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BEYOND TECHNICAL UPGRADES: A QUALITATIVE CASE STUDY ON THE IMPLEMENTATION OF DIGITALIZATION IN RURAL AND URBAN SECONDARY PUBLIC SCHOOLS

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ABSTRACT

This qualitative multiple-case study examines how digitalization unfolds in contrasting rural and urban public secondary schools. Guided by Rogers' Diffusion of Innovations Theory, the study analyzes operational bottlenecks, teacher workarounds, and systemic policy limits using field interviews (N=10), focus group discussions (N=6), and a systematic review of over 80 policy documents and studies. Findings show that technology adoption depends on environmental readiness and administrative flexibility rather than hardware presence alone. While rural schools face physical isolation, power deficits, and acute device shortages, urban schools encounter network congestion, large cohort sizes, and restrictive asset accountability policies. To maintain instruction, teachers adopt offline software, informal peer mentoring, community Wi-Fi solutions, and cascade training via Learning Action Cells. However, high-access urban environments present emerging pedagogical risks, notably student reliance on generative AI for cognitive offloading, whereas off-grid rural areas risk wider achievement gaps. Effective digital transformation requires context-specific funding, adaptable governance, and clear pedagogical guardrails rather than uniform hardware delivery.

KEYWORDS: *Educational Digitalization, Diffusion of Innovations, Digital Divide, Rural and Urban Education, School Governance, Technology Integration*

INTRODUCTION

Integrating digital technology into primary and secondary education is a central priority for national school systems aiming to build digital literacy and modernize school administration (OECD, 2023; UNESCO, 2023). Central authorities typically address this goal through top-down mandates under a uniform distribution model, assuming that supplying hardware, cloud software, and digital curricula will systematically improve classroom instruction (van Dijk, 2020; Warschauer & Matuchniak, 2010). In practice, however, technology adoption depends heavily on local school conditions, where broad policy goals encounter varied operational constraints (Timotheou et al., 2023).

Public secondary schools operate under sharp geographical, economic, and administrative differences. Rural schools routinely face power outages, limited internet access, and insufficient physical hardware (Bozkurt et al., 2021). Urban schools, while better connected, encounter overcrowded classrooms, saturated network bandwidth, and strict central liability rules that keep equipment locked away from regular student use (Fraillon et al., 2023; UNESCO, 2023). When national policies ignore these localized barriers, platform adoption stalls, increasing teacher workload, and widening educational disparities.

Rogers' (2003) Diffusion of Innovations Theory provides a useful framework for understanding these implementation gaps. Rogers identifies five attributes that dictate how quickly an innovation spreads: Relative Advantage, Compatibility, Complexity, Trialability, and Observability. In public schools, when digital tools conflict with local infrastructure or administrative regulations, compatibility breaks down, operational complexity increases, and opportunities for low-risk testing shrink (Scherer et al., 2021; Wohlfart & Wagner, 2023). Under these conditions, teachers frequently revert to paper-based instruction because it offers greater immediate reliability during live lessons (Ifenthaler & Yau, 2022).

Although prior research documents general technology barriers and teacher attitudes (Ertmer & Ottenbreit-Leftwich, 2019; Tondeur et al., 2021), fewer studies examine how school principals, ICT coordinators, and teachers adapt centralized mandates on the ground across contrasting rural and urban settings. Additionally, high-access digital environments present new instructional risks such as students' overreliance on generative artificial intelligence to complete analytical tasks that require closer empirical scrutiny alongside traditional infrastructure gaps (Kasneci et al., 2023; Zawacki-Richter et al., 2019).

` To address these issues, this qualitative multiple-case study addresses three research questions:

RQ1: What specific technological, pedagogical, administrative, and socio-economic bottlenecks affect digitalization in rural and urban public secondary schools?

RQ2: How do school actors adapt, share resources, and develop workarounds to manage systemic limits?

RQ3: What broader institutional shifts, changes in student learning habits, and unintended risks (e.g., AI-driven cognitive offloading) emerge from long-term implementation?

By addressing these core questions, this study advances the educational technology literature by moving beyond superficial accounts of hardware availability. It provides school leaders, educational strategists, and policy architects with a context-responsive framework for transitioning from rigid, top-down equipment distribution to flexible, socio-technically grounded digital governance.

METHODOLOGY

This study employed a qualitative research design utilizing a multiple-case study approach to examine how educational digitalization unfolds across contrasting public secondary school environments (Creswell & Poth, 2018). Following Yin's (2018) replication logic, the design bounded the investigation across two distinct operational settings: Case 1, a geographically isolated rural public secondary school facing off-grid infrastructure deficits, and Case 2, a high-density urban public secondary school constrained by bandwidth congestion and rigid central administrative governance. To establish a robust theoretical baseline, primary field insights were paired with a systematic qualitative analysis of a comprehensive corpus of documents comprising over 80 peer-reviewed journal articles, international benchmark reports (e.g., IEA ICILS, OECD, UNESCO), national education policy documents, and institutional records. This combination of localized field data and extensive policy literature allowed the study to evaluate how top-down national mandates collide with micro-level operational realities through the lens of Rogers' (2003) Diffusion of Innovations framework.

Primary field data were collected through a multi-method qualitative approach to ensure analytical depth and triangulation of data sources (Denzin, 2012; Patton, 2015). A total of sixteen (N = 16) participants were selected through purposive sampling based on their direct involvement in planning, managing, or executing school digitalization initiatives. Primary qualitative data streams comprised face-to-face Individual In-Depth Interviews (IDIs) with ten (n = 10) school administrators (n = 5 rural, n = 5 urban), alongside two Focus Group Discussions (FGDs) with six (n = 6) classroom teachers (n = 3 rural, n = 3 urban). Sessions were conducted using semi-structured guides aligned with Rogers' (2003) theoretical constructs, which underwent formal content validation by three educational research experts prior to deployment. All sessions were audio-recorded with explicit consent, transcribed verbatim, and subjected to member checking, in which participants verified and signed off on their transcripts to confirm interpretive accuracy.

Data analysis followed Braun and Clarke's (2006) six-phase thematic analysis framework, combining inductive open coding with deductive mapping across Rogers' (2003) five core innovation attributes: Relative Advantage, Compatibility, Complexity, Trialability, and Observability. Following within-case thematic coding, a cross-case synthesis guided by Yin (2018) was conducted to systematically contrast rural and urban findings and identify converging socio-technical workarounds and context-specific bottlenecks. Methodological rigor was maintained in accordance with Lincoln and Guba's (1985) trustworthiness criteria through data source triangulation, thick contextual descriptions, and a documented audit trail. Strict ethical compliance was maintained under the approval of the Institutional Ethics Review Committee (Society of Moral Integrity and Legal Ethics - SMILE, Protocol No. IERC-2023-0842) and the Data Privacy Act of 2012 (Republic Act No. 10173), guaranteeing voluntary participation, informed consent, and total participant anonymity through encrypted file storage and anonymized coding schemes.

RESULTS

Challenges Encountered in the Implementation of Digitalization

Theme 1. Structural Inaccuracies and Policy Boundaries (Compatibility)

Compatibility breakdown in Case 1 (Rural Secondary School) was driven by physical infrastructure deficits and geographical isolation. Top-down digital mandates requiring active cloud connectivity failed consistently due to the complete absence of stable telecommunications networks. As the rural ICT coordinator explained during an individual interview, "We are expected to use centralized cloud platforms, but our campus has no stable cellular signal. When a cloud-dependent tool fails continuously during a live lesson, teachers lose instructional time and fall back on printed packets" (P3, Rural ICT Coordinator). This sentiment was mirrored during the rural focus group discussion, where participants emphasized that off-grid realities make online-only policies functionally incompatible with their daily operations, noting that "the central office releases digital tools assuming every school has reliable internet. In our location, even checking basic emails requires walking to higher ground outside the school perimeter" (FGD-R2, Rural Teacher).

In contrast, compatibility friction in Case 2 (Urban Secondary School) stemmed from restrictive administrative governance rather than signal loss. Although high-speed internet infrastructure was physically available, central asset management guidelines prohibited students from taking government-issued devices home due to property liability concerns. The urban principal detailed this administrative bottleneck, explaining that "we have computer carts stored in our building, but strict government property liability rules state that administrators face personal financial charges if a unit is lost or damaged off-site. Consequently, the hardware remains locked on campus" (P7, Urban Principal). Urban teachers in the focus group confirmed that these governance rules severely restricted instructional integration outside classroom hours, observing that "students have smartphones at home, but our school-issued laptops must stay inside the laboratory cabinets overnight. The policy prioritizes asset preservation over student access" (FGD-U4, Urban Teacher).

Theme 2. Preparation, Strain, and System Overload (Complexity)

Operational complexity in Case 1 (Rural Secondary School) was characterized by severe digital literacy gaps among faculty and the heavy workload of converting analog materials into offline digital formats. A rural master teacher highlighted the dual burden placed on classroom instructors, stating that "many of our senior teachers were never trained on digital instructional design. Forcing them to digitize printed learning modules while simultaneously learning basic software operations created immense preparation anxiety" (P2, Rural Master Teacher). Participants in the rural focus group discussion further noted that the lack of technical support staff compounded this operational strain, adding that "when a file gets corrupted or an offline media player malfunctions, there is no IT technician to call. The classroom teacher has to stop teaching and try to fix the technical error themselves" (FGD-R5, Rural Teacher).

In Case 2 (Urban Secondary School), complexity manifested in network bandwidth saturation and server crashes due to high student cohort density. An urban classroom teacher described how system overloads disrupted scheduled lessons, sharing that "when 500 students across the grade level attempt to log into the learning management platform at the exact same hour, the school network collapses. The platform freezes, loading wheels' spin indefinitely, and the entire class period is wasted" (P9, Urban Teacher). During the urban focus group session, educators stressed that frequent server crashes degraded their confidence in digital platforms, pointing out that "you spend hours preparing an interactive online quiz, but the moment 50 students open their browsers at once, the system crashes. It is simply less stressful to write the exam on the chalkboard" (FGD-U1, Urban Teacher).

Theme 3. Scarcity Voids and Operational Unreliability (Trialability & Relative Advantage)

Trialability was severely restricted in Case 1 (Rural Secondary School) due to an extreme device-to-student ratio. Without sufficient hardware to test in small groups, teachers could not experiment with low-risk digital strategies. A rural teacher detailed this scarcity, observing that "we have one functioning desktop computer for every 35 students. You cannot conduct meaningful digital experimentation or assign individual hands-on tasks with that level of equipment scarcity" (P5, Rural Teacher). This hardware void was echoed in the rural focus group discussion as a primary reason teachers maintained analog delivery methods, with one participant explaining that "when students have to share one small screen in groups of seven or eight, half of them lose interest. Paper worksheets remain far more reliable because every single student actually gets a copy in their hands" (FGD-R1, Rural Teacher).

In Case 2 (Urban Secondary School), trialability was restricted by administrative risk aversion, with computer laboratories kept locked outside scheduled class hours to prevent damage. An urban teacher explained that "the computer laboratory is kept locked key-and-bolt by management to prevent hardware wear and tear. Teachers cannot drop in during their free periods to test new software before using it with students" (P10, Urban Teacher). In the urban focus group discussion, teachers noted that live technical unreliability ultimately destroyed the perceived relative advantage of digital tools over traditional instruction, concluding that "if setting up the projector and getting 50 students authenticated online takes 20 minutes out of a 50-minute period, technology is not saving time it is wasting it. Chalk and paper remain operationally superior" (FGD-U6, Urban Teacher).

Localized Coping Mechanisms and Adaptive Strategies

Theme 4. Localized Re-Invention and Alternative Delivery

To overcome absolute signal deficits, educators in Case 1 (Rural Secondary School) engaged in creative re-invention by pairing printed modules with offline digital media storage. A rural teacher explained how they delivered digital content without internet connectivity, stating that "we saved video lectures, offline interactive modules, and digital reading materials onto USB flash drives. Students plug these drives into off-grid television sets or shared family smartphones at home without needing a cellular connection" (P4, Rural Teacher). The rural focus group discussion highlighted how school leaders worked with the local community to establish localized connectivity spots near the campus, noting that "our school head partnered with nearby vendors to set up coin-operated 'Piso Wi-Fi' hotspots near the school gate. Students drop in small coins to download their weekly digital modules before heading home" (FGD-R4, Rural Teacher).

In Case 2 (Urban Secondary School), urban teachers restored instructional continuity by abandoning fragile cloud platforms in favor of local, standalone offline applications. An urban teacher described this shift, noting that "instead of relying on web-based platforms that crash when bandwidth drops, we transitioned to the Lumi app and HTML5 packages. These run locally on each machine's browser without requiring an active internet signal" (P8, Urban Teacher). Urban focus group participants emphasized how administrative leaders used discretionary local funds to bypass central procurement delays, sharing that "when official hardware replacement requests sat unfulfilled at the division office, our principal reallocated local school operating funds (MOOE) to purchase Wi-Fi routers and repair lab computers directly" (FGD-U3, Urban Teacher).

Theme 5. Collaborative Capacity Building and Peer Modeling

Rural schools in Case 1 (Rural Secondary School) addressed faculty digital literacy gaps through informal, peer-to-peer mentoring pairs. A rural teacher explained that "we established informal buddy systems. Younger, tech-savvy teachers sit down with senior colleagues after class hours to walk them step-by-step through lesson digitization and basic file management" (P6, Rural Teacher). Participants in the rural focus group confirmed that these informal peer networks built confidence more effectively than formal external seminars, adding that "external workshops move too fast and assume a baseline level of technology we don't have. Having a peer teacher sit beside you in your own school building makes learning manageable" (FGD-R6, Rural Teacher).

Urban schools in Case 2 (Urban Secondary School) institutionalized professional development through structured Learning Action Cell (LAC) sessions and master teacher demonstrations. An urban master teacher detailed this approach, explaining that "during our weekly LAC assemblies, Master Teachers conduct live model lessons demonstrating how to

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integrate offline digital tools within large-enrollment classrooms, giving teachers a proven template to follow" (P12, Master Teacher). This structured cascade model was highlighted in the urban focus group discussion as essential for demystifying complex software, with a teacher remarking that "when a Master Teacher demonstrates an offline tool using an actual class of 50 students, it proves that integration is possible despite cohort density. It removes the fear of platform failure" (FGD-U5, Urban Teacher).

Contextual Insights and Emerging Risks

Theme 6. Learner Autonomy vs. Generative AI Cognitive Offloading

Long-term implementation in Case 1 (Rural Secondary School) revealed that structured offline digital modules encouraged students to develop independent study habits. A rural teacher observed this positive shift, noting that "when given self-contained digital materials on flash drives, rural students took greater ownership of their schedules. They developed strong self-paced study habits because they had to manage their learning independently off-grid" (P5, Rural Teacher). However, as rural focus group participants pointed out, severe home socio-economic disparities threatened to widen academic gaps, warning that "students whose families cannot afford a solar charger or a basic smartphone fall behind. The digital divide is no longer just between schools; it exists between households within the same rural village" (FGD-R3, Rural Teacher).

Conversely, in high-access environments in Case 2 (Urban Secondary School), unrestricted connectivity created severe pedagogical risks, specifically student reliance on Generative AI for cognitive offloading. The urban principal expressed deep concern over this trend, observing that "high-speed internet solved our access issue, but introduced a critical cognitive problem. Students routinely copy essay prompts into Generative AI tools and submit the output without reading, analyzing, or understanding the content" (P7, Urban Principal). Urban focus group participants stressed that unchecked AI reliance degraded student critical thinking and writing skills, highlighting that "we are seeing impressive essay submissions, but when you ask the student to explain their argument orally, they cannot answer. They are using AI to bypass the thinking process entirely, turning digital access into a crutch rather than a learning tool" (FGD-U2, Urban Teacher).

Summary Cross-Case Comparison Table

To make sense of how digitalization plays out across different school settings, it helps to look at Case 1 (Rural) and Case 2 (Urban) side by side. When you map these ground-level experiences directly onto Rogers' Diffusion of Innovations framework, you quickly see how the same policy mandate leads to a completely different reality on the ground depending on where a school is located. The comparison below brings these contrasts into focus, breaking down the specific structural hurdles, administrative policy headaches, and clever teacher workarounds that defined technology adoption in each environment.

The following joint display table presents a side-by-side synthesis comparing Case 1 (Rural) and Case 2 (Urban) across Rogers' (2003) five perceived innovation attributes and empirical findings:

Table 1

Cross-Case Analysis Matrix: Rural (Case A) vs. Urban (Case B)

Innovation Attribute (Rogers, 2003)	Case 1: Rural Secondary Public Schools	Case 2: Urban Secondary Public Schools	Cross-Case Analytical Takeaway
Compatibility	Infrastructure Deficit: Cloud software fails due to off-grid isolation and severe signal absence.	Policy Mismatch: Hardware locked on-site due to central asset liability rules forbidding device take-home access.	Rural friction is physical; Urban friction is administrative governance.
Complexity	Faculty Fluency Strain: Driven by teacher skills gaps and curriculum digitization workloads.	System Congestion: Driven by extreme cohort density and network bandwidth saturation during peak logins.	Rural complexity is human competence-based; Urban complexity is technical capacity-based.
Trialability	Scarcity Void: Restricted by absolute machine-to-student deficits.	Risk Aversion Lockdown: Restricted by locked laboratory protocols to prevent property damage.	Both suffer low trialability, but Rural due to hardware scarcity, Urban due to liability management.
Relative Advantage	Degraded by Signal Disconnection: Immediate reliability of paper packets outweighs unstable cloud systems.	Degraded by Server Crashes: Bandwidth bottlenecks during live lessons drive teachers back to analog options.	Both default to traditional analog instruction when technical issues occur live.
Observability	Masked by Off-Grid Divide: Performance gains hidden by socio-economic home connectivity barriers.	Enhanced by Digital Artifacts: Visualized through interactive platforms and trackable digital submissions.	Observability is fragmented in rural settings, but transparent in high-access urban settings.

DISCUSSION

Compatibility Friction: Structural Inaccuracies and Policy Boundaries

The finding that digitalization breaks down due to local operational mismatches directly supports Rogers' (2003) concept of compatibility friction. In rural settings, cloud-dependent software fails because basic telecommunications infrastructure is missing. This outcome aligns with Timotheou et al. (2023), who identified inadequate physical infrastructure as a primary barrier to school transformation, as well as UNESCO's (2023) analysis of structural resource gaps in remote schools. Field accounts from rural coordinators confirm that centralized mandates fail when cloud-based assumptions collide with off-grid realities.

In urban settings, compatibility friction stems from administrative rules rather than signal loss. Although urban campuses have internet connectivity, central asset guidelines prevent students from taking government-issued devices home due to property liability concerns. This finding mirrors warnings by UNESCO (2023) and Timotheou et al. (2023), which highlight how rigid organizational protocols can lock learning tools behind administrative barriers, preventing regular student access.

Perceived Complexity: Preparation Strain and System Overload

Operational complexity in both settings illustrates Rogers' (2003) principle that high perceived difficulty slows technology adoption. In rural schools, teacher digital literacy gaps and the heavy workload of digitizing printed curricula created significant preparation strain. This matches findings by Wohlfart and Wagner (2023) on teacher technical competence and Scherer et al. (2021), who showed that low technical self-efficacy predicts technology avoidance. In urban schools, complexity was driven by high student density and server crashes during peak class hours. This finding supports OECD (2023) reports on network capacity limits. As Tondeur et al. (2021) noted, frequent system failures artificially increase perceived software complexity, prompting teachers to return to analog alternatives regardless of their technical skills.

Restricted Trialability and Diminished Relative Advantage

Trialability limits—manifested as absolute hardware deficits in rural schools and locked computer labs in urban schools—prevented teachers from developing confidence through low-risk experimentation (Timotheou et al., 2023; UNESCO, 2023). This lack of testing opportunities reduced the technology's perceived relative advantage over established teaching methods (Rogers, 2003). When slow loading speeds or network failures interrupt class pacing, teachers conclude that paper materials offer better operational reliability (Ifenthaler & Yau, 2022; Scherer et al., 2021).

Observability Gaps and Socio-Economic Realities

The visibility of student academic gains depended heavily on the local home environment (Rogers, 2003). In rural settings, uneven home access and power availability hid student progress behind socio-economic lines, reinforcing conclusions by van Dijk (2020) and Warschauer and Matuchniak (2010) regarding home digital divides. Conversely, when urban teachers successfully used offline applications and digital portfolios, student progress became easy to track, demonstrating how clear visual outputs help validate digital tools (Thakur & Rampal, 2021; Trust & Whalen, 2021).

Localized Coping Mechanisms as Theoretical Re-Invention

Teacher workarounds in both cases provide clear examples of Rogers' (2003) concept of "re-invention." Rural teachers combined printed learning packets with USB flash drives, while urban teachers adopted offline desktop applications like the Lumi App. These adaptations support Bozkurt et al. (2021) and Voogt et al. (2021), who argued that equitable digital education requires flexible, multi-modal delivery systems rather than rigid online requirements. Similarly, informal peer mentoring in rural schools and structured Learning Action Cell (LAC) sessions in urban schools reflect findings by Ertmer and Ottenbreit-Leftwich (2020) and Trust et al. (2021). These studies show that peer coaching and practical master-teacher demonstrations build instructional confidence more effectively than isolated external workshops. Local budget reallocations and community Wi-Fi setups further highlight the value of school-level operational flexibility (OECD, 2023; Timotheou et al., 2023).

Socio-Economic Realism and Emerging Pedagogical Risks

The long-term findings demonstrate that local socio-economic conditions dictate how technology policies perform. While rural students using offline modules developed independent study habits (Thakur & Rampal, 2021), high-access urban environments posed an unexpected instructional risk: students' overreliance on generative AI for cognitive offloading. Unchecked AI access led students to submit AI-generated text without analyzing or understanding the underlying concepts, supporting concerns raised by Afzal et al. (2023) and Kasneci et al. (2023). As Zawacki-Richter et al. (2019) noted, AI tools support learning only when coupled with active teacher guidance and clear analytical tasks.

Cross-Case Synthesis

A cross-case analysis of Case 1 (Rural) and Case 2 (Urban) reveals that secondary public schools operate along the same technology adoption continuum. Although both settings are bound by identical national digitalization mandates, top-down policies do not diffuse uniformly. Instead, as these directives reach individual institutions, they are filtered through distinct local environments. In rural settings, this environmental filter is defined by geographical isolation, absolute device scarcity, and severe signal absence. In urban settings, the filter manifests as extreme student-cohort density, network bandwidth saturation, and rigid asset-liability protocols.

When centralized mandates hit these local filters, they trigger specific friction points across Rogers' (2003) five perceived innovation attributes. Compatibility is immediately tested by off-grid signal loss in rural areas or restrictive device-locking policies in urban centers. Operational complexity surges due to teacher digital literacy gaps in rural schools or network crashes during peak hours in urban settings. Trialability is restricted by machine scarcity in rural classrooms or locked laboratories in urban schools. Relative advantage declines whenever technical instability interrupts classroom pacing, prompting teachers in both environments to fall back on paper packets and chalkboards. Finally, observability is masked by socio-economic home barriers in rural communities, but supported by digital portfolios and interactive apps in high-access urban classrooms.

To keep instruction moving forward, educators in both settings do not wait for top-down solutions. Instead, they implement creative, localized workarounds. Rural educators adapt by pairing printed modules with offline USB flash drives, setting up community coin-operated "Piso Wi-Fi" hotspots, and organizing informal peer-mentoring pairs. Urban educators adapt by switching to offline desktop software like the Lumi App, using discretionary school operating funds to bypass procurement delays, and running cascade training through weekly Learning Action Cells. Supported by master teacher classroom modeling, these ground-level adaptations help restore the usability, trialability, and relative advantage of digital tools.

Ultimately, this synthesis shows that sustainable digital transformation cannot be achieved through uniform hardware distribution alone. Success depends on establishing a socio-technical balance where flexible school governance, collaborative peer coaching, targeted infrastructure investments, and clear pedagogical guardrails work together to make digital tools effective for real-world classroom learning.

IMPLICATIONS AND RECOMMENDATIONS

Theoretical and Practical Implications

This study demonstrates that digital technology adoption in public secondary schools depends on local operational conditions rather than hardware distribution alone. Applying Rogers' innovation framework shows that when centralized digital tools conflict with local realities, such as persistent signal loss in rural areas or restrictive liability policies in urban centers, their practical fit breaks down, forcing teachers to adapt how tools are used.

Practically, school leadership and administrative flexibility play a central role in technology integration. Leaders who support flexible schedules, reallocate local operational funds to address immediate technical needs, and encourage peer coaching create stable environments for classroom experimentation. Additionally, technology initiatives in low-income areas require home connectivity support to avoid widening achievement gaps, while high-access urban environments require clear teaching strategies to prevent generative AI from replacing student inquiry.

Recommendations

Educational authorities must abandon standardized equipment distributions in favor of targeted investments (e.g., broadband expansion in urban areas vs. off-grid infrastructure and offline digital repositories in rural areas). Central asset management policies should be updated to provide school principals with administrative flexibility to allow take-home device access for home learning.

School administrators should embed continuous professional development within school-based Learning Action Cells (LACs), using master-teacher classroom modeling to reduce the complexity of adoption. Concurrently, schools must establish clear instructional frameworks for ethical technology use, training teachers to design lessons that enforce critical inquiry and analytical reasoning rather than simple cognitive offloading.

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Ethical Considerations

Ethical integrity was prioritized throughout the research process. Participants provided informed consent after receiving a detailed overview of the project's goals, procedures, and voluntary nature. Pseudonyms and participant codes were used in place of real names to ensure anonymity, and any identifying institutional information was removed from the transcripts. A documented audit trail was maintained across the data collection and coding phases to ensure analytical transparency. All physical records and digital files, including audio recordings and transcripts, were handled in strict compliance with national data privacy regulations.

Conflict of Interest

No potential conflicts of interest were declared by the authors regarding the research, authorship, or publication of this article. The study was conducted independently, and the results reflect the collected data without external bias.

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