmentally sustainable energy mix (Artacho 2021).

In 2019, 70.4 percent of Senegal's population had access to electricity; 95.2 percent of its urban population had access, but only 47.8 percent of its rural population did (World Bank 2019). Over half of Senegal's total population live in rural areas (51.9 percent in 2020) (World Bank 2020), which means more than a quarter of Senegal's population still lacks access to electricity. To achieve universal electrification, which is a prerequisite for digital learning to reach all learners, the government plans to raise the rural electrification rate to 79.2 percent by 2023 through state investments and the implementation of the Second Millennium Challenge Compact (Senegal Budget 2021).

The cost of electricity for households in Senegal, CFA 103.25 (US$0.174) per kWh, is above the world average of CFA 80.487 (US$0.136) per kWh (Global Petrol Prices 2021).

INTERNET NETWORKS

The Internet can be accessed via fixed broadband or the mobile broadband network. With 54 percent of the market share, Orange-Sonatel dominates the fixed and mobile markets in Senegal. Other major providers are Expresso (22 percent) and Tigo (24 percent) (ITA 2020). Orange-Sonatel was also the

[25] 100 lower secondary school, 30 upper secondary schools, and 100 primary schools.

first provider of 4G technologies and was the only 4G provider until 2018–2019. Recently, Orange, together with Sonatel, its Senegal subsidiary, and SES (Société Européenne des Satellites) will deploy and manage the first O3b mPOWER26 gateway in Africa. This new technology will allow Senegal and the whole African continent to enjoy easy access to high performing, faster connectivity services that can reach remote areas (Orange 2022).

Guided by the vision outlined in Digital Senegal 2025, Senegal experienced a more rapid expansion in digital technologies over the past decade than its peers, such as Côte d'Ivoire, Kenya, and Rwanda (ARTP 2019 in Masaki et al. 2020).

FIXED BROADBAND

In 2020, fixed broadband subscriptions for Senegal were 177,363, about 1.06 percent of the total population (World Bank 2020). The average monthly cost of fixed broadband with 5 GB of data in Senegal is CFA 32,964 (US$55.17) when adjusted for purchasing power parity. This cost is higher than the world median of CFA 25,932 (US$43.40) (ITU 2020). Fixed broadband subscriptions have been steadily increasing since 2016 at an average of about 16 percent per year (author's calculation based on World Bank data 2020). The average download speed for fixed broadband is 19.95 Mbps (Speedtest February 2022), which is still low compared to South Africa, which has the highest download speed within the African region at 32.26 Mbps (Speedtest February 2022).

MOBILE BROADBAND NETWORK

In Senegal, as in other African countries, mobile broadband is the dominant channel through which people access the Internet. Of the 39.5 percent of Senegal's population that uses the Internet (World Bank 2019), a recent estimate suggests that 98.7 percent access it through mobile phones (ARTP 2019 in Masaki et al. 2020).

As of 2020, 99 percent of Senegal's population was covered by at least a 3G network and 75 percent was covered by at least a 4G network (ITU 2020). Having 3G or 4G coverage enables access to high-speed Internet through mobile phones, while 2G coverage only allows very limited Internet browsing and application use (Masaki et al. 2020). Although mobile broadband network coverage has increased, this has not translated to a comparable increase in mobile Internet usage. There are no country-specific data for Senegal, but for West Africa, the coverage/usage gap for 2019 was 46 percent (Wyrzykowski 2020).[27] In a survey of low- and middle-income countries (LMICs) in 2019, lack of awareness of mobile Internet was a key barrier for further adoption; almost 25 percent of adults were not aware of the presence of mobile Internet. However, for those already aware of it, the biggest barrier to adoption was lack of literacy and digital skills, followed by affordability and perceived relevance (Wyrzykowski 2020).

Below are targets set by Digital Senegal 2025 to promote the accessibility of its telecommunications and ICT services and the current situation related to these services in Senegal.

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[26] Explanation of O3b mPOWER

[27] Usage gap refers to the percentage of the population that lives in areas with mobile broadband network but does not connect to mobile internet (GSMA 2021).

Exhibit 31. Senegal ICT targets and current situation

DIGITAL SENEGAL 2025 TARGETS	CURRENT SITUATION
Set minimum broadband Internet speed of 2 Mbps for 3G and 30 Mbps for 4G	16.97 Mbps: mobile download median speed 8.43 Mbps: mobile upload median speed as of February 2022 (Speedtest 2022)
Provide access to online services to 100 percent of urban and rural communities Reach a ratio of 5 out of 10 households with Internet access at home by 2025	15 percent of urban households have Internet at home 3.1 percent of rural households have Internet at home (Percentage is based on survey of 4,538 households) (DHS 2019)
Ensure 70 percent 4G network coverage within the next five years and increase 4G network coverage to 90 percent by 2025	75 percent is covered by at least a 4G network (ITU 2020)
Halve the fees for fixed and mobile broadband within three years	CFA 4,858 (USD$8.13)[28] for 1.5 GB of data for mobile broadband which is lower than the median global download cost of CFA 11,054 (USD$18.5) (ITU 2020) Senegal is ranked 99 out of 155 countries in terms of cost of mobile data (Rank 1, India, has the cheapest cost for 1 GB of data at 54.28 CFA [US$0.09]) (Ang 2020). That said, between 2019 and 2020, prices for mobile data (500 Mb minimum monthly allowances) fell by 66 percent or more in Senegal (ITU 2020).

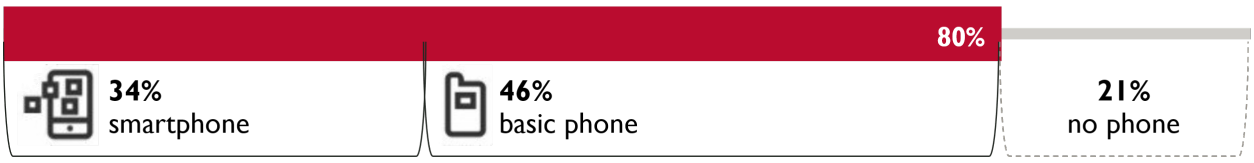
TEHNOLOGY DEVICE ACCESS

MOBILE PHONE OWNERSHIP

Ninety-seven percent of households own a mobile phone (DHS 2019).[29] Smartphone ownership is increasing across much of the developing world, including Senegal. In fact, 34 percent of Senegalese adults owned a smartphone in 2018, up from just 13 percent in 2013 (Pew Research 2018).

The price of devices remains one of the biggest barriers to smartphone adoption in Africa. The average cost of an entry-level smartphone in Africa still exceeds 60 percent of the average monthly income (Messo 2020). To address this issue, Orange, in partnership with Google, launched an exclusive smartphone that retails at around 18,000 CFA (US$30), making it the most affordable 4G Android device on the market. It includes an application that allows buyers to pay for their smartphone in installments (Orange Press Release 2020).

Exhibit 32. Percentage of adults by type of phone owned in Senegal (2018)



[28] Cost quoted for 1.5GB data is corrected for differences in purchasing power parity (ITU 2020).
[29] Total interviewed household is at 4,583 (DHS 2019).

COMPUTER, LAPTOP, AND TABLET OWNERSHIP

Only 13.6 percent of households from a representative sample of 4,583 households have a computer. The difference in ownership in rural and urban households is stark, with 4 percent of rural households and 22.9 percent of urban households having a computer (DHS 2019).

EQUITABLE ACCESS TO DIGITAL TECHNOLOGY DEVICES AND INFRASTRUCTURE

Equitable access to technology infrastructure and digital devices (e.g., mobile phone or a computer) is crucial for digital learning to reach all students, especially the most disadvantaged and marginalized. The learning crisis brought about by the COVID-19 pandemic highlighted problems related to geographic, gender, and economic divides.

A. GEOGRAPHIC DIVIDES

Mobile adoption has grown rapidly in West Africa in recent years because of the expansion of mobile networks to underserved communities and the increasing affordability of services and devices. In 2019, 99.2 percent of urban households and 94.8 percent of rural households reported owning a mobile phone (DHS 2019). Despite this increased equity in mobile phone ownership, a gap in rural-urban mobile Internet usage persists (GSMA 2018).[30] Globally, people in urban areas are twice as likely to use the Internet than those in rural areas (ITU 2021). In Africa, the gap is greater: 50 percent of urban dwellers are online, compared with just 15 percent of the rural population (ITU 2021). Senegal's data reflect a similar rural-urban gap.

- 49 percent of urban dwellers are connected to the Internet compared to just 17 percent of rural dwellers (Rodriguez-Castelan et al. 2021).
- 15 percent of urban households in Senegal have Internet at home compared to just 3 percent of rural households (DHS 2019).
- 64.7 percent of urban women compared to just 32.6 percent of rural women use the Internet (DHS 2019). Among rural and urban women, the rural-urban gap is almost 50 percent (author's own calculation using GSMA's rural-urban gap formula).
- 80.3 percent of urban men compared to just 38.1 percent of rural men use the Internet (DHS 2019). Among rural and urban men, the rural-urban gap is almost 53 percent (author's own calculation using GSMA's rural-urban gap formula).

B. GENDER DIVIDES

The gender gap is the difference between how many men and how many women are mobile phone owners or mobile Internet users, as a proportion of how many men are mobile phone owners or

[30] Rural-urban gap is calculated using the following formula: (GSMA, 2021) (% of urban users) - (% of rural users) / (% of urban users)

mobile Internet users.[31] The lower the percentage of women, the larger the gender gap (Iglesias 2020). Like most countries in the world, Senegal's gender gap in mobile phone ownership is smaller than the gender gap in mobile Internet use (Amorighoye 2020). That said, Senegal's government focus on attracting private-sector investment to expand access to services and its promotion of digital inclusion of women as part of its digital strategy has created an enabling environment that supports closing the gender digital divide (Chemonics 2020).[32] Aside from increasing mobile network coverage in rural and peri-urban areas, healthy competition among service providers has also reduced ICT costs and services, resulting in more women buying mobile phones (Chemonics 2020). The gender gap in mobile phone ownership is therefore only at 4 percent in Senegal (GSMA 2020). While Senegal is making considerable progress in closing the gender digital divide, more needs to be done to eliminate it entirely (USAID 2020). Below are additional data on the gender divide in Senegal:

- 68 percent of male smartphone owners purchased their own device, while only 26 percent of women smartphone owners purchased their own device (GSMA 2020).
- 58.3 percent of men use the Internet compared to 46.7 percent of women (DHS 2019), which results in a gender gap of about 20 percent (DHS 2019 and GSMA 2020).
- Women in urban areas are 11 percent less likely than men to use mobile Internet, and in rural areas, women are 32 percent less likely than men to use mobile Internet (GSMA 2020).
- Among Internet users, 64.7 percent of urban women compared to just 32.6 percent of rural women use the Internet, and 80.3 percent of urban men compared to 38.1 percent of rural men use the Internet (DHS 2019).
- 36 percent of sampled women in Senegal cited reading and writing as the main barrier to mobile Internet access, compared to only 12 percent of sampled men (GSMA 2020).

Exhibit 33. Mobile device ownership and mobile Internet use by gender in Senegal (2019)

Exhibit 34. Share of smartphone owners in Senegal who purchased their own device by gender (2019)

[31] Gender gap is calculated using the following formula: (GSMA, 2021) (Male owners/users (% of male population) - Female owners/users (% of female population)) / ((Male owners/users (% of male population))

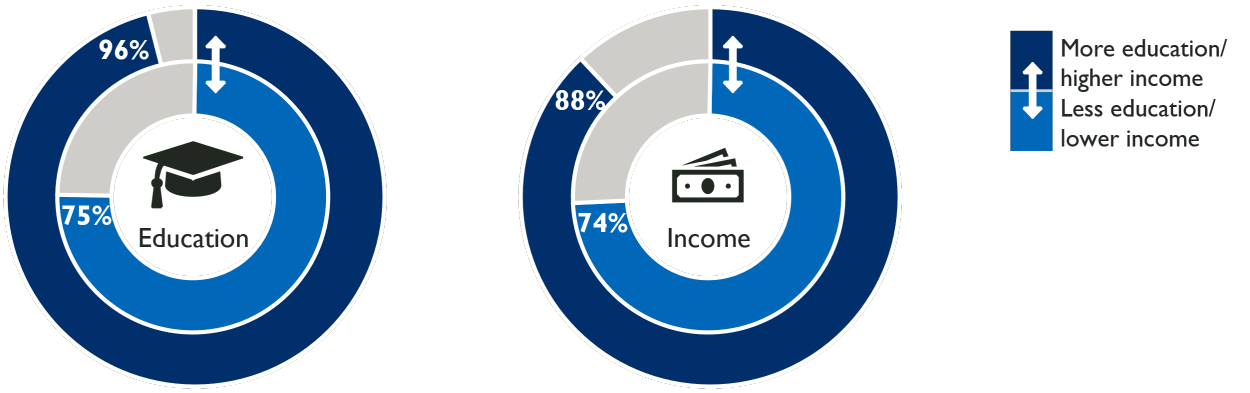
[32] Senegal's strategy has resulted in investments in projects to increase women's access to ICT and promote employment opportunities and emphasize women's digital entrepreneurship through increased access to e-commerce. For instance, the strategy plans to reach 33 percent of rural women with e-commerce skills training by 2025 and subsidize broadband access to underserved areas (USAID 2022).

C. ECONOMIC DIVIDES

Mobile phone ownership in Senegal is higher among people with more education and higher income.

- 95 percent of people with more education compared to just 75 percent of people with less education own a mobile phone (Pew Research 2018).[33]
- 88 percent of people with higher income compared to just 74 percent of people with lower income own a mobile phone (Pew Research 2018).

Exhibit 35. Mobile phone ownership by education and income



A study that examined the relationship between access to broadband Internet and household welfare in Senegal between 2011 and 2018 found that (Masaki et al. 2020):

- 3G coverage is associated with a 10 percent decline in extreme poverty. The study also showed some evidence of the causal mechanism through which mobile broadband coverage affects labor outcomes and yields welfare gains.
- Mobile broadband coverage is positively associated with the level of household consumption.
- The welfare effect of 3G coverage is evident in both urban and rural areas (though its magnitude appears to be larger in urban areas), and particularly among young male-headed households.

D. ACCESS FOR PEOPLE WITH DISABILITIES

According to official records, people with disabilities represent 5.9 percent of the Senegalese population (UNHR 2019). However, this number may be higher since there is little quantitative data on incidence of disability among children in Senegal (Malinick and Diop 2020). Senegal adopted the Social Orientation Act for the promotion and protection of people with disabilities after the ratification of the Convention on the Rights of Persons with Disabilities in 2009 (UNHR 2019). In the updated action plan for Digital Senegal 2025, there is provision for promoting digital inclusion with a budget of 700M CFA (US$1.16

[33] The lower or less education category is below secondary education and the higher or more education category is secondary or above.

million) wherein the following steps will be taken to help people with disabilities develop ICT micro-enterprises by 2024:

- Analyze capacity-strengthening needs
- Strengthen the capacities of people with disabilities
- Provide support in setting up micro-enterprises
- Provide computer equipment

Senegal adopted a disability measurement instrument aligned with international standards in 2016 for the assessment and granting of an Equal Opportunities Card that gives people with disabilities access to free or subsidized health, education, transport, and finance services (UNHR 2019). At present, there is no mention of ICT-related support for people with disabilities who have an Equal Opportunities Card.

TECHNOLOGY DEVICE AND SOFTWARE ACCESS IN LEARNING INSTITUTIONS

Like other low- and middle-income countries, Senegal closed schools from March to September 2020 in response to the pandemic and faced a number of challenges in ensuring continuity of teaching and learning for its children and youth throughout this period. Given that less than 20 percent of Senegal's students can access online resources because of lack of hardware, software, and Internet connection, the Ministry of Education has relied heavily on radio and television to reach those who do not have access to digital resources (Diawara and Tidiane 2020).

As mentioned earlier, one of Digital Senegal 2025's priorities is to promote innovative uses of digital technology improving education and training (Sénégal Numérique 2016–2025). To make that happen, it has set the following targets for the education sector:

Exhibit 36. Digital Senegal 2025 targets

INDICATOR	2025
Pupils and students equipped with computers and connected to the Internet	100 percent
Schools equipped with computers and connected to the Internet	100 percent

In its updated action plan for Digital Senegal 2025, the government prioritized strengthening of ICT training through the introduction of digital technology into the primary and secondary curriculum and the integration of digital technology in the education system and training (Digital Senegal 2025). The government allotted 50B CFA (US$83 million) to introduce and integrate digital technology into the primary and secondary curriculum and plans to take the following steps by 2023:

- Design training curricula
- Train the teaching staff
- Adapt the digital infrastructure in schools (Internet, computers, etc.)

- Conduct a pilot project
- Deploy and implement the curriculum

It also allotted 20 billion CFA (USD$33.3 million) to integrate digital technology into its education system and training by taking the following steps in 2022:

- Develop and implement a roadmap
- Integrate technology into initial teacher training
- Put in place adequate infrastructure (provide Internet connection and equip schools with the necessary hardware)
- Develop and integrate digital educational content
- Introduce the teaching of computer science from elementary school onwards
- Train users
- Communicate and raise awareness

A key part of Digital Senegal 2025 is improving and reforming the education system at all levels, especially the tertiary level. To strengthen tertiary education, to meet the growing demands of a technology and knowledge-based economy, and reduce overcrowding in public universities, Senegal established the Virtual University of Senegal (Université Virtuelle du Sénégal [UVS]) in 2013 through a presidential decree. To date, it has more than 60,000 students, more than 400 associate teachers, and 38 permanent teachers. It offers a variety of undergraduate and graduate courses, such as English, Legal Sciences, Economic and Social Administration, Robotics, Artificial Intelligence, and Software Engineering (Cissé 2019). UVS reaches all 14 regional capitals of the country through the Open Digital Spaces (Espaces Numériques Ouverts [ENO]). The centers are equipped with the latest hardware that connects to the Internet that UVS students can use to access digital resources and productivity software. UVS students are given the flexibility to take classes from home or at the ENO with other students. Interestingly, ENOs also enable the use of telemedicine for communities in remote regions. There are currently 17 ENOs (Cissé 2019) and the goal is to establish a total of 50 (ITU 2019).

GOVERNMENTAL PROGRAMS

On June 17, 2020, Senegal received COVID-19 accelerated funds of almost 4.2B CFA ($7 million) from GPE to support the national COVID-19 response based on the national response plan. Agence Française de Developpement (AFD) is the grant agent for the COVID-19 GPE grant. Below are other government-initiated programs:

Exhibit 37. Government-initiated EdTech programs

PROGRAM NAME	FUNDER/ IMPLEMENTER	DETAILS	TARGET AND REACH
Learn at Home	Ministry of Education	The government's main initiative to support learning from home, which includes an online portal that currently houses downloadable teaching and learning print materials to support distance learning (Upadhyay 2020).	Teachers and students at all levels of education and parents

PROGRAM NAME	FUNDER/ IMPLEMENTER	DETAILS	TARGET AND REACH
Mirador	Ministry of Education	A centralized request system used by human resources departments that classifies and allocates new positions for teachers.	Teachers from all levels
Planète	Ministry of Education	A distance learning platform that was developed several years ago but not deployed at the national level. Teachers and school directors are given online accounts to access resources they can use for interactive teacher-student distance learning.	14,500 teachers and school directors
Quality Improvement and Equity of Basic Education Project	Ministry of Education, funded by the World Bank	Large basic education project that includes ICT components to improve mathematics and science. Activities include teacher training on ICT use, integration of ICT in the classroom for improved teaching and learning, and support for ICT-rich classrooms and schools (Upadhyay 2020).	Primary, lower secondary, and upper secondary school students and teachers Reach: 230 pilot schools: 100 lower secondary schools, 30 upper secondary schools, and 100 primary schools
Senprof	Ministry of Education	An online portal with digital education resources for teachers (Upadhyay 2020).	Teachers from all levels

NONGOVERNMENTAL PROGRAMS

The COVID-19 pandemic forced schools to close, and many children were unable to continue their education (UNICEF 2021). Like other countries worldwide, Senegal, with help from the private sector and nongovernmental organizations, took actions to provide distance learning. Below are programs implemented by the private sector or nongovernmental organizations:

Exhibit 38. Nongovernmental sector EdTech programs

PROGRAM NAME	FUNDER/ IMPLEMENTER	DETAILS	TARGET AND REACH
Lecture Pour Tous	USAID (funder) Chemonics International (implementer)	An early-grade reading program that piloted a self-guided distance professional development program for teachers, coaches, and school inspectors (Chemonics website n.d.). (Program ended in December 2021.)	91 teachers, *daaras*,[34] and coaches (Chemonics 2020)
Mastercard Foundation COVID-19 Recovery and Resilience Program	Mastercard Foundation (funder) UNICEF (partner)	A US$5 million program that supports the Senegalese government's response to the COVID-19 pandemic and efforts to build back better for children and young people. It includes providing technical support to the Ministry of	All children

[34] Traditional Quranic schools

PROGRAM NAME	FUNDER/ IMPLEMENTER	DETAILS	TARGET AND REACH
		Education for the development of a national e-learning strategy (UNICEF 2020).	
Orange Digital Center in Dakar	Orange	The center brings together several of Orange's programs under one roof, including a coding school, a Solidarity FabLab, Sonatel Academy, and Orange Digital Ventures Africa (Orange's investment fund). All of the programs provided are free of charge and include digital skills training for young people, startup acceleration, and investment (Orange Foundation n.d.).	In-school and out-of-school youth
Paradigm Initiative	Internet Society Foundation (funder)	A program that equips young people living in under-served communities with demand-driven digital literacy and entrepreneurship skills and connects them to internships, online work, or entrepreneurial ventures (Internet Society Foundation website 2020).	
Senegal DigiSchool	Huawei (funder)	Huawei worked with the Ministry of Education to build smart classrooms in selected schools in Dakar and provide an interactive multimedia-based learning experience (Huawei 2021).	At the end of 2020, more than 200 teachers were trained; 60 schools and 15,000 students benefited from this program (Huawei 2021)
Simplon in Senegal (Sonatel Academy and Simplon Kids program)	Simplon in partnership with Orange	Established in 2017, the Sonatel Academy trains students in web-based professions (e.g., digital expert, developer, web integrator). Simplon Kids help children become digitally literate.	385 people trained (Internet Society Foundation)
	Synergy Association for Digital and Media Education (Synergie pour l'Education aux Numériques et aux Médias [SENUM])	Organizes awareness and training sessions on media and information literacy for students and teachers (Acacile 2021).	For 2021, the target is 30 primary and middle-secondary teachers and 50 students from Dakar region.
Women's Digital Centre	Orange Foundation	A training program for young women on using digital tools for project management, entrepreneurship, and personal development (Orange Foundation 2018)	Young women aged 16–25

PRIVATE SECTOR-DEVELOPED SOFTWARE AND PLATFORMS

Senegal's experience in successfully implementing the Virtual University of Senegal and its commitment to use technology to drive social and economic development has made it a conducive environment for EdTech companies to develop. In fact, one of the key objectives of Digital Senegal 2025 is to implement the "Startup Senegal" project to incubate and support 100 companies each year. Below is a list of Senegal-based companies that develop software and platforms.

Exhibit 39. Senegal-based EdTech companies

COMPANY/ INSTITUTION NAME	NAME OF SOFTWARE OR PLATFORM	DETAILS	TARGET USERS
Agence Universitaire de la Francophonie (a global network of Francophone higher education and research institutions)	AUF Digital Library	The AUF has developed several online platforms for teachers, researchers, and students to promote content and to help develop training courses, especially for developing countries. These platforms are regrouped in a global initiative called IDNEUF and include a global library of resources, an atlas of experts, a catalogue of online courses and massive open online courses (MOOCs), and a platform to help higher education institutions develop and share good practices.	Teachers, researchers and students in higher education
Apprendre and France Education International	Apprendre-EV@LANG	A mobile application specially designed for teachers. The software's positioning test will help users understand their level of French.	All teachers
Galactis.Education		A comprehensive school management software that supports a school's administrative, financial, and academic needs.	K–12 and higher education institutions
Google and Microsoft with the Ministry of Education	Education.sn (messaging and apps feature in the upper righthand corner of the web page)	Ministry of Education website that links to Google and Microsoft programs and apps.	All students and teachers
Miracle Software		A school management software that addresses the needs of primary, middle, high school, and university teachers and students.	All students and teachers
Orange Middle East and Africa	Orange Campus Africa	Orange developed and launched an online training platform in partnership with Virtual University of Senegal (UVS). The platform enables universities to monitor their students online and supplement training with virtual classes.	African universities
Sissokho Systems	School'Gest	Sissokho Systems is a Senegalese software publisher that develops management software for schools and training institutes in different cities of Senegal.	Teachers and students
Tutoo+		A Côte d'Ivoire start-up that is also launching in Senegal. It is an online platform that offers courses at a lower cost and uses a job matching algorithm to connect its students with potential employers.	High school to university students and young professionals.

TECHNOLOGICAL AND PEDAGOGICAL KNOWLEDGE OF TEACHERS

In Senegal, the rapid growth in the number of school-age children and youth in the last 25 years put great stress on the country's teacher training capacity, which resulted in the recruitment of new teachers with a junior secondary diploma who are trained for just a few weeks (Adotevi and Taylor 2019). It was only in 2010 that the Directorate of Training and Communication (at the central level) and the Regional Centers for the Training of Educational Personnel were established to address the problem of providing teachers with adequate pre-service teacher education and in-service training or continuing professional development (Niang 2017 in Adotevi and Taylor 2019). According to a case study on Senegal's Secondary Teacher Preparation Deployment and Support, there is a general perception, supported by evidence, that prospective teachers have poor academic subject knowledge and that many teachers, particularly in mathematics and science, could not pass high school examinations (Adotevi and Taylor 2019).[35]

A solid understanding of the subject content, coupled with strong technological and pedagogical knowledge, is crucial for teachers to effectively integrate technology into their teaching. Education technology is a complex intervention that requires training teachers to use, design for, and teach through and with a variety of technologies, and to have the skills to change dominant instructional paradigms (e.g., teacher-centered versus student-centered instruction)[36] to maximize the benefits of technology for teaching and learning (Burns 2021). More importantly, training and support for teachers need to be continuous and ongoing because of rapid changes in existing technologies and development of new technologies (Burns 2021).

Donors such as USAID, the World Bank, and AFD are supporting several education programs that use ICT for continuous teacher professional development and help teachers integrate ICT in classrooms to improve learning. For its Lecture Pour Tous project, USAID worked with the Department for Elementary Education (Direction de l'Enseignement Elémentaire [DEE]) and the Training and Communication Department (Direction de la Formation de la Communication [DFC]) to develop and pilot a self-guided distance learning approach to teacher training. Primary school teachers from a small sample of schools, as well as *daara* monitors,[37] school directors, and coaches, were provided with self-guided modules that consisted of individual learning exercises coupled with virtual interaction among teachers via WhatsApp and feedback provided by coaches involved in in-service teacher training (USAID 2020). An evaluation of this pilot for primary school teachers found that (USAID 2020):

- A high percentage of teachers were able to access the material.
- The teachers understood the content and appreciated opportunities to engage with peers via WhatsApp and interact with their coaches by text and phone.

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[35] The case study was conducted for the Mastercard Foundation report, *Secondary Education in Africa: Preparing Youth for the Future of Work*. Data was derived from academic and other literature, as well as interviews with key role players in the field of teacher education (i.e., government officials, teacher educators, and teacher unions).

[36] Teacher-centered instruction is usually whole group teaching and direct instruction wherein the teacher transmits knowledge about concepts, skills, and procedures via demonstrations, lectures, screencasts, or online presentation to students as one large group (Burns 2021). Student-centered instruction allows students to control the pace of their learning and adopts a more social approach to learning. It attempts to make learning more adaptive and individualized (Burns 2021).

[37] Instructors at traditional Quranic schools.

- Teachers found it challenging to read the material in PDF format on smartphones and they had difficulty accessing content because of weak Internet in some locations.

Some of the lessons learned from the USAID pilot were (USAID 2020):

- Distance continuous professional development is feasible to implement with certain conditions in place (e.g., use of WhatsApp to distribute content with the option of providing hard copies to schools that do not have access).
- Content can be improved to make it easier for everyone to learn (e.g., providing audio files as an alternative to printed text).
- Peer interaction is highly valued and can be facilitated through WhatsApp.
- Coaching is an essential element of distance continuous professional development.
- Ongoing monitoring, evaluation, and research is necessary.
- System-wide support and motivation (financial or non-financial) for participation is essential for success.

As part of its COVID-19 response, Senegal was granted CFA 4.2B (US$7 million) by AFD to support a number of interventions including training of 14,500 public elementary and middle school teachers in the use of distance learning methods (PADES-RR program document 2020).

A UNESCO pilot project that sought to strengthen teaching and learning in mathematics through the use of services accessible from mobile phones provides insights into teachers' technological and pedagogical knowledge. The study found that:

- Two-thirds of the participating teachers owned a basic mobile phone.
- Almost 20 percent owned a smartphone.
- About one in three owned a laptop and one in five had a personal computer.
- Almost half of the teachers (44 percent) accessed the Internet, usually from home.
- Teacher skills levels in using ICT and mobile phones increased significantly as a result of the project, with the biggest increase seen in teachers accessing the Internet from mobile phones.
- However, actual use of the target educational app with students was quite low, which likely reflects difficulties teachers had in getting acquainted with the application.[38]
- Although teachers reported improvements in their teaching, they also found their training insufficient.
- Participating teachers also felt less positive about the project at its conclusion. One possible reason for this was that they had to take on the additional task of developing high-quality online materials on top of their regular workload (UNESCO 2017).

The above examples show that ICT integration in schools needs to be carefully planned and complemented with improved pedagogy and training for teachers.

[38] The target educational app is called MoMath. It is a free, browser-based mobile application that can be accessed from any mobile phone with a data connection or any computer with Internet connection (UNESCO 2017).

GENERAL CONCLUSIONS

- All governments reviewed had some form of ICT policy. Kenya and Nigeria have specific policies and plans on ICT in education, but Senegal does not.
- Kenya is the only country that sets a specific yearly budget for its ICT in education initiatives (e.g., Digital Literacy Program for primary levels and ICT-related initiatives for secondary levels).
- Countries have made great strides in expanding electrification in recent years but rural households and poorer areas lag behind urban and better off areas. All three countries have taken steps to open up their power industry through privatization and diversification of their power sources (e.g., solar technology and geothermal power).
- Reliability of electricity remains an issue in all three countries. Power outages is an ongoing problem, especially in Nigeria. Nigeria has the longest hours (6–8) of no power per day.
- Cost of electricity per kWh in Kenya and Senegal is high compared to the world average. While Nigeria may have a slightly lower per kWh cost compared to the world average, its long hours of power outages and Nigerians' reliance on diesel generators result in higher electricity costs for households and businesses.
- In all three countries, the Internet can be accessed via fixed broadband or the mobile broadband network with the majority of users using mobile broadband network to access the Internet.
- While 3G and 4G network access and coverage has increased in the last few years, adoption and use of mobile Internet has not kept pace even though the average download cost of 1.5 GB of data in all three countries is lower than the median global download cost. Given the growing income inequality in all three countries, the current cost of data remains unaffordable to the majority who make less than the national average income.
- Over the past two decades, China has become a major developer and investor in Africa's telecommunications industry. Huawei has built about 50 percent of Africa's 3G networks and 70 percent of its 4G networks (Xi 2021). Most of Kenya's national fiber optic network was built by Chinese companies, ZTE and Huawei. Kenya also signed a deal in 2019 with Huawei for a data center, a smart city, and a surveillance project. While Senegal's telecommunications industry is dominated by Sonatel, a Senegalese subsidiary of the French multinational company, Orange, Senegal's national data center in Dakar was built by Huawei (Xi 2021). Both Senegal and Nigeria use devices produced by Huawei manufactured middleboxes within its Internet infrastructure that forward, read, and filter data (Ehl 2022). Thus, to work in tech within these countries, it is imperative to find ways to work with the existing technology infrastructure.
- Clear digital divides exist in gender, geography, education levels, income levels, and disability status. The gender gap in mobile phone ownership is smaller than the gender gap in mobile Internet use across all three countries. While the gender gap in phone ownership has steadily decreased in the last few years, COVID-19 and the economic challenges it brought may affect and increase the gap in the foreseeable future. Mobile phone ownership is higher among people with more education and higher income. There is a disability gap in mobile phone ownership between people with and without disabilities. Interestingly, in Kenya, where an in-depth study of the disability gap was conducted, persons with disabilities use mobile Internet with similar frequency to non-disabled persons, and among smartphone users, persons with disabilities have a higher daily mobile Internet usage.

- There are existing government, non-government, and private company initiatives on education technology. All three countries have a number of innovative indigenous EdTech companies.
- Teachers across all three countries not only need training in basic digital literacy skills and online safety skills but also ongoing technological and pedagogical support and training to better integrate technology into their teaching.

NOTE: Any training on digital literacy for teachers must include strategies and tools on how to best guide their students in developing critical thinking and specific skills to protect themselves from cyber-attacks, predators, bullying, and misinformation (UNICEF 2021).

RECOMMENDATIONS

1. Work with relevant ministries to understand how to build on and support government initiatives and investments that are already specified in each country's EdTech or ICT policies.
2. Understand where decision-making on ICT for education policy, support, and implementation lies to better design and implement demand-driven projects and programs. For example, in Kenya, the national government drives and implements the ICT for education programs. That is different from Nigeria, where the state and local governments decide and implement the ICT policies set by the federal government.
3. Partner with key stakeholders (e.g., government ministries, power and telecommunications companies) and study financing, maintenance, and sustainability of alternative power sources and network coverage for remote areas to develop sustainable strategies that can increase demand and know-how among users. Addressing the affordability issue of services is a good first step.
4. Find ways to work with or build on existing technology network infrastructure.
5. Support efforts to evaluate existing programs for effectiveness and document lessons learned since there have been limited to no systematic, ongoing, or in-depth monitoring of EdTech programs.
6. Build on or extend existing government or non-government programs that have proven reach and efficacy to serve the most marginalized students.
7. Engage with indigenous private EdTech companies to build on and support in-country expertise.
8. Support effective local private EdTech companies to make their products and services more accessible and affordable to a larger number of schools, teachers, and students including the most marginalized and underserved.
9. Work with key stakeholders to study, define, and set standards and to measure digital literacy skills of target populations. Setting digital literacy standards can help guide the government and other organizations in designing training and support accordingly.
10. Invest in pre-service and ongoing in-service training and materials that strengthen digital literacy skills (including digital safety) of school administrators and educators.
11. Incentivize teacher adoption of ICT in their teaching. It is important to acknowledge that teachers will need additional planning and prep time to integrate technology into their teaching and they should therefore be compensated accordingly.
12. Develop materials that can strengthen digital literacy skills among education support staff, parents, caregivers, and students. Digital literacy and digital safety are requisite skills as more and more people go online.

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