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Rethinking Educational Strategies for Rural India: An Exploratory Qualitative Study of a Synchronous Digital Classroom Pilot in Two Rural Indian Schools

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Rethinking Educational Strategies for Rural India: An Exploratory Qualitative Study of a Synchronous Digital Classroom Pilot in Two Rural Indian Schools

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Abstract

This exploratory pilot study assesses the socio-technical, educational, and structural effects of a synchronous remote Digital Learning Room (DLR) intervention involving 61 children across two geographically separated rural regions in India. Aimed at addressing systemic vulnerabilities in rural education—including dependence on single teachers, resource limitations, and pronounced geographical isolation—this study investigated the integration of accessible digital technologies to support cross-regional peer learning, collaborative teacher development, and parental engagement.

Utilising a qualitative and interpretive case study methodology in accordance with ICT4D (Information and Communication Technologies for Development) frameworks, we analysed empirical field data collected from three interconnected entities: learners, educators, and members of historically marginalised communities.

The findings suggests that a combination of arts-integrated pedagogy and a highly resilient, low-tech digital interface may support engagements with foundational literacy and numeracy. Furthermore, it may support the development of robust, self-directed professional learning communities among rural teachers, and the transformation of socio-

economically disadvantaged marginalised parents into proactive partners within the home-based learning ecosystem.

Given the constraints imposed by the exploratory nature of this research, this study advocates for a larger randomised controlled trial, incorporating rigorous assessments of outcome measures, to elucidate the findings noted herein. Ultimately, such further interventional research could establish a scalable, weather-resistant, human-centred framework that leverages fundamental digital infrastructure to guarantee equitable early childhood education across the Global South.

A. Introduction and contextual background

Early childhood education in rural India is subject to significant structural limitations (Mahanta and Saikia, 2024). These comprise pronounced geographical remoteness, inadequate physical infrastructure, and the conventional "one-room, one-teacher" paradigm (Diwan, 2015). Pupils within these environments seldom encounter educational opportunities beyond their immediate village confines, thereby perpetuating a cycle of generational educational disparity (Anazia et al., 2026). This phenomenon is closely linked to the rural digital divide, where technical implementations often prioritise physical infrastructure while overlooking the human-centric social networks necessary for their sustainability (Warschauer, 2003).

The intervention reported here sought to disrupt the conventional arrangement by establishing a synchronous digital connection among children across two distinct rural regions in India. Operating within the strategic framework of India's National Education Policy (NEP) 2020 and the National Initiative for Proficiency in Reading with Understanding and Numeracy Bharat Mission—both of which advocate for experiential learning, digital inclusion, and localised pedagogical approaches—the project examined the impact of a shared virtual classroom on early cognitive and social development.

Crucially, the intervention was conceived not solely as an isolated implementation of technology but as an integrated, human-centric network involving three essential stakeholders: the student, the educator, and the parent. This tripartite alliance constitutes a resilient "Educational Triad" that may be capable of maintaining learning continuity even under adverse environmental conditions.

B. Literature review & theoretical foundations

B.1 Education and poverty in India

Education is widely recognised as a key pathway out of poverty. Nevertheless, for children hailing from low-income families in India, opportunities for access to quality early education remain limited. Despite extensive national initiatives such as Sarva Shiksha Abhiyan (Kapur, 2013), Digital India (Digital India, 2015), and the NEP 2020 (National Education Policy, 2020), the learning outcomes and quality of educational experiences continue to lag for children from economically disadvantaged backgrounds (Choudhury et al., 2023).

Educational institutions serving economically disadvantaged communities face severe resource limitations, such as insufficient infrastructure, outdated materials, shortages of qualified teachers, and limited access to electricity and the internet. The Annual Status of Education Report regularly indicates that a significant proportion of children from poor households do not engage in age-appropriate learning experiences or acquire requisite skills (Annual Status of Education Report, 2024). Educators in these environments frequently oversee multigrade classrooms with limited expertise, inadequate training, and minimal pedagogical support (Abadzi, 2012).

Poverty introduces additional obstacles. Limited parental awareness of the importance of early childhood education reduces support at home and hampers enrolment (Cashman et al., 2021; Sosu et al., 2026). Economic instability, geographic remoteness, and adverse weather conditions further impede the educational process (Diwan, 2015; UNICEF, 2026; Tulsyan, 2025). Educators also report low levels of digital literacy and apprehension toward technology use, which constrains the adoption of innovative tools (Jiang and Jamaludin, 2025). Collectively, these factors perpetuate a cycle in which poverty constrains educational opportunities, and adverse educational experiences, in turn, sustain intergenerational poverty (Nair, 2025).

B.2 Digital interventions in early years for low-income contexts

Although high-resource EdTech solutions may be implemented in low-income environments, evidence indicates that affordable, cost-effective digital interventions can enhance early childhood experiences, as discussed below.

Mobile and messaging platforms: mHealth and messaging platforms have been extensively evaluated in low- and middle-income countries. A systematic review has demonstrated that text messaging and voice messages enhance immunisation rates, breastfeeding practices, and health-seeking behaviours among mothers (Grewal and Rai, 2025). In India, the mMitra pseudo-randomised controlled trial involving low-income women in Mumbai revealed improvements in infant care knowledge and practices (Murthy et al., 2019). In the domain of early childhood development, Rocket Learning utilises WhatsApp to provide daily educational experiences and activities to parents and *Anganwadi* workers, leveraging increased smartphone penetration in low-income households following 2020 (Gupta and Sachdeva, 2023).

Frontline-worker digital tools: Digital tools can in theory support frontline workers like teachers with low training and high workloads. Patil et al. (2023) evaluated a mobile decision-support platform for community health workers working in child health in Mumbai slums, incorporating a Social Return on Investment framework. There was an increased uptake of community-based treatment from 4% to 76% at a cost of INR 625 per child/year. Such platforms can provide real-time mentoring, data tracking, and reduced administrative burden, making them suitable for teachers with limited digital skills whilst enabling richer classroom experiences.

Augmented reality and multimedia for learning experiences: Interactive digital content has the potential to enhance engagement in settings where traditional materials are limited. An augmented reality application designed for nursery children in rural India integrated 3D overlays of letters to facilitate interactive learning and generate more engaging experiences (Pawshekar et al., 2023). Similarly, multimedia tools have been proposed to provide cost-effective, immersive instructional experiences for underprivileged children facing teacher shortages (Ramamoorthy et al., 2013). Evaluations of mobile learning affirm its positive influence on flexibility, personalisation, and the overall quality of educational experiences in resource-constrained environments (Ugwu et al., 2025).

B.3 Policy alignment and frugal community models

The NEP 2020 emphasises the universalisation of early childhood care and education with a focus on equity and inclusion. Scholars contend that integrating straightforward digital content with community-based delivery methods renders meaningful learning experiences achievable at home without the necessity for advanced infrastructure (Fitriana, 2022). For example, scoping reviews of digital parenting interventions in low- and middle-income countries indicate that applications, SMS messaging, and group chats are viable for parents with children aged 0 – 5 years; however, they necessitate careful consideration of digital literacy and community context (Jäggi et al., 2025). Furthermore, the Digital India programme facilitates scalability through the expansion of connectivity.

B.4 Research gap

Notwithstanding this evidence, there is limited empirical research concerning integrated, cost-effective digital interventions tailored for early childhood classrooms, particularly those serving children in impoverished settings, where educators possess limited digital literacy and parental awareness is diminished. The majority of existing studies concentrate on health-related or single-function tools, rather than comprehensive, classroom-based interventions aimed at improving children's learning experiences.

B.5 Theoretical foundations

To contextualise the Digital Learning Room (DLR) intervention described below within international development and information systems literature, this study draws upon three intersecting bodies of theory.

B.5.1 Vygotsky's social constructivism and extended peer windows

Lev Vygotsky's seminal work on the Zone of Proximal Development (ZPD) underscores that learning is inherently a social process mediated by culture, language, and peer interaction (Vygotsky, 1978). Traditional rural classrooms in the Global South frequently restrict a child's ZPD to a single educator and a highly localised, static peer group.

Based on these considerations, and by implementing synchronous cross-regional interactions, the DLR framework intended to establish an extended peer window. DLR intended to observe the processes of engagement in collaborative cognitive scaffolding, in which children from one region could present their cultural artefacts to children in the other region, thereby transcending regional boundaries. The digital room was envisaged to serve as an expanded social platform, facilitating the acceleration of socio-emotional development and foundational literacy and numeracy through peer-led activities such as play, singing, and storytelling.

B.5.2 Socio-technical systems theory and "low-threshold" innovation

Socio-technical systems theory asserts that institutional performance is optimised exclusively when the social needs of human actors and the technical requirements of tools

are concurrently designed (Trist and Bamforth, 1951). In the ICT4D literature, rural interventions often fail due to "technological determinism"—the deployment of highly complex hardware without sufficient consideration of user readiness or environmental realities (Heeks, 2018).

This study employed the concept of low-threshold applications—technologies characterised by minimal barriers to entry, requiring minimal troubleshooting, and inducing negligible technology-related anxiety (Gilbert, 2002). By ensuring that the classroom user interface necessitates straightforward setup procedures, the intervention aligned with Everett Rogers' Diffusion of Innovations framework (Rogers, 2003). It rendered the technology adaptable, observable, and compatible with the daily realities of rural educators and local youth volunteers, thereby fostering system-wide resilience against climate and health shocks.

B.5.3 Dismantling the parent deficit model: "Funds of Knowledge"

For decades, educational sociology has highlighted the tendency of formal schooling systems to perceive low-literacy, marginalised rural families through a "deficit lens"—assuming that illiterate parents are incapable of contributing to their children's academic development (Auerbach, 1989). This study aligned with Luis Moll's Funds of Knowledge framework, which argues that all households, irrespective of formal literacy levels, possess rich, historically accumulated sociocultural and practical resources (Moll et al., 1992). By substituting text-intensive assignments with video-guided visual scaffolding, this study intended to circumvent barriers posed by formal texts. This approach legitimised the domestic environment as an appropriate site of learning, transforming first-generation rural parents into active co-facilitators and fostering an organic demand for direct-to-device mobile learning.

C. Methodology

This initiative encompassed twelve interventions across two groups of children from socio-economically disadvantaged communities located 267 kilometres apart (Sargachi and Raidighi, West Bengal, India) (Fig 1). The programmes were hosted by RKM Sargachi (https://www.rkmsargachi.org/) and Mukti (https://muktiweb.org/), both reputable, large local charitable institutions involved in several community development projects. The parents of the participating children were involved in various activities at these non-governmental institutions, which serve as the anchor for community service provision in the locality. All parents had heard about this project from the organisational channels and expressed their interest in being part of the study. Inclusion criteria involved children who were residents locally, aged between 4 and 8 years, spoke the native language of Bengali, without any significant special health needs, and belonged to a poor socio-economic background as defined by the 'below poverty level' standards in India (Alkire and Seth, 2012). This resulted in the recruitment and participation of 31 and 30 students from the Sargachi and Raidighi centres, respectively.



Fig 1. Sargachi and Raidighi sites

Baseline demographic data gathered included age, gender, family size, gross annual household income, main occupation, availability of electricity, presence of a sanitary toilet, highest educational attainment, internet access, television (or smart television), and use of mobile phones, including smartphones.

Both the sites allocated a room specifically for this project, which had, among other basic furniture, fans, adequate lighting, and a smart television. A teacher and assistants were recruited by the respective organisations from their own local primary schools. Altogether, there was one remote teacher who was based at the Sargachi site, and 2 teaching

assistants, one at each site. Additionally, the Sargachi site had access to a laptop, which the remote teacher used. Furthermore, the assistant teachers had access to smartphones, which they used for real-time communication. Additionally, the remote teacher coordinated all activities and maintained communication between the parents, students, assistant teachers, research coordinator, and the host and sponsoring organisations.

The respective classrooms implemented a blended learning approach on alternate Sundays (from 10:00-12:00), substituting conventional chalk-and-blackboard instruction with a smart TV, a laptop, and smartphones, under the guidance of a lead teacher and an assistant teacher. Sunday was selected because it was considered the most convenient day by the parents of children participating in this study. The lead teacher facilitated sessions via Google Meet, establishing a remote connection between both classrooms (Fig 2). The curriculum—including stories, songs, rhymes, basic numeracy, and literacy activities—was delivered synchronously to both groups. Assistant teachers provided support for in-class activities, managed logistical arrangements, and liaised with parents. A 30-minute break was provided following each 45-minute session to maintain children's engagement.

Prior to initiation, the DLR project coordinator/researcher conducted meetings with teachers and assistant teachers, including identifying digital resources, preparing teaching materials and curriculum, and consulting with other personnel to share risk management strategies, ensure the seamless operation of classes, and address related matters. Additional volunteers were prepared to assume responsibilities, if necessary, with lesson plans crafted for flexibility to enable rapid adaptation.

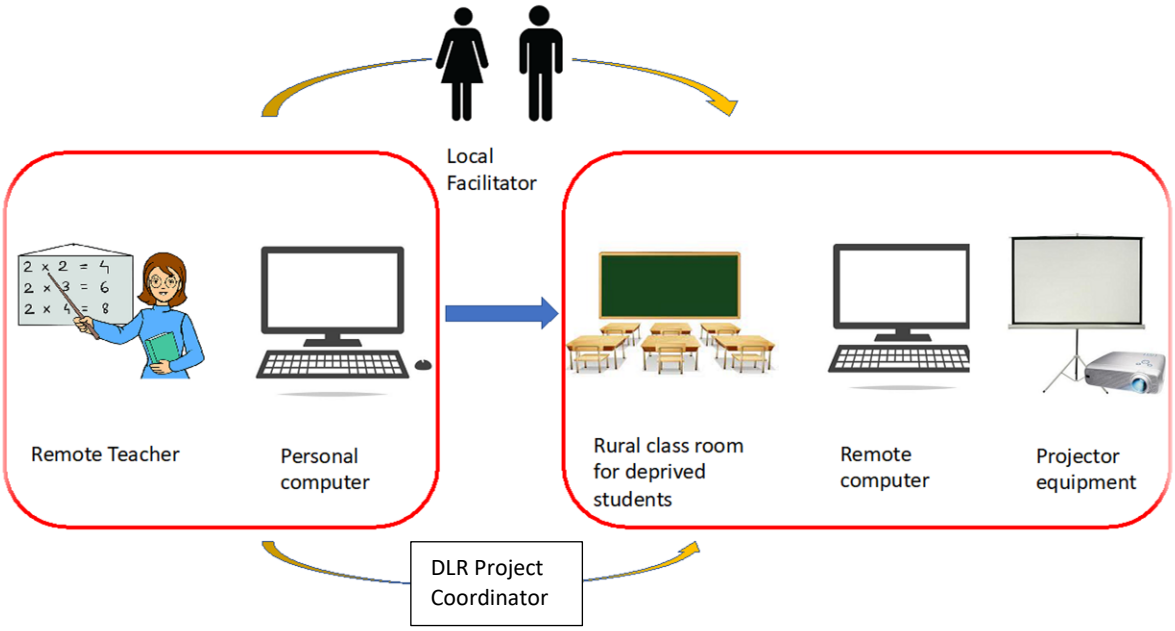

Fig 2. Schematic diagram of DLR

On the day of training, the DLR project coordinator/researcher briefed the class regarding the schedule, noting the physical distances between groups. Each group was overseen by an assistant responsible for arranging seating, distributing materials, providing worksheets, and

addressing needs such as fetching water or contacting the local coordinator if a participant became unwell. If personal requirements arose, the assistant communicated with the DLR project coordinator via WhatsApp, who supervised the project. Parents remained informed through mobile updates from the teacher about activities, homework, and cancellations.

During instruction, the teacher assigned tasks to each group, with assistant teachers carrying them on. Contingency plans for power outages included maintaining digital resources accessible offline. For instance, during an unforeseen power outage at Raidighi, the assistant teacher showed a video on his smartphone to one group, while other groups participated in activities such as constructing with blocks and drawing. Once power was restored, the groups shared their experiences.

C.1 Outcome assessments

Considering the exploratory pilot nature of this study, the outcomes were assessed through formative, informal, conversational focus group discussions rather than using standardised formal tools. Structured interviews were deemed inappropriate in this context; consequently, the decision to employ informal techniques was influenced by both study constraints and the socio-economic and demographic profile.

C.1.1 Socio-economic and demographic profile constraints

Low literacy and formality anxiety: Nearly all parents, rural teachers, and teaching assistants have limited formal schooling. Conducting a structured interview with a recorder and formal questions may feel like an 'interrogation,' which can hinder open communication.

Age appropriateness: Children aged 4-8 are unable to participate in a 30-minute structured interview. Play-based, single-question discussions yield more accurate data.

Cultural context: In rural West Bengal, trust is established through informal "*adda*" or casual conversations, rather than through formal procedures. These informal groups help bridge the power gap between researchers and the community.

C.1.2 Pilot study-related constraints

Feasibility and time: This was a brief exploratory pilot study conducted by a single researcher; the first author. The development, piloting, and validation of a structured interview tool in Bengali (native language) were beyond the scope of this project.

Exploratory aim: The aim was to identify themes rather than rely on reliability coefficients. According to Thabane et al. (2010), pilot studies should employ flexible methods to improve future tools.

Therefore, although structured interviews offer higher reliability, they were deemed developmentally inappropriate for children, culturally inappropriate for adults in this context, and logistically infeasible for a pilot study. This trade-off is acknowledged as a

methodological limitation. The researcher casually inquired of students about their learning experiences, discussed with parents their expectations and realisations, and engaged teachers in discussions about the overall process. It was not possible to ask all the questions on every occasion due to parents' unavailability, time constraints, and other competing schedule pressures. Questions were open-ended, asked in Bengali, and phrased as conversation rather than interrogation. This methodology was chosen to enhance participant comfort, elicit genuine responses, and ensure feasibility within a resource-limited field setting. These questions are documented in Table 1.

For Students (Age 4 - 8 years, in small groups of 4-5)

Objective: Assess participant engagement, recall ability, and overall enjoyment. There are no right or wrong responses.

Question 1. *"TV class ta tomader kemon laglo? Sabcheye moja konta hoyechilo?"* (How did you like the TV class? What was the most fun part?)

Question 2. *"Aaj ki notun jinish shikle? Amake ekta bolo to."* (What new thing did you learn today? Tell me one.)

Question 3. *"Abar TV class korte chao?"* (Do you want to do TV class again?)

For Parents at the centre after pick-up of their children

Objective: Clarify expectations versus actual experiences regarding home support and changes in the child's development.

Question 1. *"TV class suru howar aage, apnar ki expectation chilo chhele/meye'r jonno?"* (Before the TV class started, what were your expectations for your child?)

Question 2. *"Ekhon barite ki kono bodol dekhchen? Jemon golpo bola ba TV class er kotha bola?"* (Are you noticing any changes at home now? Like telling stories or talking about TV class?)

Question 3. *"Apni barite kivabe chhele/meye ke help korte paren bole mone hoy?"*(How do you think you can help your child at home?)

For Teachers and teaching assistants, after the classes were concluded

Objective: Outline the capture process, assess its feasibility, and identify challenges.

Question 1. *"Overall process ta chalate giye sabcheye bhalo ar sabcheye kothin ki laglo?"* (What was the best and most difficult part of running the overall process?)

Question 2. *"Bacchader engagement TV class e normal class er theke alada chilo?"* Was children's engagement in the TV class different from a normal class?

Question 3. *"Ei programme ta continue korar jonno apnar ki suggestion ache?"* (What are your suggestions for continuing this programme?)

Table 1. Informal questions used in group conversations

D. Ethical considerations and consents

Institutional ethical approval was obtained from the two governing bodies of the participating organisations. Verbal / written fully informed consent was obtained from all parents/carers/guardians of participating children in Bengali, the local language (ICMR, 2017). The consent form explained the purpose of this study, which was voluntary participation; the right to withdraw at any time without penalising consequences; the digital learning intervention; data confidentiality; the safekeeping of details; and the contact details of the researcher and the ethics committee. For low-literacy parents, the consent was read aloud, and a thumb impression and a witness signature were taken. Since children aged 4-8 cannot give legal consent, "assent" was sought verbally. Children were told in simple Bengali: "We will show some cartoons and games on TV to help you learn. If you don't want to join, you can say no." Children showing discomfort or refusal were to be excluded from video recording/observation, even if parental consent existed. Participation was completely voluntary. Parents, teachers, and children were informed they could withdraw at any stage without giving a reason and without affecting services/benefits. Parental scepticism about technology was addressed through transparent demo sessions that respected community values and avoided top-down imposition (Masango et al., 2020). No incentives were offered that could be coercive. Children were given "break time" during observations and could leave the learning area at any time.

Written informed consent was obtained from all teachers, explaining the time commitment for training, video recording of classroom sessions, and the use of data for academic publication (UNICEF, 2019). All Bengali content was pre-screened based on the National Curriculum Framework for Foundational Stage 2022 guidelines (NCERT, 2024). No child was photographed or video-recorded without explicit parental consent (POCSO Act, 2012). All data were anonymised using codes, and digital data were stored on a password-protected laptop. Paper consent forms are kept in a locked cabinet, accessible only to the principal investigator. Video recordings of classroom sessions were used solely for pedagogical analysis and were to be destroyed after 5 years, in accordance with UGC data retention norms. No personal data will be shared with any third parties. This complies with the Digital Personal Data Protection Act, 2023, and the GDPR principles for research data.

The study received no external funding, and there were no conflicts of interest to be declared.

E. Findings

A total of 61 children participated in this study: 31 from the Sargachi site and 30 from Raidighi. Although the study was open to all children aged 4–8 years, most participants were 7–8 years old and 59% were female. The average household size was five members. Some parents had completed secondary education, although only a few had pursued studies beyond middle school. None of the parents had attended university. The average annual household income was Rs 42000 (equivalent to approximately £365 in 2025 estimates). The predominant occupation was manual labour, accounting for 81%, while others were engaged in farming, driving, and shopkeeping. The majority of homes were constructed of

brick (74%), with 94% having sanitary toilets and 90% having an electricity supply. Every household owned a mobile phone; however, only half possessed smartphones with internet access. Fewer than a quarter had a television at home.

During these informal conversations with students, teachers and parents, some common themes emerged. As the perspectives were explored informally, and the conversations were not formally captured, digitally or by any other means, the essence from the conversations is highlighted in Tables 2, 3 and 4: these excerpts are reconstructed from researcher field notes rather than being verbatim transcripts. Acknowledging that this study was exploratory and pilot in nature, and that no formal software such as NVivo was used to extract themes, the findings are presented systematically below.

E.1 The student experience: affective, communicative, and spatial shifts

The impact of the DLR framework on rural learners revealed perceived advancements across three critical dimensions, with a summary of some quotes provided in Table 2:

- **Affective domain and joyful learning:** In rural settings where resources are severely limited, incorporating creative arts such as storytelling, music, dance, theatre, and drawing helped modify the educational environment into a dynamic and engaging space. As a result, this heightened intrinsic motivation that might directly counter a major rural challenge: persistent student absenteeism and seasonal dropout rates (Mahalanabis and Acharya, 2021).

- **Communicative competence and collaborative cognition:** The digital environment served as a catalyst for dynamic peer interaction. Children appeared to shed any social hesitations to engage in conversation, debate, and collaboration across geographical boundaries. Foundational mathematical concepts, mental arithmetic, and multiplication tables (*Namta*) were allowed to be assimilated through interactive digital group games, thereby moving away from rigid, fear-inducing rote memorisation.

- **Overcoming spatial isolation:** Moving beyond their traditional single-teacher, single-classroom boundaries, these rural children were seen to engage simultaneously with remote educators and peers from different subcultures.

Student excerpts

- **Student A:** *We get to listen to stories every time in class.*
    - *Possible implications (authors' interpretation):* Regular narrative-based learning may enhance vocabulary and auditory processing in first-generation learners.

- **Student B:** *We can listen to it repeatedly.*
    - *Possible implications (authors' interpretation):* Asynchronous digital media may allow self-paced learning and reinforcement through repetition.

- **Student C:** *I can see kids from other schools; they watched our dance.*
    - *Possible implications (authors' interpretation):* Cross-cultural validation can reduce social anxiety and build self-esteem.

- **Student D:** *They shared pictures of their park.* and **Student E:** *We shared pictures of our Ashram.*
    - *Possible implications (authors' interpretation):* Contextual knowledge sharing may expand spatial awareness and encourage children to articulate pride in their unique local institutions.

Table 2. Qualitative evidence: student perspectives

E.2 Empowering rural educators: formalising informal professional networks

The qualitative data from rural educators, some of it summarised in Table 3, demonstrated a shift from isolated teaching practices toward a collaborative network:

- **Joy of reach and engagement:** The educators highly valued establishing emotional connections with many children simultaneously, despite geographic distances involved, and that their efforts served to fill the major content gap faced by children from marginalised communities. Additionally, they acknowledged that the remote format fostered an uncommon discipline within the classroom setting. Furthermore, they were pleased to observe that their innovative use of technology was well received and appreciated by the students.

- **Collaborative pedagogical co-creation:** Rather than working in isolated professional silos, teachers expressed satisfaction in engaging in cross-regional collaboration. They jointly developed localised learning materials and contextual stories through accessible

platforms such as WhatsApp, directly aligning with the NEP 2020 guidelines on creating indigenous, play-based learning frameworks.

- **Decentralised professional upskilling and low-threshold EdTech:** Peer training and digital skill acquisition took place organically outside official hours. Teachers utilised their personal spaces to learn digital operations, troubleshoot software issues, and exchange innovative pedagogical techniques at their own discretion. The hardware and software interfaces within the classrooms were designed for utmost simplicity. Due to the highly user-friendly operational workflow, alternative community members or local volunteers could also manage the digital classroom setup in the lead teacher's absence.

- **Contingency management and operational resilience:** Rural education in India remains particularly vulnerable to seasonal adverse weather phenomena (such as monsoons, storms, and extreme heatwaves), political unrest, in addition to emergencies concerning staff health. The distinctive architecture of the DLR allowed the primary educator to effectively oversee, guide, or support the classroom remotely from their residence in instances of illness or travel restrictions caused by severe weather conditions. Furthermore, during unforeseen power outages, educators were able to continue delivering their instructional content via mobile phones.

- **Challenges and limitations:** Teachers highlighted the lack of personalised interaction. They underscored the necessity for enhanced interactive technology capable of delivering real-time feedback and assessment responses from students. Furthermore, they acknowledged barriers encountered at home, particularly the lack of internet connectivity and smart televisions, which hinder the sharing of teaching materials with parents for continuous education. Additionally, they noted that, given the novelty of this instructional approach, meticulous pre-planning is imperative for the successful implementation of pedagogical content. They also recognised the need for teachers to undergo training and to be proficient in the use of digital technologies and video platforms.

- **Recommendations:** Teachers valued the significance of this pedagogical approach and expressed a strong demand within their community. They emphasised the necessity to expand the reach of this technology so that a broader range of children from marginalised communities could benefit from it. They advocated for technological investments to facilitate larger-scale implementation, supported by government funding. Additionally, they highlighted the importance of establishing a comprehensive teaching and training framework to assist educators in executing the educational interventions. They perceived this as essential for elevating local schools to higher standards, achieving an educational scope comparable to that of major cities in India.

Teacher Excerpts

- **Remote school teacher (Sargachi)** – **On access for underserved children**: *Here, children don't have TV at home, no storybooks, no good library. Parents also don't get time because they have to go to work. In this situation, they felt so much joy listening to and watching my stories.*

- **Remote school teacher (Sargachi) – On emotional connections despite geographical separation**: *I really enjoyed being a remote teacher. As a teacher, I always get to be with children. I missed that company a lot*.

- **Remote school teacher (Sargachi**) – **On collaborative pedagogical co-creation:** *Earlier, I was the only teacher in my school handling four classes together. I felt exhausted and alone. Now, through this digital room, I have a brother teacher miles away. We talk on the phone every evening, plan tomorrow's lesson, and share the load.*

- **Teaching assistant (Raidighi) – On low threshold EdTech:** *I was terrified of computers... But the setup is so simple—just two clicks. When I faced an audio issue last week, the teacher from the other school guided me over a phone call while sitting at his home. Learning this digital skill at my own pace has given me immense confidence.*

- **Teaching assistant (Sargachi) – On Climate Resilience:** *During the heavy monsoon floods last month, the roads to my school were completely blocked... This time, I logged in from my mobile at home. A local village youth turned on the classroom screen, and I took the storytelling class seamlessly. Nature couldn't stop our school.*

- **Remote school teacher (Sargachi) – On lack of individual interaction:** *It was not possible to ask each and every one of the 61 children individually. I had to ask group by group….I miss being able to sit with them and talk a lot. Other teachers didn't miss this like I did.*

- **Teaching assistant (Raidighi) – On the need for training and planning:** *This teaching method is very innovative. It needs perfect planning. The remote teacher has to sit and plan a lot. Those working on the ground also have to match with the plan….To do this work, teachers need to know a little about technology, need to know children, need to know the subject.*

- **Remote teacher (Sargachi) – On aspirations, technology investments and government support.** *The government could give a little subsidy for these families. Or arrange a mobile educational van in the village with a digital learning room and library. Parents could borrow smart TV or smart phone from there… If the government helps with our training and gives us a little time, we ourselves can take stories, songs, dance, poems, and maths to every home. But this needs a lot of money … To bring village children's education to an international level, to bring children to school – we have to give them stories, songs, pictures. We need good teachers, and we need to bring in parents. For this we need time, money, and technology.*

Table 3. Qualitative Evidence: Rural teachers' opinions and perspectives

E.3 Inclusion of socio-economically deprived parents

In historically marginalised rural Indian communities, low parental literacy often leads to a disconnect between the home and the school (Banerji et al., 2017). This intervention attempted to address this gap, yielding the following thematic insights, with some expressions relating to these summarised in Table 4:

- **Radical pedagogical transparency and accountability:** Historically, parents in rural areas lacked a mechanism to observe the content and manner of their children's learning within classrooms. The DLR offered real-time visibility, enabling parents to directly observe the curriculum, oversee scheduling, and establish direct communication channels with educators.

- **Digital scaffolding for home-based learning (homework support):** For parents belonging to deprived rural communities, traditional homework, which heavily relies on written material, frequently serves as a means of exclusion. This project addressed the issue by using short, action-oriented digital videos to visually demonstrate exactly how parents can assist their children with homework. By transitioning from written instructions to audio-visual guidance, the intervention enhanced parental capacity regardless of their formal literacy levels.

- **Asynchronous remediation and learning continuity:** To address rural absenteeism caused by illness or domestic issues, teachers established an immediate remediation protocol. In instances where a child was absent from a class, parents had the opportunity to notify the teacher, who would then systematically review and present the previous session's coursework at the commencement of the subsequent session. This 'recap' approach aimed to prevent vulnerable students from falling behind.

- **The aspiration for direct-to-device mobile pedagogy:** The perceived success of the digital classroom triggered an organic demand among parents for a transition from classroom-based digital learning to home-based mobile learning. Parents expressed a strong preference for all educational videos, stories, and activities to be delivered directly to their personal mobile devices, thereby enabling their homes to be a locus of learning.

- **High interest and demand for digital classes:** The contemporary, engaging teaching approach was met with great enthusiasm from children and their mothers alike. Parents valued the learning experience highly and showed a keen interest in having sessions more often and regularly.

- **Infrastructure, device, and accessibility challenges:** Notwithstanding the project's achievement, challenges to accessibility were encountered due to adverse weather conditions, such as substantial monsoon rains, coupled with the absence of essential devices (smartphones with internet access, electricity, etc) at home. Furthermore, the lack of formal education among numerous mothers contributed to reports of difficulty in independently guiding their children's studies.

- **Need for teacher guidance and parental support:** Mothers often encountered challenges in educating their children at home. They articulated a need for concise guidance or assistance from educators through video conferencing. Nonetheless, acknowledging the existing substantial workload on teachers, many parents hesitated or felt embarrassed to request such support.

Parental excerpts

- **Parents' perspectives on transparency:** *Before, we had no idea what was being taught in the school classrooms. We would just send our children there. Now, because of this Digital Learning Room (DLR), we can clearly see what is being taught. We can talk directly with the teachers, and we can find out from our mobile phones when classes will take place.*

- **Parents' view on homework support:** *I have never been to school myself, so I always felt a kind of fear regarding my child's homework. But when the teachers showed us through short, play-like skits in videos how to help the child at home... even though I cannot read or write, by watching the videos, I can now solve simple math and multiplication tables along with them.*

- **Parents' perspectives on asynchronous remediation:** *When my child cannot go to class for any reason, especially due to illness or chores, I let the teachers know over the phone. The teachers are so caring that as soon as the child comes to class the next day, they beautifully show the previous day's work on the screen. As a result, my child does not fall behind in any lessons.*

- **Parent view on direct-to-device learning request:** *We are very happy to see this form of the school. Now, we all sincerely wish that the teachers could send pictures, songs, plays, and math videos about all the school stories directly to our phones. Our children will then be able to revise these again through the phone whenever they want, even while sitting at home.*

- **Parents' need for teacher guidance and parental support**: *If we could understand a little bit about how to teach, it would be wonderful if the teacher could make a quick video call. When I fail to explain something, my child says, 'Go to the computer teacher, they will open a video and explain it to you.' I feel very shy to ask. They have to do so much work...*

- **Parents' view on infrastructure, device, and accessibility challenges:** *During heavy rains, it is very difficult to send our children from home. It would be so convenient if we had this kind of phone and TV at home. If we could attend this kind of class someday, we don't know much about education. We cannot help.*

- **Parents' view on frequency of classes:** *We really liked this class. But it would be very good if one such class could be conducted every week.*

Table 4. Qualitative Evidence: Parents' opinions and perspectives

F. Discussion

The findings from this cross-regional exploratory pilot intervention offer interesting insights into how synchronous digital technologies can potentially impact early childhood education within historically marginalised communities. Instead of viewing technology as a mere tool for content delivery, this discussion evaluates the intervention through the lens of a socio-technical framework, focusing on the intersection of low-threshold educational technology, teacher solidarity, and parent-led pedagogical scaffolding.

F.1 The power of "low-threshold" EdTech in overcoming the digital divide

A key contribution of this research is its rejection of complex educational technologies, which often struggle in rural settings due to "tech-anxiety" and fragile infrastructure. By creating an interface that requires minimal interaction from users with limited technical skills, the project has rendered classroom management more accessible. When the main teacher was absent due to illness, the ease with which a teaching assistant could start the synchronous session suggested that this approach to technology may reduce reliance on a single teacher. This low-threshold design shifted attention from hardware issues to fostering shared learning environments, suggesting that the sustainability of educational technology in such contexts can be related to simplicity and human agency.

F.2 Digital learning and children's learning experiences

Joy is increasingly recognised as central to children's early learning experiences (Little and Karaolis, 2024). Previously, these students engaged in collective learning within the same classroom setting through peer interaction. The advent of Digital Learning Rooms has marked a qualitative change in their educational environment. The availability of audio-visual content via smart TVs and mobile phones rendered the learning process more diverse and participatory. Acknowledging the exploratory pilot nature of this study and the limitations imposed by the absence of formal analyses of foundational literacy and numeracy, the following key themes emerged.

Impact potential of digital learning room: subject-wise analysis

- **Literacy**: Through videos, stories, and plays, children were provided with opportunities for auditory and visual language practice. Observing characters, events, and dialogues helped expand their vocabulary and improve comprehension. It was possible that storytelling through digital media strengthened their imagination and helped them lay the foundation for creative thinking.

- **Science:** Viewing pictures, animations, and experiment videos on smart TVs could help facilitate the concretisation of abstract scientific concepts. The "learning by seeing" approach would augment the children's observational skills and curiosity. Presenting fundamental scientific ideas through songs and dance could change the learning process from a source of apprehension into an enjoyable experience.

- **Numeracy:** Interactive songs and visuals can help children build a basic understanding of numbers, counting, and simple calculations. By engaging remote learners via mobile phones and having them actively solve mathematical puzzles and problems, there was potential for their problem-solving abilities and confidence to improve.

Overall learning experience: The Digital Learning Room did not merely deliver information; it fostered a degree of awareness and promoted social interaction among children. Audiovisual content kept them engaged, and the opportunity to share stories and experiences with remote learners helped integrate them into a broader learning community. As a result, the educational process extended beyond the confines of the classroom, becoming collaborative and engaging. The utilisation of technology could help shift learning from rote memorisation towards experiential, interactive, and conscious education.

F.3 Structural transformation of the rural teacher: from isolation to solidarity

In rural India, the "one-room, one-teacher" model engenders significant professional burnout and pedagogical stagnation (Tripathi, 2025). Our observational findings suggest that the DLR has fundamentally revised this by cultivating an organic professional learning community that cut across geographical boundaries. The nocturnal communication patterns among educators—engaging via mobile devices from their residences—indicate that professional development does not require formal, expensive, top-down bureaucratic training. Instead, when equipped with a shared digital workspace, educators established lateral peer-mentorship networks. This cross-pollination of skills (e.g., combining one teacher's musical expertise with another's artistic talent) constructs a framework where the collective effort could surpass the mere aggregation of individual components.

F.4 Bypassing the literacy barrier: transforming deprived parents into educational assets

Historically, parental illiteracy and the digital divide in underprivileged rural communities have been recognised as a significant impediment to home-based learning (Anazia et al., 2026; Badiuzzaman et al., 2025). Considering the limitations posed by the absence of mobile phones in some of the studied households, this intervention attempted to address the deficit paradigm. By substituting text-heavy assignments with video-guided visual support, the study endeavoured to bypass the literacy barrier. Furthermore, the parental demand for direct-to-device mobile content delivery suggested a cognitive change. Informal interviews revealed that rural parents did not wish to be passive spectators, merely entrusting their children to confined institutional settings; rather, they aspired to convert their personal domestic spaces into mobile-enabled micro-learning environments. This development reflects a presence of social and educational capital within the household.

F.5 Systemic and environmental resilience against learning loss

Climate vulnerability, including phenomena such as monsoons, flash floods, and heatwaves, frequently results in significant learning deficits in rural educational settings, thereby

affecting attendance among both educators and pupils (UNICEF, 2026; Tulsyan, 2025). The DLR's ability to mitigate these disruptions through remote classroom management – where teachers teach from their homes via mobile devices under the supervision of local volunteers overseeing in-person classes – introduced an innovative strategy for ensuring educational continuity. Moreover, the DLR implemented an asynchronous catch-up protocol, whereby educators systematically recapped missed lessons on the subsequent school day, thus endeavouring to establish an institutional safeguard that potentially reduces the impact on some first-generation learners of cumulative academic losses associated with unavoidable absences.

G. Limitations of this study

This study was subject to several limitations arising from its exploratory pilot design, the absence of a comparator intervention, and the lack of formal assessment of outcome measures. While these limitations do not invalidate the findings, they define the boundaries within which the results should be interpreted. Recognising these constraints facilitates a more balanced understanding of the study outcomes and provides a clear framework for future research.

G.1 Methodological limitations

Scope and generalisability: This study was designed as a case-based intervention within a specific institutional and geographical context. Consequently, the findings may have limited external validity and cannot be readily generalised to other educational settings, particularly those with different socio-economic, cultural, or infrastructural characteristics.

Cross-sectional design: The study adopted a cross-sectional design, with user engagement assessed over a defined project period. In the absence of longitudinal follow-up, it is not possible to determine the sustainability of observed outcomes, long-term knowledge retention, or behavioural changes associated with the intervention.

Lack of a comparator group: Due to logistical and resource constraints, a randomised controlled design could not be implemented. This represents a significant methodological limitation, as the absence of a comparator group restricts the ability to attribute observed outcomes directly to the intervention. However, the primary aim of this exploratory study was to identify emerging themes and assess feasibility rather than establish causal relationships. The findings therefore provide a foundation for future large-scale randomised controlled studies incorporating robust outcome measures to further evaluate the effectiveness of the intervention.

Lack of formal outcome assessments: The socio-economic and demographic characteristics of the participating rural communities influenced the choice of evaluation methods. Factors such as low literacy levels, anxiety associated with formal assessments, the developmental stage of the participating children, and the cultural preference for informal discussion shaped the methodological approach, as detailed in Section C. The development, piloting,

and validation of a structured interview instrument in the local language was beyond the scope of the current project. Although structured assessments may have provided greater reliability and standardisation, they were considered developmentally inappropriate for children, culturally unsuitable for adult participants in this setting, and logistically impractical within the constraints of a pilot study.

Self-reported data bias: Findings rely on informal group conversations, discussions with parents and researcher observation. These can be susceptible to social desirability effects, recall bias and researcher interpretation

G.2 Human resource and workforce limitations

Variability in digital literacy: As this was an informal pilot study, neither educators nor learners received formal training in digital technologies before implementation. Consequently, variations in digital competence may have influenced engagement and adoption of the platform, potentially contributing to unequal learning experiences across participants.

Limited availability of specialist expertise: The effective implementation of this study required amongst others, interdisciplinary expertise in digital content development, and subject-specific pedagogy. Personnel possessing proficiency across all these areas were limited, necessitating overlap of responsibilities that may have affected the depth and consistency of implementation.

Teacher capacity and training burden: The transition to a Digital Learning Room model requires substantial teacher development in content creation, platform administration, and technology-enhanced pedagogy. Due to time constraints and other competing commitments, technological adaptation among educators was gradual, which might have potentially influenced the implementation process.

Sustainability of support structures: Continuous technical support, and content curation require dedicated personnel. This study attempted to address this by the researcher revisiting the support provided, the pedagogic aims of this study, and continued refreshment of the digital skill of the educators.

G.3 Technological limitations

Infrastructure dependency: The effectiveness of the Digital Learning Room depended heavily on reliable internet connectivity, stable power supply, and access to suitable digital devices. In locations where these resources were inconsistent or unavailable, platform performance and equitable participation were adversely affected.

Data security and privacy concerns: The collection and analysis of learner data raise important considerations regarding privacy, informed consent, data ownership, and algorithmic bias. Although the project adopted GDPR-compliant processes, the evolving nature of data governance regulations and the possibility of cybersecurity breaches remain ongoing challenges.

Technological obsolescence: Educational technologies evolve rapidly, increasing the risk that hardware and software acquired at the beginning of a project may become outdated during its implementation. Such technological obsolescence may necessitate additional investment to maintain functionality, compatibility, and contemporary standards of educational delivery.

H. Policy recommendations

Drawing upon the empirical evidence collected from this exploratory pilot involving the two-region rural trial, the following policy recommendations are proposed. These do reach beyond the limits that are acknowledged above, and should be seen at this stage solely as suggestive implications of the project, to be confirmed by later work. They seek to enhance resilient and equitable early childhood education within the framework of international development initiatives and national policies such as India's National Education Policy 2020 that mandates experiential, arts-integrated, and joyful learning:

1. **Mandate the implementation of "low-threshold" EdTech protocols in rural procurement:** Government procurement agencies should substitute complicated, high-maintenance computer labs and smartboards that need specialised IT support with straightforward "one-touch" or "two-click" real-time classroom systems. Hardware must withstand voltage fluctuations typical in rural regions, and the software interfaces should be intuitive enough for local volunteers or proxy facilitators to use with minimal or no training.

2. **Establish formal peer-to-peer "sister classroom" networks:** Governmental educational strategies should consider establishing structural links between under-resourced, single-teacher rural schools and partner classrooms across regional or cultural boundaries. Rather than viewing digital classrooms solely as tools for top-down lecture broadcasts, strategies should support horizontal, peer-to-peer interactive sessions.

3. **Shift from traditional bureaucratic teacher training to collaborative professional learning communities:** Educational policies ought to contemplate the reallocation of resources away from centralised, hierarchical teacher-training seminars, which frequently demonstrate low efficacy in classroom transmission. Conversely, teacher training initiatives should endorse and finance peer-to-peer mobile communication and collaborative digital workspaces among educators. Additionally, these policies should empower educators with the autonomy to collaboratively develop localised, indigenous digital learning solutions flexibly within their own time and spatial contexts.

4. **Implement visual, direct-to-device parent scaffolding systems:** Future educational strategies ought to reevaluate the structuring of home-school communication systems, advancing beyond conventional text-based report cards or written diaries. It is recommended that educational portals be established to enable educators to actively curate and dispatch micro-video guides directly to parents' smartphones through accessible networks such as WhatsApp. These concise videos should visually illustrate

play-based homework support methods, thereby effectively addressing parental illiteracy and transforming rural households into sustainable learning centres.

5. **Develop digital contingency frameworks to manage unforeseen circumstances, ensuring educational continuity:** Another consideration should be the formulation of a comprehensive policy framework designed to ensure the continuity of education amidst extreme weather events, socio-economic turmoil, political unrest, or other unpredictable disruptions. This could be accomplished by officially acknowledging synchronous remote learning as a legitimate instructional method for educators in rural areas. By establishing cost-effective remote connectivity solutions, policies can facilitate the development of home-to-classroom streaming when educators are unable to attend the classroom or enable the conversion of homes into classrooms when students are affected. Such a strategy could protect vulnerable first-generation students from cumulative learning loss during climate-related and other school closures.

I. Conclusion

This exploratory pilot study suggested that addressing educational disparities in rural India necessitates advancing beyond hardware deployment to focus on cultivating a socio-technical network among children, educators, and parents. By implementing a low-threshold, human-centric Digital Learning Room remotely across two distinct rural terrains, this initiative could form the basis for a more resilient, weather-resistant, and participatory educational ecosystem.

The findings suggest that digital interventions focused on human relationships, rather than complex software, may help learners overcome geographic isolation and improve their socio-emotional well-being. They also have the potential to promote development in foundational literacy and numeracy through arts-based peer learning. Additionally, the study suggests that rural teachers can be helped to move from professional isolation to collaborative solidarity by the creation of decentralised networks that protect classrooms and ensure educational continuity during unpredictable disruptions. Moreover, the results suggest that socio-economically disadvantaged parents can be helped in overcoming generational literacy barriers using visual scaffolding, thereby helping them move from marginalised observers into more active educational allies advocating for mobile-first learning.

Given the constraints imposed by the exploratory nature of this research, this study advocates for a larger randomised controlled trial, incorporating rigorous assessments of outcome measures, to elucidate the findings noted herein. Ultimately, such further interventional research could establish a scalable, weather-resistant, human-centred framework that leverages fundamental digital infrastructure to guarantee equitable early childhood education across the Global South.

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