

Beyond the Access Paradox: Infrastructure, Epistemic Friction, and Inclusive Pedagogy in the GenAI-Enabled Landscape of Indian Rural Classrooms

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ABSTRACT

The rapid expansion of India's digital infrastructure has transformed the means of acquiring, producing, and disseminating knowledge. However, the emergence of an increasingly artificial-intelligence-driven digital society has not bridged the rural-digital divide. The growing availability of smartphones, internet connectivity, and 5G networks has instead created an "access paradox." This paper identifies digital inclusion in rural learning environments as a gradual and continuous process of infrastructural adaptation. According to the Annual Status of Education Report (ASER), National Digital Infrastructure Development and the National Education Policy (NEP) 2020 policy framework, first-tier barriers such as unreliable power, network instability, hardware limitations and affordability are largely directly related to second-tier barriers such as uneven digital skills and teacher training, pedagogic approaches, linguistic constraints, and differences in household and group-level digital literacy. This disparity is largely linked to linguistic, cultural, pedagogical and experiential knowledge systems, which create epistemological asymmetries. Such asymmetries are particularly significant in rural classrooms, where limited capacity to evaluate, adapt, produce and meaningfully use knowledge acquired through digital means can coexist. This paper explores the dual potential of GenAI. While technological, linguistic, algorithmic, and infrastructural barriers can reproduce inequality, GenAI can also enrich a platform for inclusive education through personalised learning, local language translation, knowledge mediation, heterogeneous instructional support, and teacher support. The paper emphasises that GenAI can never be a substitute for a teacher, primary education, or situational knowledge. However, it can serve as a tool for local identity formation and for expanding participation. Accordingly, the paper establishes a participatory and community-centred model of GenAI-enabled rural education with the goal of epistemological equity, social justice, and human empowerment.

Keywords: AI-Integrated Rural Classrooms, Digital Divide 3.0, GenAI-Enabled Pedagogy, Epistemic Friction, Inclusive Education, Rural Education

In the early decades of educational expansion in rural India, public policy and philanthropic investments focused heavily on institutional inputs, classroom construction, and enrolment targets. Relative enrolment metrics suggest a high level of schooling, but the primary indicators of education have been disappointing (Chavan, Pratham, 2024, p. 6). Although almost everyone in India is enrolled

in its K-12 system, which has some 250 million students, there is a major "access disparity." As

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Sharma and Thomas (2026) recommend, despite increased external participation, Indian education has not delivered learning, as evidenced by the lack of deep knowledge and confidence among rural students. This necessitates targeted educational interventions, as the expansion of infrastructure alone is essentially inadequate for equitable outcomes (Sharma & Thomas, 2026). In response to this educational stagnation, successive waves of digital technologies have been introduced to revolutionise education in low-resource settings. This digital transformation gained momentum during the COVID-19 pandemic, which served as a massive reality check and forced rural communities to adopt digital learning methods (Chavan, Pratham, 2024, p. 6).

The Illusion of Device Ubiquity

The ultimate consequence of this historic shift has been the widespread proliferation of hardware. According to recent long-term data from the Annual Status of Education Report (ASER), smartphone ownership in rural India has increased from 36% in 2018 to over 74% in 2022 and is set to reach an unprecedented 84% in 2024 (Pratham, 2024, pp. 6, 64). 90% of boys and girls aged 14 to 16 reported having a device in their household (Pratham, 2024, p. 9). This near-universal availability exposes a complex “availability paradox,” or “apparent paradox of access.” However, the availability of smartphones in households exceeds personal smartphone ownership among adolescents aged 14-16, rising from 19.6% to 31% in a year (Pratham, 2024, pp. 11-12). Furthermore, this personal ownership is characterised by a pronounced gender gap, with 36.2% of boys reporting owning a smartphone compared to only 26.9% of girls (Pratham, 2024, p. 11). This disparity highlights the limitations of traditional, device-centric approaches to the digital divide. Historically, the term “digital divide” was defined in a binary, have/have-not fashion, focusing almost exclusively on the physical presence of hardware and connectivity. However, as technology penetrates deeper into marginalised communities, academics and policy planners have recognised that a bipolar split is inaccurate. Meaningful access exists in gradations and is deeply embedded in a complex network of physical, digital, human, and social resources (Warschauer, 2003, p. 4).

In rural families, human and social educational resources are extremely limited. First, more than 40% of mothers of school-going children are either completely illiterate or have completed less than grade five, and another 40% have only completed grades six to ten (Chavan, Pratham, 2024, p. 7). This insufficient and moderate education for mothers is a major barrier to their becoming technologically savvy, and they are significantly less able to help their children solve technological problems or guide their digital interactions. As a result, parental hesitation, driven by deep distrust and fear of the online environment, is increasingly limiting students’ opportunities to use mobile devices unsupervised (Warschauer, 2003, p. 220). Smartphones might be a primary tool for developing 21st-century skills and knowledge, and for staying updated on the news. However, it is primarily used as a passive carrier of entertainment or video reels (Chavan, Pratham, 2024, p. 7). 76% of rural children reported using a smartphone for social media in a given week. Only 57% of users use it for any educational purposes (Pratham, 2024, pp. 11, 143). Physical presence alone does not guarantee meaningful cognitive engagement.

The Failure of Minimally Invasive Models

The limitations of device-only strategies are further highlighted by the historical failure of “minimally invasive” technology models. In 2000, the government of New Delhi, in collaboration with an information technology corporation, launched the “Hole-in-the-Wall” experiment in one of the city’s poorest slums (Warschauer, 2003, p. 211). The project consisted of an outdoor five-station computer kiosk, where monitors, joysticks, and buttons protruded through holes in a brick wall, providing street children with unguided, 24-hour dial-up internet access (Mitra, 1999, p. 12). Operating on the assumption that children could learn autonomously at their own pace without adult supervision, the design intentionally omitted instructors. Initial evaluations praised the initiative and found that children quickly learned to perform basic mechanical tasks on their own, such as launching simple applications like Paint or Microsoft Word and playing simple games. However, long-term monitoring of the kiosk revealed a completely different educational reality. The unmaintained

dial-up internet seldom functioned, there were no structured educational applications, and the software completely lacked local-language content in Hindi, the only language the children knew (Warschauer, 2003, p. 211). Lacking any adult instruction or community integration, children spent almost all their time playing simple video games or drawing. Parents in the neighbourhood expressed deep concern that the lack of organised instruction diminished the kiosk's value, complaining that their children's schoolwork suffered as they spent their free time playing games at the wall (Warschauer, 2003, p. 211, 237). Ultimately, the community came to realise that minimally invasive education was, in practice, minimally effective education.

The failure of the Hole-in-the-Wall model demonstrates a fundamental principle of educational technology: tools are not independent, external variables that can be injected into a community to automatically produce cognitive development. As sociological and pedagogical research indicates, human activity is mediated by tools. However, a physical tool only alters the structure of mental functions when it is actively integrated into a socially supportive practice (Warschauer, 2003, p. 4, 213). Meaningful learning is situated within social interactions and structured mentorship, rather than isolated interactions with a screen (Patel, 2018, p. 9). Although independent use of technology teaches basic procedural skills, it fails to develop critical thinking, structured communication, and higher-

order problem-solving skills, which are required for 21st-century technological literacy (Warschauer, 2003, p. 145). The integration of high-quality educational technology cannot rely solely on the availability of individual computers. It requires a skilful guide to mentorship, structured curricular coordination, and local social support to avoid degenerating into passive consumption and rote training (Warschauer, 2003, pp. 145, 209).

School-Centric Offline GenAI: An Opportunity to Uplift

In economically disadvantaged rural communities, government schools are the primary and often the only institutional setting where disadvantaged students have access to modern computer technology (Sampath Kumar and Shiva Kumara, 2018, p. 158; Sampath Kumar *et al.* 2014, p. 267). However, rural government schools face external resource constraints that pose major barriers to Internet-based technological activities. Chief among these is chronic power outages, which pose a major operational constraint to school computer laboratories (Sampath Kumar and Shiva Kumara, 2018, p. 156). The "bandwidth pipe" exacerbates this infrastructure deficit; slow connections, high prices for satellite data, and unreliable broadband networks cause online educational media to constantly pause, buffer, and waste time (Sundeen & Sundeen, 2013, p. 461). Instead of relying on expensive, continuous cloud connectivity that is easily disrupted by local

Table 1: Household Smartphone Access, Ownership Gender Gaps, and Usage Patterns

Dimension	Indicator	Percentage	Interpretation
Household Access	Household smartphone availability (2018)	36%	Early stage of rural household digital penetration
Household Access	Household smartphone availability (2022)	74%	Rapid expansion of smartphone availability
Household Access	Household smartphone availability (2024)	84%	Near-saturation of household-level device availability
Personal Access	Personal smartphone ownership among 14–16-year-olds	31%	Household availability does not ensure individual ownership
Gender Gap	Boys owning a smartphone	36.2%	Higher personal access among boys
Gender Gap	Girls owning a smartphone	26.9%	Persistent gender disparity in personal ownership
Usage Pattern	Smartphone use for social media	76%	Social/recreational use remains dominant
Educational Use	Smartphone use for educational activities	57%	Educational use remains substantially lower than social-media use

Source: Compiled from ASER 2024 data as reported by Pratham (2024, pp. 6, 9, 11–12, 64, 143).

infrastructure failures, we propose the integration of localised, offline Generative Artificial Intelligence (GenAI) hosted directly on local school servers and school intranet systems (Goh & Kale, 2015, p. 20; Warschauer, 2003, p. 210).

Recent technological advancements have made it highly cost-effective to deploy specialised, compressed Large Language Models (LLMs) on local school hardware, bypassing the need for an active external internet connection. By establishing an offline school intranet, the rural public school becomes a self-contained, intellectually rich “intelligent space” (Goh & Kale, 2015, p. 20). Under this model, the school provides a centralised environment in which students’ questions about “what, where, and how” can be answered directly by an intelligent device, relieving families of the economic burden of individual device ownership (Chavan, in Pratham, 2024, p. 318). Furthermore, offline GenAI directly addresses the historical barrier of language. Rather than forcing rural students to navigate English-dominated software, local GenAI engines can provide real-time, oral and written translation and scaffolding in local languages (Pratham, 2024, p. 331). By deploying offline GenAI on school servers, educational planners can bypass both household socio-economic inequalities and erratic external network constraints, providing rural students with a highly resilient, equitable, and pedagogical framework to master 21st-century cognitive skills within their daily classroom community (Florian & Black-Hawkins, 2011, p. 814; Warschauer, 2003, p. 209).

Theoretical Framework: Epistemic Friction, Situated Learning, and Inclusive Pedagogy

If digital interventions are implemented in rural education without testing and monitoring, this framework will demonstrate the failure of a top-down technology-based education system. Cloud-based technology imposed on schools with limited resources, without considering local infrastructure, becomes a bottleneck. They ignore first-order barriers, such as electricity deficits and the “bandwidth pipe” bottleneck (Sundeen & Sundeen, 2013, p. 461), and bypass localised linguistic and cultural practices (Sher, 2016, p. 8). Because they are designed for an idealised, high-bandwidth environment that does not exist in rural village

schools, they experience a catastrophic breakdown in veridicality (Sher, 2016, p. 8). To avoid empty, trivialised applications that lack connection with reality, this paper adopts Sher’s methodology of “foundational holism” (Sher, 2016, p. 20, 61). Instead of assuming a rigid ordering where schools must wait for complete national connectivity, we employ a Neurathian model: we rebuild our educational system from within, utilising local school-level server intranets and offline digital resources as sturdier footholds to mend our “boat” at sea (Sher, 2016, p. 40, 62).

Pedagogically, our framework shifts learning away from individual, decontextualised cognitive processing toward active participation in “communities of practice” (Lave & Wenger, 1991, cited in Patel, 2018, p. 11). Situated learning theory argues that “learning is dependent on its social situation” and emphasises relationships situated within a social context rather than isolated cognitive tasks (Patel, 2018, p. 11). Lave and Wenger challenge the traditional educational psychology model, which treats learning as a series of decontextualised internal steps like acquisition, analysis, and application; asserting that “the mind as an independent factor, stripped of its context, has no power in explaining learning activities” (Patel, 2018, p. 11, 20, 24). Under this model, mastery of a practice, whether tailoring among the Vai of Liberia (Scribner & Cole, 1981, cited in Patel, 2018, p. 19) or digital literacy in rural schools, occurs through “legitimate peripheral participation” (Lave & Wenger, 1991, cited in Patel, 2018, p. 12). Newcomers enter a community as fringe players, gradually moving toward “full participation” as they absorb the culture, language, and shared identity of the practitioners (Patel, 2018, p. 12, 172). This pedagogical shift demands that technology integration support peer interaction, collaborative writing, and contextualised problem-solving (Patel, 2018, p. 15).

Traditional educational technology interventions often rely on a “transmission” or a highly individualised “constructivist” perspective, where a student sits in isolation before a monitor (Warschauer, 2003, pp. 119-120). This neglects the social capital and communal networks vital for learning in under-resourced settings (Warschauer, 2003, p. 120, 152). When digital tools are stripped of

their social environment, students struggle to form a confident “identity of practice” as technology users, feeling that computers are “too far from reality” and meant only for “smart people” (Stanley, 2001, cited in Warschauer, 2003, p. 121). An offline GenAI model hosted on local school servers directly supports situated learning by acting as a collaborative, multilingual scaffolding (Warschauer, 2003, p. 120). Rather than encouraging screen-centric behaviour, the offline GenAI engine, connected to a document camera or projector, serves as a shared conversational partner that stimulates group debates, peer-to-peer modelling, and co-intentional problem-solving in the students’ native language (Warschauer, 2003, pp. 107, 120).

Lani Florian’s Inclusive Pedagogy

Lani Florian’s concept of “inclusive teaching” offers a radical departure from the “additional needs” model that still dominates special and remedial education. Conventional methods rely heavily on what (Florian and Black-Hawkins, 2011, p. 813) term “bell-curve thinking about competence.” This is an inherently fatalistic mindset that imposes a rigid hierarchy in the classroom, unfairly categorising students into strict binaries of “gifted” or “weak” (ASER, 2024, p. 3). Under the additional demand approach, teachers attempt to accommodate diversity by providing something “different” or “extra” to what is typically available to the majority, and often rely on differentiated and simplified worksheets (Florian & Black-Hawkins, 2011, pp. 814, 819). While well-intentioned, this segregation strategy often leads disadvantaged learners to feel that “they are not as good as others” and to suffer “shame and stigma” when given easier tasks (Florian & Black-Hawkins, 2011, pp. 819–822).

In contrast, inclusive pedagogy shifts the focus from “providing for all by differentiating for some” to “extending what is generally available to everybody” (Florian & Black-Hawkins, 2011, p. 813). Teachers need to build a “rich learning community characterised by learning opportunities that are sufficiently made available for everyone, so that all learners can participate in classroom life” (Florian & Black-Hawkins, 2011, p. 814) rather than dividing students into specialised interventions. Digital learning transformed rural classrooms; it should do so without deterministic ability groupings and

without labelling students who are under-resourced as inherently ‘deficient’ (Florian & Black-Hawkins, 2011, pp. 819–820).

Localised, offline GenAI directly addresses this inequity by transforming the typical classroom environment. Offline GenAI offers a highly “elastic and creative” resource, rather than relying on software to place students in fixed capability bands (Nind, 2005, cited in Florian & Black-Hawkins, 2011, p. 819). It enables teachers to create open-ended ‘work choice’ matrices, individual maths puzzles and adaptive reading prompts available to the whole class (Florian & Black-Hawkins, 2011, p. 819–820). The provision of rich, multi-sensory cognitive scaffolds for all respects human differences without the marginalising effects of pre-determining individual learning potential (Florian & Black-Hawkins, 2011, p. 820, 825).

Forcing a single curriculum across vastly unequal socio-economic landscapes fractures the learning process. The issue is not a lack of student capability, but a lack of relatability. Picture a rural student staring at a maths problem about digital subscriptions, or trying to understand thermodynamics through the mechanics of air conditioners (Sharma & Thomas, 2026). The disconnect is instant. Generative AI intervenes here as a translator of context. It gives educators a practical way to reshape these alien examples into familiar, lived realities, stripping away the barriers that make abstract concepts feel untouchable. Running these AI models offline, directly on school servers, rewrites the educational technology debate in the Global South. We must stop viewing local networks as a ‘make-do’ backup plan for underfunded areas. Instead, this approach acts as a robust decolonial framework. For decades, standard individualised computing models have isolated students behind individual screens. This architecture fuelled cultural alienation, demanding that users conform to English-dominant standards and purely transmissive, commercial software (Warschauer, 2003, p. 115). Offline AI dismantles that hierarchy. Operating as a multilingual, speech-enabled assistant, it turns the room back into a shared, dialogic space, an environment where, as Freire (1970, p. 75) notes, “people teach each other through the mediation of the world.” These offline networks push back against context-blind rote memorisation. They spark group problem-

solving and collective creation, ensuring that regional languages and identities hold their ground. Ultimately, the student stops being a passive recipient of pre-packaged digital content and emerges as a critical co-investigator in their own education.

Realising this shift means educational planners and philanthropists must drastically rethink their strategies. Pouring money into the unstable distribution of household-level hardware is a dead end. Capital must pivot towards reinforcing local infrastructure and school-based intranets (Goh & Kale, 2015, p. 16). Leaving generative AI access to private market forces will only deepen the regional and class divides we are actively trying to erase (Warschauer, 2003, p. 209; Chavan, 2024, p. 15). The alternative demands public funding. Schools need to be established as self-contained “intelligence spaces” where intellectual exploration happens naturally in a student’s mother tongue (Chavan, 2024, p. 15). This school-centred architecture also rewires the teaching profession. Stripped of the daily exhaustion of generating rote lesson plans, educators can finally focus on deep classroom mentoring and high-quality “epistemological care” (Johnson, 2019, p. 265). Build a resilient, offline public digital infrastructure, and rural Indian schools can reclaim their status as intellectually dynamic centres of social justice. When technology serves as a tool for social action rather than a vector for passive consumption, it drives true epistemic equality.

Amartya Sen’s Capability Approach & Community Agency

What makes the digital equity review, in light of Amartya Sen’s capability approach, unique is that it provides a normative framework at the intersection of sociology and economics; it shifts the focus from the dissemination of physical goods to the extension of substantive human freedoms (Sen, 1999, p. 3). In Sen’s view, the development of individuals’ ‘capability’ means not only an expansion of the opportunities and freedoms people have, but also the ability to lead a life worth living (Sen, 1999, p. 18). Within this framework, education and literacy are not economic inputs. Rather, they are ‘instrumental freedoms’ that enhance the ability to engage in public discourse, make informed

decisions, and define one’s values and preferences (Sen, 1999, pp. 293-294). Therefore, achieving digital equity goes beyond the ‘service delivery’ of technology, which includes the ‘smartphone dumping’ in villages without adequate support (Warschauer, 2003, p. 152; Castells, 2000, as cited in Salinas & Sánchez, 2009, p. 574). True inclusion is achieved through technology that promotes local community agency and collective problem-solving (Warschauer, 2003, p. 152).

We put Sen’s capability approach to work in our project by setting up an offline GenAI in schools. This approach serves as an alternative to the dependency model of expensive cloud-based services, which can be disrupted by equally expensive and erratic bandwidth. The school, in this case, becomes an “Intelligent Hub” (Chavan, in Pratham, 2024, p. 6; Goh & Kale, 2015, p. 20), controlled and managed in-house. By making the hub/school the centre of architecture in an offline GenAI set-up, local teachers, parents, and District Institutes of Education and Training (DIETs) can co-design and co-create resources, thereby ensuring community agency and building community solidarity (Botha, 2017, p. 399; Pratham, 2024, p. 7). Offline GenAI bypasses the exclusionary linguistic and financial hurdles that characterise cloud-centric software, providing rural students with a resilient pathway to develop critical, 21st-century digital competencies (Sampath Kumar & Shiva Kumara, 2018, p. 158). Ultimately, this model transitions rural education from passive digital consumption to active, democratic human capability, turning technology into a genuine instrument of social justice and epistemic equity (Sen, 1999, p. 294; Florian & Black-Hawkins, 2011, p. 813).

Glimpses of Realities of Rural Indian Classrooms

To meaningfully utilise modern digital tools for learning, educational solutions must specifically understand and design around the challenges faced by rural classrooms. This chapter identifies the challenges faced by rural schools in India at both the operational and pedagogical levels by describing Peggy Ertmer’s (1999) two-barrier framework that is used in rural technology initiatives (Botha & Herselman, 2015, p. 19; Botha, 2017, p. 6). First-order barriers, for Ertmer, are resource-based and

external to the teacher. In contrast, second-order barriers are pedagogy-based and ingrained in the teacher's deep-held beliefs, attitudes, and culture. The combination of both levels of barriers in under-resourced rural public schools presents a profound "home-school disconnect" (McClure & Pilgrim, 2021, p. 8). Whether you are a researcher, an educator, or an advocate, understanding complexity and friction is the first step towards developing digital learning resources that do not further exacerbate existing social inequities.

First-Order (Extrinsic) Barriers: Infrastructure and Bandwidth

For rural school computer labs, first-order problems are the most obvious disruptions in day-to-day operations. Of particular concern are persistent "power failures." Empirical data gathered by Sampath Kumar and Shiva Kumara (2018) in rural high schools indicates that electric power failure is regarded by rural students as the single most severe obstacle to computer integration, recording a staggering mean trouble score of 2.75 out of 3.0 (Sampath Kumar & Shiva Kumara, 2018, p. 164). This infrastructure deficit is heavily exacerbated by the widespread absence of Uninterrupted Power Supply (UPS) systems in school computer laboratories, meaning that even a minor, localised voltage fluctuation or routine rolling blackout completely terminates scheduled computer instruction, corrupts local files, and damages sensitive hardware (Sampath Kumar & Shiva Kumara, 2018, p. 166). As a direct consequence of these persistent electrical disruptions and hardware shortages, only 20.66 per cent of rural Indian students can use computers for academic purposes, compared to nearly 70 per cent of their urban peers (Sampath Kumar & Shiva Kumara, 2018, p. 156).

This electricity bottleneck is made worse by the "bandwidth pipe" bottleneck that constrains learning over the internet in remote areas. Internet bandwidth (as perceived in rural areas) can be thought of as capacity. The "pipe" in this analogy is not big enough to fill the media requirements of most schools today (Sundeen & Sundeen, 2013, p. 12). Rural schools constantly pay the price of slow internet and high data transmission costs, resulting in problems such as media skipping and buffering (Sundeen & Sundeen, 2013, p. 12; Kormos, 2018,

p. 4). An unreliable, congested network makes advanced teaching methods and techniques using cloud-based tools completely ineffective in the classroom, as teachers cannot download, display, or stream files due to inconsistent connectivity (Kormos, 2018, p. 4). When rural teachers face connectivity issues, traditional digital tools stop working, forcing them to revert to older non-digital methods.

Second-Order (Intrinsic) Barriers: Pedagogical Beliefs and Training

Overcoming physical infrastructure challenges is one thing, but removing only first-order barriers is not enough to support technology-enhanced learning when second-order barriers remain. Second-order barriers describe the cognitive and philosophical obstacles to change that are usually based on teachers' beliefs and attitudes about classroom teaching and learning, as well as the role of technology (Ertmer, 1999, p. 47; Botha, 2017, p. 6). Several schools maintain strongly traditional, teacher-centric beliefs and attitudes toward technology; to them, technology is just a more efficient way for students to write on the board (Botha, 2017, p. 6). While teachers in affluent, suburban districts utilise digital tools to foster constructivist, project-based learning (PBL), teachers in disadvantaged or rural schools are twice as likely to restrict technology use to basic "drill-and-practice" software or rote presentation tools, placing a cognitive ceiling on students' digital interactions.

This pedagogical limitation is directly maintained by a major "training gap" in professional development initiatives. Standard teacher training courses in rural areas focus almost exclusively on basic mechanical computer operations, such as turning on a laptop, setting an alarm, or operating standard word processors, rather than developing sophisticated, technology-enhanced inquiry skills (Goh & Kale, 2015, p. 4). This technologically deterministic approach fails to provide teachers with "Technological Pedagogical Content Knowledge" (TPACK), which is the integrated understanding of how technology, pedagogy, and specific subject content intersect (McClure & Pilgrim, 2021, p. 7). Professional development workshops are typically "one-time," transmissive events that fail to provide teachers with opportunities to discuss, observe,

Table 2: Classification of Technological Barriers in Rural Classrooms

Barrier Classification	Theoretical Focus	Rural Empirical Reality
First-Order (Extrinsic)	External, structural resource deficits, including hard equipment availability, electrical power supply, network conduits, and operational timetabling.	Electrical failure is the highest-scoring hurdle (mean: 2.75). Only 20.66% of rural Indian students have access to computers at school due to chronic outages and a lack of UPS systems.
Second-Order (Intrinsic)	Internal, cognitive, and cultural structures, including teachers' beliefs about education, technological self-efficacy, and pedagogical competencies.	Teachers restrict the use of devices to drill-and-practice rote exercises. Disproportionately high rural teacher turnover forces schools back to baseline mechanical training, preventing TPACK development.

Source: The Digital Divide in India: Use and Non-Use of ICT by Rural and Urban Students.

or model pedagogical integration within their specific rural constraints (Goh & Kale, 2015, p. 16). Furthermore, the development of a consistent, long-term technological-pedagogical strategy is severely disrupted by high teacher turnover and shortages in rural public schools (Kormos, 2018, p. 4). Teacher attrition rates are disproportionately higher in rural schools than in urban or suburban schools. A significant number of rural school teachers leave their jobs each year, forcing school administrators to recycle their professional development budgets. As a result, they repeatedly return to basic, mechanical training rather than “moving forward” toward integrating advanced, inquiry-based technological teaching methods (McClure & Pilgrim, 2021, p. 6). This discontinuity prevents the formation of a collaborative “workplace community” and ensures that rural schools remain stuck in the very early, rudimentary stages of technology adoption.

Parental Dilemma and Illiteracy

The barriers to digital learning in rural India not only exist within the physical walls of the classroom but also manifest as a profound “home-school disconnect.” This disconnect limits students’ ability to engage with digital curriculum outside of school hours (McClure & Pilgrim, 2021, p. 8). At the core of this disconnect is the high level of maternal educational deprivation in rural households. According to Madhav Chavan, noted in the Annual Status of Education Report (ASER) longitudinal surveys, over 40 per cent of mothers of school-aged children in rural India are entirely unschooled or have completed less than Std V. An additional 40 percent have completed only basic schooling between Std VI and X (Chavan, in Pratham, 2024,

p. 7). This severe educational deficit leaves parents less technologically literate and significantly less able to guide their children with online questions (McClure & Pilgrim, 2021, p. 8).

This lack of technological competence in families is also reflected in the complete lack of communication infrastructure: although parents can respond to text messages, most parents in rural areas do not have active email addresses, which have become the main administrative means for teachers to coordinate digital learning, distribute homework, and provide support at home (McClure & Pilgrim, 2021, p. 8). For those whose parents are completely unable to support digital tasks, teachers are forced to double their workload and create parallel offline and online homework arrangements for those students (McClure & Pilgrim, 2021, p. 8). This technical gap is heavily compounded by “parental hesitancy” and a profound lack of trust and fear regarding digital environments. Rural parents are generally unwilling to allow their children to use smartphones or computers, expressing concerns that unsupervised access will expose children to inappropriate content or distract them from their traditional academic duties (McClure & Pilgrim, 2021, p. 8; Warschauer, 2003, p. 220). Parents argue, “We did not have technology when we grew up, so why do our children need it now?” (McClure & Pilgrim, 2021, p. 8). Consequently, smartphones in rural households are kept under strict parental custody. When they are used for educational purposes, they are restricted to serving as passive “carriers of worksheets” or video files that merely substitute for missing physical textbooks, rather than being utilised as interactive, 21st-century cognitive tools at all (Chavan, in Pratham, 2024, p. 7).

The Core Intervention of Localised, Offline GenAI on School Servers

Enhancing School Intranet Systems

To overcome the persistent digital divides that disrupt rural education, public policy must shift away from the expensive and often unreliable model of continuous cloud connectivity toward localised, school-centric infrastructure. In rural school settings, erratic electrical grids and limited bandwidth represent severe first-order, extrinsic barriers that consistently paralyse standard internet-dependent initiatives (Ertmer, 1999, p. 47; Sampath Kumar & Shiva Kumara, 2018, p. 156). A highly viable and cost-effective alternative to this connectivity trap is to establish school intranets and host emerging digital tools directly on local school servers (Goh & Kale, 2015, p. 17). By hosting software resources locally, schools can bypass the “bandwidth pipe” bottleneck entirely. Sundeen and Sundeen (2013, p. 466) conceptualise internet bandwidth as a physical pipe carrying water: when the pipe is too narrow, data transfer is restricted, causing streaming media to pause, buffer, and skip, which renders educational videos of limited value in daily classroom instruction. Indeed, two-thirds of surveyed schools in national infrastructure reports have reported bandwidth capacities insufficient to accommodate even basic current internet applications (Sundeen & Sundeen, 2013, p. 466).

Local server architecture effectively replaces this narrow, external pipe with a high-capacity, on-site Local Area Network (LAN), ensuring that complex digital materials and interactive software remain continuously and instantaneously available to students without requiring active broadband internet connections (Goh & Kale, 2015, p. 17; Sundeen & Sundeen, 2013, p. 466). This model of a self-contained school intranet serves as a secure, high-speed regional repository for educational materials and localised digital educational resources. Rather than assuming that rural schools must maintain a constant connection to a costly and fragile external cloud, the local server functions as an independent, localised node that can be periodically updated or synchronised during off-peak hours (Goh & Kale, 2015, p. 17). This local server can host curriculum-aligned materials, local-language e-books, early-grade reading materials, and interactive math

puzzles (NEP, 2020, p. 321; Warschauer, 2003, p. 220). This offline approach drastically reduces the burden on rural teachers, who currently spend up to 60% of their planning time personally searching for or financing free materials due to severe school budget shortfalls (Sundeen & Sundeen, 2013, p. 404). Historically, similar localised intranets have been deployed successfully in under-resourced settings. For instance, the Gyandoot project in the Dhar district of India established a district-wide intranet that provided rural poor communities with offline access to Hindi-language e-education modules, mathematical quizzes, and government forms (Warschauer, 2003, p. 220). Similarly, Robinson (2008, p. 12) documents how the EU-China Gansu Basic Education Project (GBEP) successfully utilised township-level Teachers’ Learning Resource Centres (TLRCs) as local nodes. These TLRCs housed localised digital resources, CD-ROMs, and video databases that allowed rural teachers and students to access and share high-quality pedagogical content offline, completely bypassing the county-level telecommunications barrier (Robinson, 2008, p. 12). By localising content distribution, the school intranet insulates the educational environment from the high costs, erratic buffering, and chronic dropouts associated with satellite networks, converting the rural public school into a technologically resilient, self-sustaining educational ecosystem (Goh & Kale, 2015, p. 17; Robinson, 2008, p. 12; Warschauer, 2003, p. 220).

The School as the Local “Intelligent Space”

By anchoring digital infrastructure to the local school server, educational planners can operationalise Madhav Chavan’s proposition of transforming the public school into the centralised, community-based “intelligent space” of the village (Chavan, in Pratham, 2024, p. 3). Chavan argues that instead of scattering scarce public and philanthropic resources to provide individual, cloud-connected mobile devices to every child; a strategy that has historically failed the underprivileged due to device availability crises and the for-profit nature of high-end hardware markets; governments should establish “one place in a village; let us call it school; where questions of what, where, and how were answered by an intelligent device” (Chavan, in Pratham, 2024, pp. 3, 5). Hosting localised, offline

Generative Artificial Intelligence (GenAI) engines directly on these school-centric servers fulfils this vision by creating an on-site cognitive utility universally accessible to all students in their daily school environment, without relying on household smartphone ownership (Chavan, in Pratham, 2024, p. 3).

This centralised, school-centric model directly mitigates the severe socio-economic and gender divides that characterise private device usage in rural India. Long-term data from the Annual Status of Education Report (ASER) shows that, despite the high availability of smartphones in households, actual smartphone ownership among rural adolescents is very low and is skewed more towards boys due to patriarchal control and low digital literacy of parents (Pratham, 2024, p. 11). By hosting offline GenAI tools on the school's own servers, rural government schools create a democratic learning environment that ensures equal access to advanced digital tools for every child, regardless of gender, race, or family income (Florian and Black-Hawkins, 2011, p. 814; Warschauer, 2003, p. 202). Furthermore, this model relieves low-income families of the economic burden of device maintenance, hardware repairs, and data subscription costs, which often lead to high rates of student dropout and anxiety (McClure & Pilgrim, 2021, p. 326; Salinas & Sánchez, 2009, p. 375).

In 1:1 device programs, teachers often act as restrictive “gatekeepers” who regulate or lock away devices due to administrative anxiety and fear of damage (Salinas & Sánchez, 2009, p. 375). By contrast, a school-centric, shared “intelligent space” guided by local servers ensures that technology is integrated directly into a socially supportive, face-to-face classroom community, preventing technology from degenerating into isolated, passive screen-time and ensuring that underprivileged students can engage with higher-order, 21st-century cognitive skills (Warschauer, 2003, pp. 203, 218).

Overcoming the Language Barrier with Multilingual Structured Engines

Linguistic isolation has historically been considered one of the major digital divides in educational technology, with English-dominant software interfaces excluding large numbers of students from outside the city and non-native speakers

(Warschauer, 2003, p. 96). Warschauer (2003, p. 96) has detailed how the dominance of English—which accounts for over 85% of international communication and web resources—acts as a stratifying barrier for the 95% of India's population who are not fluent in English, and thereby reinforces educational inequality (Warschauer, 2003, p. 101). Traditional English-only educational software often forces rural students to copy repetitive, monotonous symbols, a problem that can be avoided by using offline native-language interfaces (Warschauer, 2003, p. 143). As demonstrated in the Nantou Primary School in Shenzhen, giving children the opportunity to compose directly on the screen in their native language significantly accelerates literacy acquisition and creative writing skills (He and Wu, cited in Warschauer, 2003, pp. 143–144). Modern, compact Large Language Model (LLM) computers installed on local servers are a breakthrough compared to early text-to-speech software (Warschauer, 2003, p. 67), as they can perform immediate, high-quality oral translation, text-to-speech, and speech-to-text operations in regional languages, overcoming the language barriers that have historically hindered the progress of rural students (Chavan, Pratham, 2024, p. 3; Warschauer, 2003, p. 165).

This multilingual capability is directly aligned with the National Education Policy (NEP) 2020. It has been noted that the student's home language, mother tongue or regional language should be prioritised as the medium of instruction to ensure conceptual clarity in the primary grades (NEP, 2020, p. 70). By integrating offline GenAI engines that translate curriculum-compliant materials into local dialects, rural classrooms can bridge the gap between regional textbook requirements and children's home languages (NEP, 2020, p. 71). For example, instead of forcing students to interact with rigid, standardised English-centric software, a local GenAI interface allows students to ask questions in their mother tongue and receive immediate verbal or written explanations, math support enhanced to their needs, and primary-grade reading passages tailored to their environment (Chavan, Pratham, 2024, p. 3; NEP, 2020, p. 71). This versatile capability restores the dignity of natural, oral communication, connecting technology to the historical storytelling and visual learning methods of rural and indigenous peoples, thereby decolonising the digital classroom

and encouraging true epistemological equality (Warschauer, 2003, pp. 115-116).

“Workhorse Technologies”: Connecting GenAI to Local Displays

To prevent educational technology from degenerating into screen-isolated, individualistic behaviour, school-centric GenAI must be integrated with low-cost, durable “workhorse technologies” that facilitate collaborative, group-based learning. In under-resourced public schools, rather than pursuing expensive 1:1 tablet deployments that often lead to mechanical drill-and-practice and classroom distraction, school servers can connect GenAI engines to shared display devices (McClure & Pilgrim, 2021, p. 323; Warschauer, 2003, p. 203). Durable hardware inputs and outputs, such as liquid crystal display (LCD) projectors, document cameras, and basic local computer stations, can project GenAI-generated scaffolds, math puzzles, and interactive stories onto a classroom wall or screen (Sundeen & Sundeen, 2013, p. 402; Warschauer, 2003, p. 182). Projecting a single display device appeals to multiple senses: seeing, hearing, and touch, facilitating more productive and creative whole-class presentation compared to individual workstations (Wang, 2013, p. 426).

This collaborative configuration leverages the rich social networks of interaction that are fundamental to situated learning and communities of practice (Patel, 2018, p. 9; Warschauer, 2003, p. 124). By displaying a single, GenAI-generated inquiry or problem-solving prompt to the entire classroom, the teacher can organise collective decoding, peer-led discussions, and collaborative writing tasks (Chavan, in Pratham, 2024, p. 8; Warschauer, 2003, p. 206). As observed in rural school classrooms, peer grouping is highly effective when teachers “group one child who understands quickly with two other children” (Teacher, Himachal Pradesh, cited in Pratham, 2024, p. 8). This group-based interactive model reduces screen-isolated behaviour, fosters classroom communication, and allows the teacher to transition from a technical gatekeeper to an active mentor and epistemic facilitator (Salinas & Sánchez, 2009, p. 581; Warschauer, 2003, p. 214). By combining localised offline GenAI with collective workhorse displays, educational planners can establish an inclusive, collaborative pedagogy that

leverages advanced technology while preserving the essential face-to-face social relationships of the rural classroom (Florian & Black-Hawkins, 2011, p. 814; Warschauer, 2003, p. 215).

Mitigating Social and Economic Hurdles through School Infrastructure

While digital literacy initiatives frequently assume that the equitable distribution of personal hardware is sufficient to dissolve the digital divide, empirical realities in under-resourced rural contexts suggest a far more complex paradigm. Technology integration is not an isolated mechanical intervention, but is deeply embedded in the social, economic, and geographical contexts of the surrounding community. This chapter explores how shifting from personal/household device dependency to school-centric server infrastructure directly promotes educational equity. By establishing the school as a shared, server-supported intelligent hub, educational systems can systematically correct within-school and between-school inequalities, recover productive downtime during rural transits, and transition the classroom teacher from an administrative gatekeeper to a highly supportive epistemic facilitator.

Correcting Within-School and Between-School Inequalities

Traditional educational campaigns historically prioritised personal device ownership models, such as 1:1 laptop or tablet programs, operating under the assumption that device saturation naturally translates to digital equity (Warschauer, 2003, p. 132). Without structural safeguards, hardware access is often rationed or co-opted. In a detailed study of K-12 public schools, Schofield and Davidson (2000) revealed a stark ‘within-school’ digital divide: approximately 25% of teachers utilised internet-based learning activities exclusively with academically advanced or high-performing students, while only 5% integrated these technologies with lower-achieving cohorts (cited in Warschauer, 2003, p. 132). Furthermore, 70% of teachers restricted internet privileges to a small subset of students, treating access to technology not as an essential pedagogical medium but as an administrative reward or behavioural incentive for model behaviour (Warschauer, 2003, p. 132). This

rationing behaviour places a ceiling on marginalised students, who are disproportionately relegated to repetitive, passive ‘drill-and-practice’ software (often termed ‘drill-and-kill’), while affluent peers utilise computers for advanced, collaborative document creation and cognitive inquiry (Becker, 2000; Warschauer, 2003, p. 133).

To correct these inequalities, a structural pivot to a server-based school intranet is required (Goh & Kale, 2015, p. 16). Rather than prioritising cloud-dependent smartphones, establishing a robust, localised server ensures that underprivileged rural students, who rely exclusively on schools for access to computers, receive equal and non-excludable opportunities to learn (Sampath Kumar & Shiva Kumara, 2018, p. 165). In rural India, where approximately 79.33% of students do not have access to computer facilities at home (Sampath Kumar & Shiva Kumara, 2018, p. 164), the public school serves as the primary, and often sole, institutional space for technological socialisation (Sampath Kumar & Shiva Kumara, 2018, p. 165). Hosting specialised educational resources and compressed, offline Large Language Models (LLMs) on a school intranet ensures that access is democratised across the entire school population (Goh & Kale, 2015, p. 16). By converting the school into a self-contained intelligent space, rural districts bypass household economic barriers and prevent the arbitrary co-optation of technology, ensuring that every child enjoys rich, collaborative learning opportunities regardless of academic rank or socio-economic background (Chavan, 2024, p. 15; Warschauer, 2003, p. 132).

Overcoming Commute and Regional Downtime

A major operational hurdle in deep rural education is the severe temporal friction caused by student transit times and regional network downtime. Due to the sparse geographic distribution of public schools in remote areas, rural students face exceptionally long commutes, often travelling for 45-90 minutes each way via public or school-provided transportation (McClure & Pilgrim, 2021, p. 242). This lengthy travel period represents a substantial educational opportunity cost, during what teachers refer to as ‘prime homework time’ (McClure & Pilgrim, 2021, p. 242). This geographical challenge is compounded by the persistent ‘digital

gap’ in home internet connectivity. While urban students can seamlessly interact with cloud-based virtual learning environments on the move, rural students face a total connectivity blackout outside the physical school building (McClure & Pilgrim, 2021, p. 241). Home broadband remains cost-prohibitive or physically unavailable due to inadequate telecommunications infrastructure, rendering standard, cloud-dependent homework assignments highly exclusionary (McClure & Pilgrim, 2021, p. 240).

To recover this productive downtime, the proposed model utilises offline-enabled study modules, synced directly with the local school server and pre-loaded onto school-managed transit networks (Goh & Kale, 2015, p. 16; McClure & Pilgrim, 2021, p. 243). This framework adapts the innovative concept of ‘Rolling Study Halls’ designed to bridge the digital gap for rural and low-SES student groups (McClure & Pilgrim, 2021, p. 243). By installing localised, low-cost servers and school intranet systems directly within public transport vehicles, rural school complexes can establish reliable, self-contained educational intranets (McClure & Pilgrim, 2021, p. 243). During the long bus ride, students can utilise affordable, school-issued mobile interfaces to access interactive math puzzles, local-language reading modules, and pre-cached educational content (Goh & Kale, 2015, p. 16; McClure & Pilgrim, 2021, p. 243). Upon the vehicle’s arrival at the central school, these devices automatically sync with the primary school server, seamlessly uploading completed homework and updating student progress (Goh & Kale, 2015, p. 16; McClure & Pilgrim, 2021, p. 243). This model has the potential to convert geographic disadvantage into a more productive and equitable learning environment, although its effectiveness requires empirical evaluation.

Shifting the Teacher’s Role from Gatekeeper to Epistemic Facilitator

In many under-resourced public school systems, the successful integration of technology is severely undermined by the ‘gatekeeper’ phenomenon, in which teachers actively regulate, restrict, or prevent students’ access to computing resources (Salinas & Sánchez, 2009, p. 574). This behaviour is rarely motivated by professional negligence; rather, it is a defensive response to severe first-order barriers,

including chronic power outages, a lack of technical support staff, and large class sizes (Warschauer, 2003, p. 134; Salinas & Sánchez, 2009, p. 581). When schools receive expensive hardware without corresponding human or technical resources, teachers and local administrators frequently keep computer rooms locked or treat the equipment as delicate antiques to avoid the administrative risk of damage or software failure (Warschauer, 2003, p. 138). Under these rigid, top-down bureaucratic conditions, teachers act as conservative gatekeepers, regulating and controlling access to technology in ways that reproduce traditional, teacher-centred instructional delivery (Salinas & Sánchez, 2009, p. 581; Warschauer, 2003, p. 140).

To break this structural impasse, the integration of a localised, offline Generative AI (GenAI) assistant on school servers can structurally shift the teacher's role from a defensive gatekeeper to an active 'epistemic facilitator' (Johnson, 2019, p. 261). Rural public school teachers are chronically overburdened, teaching multiple grades simultaneously, preparing lessons for varied subjects, and managing high administrative loads without standard planning periods (Wang et al., 2019, p. 7; NEP, 2020, p. 28). An offline GenAI assistant directly addresses these constraints by automating time-consuming preparational tasks, such as generating localised, mother-tongue lesson plans, creating custom math puzzles, and translating complex content into regional dialects (NEP, 2020, p. 21; Chavan, 2024, p. 15). By delegating content generation and translation to an offline, server-hosted LLM, the teacher is freed from the role of a passive, rote-transmission engine (Freire, 2000, p. 71). Instead, the educator can focus on providing high-quality 'epistemological care'; facilitating student curiosity; managing collaborative peer-to-peer inquiry groups; and mentoring students within a socially situated community of practice (Johnson, 2019, p. 256; Lave & Wenger, 1991).

Strategic Alignment of School-Centric Offline GenAI within India's National Policy Framework

Aligning with NEP 2020's Mandates on Technology and Diversity

The deployment of school-centric, offline Generative

Artificial Intelligence (GenAI) directly aligns with the mandates of the National Education Policy (NEP) 2020 on technological integration and social inclusion. NEP 2020 emphasises eliminating the digital divide through concerted public efforts and affordable computing devices (NEP, 2020, Sec. 24.2, p. 58), aiming to build a 'world-class digital infrastructure' (NEP, 2020, Sec. 24.4b, p. 58). However, standard cloud-based initiatives like the Digital Infrastructure for Knowledge Sharing (DIKSHA) are constrained in rural areas by slow connection speeds and high satellite data costs, resulting in minimal classroom usage (Chavan, in Pratham, 2024, p. 15). By hosting localised, compressed Large Language Models (LLMs) on local school servers and school intranet systems, educational planners can operationalise the policy's goals in an internet-independent manner (Goh & Kale, 2015, p. 20; Warschauer, 2003, p. 210). This self-contained infrastructure fulfils the policy's recommendation to invest in open, interoperable public digital architectures that address rural scale and diversity (NEP, 2020, Sec. 24.4b, p. 58).

This offline GenAI framework also respects and promotes diversity and the local context, which is a core guiding principle of NEP 2020 (NEP, 2020, Sec. 1.25, p. 5; Sec. 4.29, p. 16). Traditional, cloud-dependent software is typically highly standardised and English-centric, which historically excludes non-urban and non-majority-language student populations (He & Wu, 2013, p. 1). In contrast, localised offline engines can provide real-time translation, speech-to-text, and speech generation in local mother tongues and regional dialects (NEP, 2020, Sec. 23.6, p. 56; Sec. 23.11, p. 57). This direct linguistic support fulfils the policy's directive to develop engaging, bilingual, and culturally responsive learning materials in children's familiar languages (NEP, 2020, Sec. 4.14, p. 14; Sec. 24.4e, p. 59). Consequently, school-centric offline GenAI moves rural classrooms away from standardised, top-down instruction, rooting advanced technology within the geographic and cultural realities of rural communities (NEP, 2020, Sec. 4.29, p. 16; Warschauer, 2003, p. 209).

Supporting Foundational Literacy and Numeracy (FLN) under NIPUN Bharat

The offline GenAI framework is also deeply

aligned with the operational guidelines of the National Initiative for Proficiency in Reading with Understanding and Numeracy (NIPUN Bharat) Mission. Under NIPUN Bharat, universal acquisition of Foundational Literacy and Numeracy (FLN) by Grade 3 is framed as an urgent national priority (NIPUN Bharat, 2021; NEP, 2020, Sec. 2.2, p. 8). Traditionally, rural teachers worked under pressure to complete a rigid curriculum, teaching strictly to the ‘top of the class’ (Chavan, in Pratham, 2024, p. 15). NIPUN Bharat shifts its focus to foundational skills through play- and activity-based pedagogy (NIPUN Bharat, 2021; NEP, 2020, Sec. 1.2, p. 7). Localised offline GenAI supports teachers by generating a continuous stream of play-based reading paragraphs and customised math puzzles (NEP, 2020, Sec. 4.25, p. 15; Sec. 24.4d, p. 58). These culturally responsive materials allow teachers to transition away from rote worksheets toward engaging, contextually relevant instruction (NIPUN Bharat, 2021; Ertmer, 1999, p. 51).

Furthermore, server-hosted GenAI supports the transition from rigid summative exams to adaptive, formative assessments (NEP, 2020, Sec. 2.4, p. 8; Sec. 4.34, p. 16). NIPUN Bharat guidelines mandate a print-rich classroom with math puzzles and toys that facilitate meaningful peer interaction and collaborative inquiry (NIPUN Bharat, 2021; NEP, 2020, Sec. 6.8.3, p. 25). An offline GenAI engine can generate individualised reading cards and math problems that adapt to each student’s progress, operationalising the ‘Teaching at the Right Level’ approach by grouping children based on what they can do rather than age (Pratham, 2024, p. 327). To foster genuinely inclusive pedagogy, the integration of GenAI must mirror the structural disruption seen in India’s microfinance sector, solving problems at scale for populations affordably and inclusively. Rather than bypassing the educator, GenAI must be leveraged as a teacher-led scaffolding tool (Sharma & Thomas, 2026). By shifting assessments from binary end-of-term evaluations to real-time diagnostic feedback loops, GenAI empowers rural teachers to adapt their instruction on the fly. This facilitates targeted remedial instruction, or “teaching at the right level,” identifying and plugging unique learning gaps before they compound into systemic dropout risks. By projecting these math puzzles onto local displays, teachers can facilitate collaborative

peer-learning groups, turning the rural classroom into an interactive learning space where children scaffold each other (Pratham, 2024, p. 23; Florian & Black-Hawkins, 2011, p. 814).

Mobilising Community-Led and DIET-Collaborative Ecosystems

The sustainability of the offline GenAI model is deeply aligned with the decentralised, community-driven structures of both NEP 2020 and NIPUN Bharat. Both policies highlight community participation and volunteerism as central to executing foundational schemes (NIPUN Bharat, 2021; NEP, 2020, Sec. 2.7, p. 8). This community-led approach is exemplified by Pratham’s citizen-led Annual Status of Education Report (ASER) survey, which partners annually with government-run District Institutes of Education and Training (DIETs) (Pratham, 2024, p. 6). Established to decentralise teacher training, DIETs serve as key last-mile resources (Pratham, 2024, p. 6). Feedback from over 1,940 student-teachers who volunteered for ASER indicates that field exposure directly builds critical capacities: 86.1% of volunteers report a deep understanding of student learning levels, 80.8% gain decision-making skills, 71.9% enhance collaboration, and 62.5% improve problem-solving abilities (Pratham, 2024, p. 8).

This active network of DIET student-teachers and local youth volunteers can be mobilised to maintain and update school-centric offline GenAI systems. Because these student-teachers represent diverse areas of each district, speak local dialects, and hold the community’s trust, they are uniquely positioned to guide local installations (Pratham, 2024, p. 10). During their mandatory internships, DIET students can refresh the offline school server’s cached educational materials, language models, and math databases using basic portable storage drives (Pratham, 2024, p. 10; Goh & Kale, 2015, p. 20). This cooperative model bypasses the need for high-speed internet or dedicated IT staff, which are major bottlenecks in rural schools (Wang & Zhu, 2019, p. 6). By leveraging ASER-style DIET partnerships, educational planners can construct a resilient, community-owned educational ecosystem that enhances localised agency and genuine epistemic equity (Sen, 1999, p. 291; Freire, 1970, p. 72).

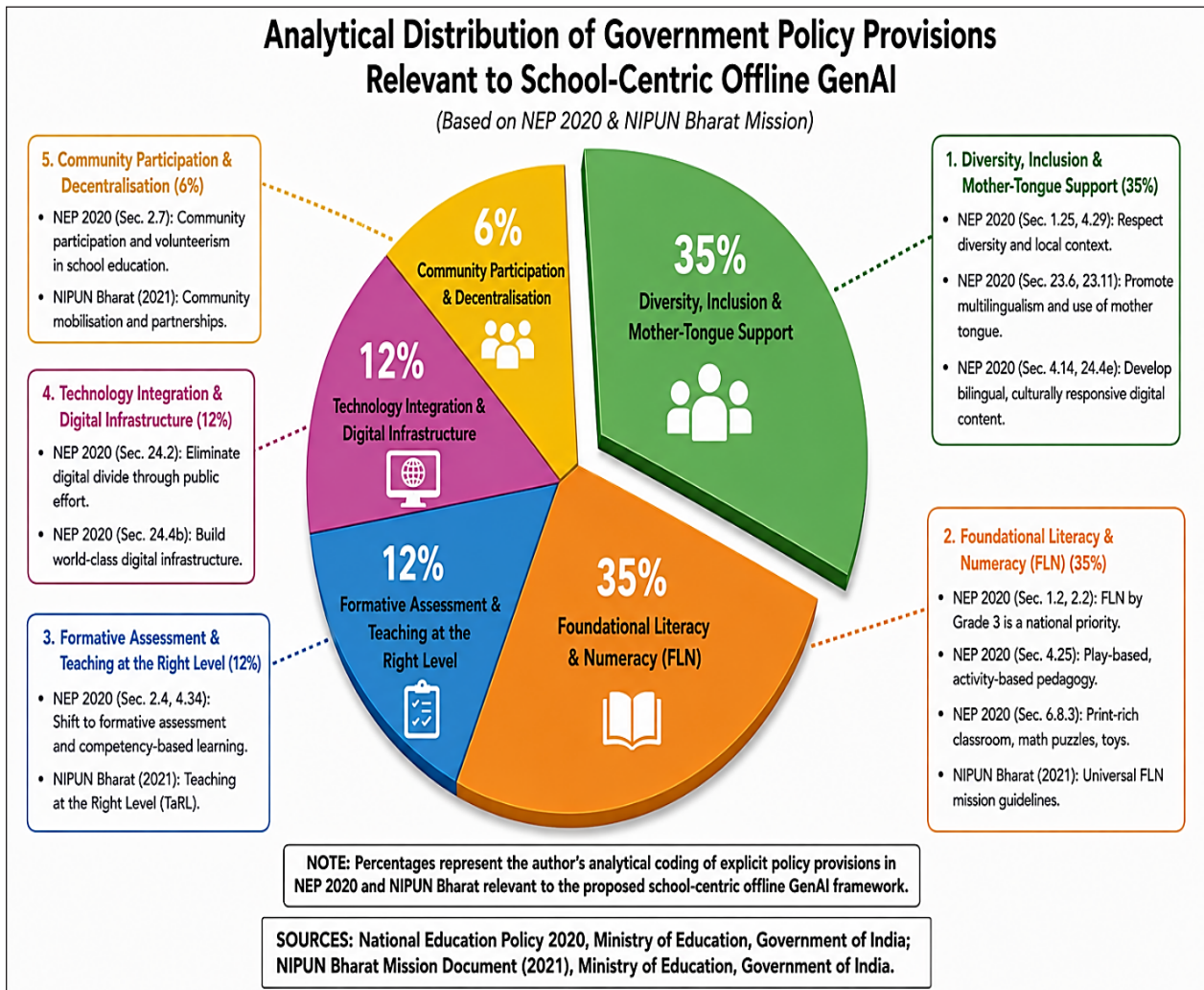


Fig. 1

CONCLUSION

A final solution to the 'access paradox' in rural Indian education requires a fundamental shift away from the idea that merely expanding hardware availability or broadband connectivity will automatically yield meaningful learning outcomes. As research evidence shows, the near-universal availability of devices in households (Pratham, 2024, p. 8) fails to translate into real educational success because it ignores the human, social, and structural resources needed to use technology for cognitive development effectively (Warschauer, 2003, p. 6). Combining Gila Sher's concept of "epistemic friction" and Lani Florian's model of "inclusive pedagogy," this paper proposes a local, offline generative artificial intelligence (GenAI) framework, hosted directly on school-level intranet servers. Sher's (2016, p. 112) "foundational holism" framework

demands that digital interventions maintain a direct "connection to reality" and actively engage with the infrastructural limitations of the village classroom rather than avoid them. When merged with an inclusive pedagogical approach that rejects deficit-based paradigms in favour of extending rich, collaborative learning opportunities to every student in the classroom (Florian & Black-Hawkins, 2011, p. 814), school-centric offline GenAI grounds educational technology in local rural realities. This structural alignment turns the school from a passive site of intermittent digital consumption into a highly resilient and collaborative learning space. This paper is conceptual and policy-analytical in nature. It does not present the findings of a field-based intervention or an empirical evaluation of an offline GenAI system. Instead, it brings together existing literature, educational policy documents, and

secondary evidence on rural education and digital access to examine how offline GenAI might address some of the epistemic and pedagogical barriers faced by rural learners. The proposed framework should therefore be understood as an analytical and exploratory model that requires further empirical testing in diverse rural classroom settings.

This standardised approach to pedagogy generates immense “epistemic friction.” When a standardised curriculum is applied to widely different socio-economic contexts, the learning process is disrupted. This is not due to a lack of student competence, but rather to the content’s lack of relevance. For example, a rural student may have difficulty engaging with online subscription-based math problems or a physics lesson that uses microwaves and air conditioners as examples (Sharma & Thomas, 2026). In this case, GenAI serves as a powerful tool for contextual translation. The initiatives allow teachers to reduce the comprehension barriers and make abstract concepts much more accessible. Most specifically, deploying offline GenAI on local school servers reshapes the educational technology debate in the Global South. This approach is not a compromise or “work-around” option for low-income regions. This is a local framework that actively decolonises the digital learning experience.

The traditional cloud-based, personal computing models have fostered screen-based isolation and cultural alienation. They have forced students to adapt to English-centric digital standards and commercialised, information-only software (Warschauer, 2003, p. 115). In contrast, offline GenAI democratises learning. It acts as a multilingual, speech-enabled cognitive assistant, and it facilitates situational and collaborative inquiry. It transforms the classroom into a dialogic space where “people teach each other through the mediation of the world” (Freire, 1970, p. 75). Rather than encouraging context-detached rote learning, offline server environments encourage collaborative creation and group problem-solving (Warschauer, 2003, p. 115) and help preserve local languages and cultural identities. As a result, students are transformed from passive consumers of pre-packaged digital content to active, critical co-investigators of knowledge.

Universal access to generative AI cannot be left to private, market-based services, which often reproduce existing class and regional hierarchies

(Warschauer, 2003, p. 209; Chavan, 2024, p. 15). Schools should be established as centralised, self-contained, and government-funded to function as “fields of intelligence,” where students’ intellectual exploration is supported in their native language (Chavan, 2024, p. 15). Therefore, teachers are unburdened from administrative routine and enabled to provide high-quality ‘epistemological care’ and dedicated classroom mentoring (Johnson, 2019, p. 265). Rural Indian schools can be described as democratic and intellectually vibrant centres of social justice. School should be a symbol of resilient, offline public digital knowledge. Where educational technology is built on social action rather than passive consumption, it becomes a powerful tool for cognitive equity and an effective means of human empowerment for the upcoming generation.

However, the integration of GenAI into rural classrooms should not be seen as a quick, easy fix for educational inequities. Generative models can generate false or misleading information, can replicate biases that exist in the data it was trained on, and can give inconsistent answers, especially in local and less resourced languages. Such concerns are heightened when these systems are employed with children and in settings where the teachers and learners might not have sufficient opportunities to check facts. Student privacy and data protection, model reliability and the upkeep of locally deployed systems are also issues to consider. Therefore, the role of the teacher is crucial in any school-based GenAI implementation and cannot be replaced. The technology should be used to accompany, translate, practice, and explore but not be the authority or substitute for the teacher.

GENERATIVE AI DECLARATION

The author(s) confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript, and no images were manipulated using AI. The authors developed and verified all scientific content, data analysis, interpretation of results, and conclusions. The authors take full responsibility for the accuracy, integrity, and originality of the work presented, and no AI tool was listed as an author.

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