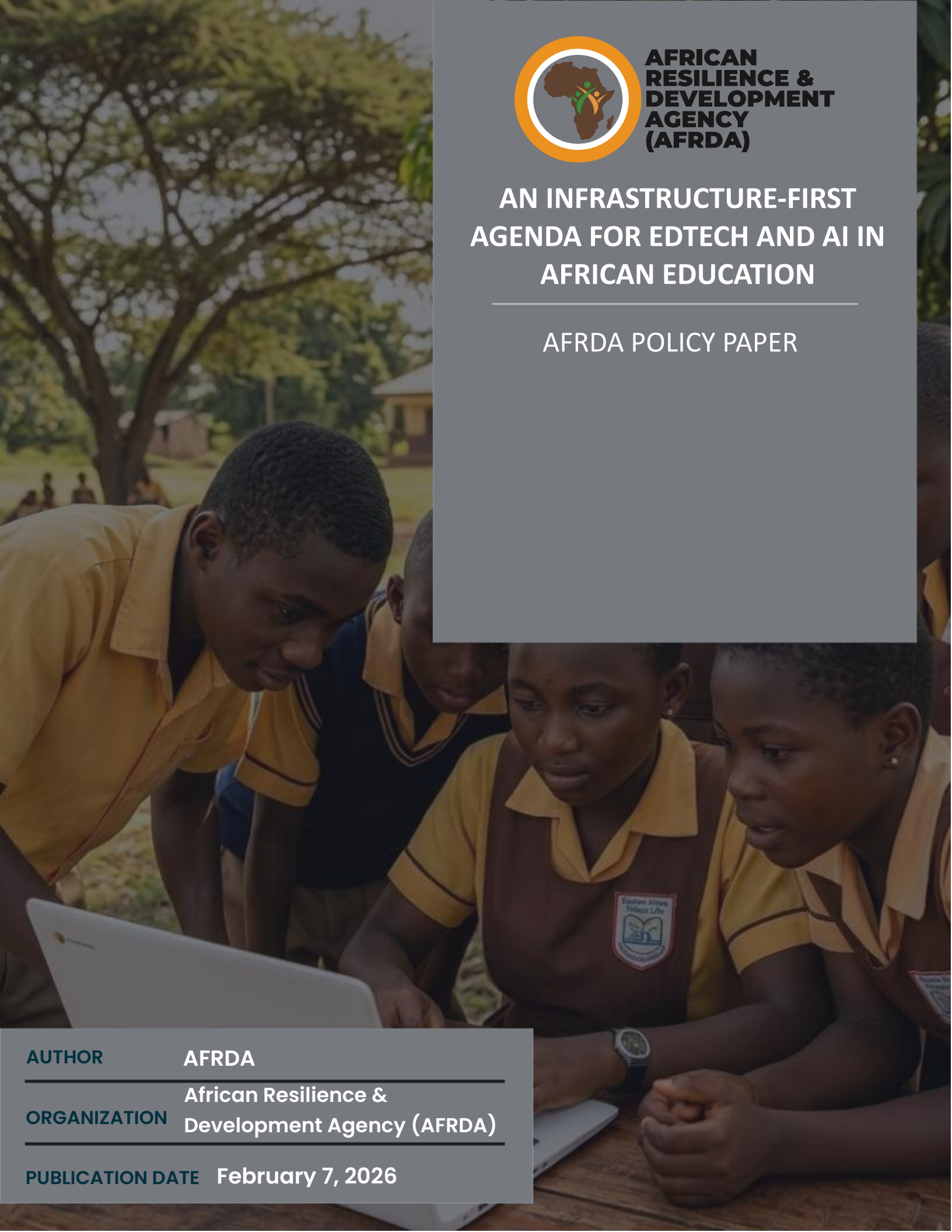


AFRICAN RESILIENCE & DEVELOPMENT AGENCY (AFRDA)

AN INFRASTRUCTURE-FIRST AGENDA FOR EDTECH AND AI IN AFRICAN EDUCATION

AFRDA POLICY PAPER

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FOREWORD

Education policy across Africa has entered a period of intense interest in digital learning, artificial intelligence and robotics. Governments, regional institutions, development agencies and technology companies increasingly describe these tools as routes towards wider access, stronger teaching and closer alignment between education and future labour markets. This ambition carries genuine value and it's fulfilment depends on the physical and institutional conditions under which teachers and learners encounter technology.

This report directs attention to those conditions and places electricity, connectivity, safe classrooms, devices, maintenance, technical support and teacher preparation at the centre of digital education policy. These foundations determine the daily reach of every platform, device and data system. Their distribution also determines which communities gain early benefits and which communities wait for later phases of investment.

The report deserves serious consideration because it connects technological ambition with the lived circumstances of schools. Rural educators, learners and communities bring essential knowledge about power supply, network coverage, equipment security, language, accessibility and local patterns of use with their participation strengthening policy design and improves the fit between public investment and classroom practice.

An infrastructure first agenda offers a disciplined route towards inclusive innovation as it gives governments and partners a basis for sequencing expenditure, measuring readiness and protecting equity during implementation. It also places long term public value above the visibility of isolated demonstrations. I commend this report to policy makers, educators, researchers, development partners and private firms working towards a digital future that reaches every learner.

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EXECUTIVE SUMMARY

African education systems are pursuing digital learning, educational technology, artificial intelligence and robotics during a period of wide variation in school infrastructure. The African Union has established continental strategies for digital transformation, digital education and artificial intelligence. These frameworks recognise infrastructure, skills, data and governance as essential capabilities. School level evidence shows that these capabilities remain unevenly distributed within countries, with rural and underserved communities carrying the largest deficits.

This report examines the relationship between foundational infrastructure and educational innovation. Its central finding is that infrastructure shapes the feasibility, intensity, continuity and distribution of technology use. Electricity powers devices and school administration. Connectivity links teachers and learners to digital content and services. Secure classrooms protect equipment. Maintenance systems preserve functionality. Teacher preparation converts access into classroom use. Data governance protects learners and guides responsible artificial intelligence. A weakness in any element reduces the educational value of investment across the wider system.

The scale of the electricity gap illustrates the policy problem. UNESCO reported that the share of schools with electricity in sub Saharan Africa rose from 30 per cent in 2015 to 32 per cent in 2020 (UNESCO, 2023). A 2025 geospatial study found that one third of Africa's school age children lived nearer to a school lacking electricity than to an electrified school (Moner Girona et al., 2025). These aggregate findings describe a continental constraint whose local expression varies by country, district and settlement. They also show why a national digital strategy requires a spatially detailed infrastructure plan.

Connectivity presents a related challenge. Around half of lower secondary schools globally had internet access for pedagogical purposes in 2022, while sub Saharan African schools recorded markedly lower access (UNESCO, 2023). Household access follows a similar geography of income and location. Learners attending a connected school may still experience limited access at home, high data prices or weak network quality. Effective planning therefore requires attention to connection quality, affordability, device availability, electricity reliability and patterns of actual use.

Prevailing narratives frequently draw their most visible examples from capital cities, private schools, universities and well resourced pilot sites. These examples demonstrate technical possibilities under favourable conditions. They provide a limited guide to system wide readiness because rural schools often operate under a different combination of power supply, connectivity, staffing, security and maintenance. National readiness scores create a similar risk when a single average conceals large subnational gaps. The resulting visibility bias can direct finance towards advanced applications while foundational needs remain dominant across large parts of the education system.

The consequences extend beyond equipment performance. Early concentration of digital resources in advantaged schools can deepen differences in instructional time, access to content, teacher support and exposure to digital skills. Advanced artificial intelligence introduces further requirements covering high quality data, child protection, privacy, cybersecurity, procurement oversight and professional judgement. Weaknesses in these areas increase dependence on vendors and reduce public authority over education data and pedagogical choices.

The report proposes an infrastructure first policy agenda organised around six priorities. Governments should establish a minimum readiness guarantee for every school; map school infrastructure at a granular level; integrate education, energy and telecommunications planning; finance the full life cycle of equipment and services; align technology packages with local readiness; and embed teacher preparation, data protection and community participation throughout implementation. Continental and regional institutions can support common indicators, pooled technical assistance, cross border learning and financing for underserved areas. Development partners and private firms can align projects with public plans, interoperability standards and transparent exit arrangements.

Implementation should proceed through sequenced readiness tiers. The first phase establishes verified baselines and governance arrangements. The second expands electricity, safe facilities, connectivity and maintenance. The third introduces technology packages suited to each school's infrastructure and pedagogical purpose. The fourth supports scale through recurrent finance, teacher development, independent evaluation and periodic technology renewal. Schools can receive low bandwidth and offline tools during early

stages while infrastructure expansion continues. This approach links present educational needs with a credible route towards more advanced capability.

An infrastructure first agenda treats equity as a design principle. It directs attention to the schools facing the largest readiness gaps, gives rural educators a formal role in policy making and measures progress through reliable service and meaningful use. Under this approach, digital transformation becomes a programme of public system development whose benefits can reach learners across geography, income, gender and disability.

1. INTRODUCTION

Digital technology occupies a growing place in African education policy. The expansion of mobile communications, online content, learning platforms and generative artificial intelligence has strengthened expectations that technology can widen educational access, support teachers and improve administration. The Covid 19 school closures added urgency by revealing the value of remote learning channels and the sharp inequalities in household connectivity, devices and adult support. These experiences moved digital education from a specialised policy field into the core business of education systems.

The material conditions of schools shape the results of this policy shift. A learning platform requires a device, power, connectivity or locally stored content, technical support and time within an organised teaching process. Artificial intelligence adds requirements for data, computing resources, privacy safeguards, procurement expertise and professional oversight. Each requirement sits inside an education system whose schools vary greatly in location, finance, staffing and access to basic services. Technology policy therefore becomes an infrastructure and institutional policy at the point of implementation.

This report asks a practical question: how should African governments and their partners sequence infrastructure and innovation to secure equitable educational value? It examines rural and underserved schools because their conditions reveal the reach of national plans. A strategy that functions in these settings possesses a stronger basis for system wide adoption. A strategy designed around highly resourced sites can generate impressive demonstrations while reaching a small share of learners.

The report uses documentary evidence from African Union strategies, UNESCO and UNICEF reports, published research on school electrification and rural digital access, and studies of African artificial intelligence policy. The available literature contains strong evidence on infrastructure access and implementation barriers. Evidence on long term learning outcomes from artificial intelligence in African primary and secondary schools remains limited. The analysis therefore distinguishes established infrastructure relationships from prospective claims about advanced technology.

The argument proceeds in five stages. Section 2 explains the foundations that support digital education. Section 3 examines the gap between visible innovation and system readiness. Section 4 identifies the mechanisms through which infrastructure affects learning, equity and public authority. Section 5 maps the roles of major actors. Sections 6 and 7 present a policy agenda and an implementation pathway. Section 8 draws the main conclusions and sets out priority recommendations.

2. THE FOUNDATIONS OF EDUCATIONAL INNOVATION

2.1. Structural inequality and the geography of schooling

School infrastructure reflects wider patterns of public investment, settlement and household income. Rural districts often combine dispersed populations, long travel distances, weaker electricity networks, lower commercial returns for telecommunications firms and constrained local revenue. These conditions raise the cost of service delivery and reduce the pace at which infrastructure reaches schools. Poverty adds a household dimension because devices, data and charging costs can place digital learning beyond the regular budgets of families.

The distribution of infrastructure also intersects with gender, disability and language. A learner with a disability may require accessible devices, adapted content and reliable support. Girls can face unequal access to shared household devices and heightened online safety risks. Linguistic diversity affects the relevance of digital content and speech based artificial intelligence. These dimensions show that access involves the quality and suitability of infrastructure, services and content within a particular community.

Rurality itself covers diverse settings. A school near a district town may receive grid electricity and mobile coverage while facing intermittent service. A remote school may rely on solar power and offline content. A pastoral community may require flexible delivery across changing locations. Conflict affected areas may depend on radio, mobile learning and community facilities. Planning based on a single rural category weakens resource allocation because the underlying delivery problems differ.

An infrastructure first approach begins with this geography. It uses school level data to identify service gaps and links each gap to a delivery model. It also recognises that equal expenditure per school can produce unequal results where the cost of reaching remote communities is higher. Equity based financing therefore directs greater resources towards locations with deeper deficits and higher unit costs.

2.2. Electricity as the first operating condition

Electricity supports lighting, device charging, connectivity equipment, school administration, teacher preparation and the secure operation of digital systems. It also affects the wider environment in which learners study.

Research on rural electrification in Nigeria associates access with higher enrolment and improved grade progression (Nano, 2022). Cross country research in Central Africa similarly identifies a positive relationship between electricity access and primary education outcomes (Kelly et al., 2023). These studies support a wider conclusion: electricity contributes to education through several channels, and digital technology represents one channel within that relationship.

Continental patterns remain uneven. UNESCO's monitoring data show slow growth in the share of sub Saharan African schools with electricity during the second half of the last decade (UNESCO, 2023). Moner Girona and colleagues used geospatial analysis to examine proximity to electrified schools in six African countries and found that one third of school age children lived nearer to a school lacking electricity (Moner Girona et al., 2025). The result draws attention to the spatial concentration of disadvantage and the value of mapping schools alongside population and energy infrastructure.

Connection status also provides an incomplete measure of readiness. Supply reliability, daily duration, voltage quality and available capacity determine which equipment a school can operate. A nominal grid connection with frequent outages supports a narrower range of uses than a reliable supply with adequate capacity. Solar systems can serve remote schools effectively when system sizing, battery replacement, security and maintenance receive sustained finance. Energy planning for digital education should therefore specify service levels and life cycle arrangements.

2.3. Connectivity devices and the learning environment

Internet access expands the range of content, communication and administrative services available to a school. Its educational value depends on speed, latency, reliability, affordability and the number of users sharing the connection. A basic mobile signal can support messaging and low bandwidth content. Live classes, cloud platforms and some artificial intelligence services require stronger capacity. Network quality during the school day provides a more useful measure than a general coverage map.

Device ratios shape the intensity of use. A single computer laboratory can introduce learners to digital tools, yet timetabling and class size may give each learner limited time. Teacher devices can support lesson preparation and formative assessment. Shared tablets can expand classroom use when storage, charging, repair and classroom management arrangements are clear. Personal

devices may extend learning beyond school while creating affordability and safeguarding concerns. Each model requires an explicit pedagogical purpose and an operating plan.

Physical facilities protect these investments. Secure doors and windows, dry rooms, suitable furniture, ventilation and safe electrical wiring influence equipment life. Overcrowded classrooms constrain movement and supervision. Dust, heat and humidity affect hardware. Rural studies from South Africa describe how inadequate facilities, connectivity gaps and limited technical support reduce regular use (Mahwai and Wotela, 2022). Systematic reviews reach a similar finding across rural sub Saharan Africa: sustainability depends on the combination of equipment, infrastructure, skills and maintenance (Aruleba and Jere, 2022; Odunga, 2024).

Maintenance forms part of infrastructure. Schools need a route for reporting faults, access to technicians, budgets for spare parts and replacement schedules. Procurement decisions influence this capability through warranties, interoperability and the availability of local repair. A programme that counts delivered devices while leaving repair finance undefined records an output and leaves continued educational use uncertain.

2.4. Teachers institutions and digital competence

Teachers convert technological access into learning activity. Their role covers selection of appropriate content, classroom organisation, assessment, learner support, safeguarding and professional judgement about automated recommendations. Training therefore needs to connect a tool with curriculum, subject knowledge and classroom practice. Short introductory workshops create awareness. Continued coaching, peer learning and school leadership support develop regular use.

Infrastructure influences teacher competence through opportunity. Educators develop skill through repeated practice with functioning equipment and relevant content. Rural teachers with intermittent access receive fewer opportunities for experimentation and support. Studies of digital divides in South African education associate competence gaps with unequal access to devices, connectivity, training and institutional support. The relationship is cumulative because stronger infrastructure encourages use, and repeated use builds confidence and pedagogical knowledge.

School leadership and district support also matter. Head teachers allocate time, organise shared equipment, set expectations and coordinate maintenance. District offices can provide technical services, professional learning and monitoring. Teacher education institutions shape the preparation of new educators. An infrastructure programme that includes these organisations creates a support system around the classroom and reduces dependence on individual enthusiasts.

3. POLICY NARRATIVES AND ACTUAL READINESS

3.1. The visibility of urban schools and pilot projects

Capital city schools, private institutions and selected public schools offer favourable sites for technology projects. They provide power, connectivity, administrative capacity and access to technical support. Their concentration of resources helps project teams demonstrate new tools and gather early lessons. Media coverage then gives these sites a large role in public narratives about national progress.

Pilot projects can answer important questions about usability, teacher response and technical performance. Their policy value depends on the relationship between pilot conditions and the wider system. A well resourced pilot may demonstrate that a platform works under stable connectivity and intensive support. Scaling requires evidence about performance under ordinary staffing, recurrent budgets and varied infrastructure. Clear documentation of pilot inputs helps decision makers judge this relationship.

Research coverage can reinforce the same visibility pattern. Studies cluster where institutions, connectivity and researchers are accessible. Remote schools consequently appear less frequently in published evidence. This creates a thin evidence base for the locations carrying the largest delivery challenges. Participatory research, district partnerships and geospatial sampling can improve representation and strengthen the basis for policy.

3.2. National averages and hidden subnational gaps

Digital readiness indices commonly combine national data on connectivity, skills, regulation, innovation and government capability. They help compare broad conditions and stimulate policy attention. Their national scale limits their ability to describe variation among provinces, districts and schools. A country can record expanding broadband coverage while remote schools experience weak signals, costly data and limited electricity.

African AI policy research has highlighted the limited fit between global readiness measures and national context. Diallo and colleagues found that global assessments can miss local policy developments and distinctive capability gaps (Diallo et al., 2025). The African Union's Continental Artificial Intelligence Strategy responds to variation among member states and identifies electricity, broadband, skills, computing, data infrastructure and

legislation as capabilities requiring context specific support (African Union, 2024). Education planning needs a comparable approach within countries.

School level readiness indicators should therefore record service quality and actual use. Useful measures include hours of available electricity, connection uptime, effective bandwidth, device functionality, learner to device ratios, repair times, teacher use, accessible content and recurrent expenditure. Disaggregation by location, school level, gender and disability reveals distributional patterns that a national score conceals.

3.3. Incentives in donor and commercial programmes

Development partners and technology firms bring finance, expertise and products to education systems. Their projects can accelerate experimentation and expand access. Their institutional incentives can also favour measurable delivery within short funding cycles, visible technologies and sites with a high probability of implementation. These incentives deserve explicit management through public plans, procurement standards and evaluation requirements.

Commercial models frequently target institutions and households with purchasing power. Public education policy carries a wider obligation to serve learners across income and geography. Agreements with firms should therefore specify affordability, data ownership, interoperability, service continuity and arrangements at contract completion. Open standards and portable data reduce switching costs and preserve public choice.

Development finance can support higher cost rural expansion through grants, concessional finance, guarantees and results based mechanisms. Its contribution becomes stronger when projects follow national infrastructure maps and recurrent financing plans. Alignment reduces fragmented platforms, duplicate equipment and parallel data systems. It also strengthens government responsibility for long term service.

3.4. The language of transformation

Policy documents often use terms such as transformation, innovation and future skills to communicate ambition. These terms gain analytical value when linked to specific changes in teaching, access or administration. A robotics laboratory may broaden exposure for learners in one institution. A national transformation requires sustained changes across a large share of schools, teachers and learners. Scale, regularity of use and educational effect provide the bridge between these levels.

Infrastructure first planning gives precision to ambition. It asks which learners can use a service, how often they can use it, which inputs support that use and which institution finances continued operation. These questions direct policy towards observable conditions. They also create a basis for comparing the educational value of alternative investments.

4. HOW INFRASTRUCTURE SHAPES OUTCOMES

4.1. Learning participation and institutional performance

Electricity can extend study time, improve lighting and support equipment for teaching and administration. Nano's study of rural Nigeria reported a substantial increase in school enrolment and an improvement in grade progression following electrification (Nano, 2022). The size of these effects reflects the study setting and method. Their direction supports the wider evidence that reliable energy can improve the environment in which education takes place.

Digital infrastructure adds further channels. Teachers gain access to curriculum materials and professional networks. Learners can use multimedia content, practice exercises and communication tools. Administrators can improve records, reporting and resource management. The realisation of these gains depends on integration into routines. Regular access and relevant content create stronger conditions for effect than occasional demonstrations.

Artificial intelligence may support translation, lesson preparation, tutoring, assessment and system planning. Each use requires evaluation against a defined educational purpose. Evidence should address learning, teacher workload, accessibility, cost, privacy and distribution. Public systems can begin with bounded applications whose risks and resource requirements remain manageable, then expand on the basis of verified performance.

4.2. The layered digital divide

Digital inequality develops through linked layers. The first concerns electricity, connectivity and devices. The second concerns skills and support. The third concerns the quality and range of use. The fourth concerns the outcomes derived from use. A school may move through these layers over time, and progress at a later layer depends heavily on the earlier ones.

This pattern explains why equipment distribution produces varied results. A device in a school with reliable power, trained teachers, technical support and curriculum aligned content becomes part of regular instruction. The same device in a school facing intermittent power and lengthy repair delays provides occasional exposure. Counting devices treats these situations as equivalent. Monitoring meaningful use reveals their difference.

The layered model also supports tiered implementation. Schools at an early readiness stage can use radio, print, local servers and preloaded content while energy and connectivity expand. Schools with stable power and limited bandwidth can use offline first platforms that synchronise periodically. Schools with stronger connectivity can adopt cloud services and carefully governed artificial intelligence. Every tier should carry a funded route towards the next level.

4.3. Equity and the allocation of public resources

The sequence of investment affects who benefits first. Concentrating advanced tools in already connected schools can improve opportunities for their learners and widen the distance from underserved schools. This effect becomes especially important when early access builds cumulative skills, influences examination performance or shapes entry into further education.

Equity based allocation uses readiness gaps as a criterion for finance. It can assign additional weight to rurality, poverty, disability access, conflict exposure and gender disparities. It can also compare the marginal value of an advanced application in a connected school with the value of electricity, connectivity or safe facilities in an underserved school. This comparison turns opportunity cost into an explicit policy consideration.

Universal service funds, rural electrification programmes and climate finance can support this agenda. Solar power offers particular value in locations far from the grid, provided that procurement includes batteries, maintenance and replacement. Telecommunications regulation can promote school connectivity through coverage obligations, spectrum policy and shared infrastructure. Education ministries need a formal role in these arrangements because pedagogical demand influences technical design.

4.4. Data governance and public authority

Artificial intelligence systems rely on data about learners, teachers and institutions. These data may include performance, attendance, behaviour, disability, location and personal identifiers. Their collection creates responsibilities covering lawful purpose, data minimisation, security, retention, access and redress. Children require heightened protection because education participation can limit practical choice about data use.

Weak infrastructure can intensify governance risks. Shared devices, insecure networks and limited technical staffing make data protection harder.

Proprietary platforms can place key decisions about storage, model behaviour and system updates outside the direct control of education authorities. Procurement teams therefore need legal, technical and pedagogical expertise alongside clear contractual safeguards.

The African Union's artificial intelligence and data policy frameworks provide a continental basis for responsible governance. National education authorities should translate these principles into sector rules covering approved use cases, impact assessment, human oversight, cybersecurity, vendor accountability and incident response. Rural schools and lower capacity districts require implementation support because formal rules acquire value through daily practice.

5. ACTORS AND IMPLEMENTATION

5.1. Continental and regional institutions

The African Union sets strategic direction through its digital transformation, digital education and artificial intelligence frameworks. Regional economic communities can adapt these directions to shared markets, cross border infrastructure and regional learning. Their comparative advantage lies in standard setting, coordination, technical assistance and the mobilisation of political attention across member states.

Continental indicators can encourage consistent reporting on school electricity, connectivity, device functionality and digital use. A common framework would improve comparison while leaving room for national context. Regional institutions can also support shared procurement guidance, model data protection clauses, professional standards and communities of practice for ministries.

Financing represents another area for regional action. Aggregated demand can strengthen negotiations for connectivity, equipment and technical services. Regional development banks and climate finance institutions can support school energy programmes whose social returns extend beyond direct revenue. Cross country learning can reduce repeated design costs and spread effective delivery models.

5.2. National government

National governments hold primary responsibility for turning strategy into a funded delivery system. Ministries of education define pedagogical objectives, curriculum requirements and school priorities. Energy ministries and utilities determine electrification pathways. Telecommunications ministries and regulators shape coverage, affordability and service standards. Finance ministries decide the scale and predictability of public resources. Effective implementation requires a joint programme with clear authority and shared targets.

Education management information systems provide the administrative backbone. Infrastructure modules should record school location, power source, reliability, connectivity quality, devices, facilities, security, accessibility and maintenance. Data collection needs validation because outdated or self reported entries can misdirect investment. Geospatial analysis can combine

school data with population, energy networks, mobile coverage, roads and climate risk.

Public procurement determines long term cost and control. Specifications should address interoperability, repairability, local support, accessibility, energy consumption, privacy and total cost of ownership. Contract management should track service quality and vendor performance. Budget systems should separate capital acquisition from recurrent operating costs while funding each category across the expected life of the technology.

5.3. Local government schools and teachers

District and local authorities connect national plans with school conditions. They can verify infrastructure data, coordinate technicians, aggregate maintenance demand and monitor service delivery. Their proximity to schools helps identify constraints that central databases may miss. Their effectiveness depends on staff, transport, technical skills and predictable operating funds.

School leaders manage daily use. They organise timetables, secure equipment, support teachers, engage families and report faults. Teachers decide how technology enters lessons and how learners receive guidance. Learners provide evidence about usability, accessibility and safety. Formal consultation structures should carry these perspectives into district and national decisions.

Community participation can support oversight, security and local adaptation. A community may help protect a solar installation, identify suitable service locations or advise on language and disability access. Public authorities should define community roles carefully and preserve government responsibility for core finance and technical standards.

5.4. Development partners civil society and private firms

Development partners can finance infrastructure, build government capability and support independent evaluation. Their programmes gain durability through alignment with national plans and public budget cycles. Civil society organisations can represent underserved groups, monitor equity and test locally grounded approaches. Teacher unions and professional bodies can strengthen training design and professional safeguards.

Private firms supply connectivity, energy systems, devices, software and artificial intelligence services. Clear public rules can align commercial capability with educational objectives. Contracts should define service levels, data

arrangements, pricing, local support, interoperability and transition at completion. Competitive and transparent procurement protects value and encourages solutions suited to local conditions.

6. AN INFRASTRUCTURE FIRST POLICY AGENDA

6.1. Establish a minimum readiness guarantee

Every government should define a minimum service package for schools. The package should cover safe buildings, reliable electricity, basic connectivity appropriate to location, secure storage, functional teacher devices, maintenance access and essential digital safeguards. Standards should specify service quality and functionality. A connection label alone provides limited guidance for planning.

The guarantee should appear in education sector plans, medium term expenditure frameworks and district targets. Its financing formula should recognise the higher cost of remote delivery. Annual reporting should show the share of schools meeting each component and the distribution of remaining gaps.

6.2. Build a verified school infrastructure map

Governments should establish a georeferenced registry of schools linked to infrastructure and service data. The registry should integrate education records with electricity networks, renewable energy potential, mobile coverage, fibre routes, roads, population and climate hazards. Verification can combine administrative reporting, field audits, network measurements and satellite analysis.

The map should support investment decisions and public accountability. Sensitive data require controlled access, while aggregated results can inform communities and partners. Regular updates should capture service deterioration, repairs and new connections. Giga's mapping approach demonstrates how governments can combine school location and connectivity data to guide expansion (Giga, 2026).

6.3. Integrate education energy and telecommunications planning

School electrification and connectivity should form a joint programme across responsible ministries and regulators. The programme should set priorities, technical standards, delivery models and financing responsibilities. It should coordinate grid extension, solar systems, mobile coverage, fibre and community access facilities around verified school clusters.

Joint planning can generate wider benefits. A connected school can serve as an anchor institution for nearby public services and community access, subject to safeguarding and capacity. Aggregated demand can strengthen the commercial case for network expansion. Education schedules and learner numbers can inform system sizing and bandwidth requirements.

6.4. Finance the full life cycle

Budgets should cover planning, procurement, installation, connectivity fees, content, training, technical support, repairs, cybersecurity, batteries, upgrades and replacement. Total cost of ownership should guide technology selection. Multi year budgeting gives schools and service providers a clearer basis for operation.

Maintenance should receive a defined institutional home. District technical teams, contracted service networks and certified local providers offer possible models. Performance measures should include equipment uptime and repair time. Asset registers should record age, condition, warranty and replacement date.

6.5. Match technology to readiness and pedagogical purpose

Technology packages should reflect school conditions and a defined learning objective. Radio and print can extend reach during an early readiness phase. Solar powered local servers and preloaded devices can support rich content under limited connectivity. Cloud services can enter as bandwidth and governance mature. Artificial intelligence applications should begin with bounded use cases and independent assessment.

Offline first design deserves a central place in African digital education. Platforms can store content locally, function during service interruptions and synchronise when connectivity becomes available. Local language content and accessible formats improve relevance. Procurement should reward these features because they expand usable reach.

6.6. Develop teachers and institutions alongside infrastructure

Teacher development should begin during infrastructure planning and continue through classroom use. Programmes should cover curriculum integration, subject specific pedagogy, assessment, accessibility, child protection, data privacy and professional judgement about artificial intelligence. Coaching and peer communities can reinforce formal training.

School leaders, district officers, technicians and procurement teams require role specific preparation. Teacher education colleges should model the infrastructure and pedagogy expected in schools. Rural colleges deserve priority because they serve many educators working in underserved communities.

6.7. Govern data and artificial intelligence in the public interest

Education authorities should establish sector rules for data and artificial intelligence. These rules should define approved purposes, lawful data handling, human oversight, security standards, impact assessment, audit, complaint channels and vendor responsibility. Procurement should require access to relevant documentation and meaningful information about system performance.

Evaluation should examine differential effects across location, income, gender, disability and language. An application that improves average performance while concentrating benefits in connected schools creates an equity concern requiring corrective action. Public reporting can build trust and support informed debate.

7. IMPLEMENTATION PATHWAYS

7.1. Phase one baseline and governance

The first phase should establish the delivery architecture. Governments should assign leadership, agree interministerial responsibilities, verify school locations, define readiness standards and create a costed investment plan. Early consultation should include rural teachers, learners, families, disability organisations, utilities, telecommunications firms and local authorities.

This phase should also review active projects and platforms. The review can identify duplication, contractual obligations, data practices, recurrent costs and prospects for integration. A national architecture should specify interoperability and approved data flows before major scale up.

7.2. Phase two foundational expansion

The second phase should direct capital towards schools with the largest readiness gaps. Investment should cover safe facilities, electricity, connectivity, security and maintenance networks. School clusters can improve procurement and service efficiency. Remote locations may require decentralised renewable energy and offline first connectivity models.

Teacher and leadership preparation should run during infrastructure installation. This timing allows schools to develop rules, lesson plans and maintenance routines before equipment enters regular use. Baseline measures should capture instructional practice, access and relevant learning outcomes.

7.3. Phase three pedagogical integration

The third phase should introduce technology packages aligned with curriculum and readiness. Implementation should begin with clearly defined use cases. Examples include teacher access to structured lesson resources, local language reading materials, formative assessment and school administration. Each use case should specify users, expected benefits, support requirements, costs and safeguards.

Routine monitoring should examine frequency of use, service quality, teacher experience, learner participation, accessibility and expenditure. Independent evaluation can assess educational outcomes and distribution. Findings should inform adaptation and the decision to expand, redesign or retire a tool.

7.4. Phase four scale renewal and accountability

The fourth phase should scale applications with credible evidence and a sustainable operating model. Recurrent budgets should support connectivity, maintenance, training, cybersecurity and replacement. Procurement cycles should anticipate technological change and preserve interoperability.

Public reporting should compare progress with the minimum readiness guarantee. Parliamentary committees, audit institutions, civil society and communities can review expenditure and distribution. Periodic strategy reviews should incorporate new evidence, changes in technology and feedback from schools.

7.5. Implementation matrix

Priority	Lead actors	Core actions	Initial indicators
Minimum readiness guarantee	Education ministry and finance ministry	Define service standards and cost the national gap	Share of schools meeting each standard by location
School infrastructure map	Education ministry statistical agency and local government	Verify locations and integrate service quality data	Share of schools with validated records and recent updates
Electricity expansion	Energy ministry utilities and rural energy agencies	Connect priority schools through grid and decentralised systems	Daily service hours reliability and functional capacity
School connectivity	Telecommunications ministry regulator and operators	Set school service standards and finance underserved connections	Uptime effective bandwidth affordability and user capacity
Maintenance system	Education ministry districts and service providers	Establish fault reporting repair networks and replacement schedules	Equipment uptime median repair time and asset condition
Teacher development	Teacher education bodies districts and schools	Provide curriculum linked training coaching and leadership support	Regular teacher use and demonstrated pedagogical competence
Data and AI governance	Education ministry data protection authority and procurement bodies	Apply sector rules impact assessment audit and incident response	Compliance reviews incidents resolved and public reports issued
Equity monitoring	Education ministry statistical agency and civil society	Disaggregate access use cost and outcomes	Gap trends by location gender disability and income

The matrix provides an organising framework. National plans should add baselines, targets, budgets, responsible units and review dates after verified costing. Indicators should measure reliability and use alongside the presence of assets.

8. CONCLUSIONS AND RECOMMENDATIONS

8.1. Conclusions

African education systems possess a clear interest in digital learning and artificial intelligence. Continental frameworks have established a direction centred on inclusion, capability and responsible governance. The principal implementation challenge lies in the uneven distribution of the foundations that allow technology to serve education at scale.

Electricity, connectivity, facilities, devices, maintenance and teacher support operate as an interdependent system. A weakness in one part reduces the value of investment in the others. School level evidence therefore deserves greater weight than national averages or high visibility pilots. Readiness should describe reliable service, institutional capacity and meaningful use in ordinary classroom conditions.

The sequence of public investment has distributional consequences. Early concentration in advantaged schools can widen differences in learning opportunity and digital experience. Priority investment in underserved schools can expand the base from which later innovation grows. Tiered technology packages allow learning support to continue during infrastructure expansion and give every school a pathway towards stronger capability.

Artificial intelligence raises the standard of readiness because it adds data, privacy, cybersecurity, procurement and oversight requirements. Public institutions need the capability to define educational purposes, evaluate systems and preserve authority over learner data and pedagogical decisions. These requirements strengthen the case for an infrastructure first approach.

8.2. Priority recommendations

8.2.1. Adopt a continental infrastructure first principle

The African Union and regional economic communities should place a clear sequencing principle within digital education and artificial intelligence implementation frameworks. Continental monitoring should include school electricity, connectivity quality, device functionality, maintenance and meaningful use, disaggregated by location and school level.

8.2.2. Create national minimum readiness guarantees

National governments should define and finance a minimum infrastructure and support package for every school. Education sector plans should show the cost, timetable and geographic distribution of progress. Funding formulas should recognise remote delivery costs and the depth of existing gaps.

8.2.3. Direct initial expansion towards underserved schools

Investment plans should use verified school maps and equity criteria to identify priority areas. Rural, remote, low income, disability inclusive and conflict affected schools should receive explicit weight in allocation. Public reports should show changes in the gaps among groups and locations.

8.2.4. Establish interministerial delivery programmes

Education, energy, telecommunications and finance authorities should operate through a shared programme with named leadership, common targets and coordinated budgets. Regulators, utilities and local governments should participate in planning and performance review.

8.2.5. Fund maintenance and renewal from the start

Every technology investment should include recurrent costs, technical support, cybersecurity and replacement. Procurement should assess total cost of ownership, interoperability, accessibility, energy efficiency and local repair capacity. Uptime and repair time should form part of programme performance.

8.2.6. Give rural educators a formal policy role

Governments and regional institutions should create representative mechanisms through which rural teachers, school leaders, learners and communities shape standards, procurement and evaluation. Participation should occur during design, implementation and review.

8.2.7. Build evidence around educational value

Evaluation should measure learning, teacher workload, access, cost, safety and distribution. Pilot reports should document the infrastructure and support intensity surrounding results. Scale decisions should follow credible evidence under conditions resembling ordinary implementation.

8.2.8. Protect public authority over data and AI

Education authorities should apply strong sector rules for learner data and artificial intelligence. Contracts should secure lawful processing, security, audit

rights, interoperability, redress and transition arrangements. Human professional judgement should govern consequential educational decisions.

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FOR MORE INFORMATION

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This policy paper represents a comprehensive overview and recommendations for the sustainable integration of EdTech, digital learning, artificial intelligence (AI) and robotics in African education systems. It reflects research from credible sources, consultation with experts and consideration of existing frameworks and best practices.

It is designed to inform policy development and implementation across African countries and regional bodies.

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