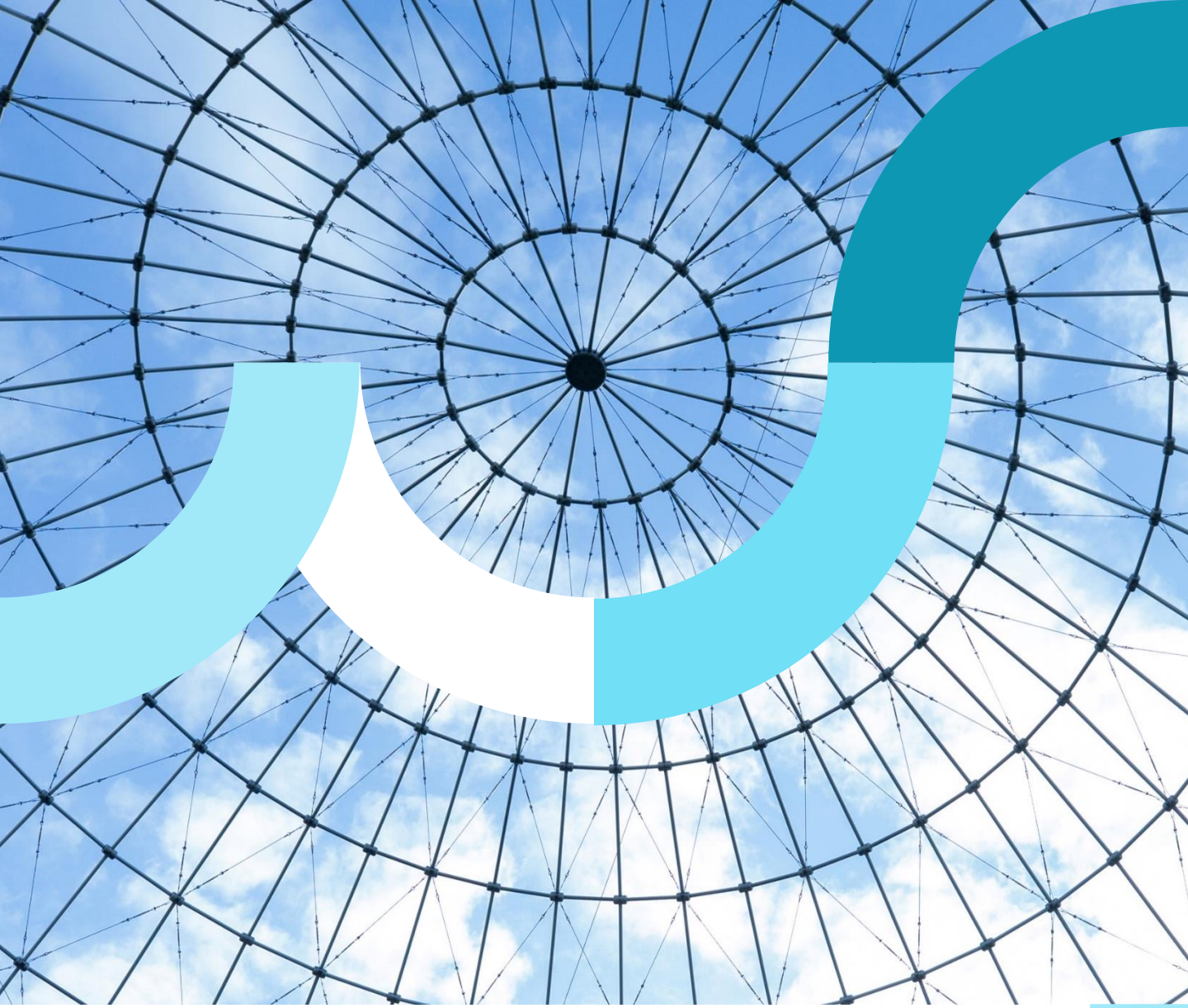

AIED Unplugged:
Practices, Challenges, and Pathways Forward in the Global South

unesco Chair

Technical Datasheet: AIED Unplugged – Practices, Challenges, and Pathways Forward in the Global South

Title: AIED Unplugged: Practices, Challenges, and Pathways Forward in the Global South;

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Publication Goal: To share knowledge on how artificial intelligence can transform teaching and learning through innovative unplugged approaches, especially in contexts with limited infrastructure.

Key Concepts:

- **AIED Unplugged (AIED-U):** A frugal, adaptable, and equity-centered design philosophy for contexts where connectivity, hardware, and digital skills are scarce;
- **Five Principles:** Conformity, Disconnect, Proxy, Multi-user, and Unskillfulness.

Scope: Comparative analysis of four countries: Brazil, Colombia, China, and South Africa.

Alignment: Aligned with UNESCO's Sustainable Development Goal 4 (SDG 4) to ensure inclusive and equitable quality education.

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1. Introduction

Artificial Intelligence is redefining the future of education. Yet, while much of the global discourse remains centered on high-connectivity, technology-intensive environments, the most urgent question still persists: how can AI serve all learners? The AIED Unplugged approach responds boldly to this challenge. It represents an innovative, equity-driven concept that empowers teachers and students to explore the logic, creativity, and ethics behind intelligent systems in contexts where access to digital infrastructure is still limited.

This publication marks a pioneering contribution to this approach. It is among **the first to be authored entirely by experts from the Global South**, presenting grounded country cases from Brazil, Colombia, China, and South Africa on AIED Unplugged. Together, these experiences demonstrate that innovation does not flow exclusively from the world's technological centers. Instead, they reveal how countries often perceived as recipients of global innovation are, in fact, generating original, contextually rooted solutions that advance equity, participation, and human-centered learning.

Produced under the UNESCO UNITWIN Chair on AIED Unplugged, this comparative study examines the policy landscapes, institutional frameworks, and pedagogical practices that are shaping **AI education** in these four countries. It identifies shared challenges and opportunities, offering insights into how unplugged approaches can bridge digital divides, foster inclusion, and inspire global pathways toward equitable AI learning.

By amplifying voices and innovations from the Global South, this work invites a reimagining of what it means to lead in **AI education**. It underscores that the future of equitable AI is not defined solely by technology, but by creativity, collaboration, and the capacity to learn, and more importantly, to innovate with what is available.

This publication aims to foster knowledge exchange and collaboration among the UNESCO UNITWIN Chair members and beyond. It provides evidence to inform policy dialogue, teacher training, and curriculum design, contributing to UNESCO's broader vision of harnessing AI for inclusive, human-centered, and sustainable education.

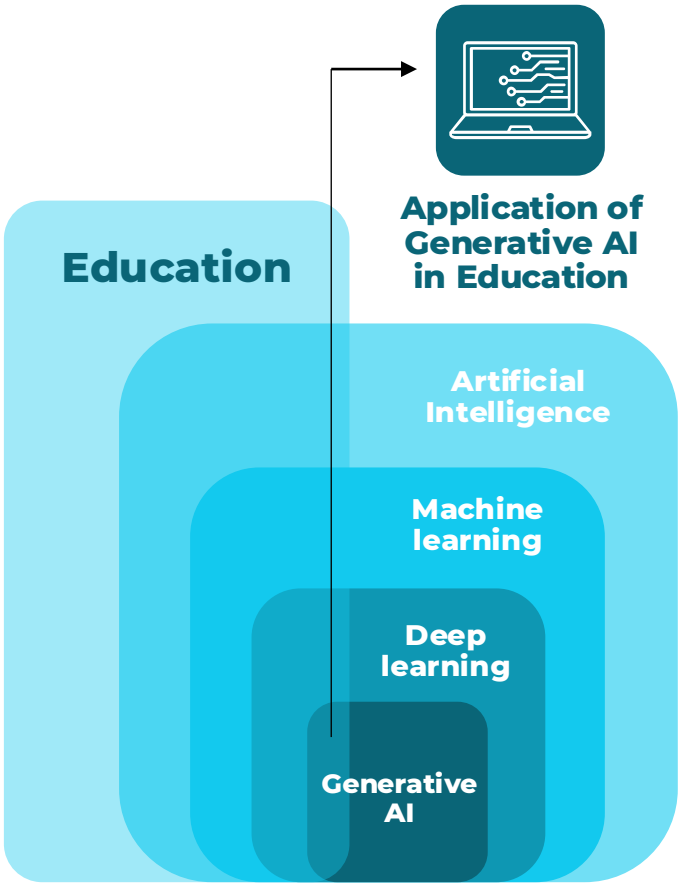
2. Conceptual Clarifications

This section establishes the foundational terminology necessary for understanding the subsequent country analyses. It begins by precisely delineating the relationship and key distinctions between Artificial Intelligence (AI) and Generative Artificial Intelligence (Gen AI), emphasizing how the capabilities and ethical implications of these technologies shape educational policy. Following this, the section introduces and thoroughly defines the concept of AIED Unplugged. This pedagogical approach, central to this publication, is framed as a critical strategy for promoting computational thinking, AI literacy, and equitable learning by reducing dependence on high-bandwidth infrastructure and advanced digital devices.

AI vs. Generative AI

Generative AI (Gen AI) belongs to the broader concept of Artificial Intelligence. It has evolved over the past few decades, progressing from Machine Learning to Deep Learning and now to the current concept of Gen AI. Machine Learning consists of algorithms that analyse large datasets to identify patterns, building models that are able to solve problems and make predictions. Deep Learning utilises artificial neural networks encompassing multiple layers, allowing it to process complex data (Unesco, 2021). Deep Learning is often used for Gen AI. Therefore, it is capable of creating 'new' content, such as text, images, music, videos or code - to a point that specialists cannot always determine how the technology arrived at that response. The ability to turn data into something original, instead of only replicating or predicting outcomes, is what differentiates this technology.

However, its rapid development and insertion into all aspects of society, market and government, along with its often unpredictable behaviour, also raise concerns for the future: how to ensure Gen AI is employed in just, equitable, ethical and healthy ways? Most research suggests that Gen AI has a great potential of increasing inequalities and reinforcing historical injustices, unless reparations are intentionally considered during its development, implementation and usage.



The Relationship Between Generative Artificial Intelligence and Education

Source: Adapted from Santos et al. (2024).

Artificial Intelligence in Education (AIED) requires the same caution. On the one hand, AIED can be a driving force to improve learning and performance, developing solutions that respond to specific needs and challenges, both at the individual and systemic levels. Crisis scenarios such as the recent Covid-19 pandemic caused a rise in Gen AI solutions in Education to reach out to students who were suddenly unable to continue their traditional studies. Its application encompasses, but is not limited to, support for administrative and pedagogical tasks, lesson planning and/or material cocreation, designing more active and/or interactive activities, assessing and grading, identifying learning gaps and difficulties, planning intervention, and supporting inclusive access to students with diverse needs.

On the other hand, AIED could accelerate the digital divide between low and high-income communities, which possess uneven resources and skills to take advantage of Gen AI. Isotani et al. (2023) address two key elements to ensure a more equitable use of Artificial Intelligence in Education: infrastructure (access to electricity, internet, and devices: mobile phones) and digital skills.

AIED Unplugged

In complex contexts, where society faces deep injustices, AI can help maintain - or even create new - inequalities. Schools are unequally equipped to work with technology, showing great challenges in connectivity and infrastructure.

In contexts marked by deep social inequalities, AI can perpetuate or even amplify new disparities. Schools are unequally prepared to work with technology, facing limitations in terms of connectivity and infrastructure—as an example, in Brazil, only **44%** have adequate internet access for educational purposes, and the national average is 29 students per computer, far from UNESCO's recommended ratio of 10:1 (Demerval et al., 2025).

Additionally, **only 8%** of Brazilian teachers report incorporating technology to their practices effectively (Demerval et al., 2025).

Without structural changes in public policies, low-income countries may take **more than 50 years** to reach levels of access to digital technologies similar to high- and upper-middle-income countries, and around **75 years to develop equivalent digital skills** (Isotani et al., 2023).

AIED Unplugged seeks to address those challenges.

AIED Unplugged (AIED-U) is a frugal, adaptable, and equity-centred design philosophy that harnesses Artificial Intelligence for Education in contexts where connectivity, hardware, and digital skills are scarce. Inspired by the spirit of jugaad, creative problem-solving with limited resources, AIED-U aims at delivering offline-first, low-cost, and culturally responsive AI tools.

The term “unplugged” refers to the fact that in our context: (i) AI solutions should not constantly access the internet; and (ii) the target users (e.g., students) lack digital skills and access to resources (hardware, internet, etc.), being disconnected from the digital world. AIED Unplugged (AIED-U) leverages artificial intelligence to advance learning opportunities for the world’s most underserved students and communities. Designed for places where connectivity, devices, and digital skills are scarce, AIED-U prioritizes AI solutions that work offline-first, require only the hardware already on hand, and demand minimal technical know-how from teachers or learners—thereby closing both infrastructure and skill gaps in low- and lower-middle-income settings.

Inspired by the Indian concept of ‘Jugaad’, it prioritises resourcefulness (the ability to adapt and improvise, creating solutions with available resources) and simplicity (the goal of developing easy-to-use solutions that do not require extensive previous knowledge). Translating it to the Brazilian educational context, which requires two prerequisites: first, AIED cannot depend on constant connectivity to work; and second, any solution must acknowledge different degrees of digital experience and skills from teachers and students, adjusting to local realities.

AIED Unplugged (AIED-U) suggests five fundamental principles (Isotani et. al, 2023):

- **Conformity.** Rather than disrupting the educational environment, requiring extensive training and changes in infrastructure, the AI-based solution should be developed considering the available infrastructure, resources and pedagogical practices.

- **Disconnect.** The AI-based solution should not require internet access to work. Conversely, it should use the internet whenever available to update AI models, collect data and provide user feedback.

- **Proxy.** We cannot assume that target users (e.g., students) own hardware to access an AI-based solution or have the skills to create a login account in a system. Thus, the AI-based solution may consider a proxy between the target user and the AI solution.

- **Multi-user.** AI-based solutions should be created considering that hardware and software are constantly shared among users and proxies. Thus, any solution that requires users to log in or needs to record individual interactions to update the AI models (e.g., the user model in an intelligent tutoring system) will most likely not work in our context.

- **Unskillfulness.** AI-based solutions should be created to be simple enough that they do not require additional digital skills other than what most people with access to a cellphone already possess (such as clicking an icon, taking a picture, sending/writing a message, making calls, etc.).:

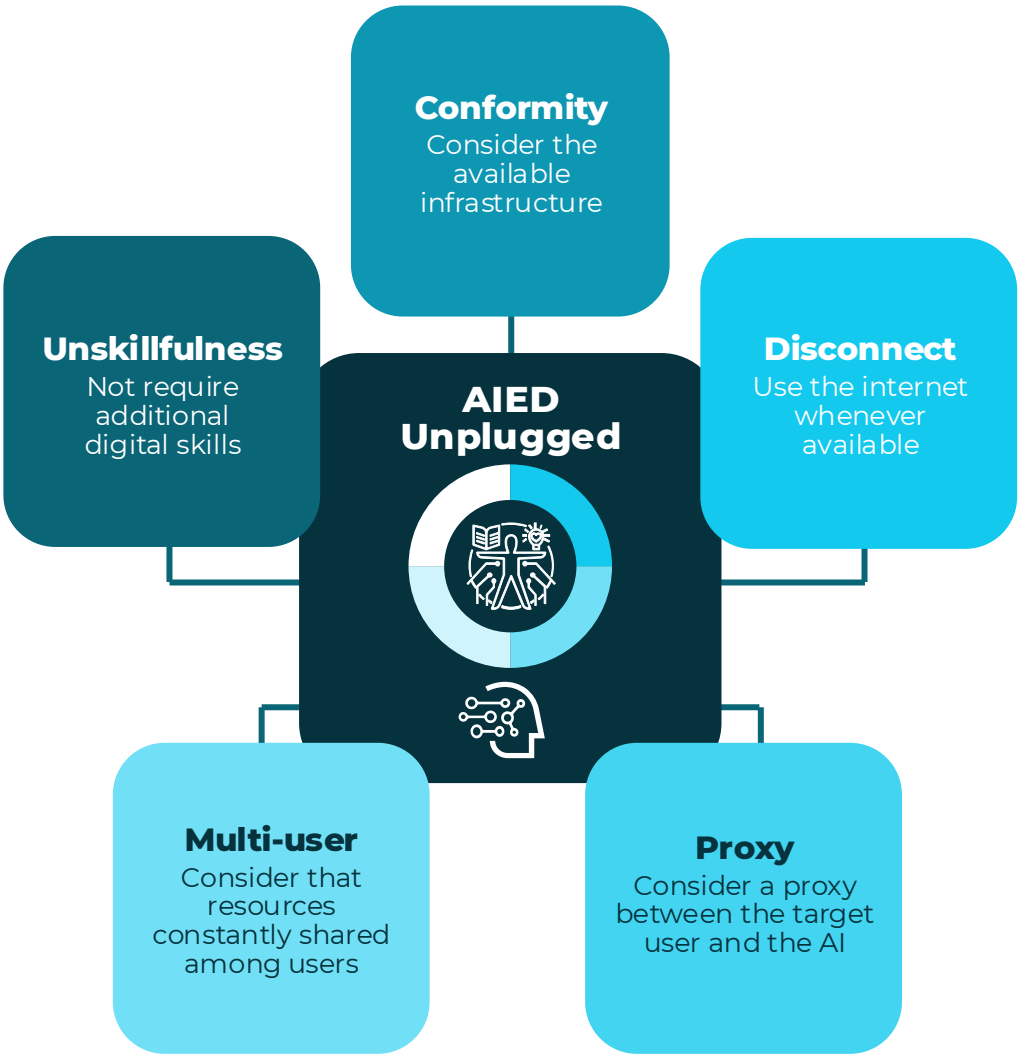


Figure 1.
AIED Unplugged Principles

Source: Demerval et. al, 2025

Source: Freepik

3. Country Case Studies

Drawing upon the conceptual approach established in the preceding section, this chapter presents a focused comparative analysis of the AIED Unplugged landscape across four distinct contexts: Brazil, Colombia, China, and South Africa. For each country, the analysis is structured to provide a comprehensive overview encompassing current practices and programs; the policy landscape and key stakeholders; major challenges and gaps in implementation; and targeted recommendations for strengthening and scaling AIED Unplugged initiatives. These case studies shed light on how diverse infrastructural, social, and governmental realities influence the adoption of equitable **AI education** models, collectively identifying pathways for sustainable and human-centered AI literacy development within the UNESCO UNITWIN Chair on AIED Unplugged.

Brazil

Source: Generated by Gemini (2026)

Brazil combines strong policy momentum on connectivity, through initiatives such as the Estratégia Nacional de Escolas Conectadas (ENEC)[1], with a mature AIED research community and active NGO–state partnerships experienced in working under infrastructural constraints. The concept of AIED Unplugged, developed and piloted by Brazilian researchers, demonstrates how equitable AI-supported learning can be advanced even in low-connectivity settings. This approach offers a pragmatic bridge between current realities and future connected classrooms, positioning Brazil as a reference point for inclusive **AI education** in the Global South (Portela et al., 2023; Portela et al., 2024).

Current Practices

Brazil is actively advancing AIED Unplugged approaches in education. The concept was first introduced by Brazilian AIED researchers, who developed and implemented the initial AIED Unplugged framework within public school networks (Isotani et al., 2023). Early applications centered on handwriting recognition and natural-language feedback to enhance students' writing skills without requiring one-to-one devices or stable internet connectivity in every classroom. Building on these foundations, large-scale pilots evolved into policy-embedded deployments during the post-pandemic learning recovery period, demonstrating how AI-driven educational tools can be effectively integrated into procurement systems, data privacy compliance, and teachers' existing pedagogical workflows at scale (Portela et al., 2023).

1. https://www.gov.br/mec/pt-br/escolas-conectadas

Follow-up research has expanded the AIED Unplugged paradigm to other domains of learning, particularly mathematics and assessment analytics. Brazilian research teams have developed offline-capable mathematical tutors that interpret students' handwritten problem-solving steps and provide adaptive feedback, enabling individualized learning support in contexts with limited connectivity (Guerino et al., 2025; Rodrigues et al., 2025). Parallel studies have explored automated analysis of multiple-choice assessments, using lightweight AI models to detect patterns of misconceptions and generate aggregate performance dashboards for teachers and school leaders.

Another emerging line of work led by Brazilian research teams focuses on the development of edge computing and small language models (SMLs) designed to run AI algorithms within local school networks (Monteiro Santos et al., 2024; Zuffo et al., 2022). These initiatives aim to reduce dependence on cloud computing and permanent internet connections by enabling on-device inference and local data processing. This direction represents a significant step toward sustainable and sovereign AI infrastructures, allowing educational institutions in low-resource contexts to benefit from AI while maintaining control over their data and minimizing operational costs (Rodrigues et al., 2025; Demerval et. al, 2025).

Beyond research-led deployments, Brazil's education technology ecosystem features initiatives relevant to AI Unplugged's design space:

- Public-policy connectivity programs are progressively improving infrastructure, but practice still needs to work under constraints in many territories, hence the emphasis on offline-first or store-and-forward mechanisms in classroom tools (Ministério da Educação [MEC], 2024).

- NGO and multilateral programs such as UNICEF's Territórios Conectados have run staged implementations in diverse contexts (urban peripheries, rural, Indigenous, Quilombola), documenting how pedagogy, culture, and infrastructure intertwine; these environments are natural targets for Unplugged AI use cases (UNICEF Brasil, 2023).

- Edtech partnerships with state networks extend AI-supported writing and tutoring. For example, Letrus has been scaled by the state of Espírito Santo to deliver AI-guided writing feedback to over 100,000 students, suggesting how feedback-at-scale can be embedded in curricular milestones (e.g., upper-secondary writing) (Letrus, n.d.). While Letrus is not explicitly branded "unplugged," its focus on teacher-mediated workflows and non-1:1 routines overlaps with Unplugged design principles for incremental infrastructure contexts.

Policy Landscape

Brazil's National Strategy for Connected Schools (ENEC) is the key policy scaffold. ENEC coordinates multiple funding streams and instruments (laws, universal service funds, tax incentives) to universalize pedagogically adequate school internet (Demerval et. al, 2025). The 2024 Executive Report describes how different policies carve out mandates and beneficiary lists, optimizing execution routes for public resources (Ministério da Educação [MEC], 2024). It highlights the sequencing problem: infrastructure upgrades take time and vary locally; meanwhile, learning recovery agendas cannot pause, exactly the tension AI Unplugged seeks to resolve (Cetic.br, 2023).

Several legal and financial instruments support Brazil's national connectivity strategy. Law 14.172/2021 guarantees federal transfers to states and the Federal District to provide internet access for students and teachers in public basic education, a mechanism that initially supported emergency connectivity actions during the pandemic and later evolved into a structural policy for digital inclusion (Brasil, 2021). In addition to this framework, the FUST (Fundo de Universalização dos Serviços de Telecomunicações) has, since 2024, issued fiscal-benefit calls inviting telecom providers to connect listed public schools in alignment with the ENEC's minimum connectivity parameters. This approach creates a sustainable pipeline for progressive infrastructure expansion, particularly in remote and underserved regions (Banco Nacional de Desenvolvimento Econômico e Social [BNDES], n.d.). Concurrently, NGOs as Fundação Lemann and MegaEdu provide technical assistance, analytics, and measurement tools that help accelerate the achievement of the "schools connected" milestones in collaboration with the Ministry of Education (MEC), reinforcing the multi-actor character of Brazil's connectivity and AI Unplugged agenda (Fundação Lemann, 2024). Finally, it is also important to mention the new UNESCO Chair for AIED unplugged, launched in 2025 as part of the global support for the field.

Meanwhile, policy guidance for **AI in education** has been developed by CIEB, which has published a series of documents framing AI as a key technology to support Brazilian basic education. The first publication in this series positioned AI as an emerging area of opportunity and mapped initial implementation experiences across the country (CIEB, 2020). Subsequent editions, such as those addressing the integration of AI in basic education and the responsible use of generative AI by education secretariats, expand on use cases, ethical considerations, and governance mechanisms. Collectively, these materials have become reference frameworks for many state and municipal education networks, serving as de facto standards while national policy guidelines continue to evolve (CIEB, 2024a, 2024b).

Stakeholders

The public sector plays a central role in advancing Brazil's AI Unplugged and connectivity agendas. The Ministry of Education (MEC) is the lead institution responsible for coordinating the ENEC, defining connectivity parameters, overseeing the Connected Schools Indicator, and aligning digital infrastructure efforts with broader learning-quality and recovery goals (Ministério da Educação [MEC], 2024). In partnership, the Ministry of Communications (MCom) and the National Bank for Economic and Social Development (BNDES) co-execute FUST-linked programs and public calls to expand broadband and backhaul coverage, particularly targeting schools in underserved areas (Banco Nacional de Desenvolvimento Econômico e Social [BNDES], n.d.). Moreover, MEC also funded an initial AIED Unplugged project that reached several municipalities across Brazil, aiming to strengthen literacy and numeracy development through low-connectivity, AI-supported learning tools (Portela et al., 2023, 2024; Rodrigues et al., 2025). At the local level, State and Municipal Secretariats of Education operationalize these strategies through teacher-training programs, AI-supported writing platforms, and localized procurement aligned with privacy and data-protection standards.

Brazil's academic and research sector provides the scientific support of the AIED Unplugged movement. Leading institutions such as UFAL's NEES (IA.Edu/NEES) and USP's ICMC have been instrumental in developing the conceptual foundations, pilots, and policy-embedded deployments of AI Unplugged technologies (Portela et al., 2023, 2024; Rodrigues et al., 2025). Their contributions include open educational datasets, prototype software, and practical toolkits designed for networks with limited infrastructure. Other universities, including UFRPE and UDESC, expand this ecosystem through teacher-education programs and applied research projects. In particular, the UNESCO Chair on Artificial Intelligence Unplugged in Education fosters interdisciplinary collaboration and capacity-building for educators and policymakers (UNESCO Chair on Artificial Intelligence Unplugged in Education, n.d.).

Finally, a wide network of non-governmental and private organizations complements these public and academic efforts. The CIEB produces key reference materials, such as connectivity guides, AI governance frameworks, and the Conectividade na Educação platform developed in collaboration with NIC.br, which provides national indicators and monitoring tools for ENEC implementation. The UNICEF-led Territórios Conectados initiative,

in partnership with Aprendiz and Casa da Árvore, pilots equity-focused and offline-capable solutions in diverse territories, including Indigenous and Quilombola communities (UNICEF Brasil, 2023). Meanwhile, the Lemann Foundation and MegaEdu offer technical assistance, analytics, and public dashboards to accelerate the achievement of the "schools connected" milestones (Fundação Lemann, 2024). On the private sector side, educational technology companies such as Letrus collaborate with state networks to deliver teacher-mediated AI feedback systems. While many of these solutions are not exclusively unplugged, their hybrid, low-connectivity workflows align with AI Unplugged principles (Letrus, n.d.). Finally, recent prototype solutions have emerged as open source tools to support the adoption of AIED Unplugged in real contexts (Mello et al., 2025).

Challenges and Gaps

A first challenge concerns infrastructure heterogeneity. Despite significant advances through national programs such as the ENEC, Brazil's connectivity gains remain highly uneven across territories and school types. ENEC's own reports and dashboards highlight the need for staged execution, requiring coordination among backhaul expansion, internal Wi-Fi installation, and classroom integration (Ministério da Educação [MEC], 2024;Fundação Lemann, 2024). For AI Unplugged, these disparities mean that offline-first and asynchronous feedback workflows remain essential in the near term, especially in rural and remote municipalities where connectivity is intermittent. Complementary infrastructure policies like FUST and Connected Schools initiatives continue to expand coverage, but gaps in bandwidth and energy availability still limit large-scale deployment of connected AI systems.

A second challenge involves teacher capacity, data governance, and instructional sustainability. National surveys such as TIC Educação show persistent disparities in digital competence among teachers and in the extent to which schools integrate technology into daily pedagogy (Cetic.br, 2023). While AI Unplugged reduces dependence on student devices, it still demands active teacher facilitation, data capture routines, and interpretation of AI-generated feedback, requiring sustained investment in professional learning and school-level support (UNESCO, n.d.; Isotani et al., 2023). At the same time, state and municipal networks must comply with the General Data Protection Law when managing student writing data and AI inferences. Research-led implementations have already demonstrated privacy-aware architectures integrated with public governance frameworks, but standardized procurement templates, data-protection clauses, and open compliance models are still evolving, posing a barrier to expansion beyond early-adopter networks.

Finally, Brazil faces challenges in evidence generalization, sustainability, and equity monitoring. Although writing-feedback systems have shown promising results, extending AI Unplugged to subjects such as mathematics, sciences, and early literacy requires additional R&D, model validation, and impact evaluation to ensure measurable learning gains across disciplines. Even when solutions are designed to be simple, school districts need clear cost models, service contracts, and device strategies to sustain teacher-mediated capture (via phones or tablets) that powers Unplugged workflows. Moreover, equity targeting and monitoring remain critical. As evidenced by UNICEF's Territórios Conectados, Brazil's vast contextual diversity in language, culture, mobility, and safety conditions shapes how "unplugged" approaches materialize in practice (UNICEF Brasil, 2023).

Recommendations

1. Practical adoption

Brazil should adopt a phased implementation strategy to ensure sustainable integration of AI Unplugged initiatives within the framework of the National Strategy for Connected Schools.

Source: Generated by Gemini (2026)

In the short term, efforts should focus on scaling offline-first, teacher-mediated AI workflows for writing and short-answer feedback, using store-and-forward pipelines and low-bandwidth notification systems where feasible. Schools should be prioritized according to their ENEC connectivity indicators, ensuring equitable coverage while maintaining functionality under intermittent connections. In the medium term, as FUST/ENEC infrastructure upgrades become operational, implementation should expand to multi-subject applications such as mathematics and early literacy, integrating AI-generated feedback into pedagogical dashboards used by local education teams. In the long term, selected schools reaching higher connectivity levels should progressively transition to connected-first AI features, such as interactive tutoring and real-time analytics. It will allow for the development of the other aspects of AIED Unplugged, such as unskilledness and proxy. Once the technical problem is no longer a barrier the ecosystem can focus on the application of unplugged activities to support students' skills development and creating applications that consider the low literacy skills of teachers (Cetic.br, 2023).

2. Institutionalize AI-pedagogy routines for teachers

To sustain adoption, AI Unplugged practices must be embedded in teachers' everyday routines through structured, lightweight pedagogical cycles. A recommended model includes four key stages: (1) teachers capture student work (e.g., photos of handwritten assignments); (2) the material is processed by the AI system; (3) teachers receive actionable feedback, including common errors, models, and improvement prompts; and (4) follow-up mini-lessons address identified learning gaps. These cycles should be incorporated into collaborative planning sessions and mentorship programs, ensuring continuity even with staff turnover. Support materials, such as exemplar banks, feedback calendars, and micro-credential systems, should be aligned with established competency frameworks to standardize good practice nationwide.

3. Build equity-first monitoring and data transparency

A key step for ensuring inclusion and accountability is to establish equity-centered monitoring mechanisms that track the real impact of AI Unplugged programs. Dashboards should measure who actually receives feedback, disaggregated by school, grade, region, gender, and social group, alongside turnaround times and teacher follow-up rates. The Conectividade na Educação platform and ENEC's Connected Schools Indicator can serve as initial datasets for this purpose. Drawing from UNICEF's Territórios Conectados experiences, territorial indicators should reflect the specific realities of Indigenous, Quilombola, rural, and urban contexts, ensuring that progress metrics are sensitive to cultural and infrastructural diversity. Publicly accessible dashboards should accompany ENEC progress reports, fostering transparency and guiding continuous improvement toward equitable outcomes.

4. Research translation

New fund programs to support applied research and development initiatives to extend Unplugged AI beyond writing, to mathematics, science, and early literacy, through lightweight, explainable models and open reference implementations. The UNESCO UNITWIN Chair on Artificial Intelligence Unplugged in Education could be a central point for coordinating a national community of practice bringing together universities, NGOs, and state secretariats to share lesson-embedded workflows, privacy frameworks, and impact evidence, accelerating knowledge transfer and harmonizing practices across regions.

Colombia

Source: https://www.diariojuridico.com/el-presidente-duque-destaca-la-evolucion-del-sistema-educativo/

As artificial intelligence reshapes the global educational landscape, Colombia has adopted an inclusive strategy for **AI in education** with a particular focus on unplugged and offline methodologies. These initiatives seek to democratize access to foundational AI concepts for children and diverse communities in regions with limited or no internet connectivity. By addressing the country's persistent digital divide, Colombia's experience illustrates how human-centered, low-tech approaches can support equitable learning opportunities while strengthening local innovation ecosystems.

Current Practices

Although Colombia is advancing toward a national AI strategy, the realities of uneven connectivity have led to the emergence of innovative offline educational practices. A prominent example is Colombia Programa, a joint initiative of the Ministry of Information and Communications Technology (MinTIC) and the British Council, which focuses on teaching computational thinking (CT) in rural schools. Among its most notable tools is Biobots (Ministerio de Tecnologías de la Información y las Comunicaciones, n.d.), a board game that introduces primary students to concepts such as algorithms and problem-solving without requiring digital devices. Another initiative, ChildProgramming (Cruz et al., 2013), cultivates the cognitive and social skills necessary for software design through play, collaboration, and communication. Over time, this approach has been refined through university research and field testing, aligning progressively with national priorities.

The Colombia Programa curriculum progresses from basic computational thinking to more complex problem-solving and introductory AI principles, delivered through hands-on, collaborative activities that foster critical thinking and creativity. Reflecting growing government interest in AI education, Computadores para Educar (CPE), in collaboration with the Ministry of National Education (MEN) and MinTIC, recently coordinated the country's first National AI Day (MinTIC, 2024). More than 2,000 schools registered to participate, and the official teacher toolkit included both online and offline activities designed for diverse classroom contexts, illustrating the government's commitment to equitable access.

Teacher training represents another cornerstone of Colombia's strategy. The SENATEC program, led by MinTIC and SENA, provides large-scale training in AI, data, programming, and blockchain until 2026, supported by an investment of COP 430 billion (MinTIC, n.d.-a). Complementary initiatives include Bogotá–IBM SkillsBuild, which offers 4,800 free training spots in AI and cloud computing, and the MinTIC–Google–Colnodo program, which provides 10,000 scholarships for AI-related certificates targeting upper secondary and technical learners (MinTIC, n.d.-b). At the subnational level, innovation labs play an increasingly important role. The Bogotá AI Educational Innovation Lab (National University) supports teachers experimenting with AI pedagogies, while Medellín's C4IR Center for the Fourth Industrial Revolution has been reoriented as a national hub for applied AI and smart city initiatives. Although these centers are not exclusively focused on school education, they contribute significantly to the country's broader AI learning ecosystem through events, mentoring, and professional development.

Policy Landscape

Colombia's regulatory and policy environment for AI is evolving rapidly, with education positioned as a strategic priority. The National Policy on Artificial Intelligence (CONPES [2] 4144), approved in 2025, provides a roadmap for the ethical development and adoption of AI, explicitly identifying education as a key pillar (CONPES, 2025). The policy recognizes the need to cultivate AI competencies from an early age and ensure that the benefits of AI are distributed equitably across society, with a planned investment of COP 479 billion by 2030. Complementing this, Bill 043 of 2025 proposes a comprehensive legal framework for AI implementation, including a specific chapter on education. The bill underscores teacher training, equitable access, and the inclusion of historically marginalized populations, implicitly affirming the relevance of both online and offline modalities.

2. CONPES (Consejo Nacional de Política Económica y Social) is the National Council for Economic and Social Policy, the highest planning authority in Colombia and the government's main advisor on economic and social development.

The Ministry of National Education (MEN) is also integrating AI into the national curriculum. Although a standardized national curriculum for AI in basic education is still under development, the 2025 Curriculum Guidelines on Technology and Informatics provide a curricular entry point for AI and AI Unplugged activities at all grade levels (Ministerio de Educación Nacional, n.d.). Colombia's efforts have been recognized by UNESCO in its global mapping of government-approved AI curricula, highlighting the country's growing leadership in the field.

Stakeholders

The promotion of **AI education** in Colombia involves a diverse network of public, private, academic, and civil society actors, reflecting a whole-of-society approach.

Leadership in the public sector is shared between MinTIC and MEN. MinTIC drives the national AI agenda and training programs such as Colombia Programa and SENATEC, while MEN defines pedagogical and curricular frameworks. These efforts are supported by entities including Computadores para Educar (CPE), responsible for teacher mentoring; SENA, which delivers technical and postsecondary training; and the National Planning Department (DNP), which ensures alignment with long-term policy goals (CONPES). At the local level, regional education secretariats are essential for classroom implementation, as evidenced by the Bogotá innovation labs (Ministerio de Educación Nacional, n.d.-a).

The academic sector contributes to pedagogical research, teacher preparation, and policy dialogue. Leading institutions—such as Universidad de los Andes, the National University of Colombia (Medellín), Pontifical Javeriana University, and EAFIT—conduct research and training programs that inform national and local initiatives. Notably, the Public Algorithm Systems group (Universidad de los Andes, n.d.) focuses on AI governance, while the AI in Education Group (National University) provides teacher support and innovation resources.

Partnerships with the private sector and international organizations further strengthen the ecosystem. The British Council, in partnership with OEI and Intel, has been instrumental in developing computational thinking programs (British Council, n.d.). Major technology companies, such as Google, Microsoft, IBM, and AWS, contribute through social responsibility initiatives and training opportunities, such as Microsoft's AI literacy program for teachers and IBM's SkillsBuild. Meanwhile, specialized educational technology companies are emerging to provide tailored offline solutions for schools.

The role of non-governmental organizations (NGOs) and foundations is equally significant. The Fundación Telefónica Movistar offers free AI courses that emphasize creative and ethical classroom applications (Fundación Telefónica Movistar, n.d.), while the Karisma Foundation advocates for human rights and AI ethics in education (Karisma Foundation, n.d.). Colnodo continues to promote digital inclusion in underserved communities. Collectively, these organizations help ensure that AI adoption reflects Colombia's cultural diversity and supports equitable access.

Challenges and Gaps

Despite these advances, Colombia continues to face persistent challenges, particularly related to connectivity and infrastructure. As of 2023, only 63.9% of households had internet access, with stark disparities between regions (e.g., Vichada 14.5% vs. Bogotá 85.9%), and just 34% of households owned a computer or tablet (MinTIC, n.d.-a). These conditions make offline learning strategies essential for equitable inclusion. Although national training programs—such as Colombia Programa and SENATEC—have achieved impressive reach, classroom-ready offline AI teaching and assessment tools remain unevenly distributed across departments (MinTIC, n.d.-c).

From a regulatory perspective, data protection and ethics frameworks are in place but not fully localized for educational use. The Superintendence of Industry and Commerce (SIC) circular 002/2024 and Law 1581 provide general data safeguards, but most school-based AI pilots lack simplified consent forms and checklists suitable for minors or low-connectivity contexts (MinTIC, n.d.-d). Financial and logistical barriers also persist: funding for teacher release time, printed materials, and linguistic adaptations is limited, especially outside major urban centers. Moreover, few impact evaluations are publicly available, with most reports emphasizing participation rates over measurable learning outcomes—an evidence gap that needs to be addressed.

Recommendations

1. Practical adoption

Colombia should leverage its existing AI education ecosystem, particularly SENATEC and regional innovation labs, to pilot a scalable, offline-first implementation strategy.

Source: Generated by Gemini (2026)

The Digital Learning Week framework and MEN's Curriculum Guidelines on Technology and Informatics could serve as key vehicles for integrating AI Unplugged activities. Priority should be given to departments with low connectivity, emphasizing printed materials, low-bandwidth resources, and teacher mentoring. Over time, the Ministry of Education should work with MinTIC and SENA to standardize these practices within national training programs, transitioning AI Unplugged from a set of isolated experiments into a coherent national readiness initiative.

2. Institutionalize AI-pedagogy routines for teachers

Sustainable adoption depends on embedding AI as a pedagogical tool rather than a technical add-on. Teacher training through SENATEC and CPE should emphasize the human-centered use of AI and include educators from the social and human sciences. Teachers need practical routines for incorporating AI-supported feedback and reflection into lesson planning, mentorship, and collaborative professional development cycles.

3. Build equity-first monitoring and data transparency

Implementation of CONPES commitments must be accompanied by transparent monitoring systems that track equitable access and learning outcomes. Public dashboards and participatory evaluations involving NGOs, universities, and communities should be encouraged. While data protection frameworks exist, schools require simplified, context-sensitive consent tools and publicly accessible impact reports that measure both reach and educational gains.

4. Research translation

To close the evidence gap, Colombia should invest in applied research linking academic innovation to classroom practice. Universities could lead research–policy partnerships to develop and test offline AI assessment tools and pedagogical models. Collaborative communities of practice should facilitate the translation of research into policy guidance, ensuring that ethical and equity considerations remain central.

China

Source: Generated by Gemini (2026)

China is advancing artificial intelligence in education at an unprecedented pace, supported by robust national policies and close collaboration among universities, research institutions, and technology enterprises. Despite substantial achievements in digital infrastructure, educational disparities persist between urban centers and rural or remote areas due to uneven resource distribution and teacher shortages (Fu et al., 2025). In this context, the AIED Unplugged approach functions both as a practical solution for under-resourced schools and as a strategic vehicle for achieving nationwide AI literacy. By prioritizing human-centered learning and adaptability, China's experience highlights how unplugged methods can complement digital expansion to ensure more equitable access to AI education (Guo & Wang, 2025).

Current Practices

To address rural education challenges, China is developing AI-powered support systems that adapt to complex classroom environments and assist teachers' professional growth. Rather than requiring advanced technical knowledge, these systems integrate AI functionalities into everyday teaching tools and workflows, offering continuous and accessible pedagogical support (Wu & Long, 2025).

Researchers are increasingly focusing on classroom practices in rural contexts characterized by heterogeneous infrastructures and limited bandwidth. Edge computing technologies are being explored to map and monitor school environments, providing situational awareness regarding hardware, connectivity, and classroom layout (Yu et al., 2022). Building on these foundations,

local edge servers analyze multimodal data—such as audio and video—in real time to identify teaching behaviors, interaction patterns, and classroom discourse, generating objective profiles of instructional quality. By transferring computational tasks to local servers, this approach reduces dependence on cloud networks and enables routine classroom analysis even in low-connectivity settings (Wu & Feng, 2025).

Following these advances in intelligent assessment, research has shifted toward developing personalized, high-quality instructional support systems for rural teachers. Knowledge graph–based technologies are being designed to organize and recommend educational resources according to teachers' profiles and instructional goals (Lu & Tang, 2025). Large language models are also being leveraged to generate automated, pedagogically grounded lesson plans adapted to local needs (Li & Li, 2024), mitigating challenges related to limited planning capacity and inconsistent instructional design.

To facilitate large-scale deployment, Chinese research teams are constructing cloud–edge–device collaborative architectures that integrate central and regional platforms. The central platform aggregates high-quality resources, trains core models, and manages maintenance, while regional platforms process local data, monitor teaching practices, and deliver tailored services directly to teachers. This distributed system ensures both efficiency and adaptability, supporting the sustainable and secure advancement of AI-enabled rural education (Guo & Wang, 2025).

Beyond academic research, China's education technology ecosystem encompasses national initiatives and commercial practices aligned with AI Unplugged principles:

- Three Classrooms Initiative: A national strategy linking high-quality urban teachers with rural schools through synchronous master teachers, and network classrooms (MOE, 2020). It provides an important framework for exploring AI's supportive role in remote synchronous and asynchronous teaching, particularly where AI can act as an intelligent teaching assistant under poor connectivity conditions.

- National Smart Education Platform for Primary and Secondary Schools: A government-led initiative providing free, high-quality digital resources to all teachers and students nationwide. This platform serves as a reliable and content-rich foundation for AI Unplugged applications, ensuring resource quality and standardization (UNESCO, 2023).

- Localized Deployment of Large Language Models: To reduce dependence on cloud services, many schools are experimenting with lightweight large language models deployed on local servers or edge devices (Wang, 2025). This enables core AI functions - such as automated homework grading and personalized exercise recommendation - to operate on internal networks or even offline.

- Active Participation of Technology Companies: Major enterprises such as iFlytek and Baidu collaborate with education authorities to develop smart education solutions. To accommodate China's diverse connectivity environments, many commercial **AI education** products include offline capabilities or low-bandwidth modes, accelerating the practical adoption of AI Unplugged approaches in real classrooms (Zhang et al., 2025).

Policy Landscape

China's AI Unplugged efforts are anchored in a broader policy framework aimed at achieving digital transformation and reducing urban–rural disparities. Initiatives such as the Modern Distance Education Project for Rural Schools, the Three Links and Two Platforms Initiative (MOE, 2018), and the Three Classrooms Policy (MOE, 2020) have laid a foundation for connectivity and hardware improvement across rural areas. The establishment of the National Smart Education Platform further consolidated equitable access to digital content (UNESCO, 2023).

National priorities also emphasize teacher capacity building. The 20th National Congress Report and the 14th Five-Year Plan underscore the importance of strengthening the rural teaching workforce (Xinhua, 2022). Complementary frameworks such as the New Era Basic Education Strong Teacher Plan (MOE, 2022a) and the Teacher Digital Literacy Industry Standard (2023) (MOE, 2022b) outline systematic approaches to enhancing digital and AI competencies among educators (Zhang & Guo, 2023).

More recently, the Outline for Building an Education Powerhouse (2024–2035) calls for deep integration between AI and education, promoting synergies between large models and pedagogical innovation (CSET, 2025). The Ministry of Education is studying the incorporation of **AI education** into the national curriculum, while municipalities such as Beijing (Feng et al., 2024) and Shenzhen (Zhang et al., 2025) have begun developing local action plans and curriculum frameworks. Collectively, these initiatives create a coherent and multilevel policy environment that supports the institutionalization of AI Unplugged practices.

Stakeholders

Advancing the AI Unplugged agenda in China involves multi-stakeholder collaboration, led primarily by the public sector. The Ministry of Education serves as the central policymaker, setting national strategies through initiatives such as the National Smart Education Platform and the Strong Teacher Plan (MOE, 2022a). Local education departments translate these strategies into concrete actions—organizing pilot projects, promoting technology adoption at the school level, and delivering teacher training to ensure effective policy implementation (Gao, 2025).

The academic and research community underpins this process with theoretical and technological contributions. Leading universities and research institutions focus on addressing structural challenges in rural education informatization through research on teaching ability assessment, classroom monitoring, and human–AI collaborative teaching models (Guo & Wang, 2025). These studies not only drive technological progress but also provide empirical evidence for policymaking and implementation.

Meanwhile, social organizations and private enterprises complement public and academic efforts. Nonprofits and charitable foundations mobilize social resources to promote educational equity, often acting as connectors that introduce innovative technologies to under-resourced schools. Education technology companies—such as Huawei and iFlytek—develop intelligent teaching tools, platforms, and hardware based on AI principles, partnering with local governments and schools for deployment and support. Together, these diverse stakeholders form a synergistic ecosystem that propels the evolution of AI-enhanced education in China (Zhang et al., 2025).

Challenges and Gaps

Despite substantial progress, three main challenges persist. First, infrastructure heterogeneity remains a structural barrier. Rural schools continue to face limited bandwidth, maintenance difficulties, and environmental constraints that restrict access to online resources and hinder the operation of intelligent systems (Jing & Yang, 2025).

Second, teacher capacity and pedagogical integration pose ongoing challenges. Rural teachers often face structural imbalances and gaps in instructional expertise (Zheng & Xue, 2025). While AI is designed to assist rather than replace teachers, some tools and external resources inadvertently override teachers' roles, leading to superficial adoption without meaningful engagement (Ma et al., 2025). The AI Unplugged philosophy stresses that technology should empower teachers, not supplant them. However, effectively embedding AI tools into daily teaching practices to foster genuine human–AI collaboration remains a significant challenge. Continuous professional development and practical training are essential to help teachers integrate these tools effectively (Zhang & Guo, 2023).

Third, personalization and sustainability remain unresolved in China. Despite the existence of extensive digital education repositories, current resource distribution models remain broad and non-personalized (Li & Li, 2024). Transitioning from a search-based to a recommendation-based paradigm requires advanced AI systems capable of analyzing teacher and student needs to deliver targeted resources. Moreover, sustainable implementation remains an unresolved issue: while pilot projects demonstrate potential, few have established viable long-term models. Clear cost structures, service mechanisms, and evaluation frameworks are needed to ensure that AI Unplugged practices can be maintained and scaled effectively across diverse regional contexts (Wu & Feng, 2025).

Recommendations

1. Phased, Contextualized Implementation

China should adopt a phased rollout strategy, aligning AI Unplugged initiatives with national programs such as the National Smart Education Platform and the Three Classrooms Initiative. In the short term, the focus should be on offline-first, teacher-centered intelligent tools for rural areas with limited connectivity—addressing fundamental needs such as automated lesson planning and high-quality resource aggregation. As infrastructure improves, these systems can evolve toward more interactive, data-driven feedback mechanisms that support teacher evaluation and professional growth. In pilot schools and demonstration zones, exploring real-time human–AI collaborative teaching models should be prioritized.

Source: Generated by Gemini (2026)

2. Equity-Focused Monitoring and Data Transparency

Establishing an equity-centered monitoring system is critical to ensure fairness and accountability. Such systems should measure the real-world impact of AI Unplugged practices, tracking resource usage, improvements in teacher competencies, and student learning outcomes. Data should be disaggregated by region, school type, and urban–rural classification to identify disparities and guide targeted interventions. Regular publication of key performance indicators through official channels would enhance transparency and inform evidence-based policymaking.

3. Research Translation and Open Innovation

Collaboration among universities, research institutes, and enterprises should be strengthened to translate foundational **AI education** research into scalable, subject-specific tools. Stakeholders should jointly develop lightweight, open-source models and reference applications that are easily deployable across different contexts. A national community of practice could be established to connect researchers, educators, and policymakers - facilitating the exchange of successful cases, privacy protection frameworks, and impact evaluation data, thereby standardizing and accelerating the national implementation of AI Unplugged.

4. International Cooperation and South–South Learning

China's experiences with AI Unplugged provide valuable models for other countries. Sharing methodologies through platforms such as the Belt and Road Initiative and South–South Cooperation could foster reciprocal learning, while helping to strengthen global educational equity.

South Africa

Source: Generated by Gemini (2026)

South Africa's approach to artificial intelligence (AI) in education is evolving within a dynamic yet deeply unequal context. While national policies such as the National AI Policy Framework (DCDT, 2024) provide a strategic foundation, disparities in digital access, educator preparedness, and institutional capacity continue to shape implementation. Against this background, AIED Unplugged initiatives are emerging as contextually relevant responses to systemic inequities - bridging the gap between policy intent and classroom realities. Through creative, low-tech methods, these efforts expand opportunities for equitable AI literacy and position South Africa as a key contributor to reimagining inclusive, context-sensitive pathways for **AI education** across the Global South.

Current Practices

AI integration in South African education remains in an early but dynamic phase, developing through both national frameworks and local experimentation. Across the system, universities, schools, and NGOs are pursuing context-specific strategies that balance innovation with equity.

In higher education, universities have begun implementing AI literacy and ethics modules (University of South Africa, 2025), publishing institutional guidelines (University of Pretoria, 2025a, 2025b, 2025c; University of Cape Town, 2025a), and piloting responsible uses of generative AI in teaching, learning, and research (Joubert & Kramm, 2023).

The emphasis is practical application, equipping educators and students to use AI responsibly while maintaining integrity and critical awareness of its pedagogical implications. Research collectives at the University of Pretoria, for instance, advance the view of AI as a mindtool, emphasizing its capacity to support cognitive and reflective processes rather than automate them (Callaghan, Stols & Joubert, 2023; Joubert, 2025).

Several universities have institutionalized AI governance mechanisms. The University of Pretoria (UP) and the University of Cape Town (UCT) exemplify dual approaches that combine policy guidance with professional development. At UP, the Department for Education Innovation has issued role-specific frameworks outlining responsible AI use in learning, teaching, research, and supervision, complemented by Lecturer and Student Guides and department-level rules in Geology that operationalize disclosure, integrity, privacy, and data minimization (University of Pretoria, 2025a, 2025b). Similarly, UCT's Centre for Innovation in Learning and Teaching (CILT) has released a suite of practical guides for staff on using AI in assessment, teaching, and professional practice, alongside an institutional AI policy to coordinate faculty implementation (University of Cape Town, 2023, 2025a).

Rhodes University has published comprehensive AI Guidelines (2025) addressing transparency, privacy, and prompting ethics, building upon its earlier brief, 'Learning and Teaching with AI Tools' (2024), while North-West University (NWU) established an AI Hub in 2025 to coordinate policy, training, and research. The Hub's resources include Senate rules on ethical AI use, best-practice research guidelines, and writing checklists to promote transparent scholarly work (North-West University, 2025).

Meanwhile, critical academic discourse continues to expand. The journal CRiSTaL (Critical Studies in Teaching and Learning) remains a key venue for scholarship on equity-centered AI pedagogy and digital integrity (CRiSTaL, 2025). Emerging research explores "post-plagiarism" teaching, in which AI-supported assessment demands new forms of evidence, authorship, and accountability (Eaton, 2025). Collectively, these developments illustrate a higher education system actively negotiating the balance between governance and innovation, translating global AI debates into pedagogical practices grounded in South African realities.

Policy Landscape

South Africa's AI policy environment is establishing itself through a national framework that consolidates existing legislation on privacy, intellectual property, and competition. The National AI Policy Framework (Department of Communications and Digital Technologies [DCDT], 2024) provides a foundational blueprint to position the country as a continental leader in AI development. It promotes talent cultivation, digital infrastructure, research and innovation, ethical principles, transparency, and human-centered design, while acknowledging itself as an iterative, evolving framework open to revision as capabilities and risks develop.

This direction is reinforced by the Artificial Intelligence Institute of South Africa (AIISA), established through a partnership between the University of Johannesburg and Tshwane University of Technology, which fosters centers of excellence and sector-specific AI hubs (University of Johannesburg, 2022).

Core AI governance is anchored in existing legislation, including the Protection of Personal Information Act (POPIA) (Act 4 of 2013), which regulates automated data processing and provides specific safeguards for AI-assisted decision-making (Republic of South Africa, 2013). Intellectual property laws, notably the Copyright Act (Act 98 of 1978) and Patents Act (Act 57 of 1978), govern ownership and protection of creative and inventive outputs, ensuring applicability to AI-generated content (Republic of South Africa, 1978a, 1978b).

Stakeholders

AI in South African education is shaped by a multi-actor ecosystem spanning government, universities, and scholarly communities. At the national level, the DCDT provides strategic direction through the National AI Policy Framework and AIISA. In basic education, the Department of Basic Education (DBE) promotes foundational digital and computational literacies through the Coding and Robotics Curriculum Framework (Department of Basic Education, 2021), which many institutions and NGOs align with in designing low-bandwidth and unplugged learning activities.

Within higher education, universities operationalize governance and capacity building through policy documents and professional training. UP, UCT, NWU, Rhodes University, and UNISA have each developed institutional guidelines and frameworks addressing integrity, privacy, disclosure, and ethical use of generative AI.

The scholarly community plays an essential role in reflexive practice and norm-setting. The journal CRiSTaL and associated contributions (Eaton, 2025) have foregrounded the importance of trust, integrity, and equity in **AI education**. Together, these stakeholders connect national policy direction with institutional action, ensuring that AI integration in education advances within an ethically grounded and pedagogically sound framework.

Challenges and Gaps

Despite a strengthening policy and institutional landscape, South Africa faces systemic and contextual barriers to advancing AI in education. These challenges are multidimensional, encompassing equity, capacity, and the operationalization of policy into pedagogical practice.

Persistent infrastructure disparities limit equitable participation. While urban universities and well-resourced schools can experiment with AI-enhanced learning, many rural and township institutions continue to face limited connectivity and device access, reinforcing existing inequalities.

Teacher readiness remains a major constraint. Professional development often prioritizes tool proficiency over pedagogical integration, leaving educators uncertain about how AI aligns with curriculum outcomes and supports learner development.

Ethical and equity concerns further challenge implementation. Without robust institutional frameworks, there is a risk that AI systems trained predominantly on Global-North data reproduce cultural biases, while unequal digital fluency exacerbates educational disadvantage.

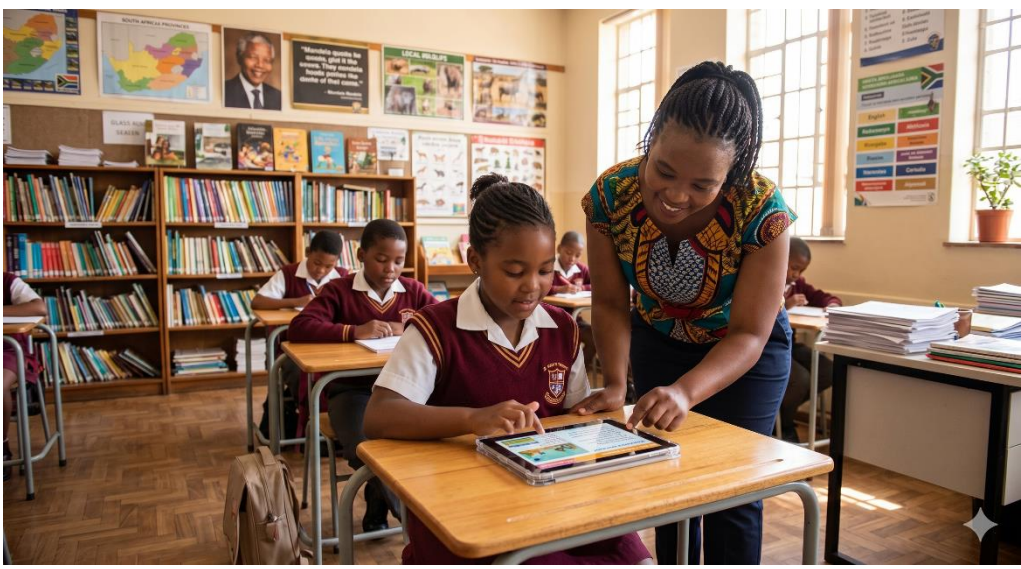
Although the National AI Policy Framework (DCDT, 2024) and institutional guidelines articulate clear objectives, the gap between policy design and classroom implementation persists. Clauses on academic integrity, privacy, and disclosure are not yet consistently embedded across faculties and disciplines. Translating high-level frameworks into discipline-sensitive practices remains an ongoing challenge. Meanwhile, the rise of "post-plagiarism" assessment paradigms also presents new complexities in evaluating student work (Eaton, 2025).

While universities have begun incorporating integrity and disclosure requirements into module guides, sector-wide clarity on provenance, oral defense, and workflow integration remains incomplete. Progress will depend on fostering new literacies around authorship, verification, and ethical AI use—moving beyond detection-based models toward approaches that cultivate trust, transparency, and critical engagement.

Recommendations

1. Strengthen Foundational AI Literacy

The National AI Policy Framework (DCDT, 2024) identifies capacity development as a strategic pillar. Universities and schools should embed baseline AI literacy within curricula as a component of digital citizenship, rather than a purely technical competency. Introductory courses, community workshops, and open-access resources can bridge national awareness gaps and promote responsible, transparent AI engagement.



Source: Generated by Gemini (2026)

2. Position AI as a Mindtool in Education

Institutions should move beyond efficiency-driven adoption toward pedagogical integration. Framing AI as a mindtool - supporting representation, interactivity, and distributed cognition - aligns with existing AI guidelines emphasizing transparency, privacy, and ethical purpose. This perspective situates AI as a catalyst for deeper learning rather than a substitute for human agency.

3. Develop Assessment Redesign Toolkits

As assessment practices evolve under “post-plagiarism” conditions, sector-wide toolkits are needed to guide redesign. Drawing on integrity scholarship (Eaton, 2025), institutions should co-create frameworks that include authentic task design, AI-use statements, oral verification, and artifact provenance. Such toolkits would move assessment beyond punitive compliance models toward pedagogically grounded, ethical, and equitable use of **AI in education** (Joubert, 2025a; 2025b).

4. Bridging the Gaps: AIED Unplugged Across Countries

Source: Generated by Gemini (2026)

Across Brazil, Colombia, China, and South Africa, the integration of artificial intelligence in education, particularly through AIED Unplugged approaches, reveals converging priorities but also distinct trajectories shaped by infrastructure, governance, and pedagogical priorities. Brazil and Colombia demonstrate how offline-first models can expand AI's reach in low-connectivity contexts, transforming infrastructural constraints into opportunities for creative, human-centered learning. China exemplifies systemic integration, where large-scale policies and technological ecosystems, including edge computing and knowledge-graph tools, enable continuity across urban and rural schools. South Africa, in turn, highlights a governance- and ethics-oriented pathway, underscoring the translation of responsible AI principles into institutional and pedagogical practice.

When viewed comparatively, these cases point to recurring themes and differentiated strategies ***(summarized in Table 1)***. Common across all contexts is the recognition that AI integration requires more than technology, it depends on teacher professional development, contextualized curriculum design, and inclusive governance frameworks. Hybrid architectures that combine online and offline capabilities are emerging as viable models, especially when coupled with robust data governance, privacy, and ethical literacy. However, persistent challenges, including unequal connectivity and infrastructure, limited localized content, and scarce longitudinal evidence of learning impact, continue to constrain scale and sustainability.

Table 1. Comparative Overview of AIED Unplugged Across Four Countries

Country	Context / Setting	Main Challenges	Key Innovations & Practices	Recommendations / Pathways Forward
Brazil 	Strong national momentum on school connectivity (ENEC) and a mature AIED research ecosystem; active NGO–state partnerships.	Unequal infrastructure across regions; need for local language and culturally relevant content; limited long-term evaluation.	Offline-first learning tools (e.g., MathAlde), AI-supported writing platforms (e.g., Letrus); integration of AI literacy in basic education.	Sustain investments in teacher training and regional adaptation; strengthen evidence generation and longitudinal monitoring; expand South–South knowledge exchange.
Colombia 	Expanding AI education with strong emphasis on inclusion and unplugged methodologies, particularly for low-connectivity areas.	Connectivity gaps (especially in rural areas); uneven access to devices and offline assessment tools; limited data governance literacy.	Offline-first teacher training (CPE, SENATEC); use of printed kits and low-tech simulations; alignment with national AI and education policies.	Develop national guidelines for offline AI learning; fund local-language materials; create ethical and data protection toolkits tailored to schools.
China 	National AI strategy supports rapid expansion of AI education; strong public–private and academic collaboration.	Uneven teacher quality and resources in rural areas; risk of urban–rural digital divide; limited focus on ethics in K–12 curricula.	Large-scale AI literacy initiatives; use of edge computing and knowledge graphs for adaptive learning; AI used as teacher-assistive technology.	Deepen ethical literacy and AI governance in education; expand teacher capacity-building in under-resourced regions; promote localized, context-aware applications.
South Africa 	Consolidated policy and ethical frameworks; growing institutional experimentation with AI in higher education and schools.	Infrastructure disparities (urban–rural); limited teacher preparedness for AI pedagogy; uneven policy implementation.	Institutional guidelines for AI use; emphasis on academic integrity and "post-plagiarism" assessment redesign; inclusion of AI ethics in curricula.	Translate policy into classroom-ready practice; promote discipline-specific AI literacy; invest in connectivity for township and rural schools; strengthen equity monitoring.

Source: Generated by Gemini (2026)

Taken together, the findings affirm that AIED Unplugged is not merely a transitional response to technological scarcity, but a forward-looking pedagogical and ethical framework. It redefines innovation through inclusion, positioning low-tech and offline learning as integral to the global **AI education** ecosystem rather than peripheral to it. Moving forward, the next phase of AIED Unplugged should focus on strengthening cross-country collaboration, investing in evidence generation, and developing adaptable models that respond to diverse linguistic, cultural, and infrastructural realities. By bridging digital divides while centering human agency and creativity, AIED Unplugged represents a promising pathway toward more equitable, resilient, and context-sensitive **AI education** worldwide.

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