Systematic Literature Review: Digital Technology-Based Policy Approaches to Improve the Quality and Access of Basic Education in Developing Countries

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Abstract

This systematic literature review examines digital technology-based policy approaches to enhance the quality and access of primary education in developing countries, a critical issue given the persistent disparities in educational equity and the urgent need for inclusive solutions. Despite the transformative potential of digital technologies, their implementation often fails due to infrastructure deficits, low teacher digital literacy, and contextual barriers. Analyzing 40 peer-reviewed articles (2019–2024), the study reveals a stark policy-implementation gap: while 68% of national policies prioritize infrastructure (e.g., internet connectivity), 70% of local challenges stem from infrastructure gaps and 65% from low teacher readiness. Successful cases, such as China's 85% school digitalization rate, underscore the importance of multi-stakeholder collaboration and balanced budgeting (e.g., 30% infrastructure, 40% teacher training). However, rural areas lag significantly, with only 15% adoption in Albania due to electricity shortages. The findings highlight the limitations of the Technology Acceptance Model (TAM) in addressing contextual challenges such as teacher technophobia (40%) and curriculum misalignment (55%). The study's implications are vital for policymakers: (1) adaptive policies must balance infrastructure investment with human capacity building; (2) hybrid learning models can bridge urban-rural divides, as proven by blended learning's 30–50% participation increase in remote areas; and (3) localized strategies, including culturally responsive teacher training, are essential for equitable adoption. The urban-centric data bias (80%) and pandemic-era context further necessitate longitudinal research in low-resource settings. By advocating for holistic frameworks that integrate infrastructure, pedagogy, and inclusive governance, this review provides a roadmap for sustainable digital education transformation in developing nations.

Keywords: Digital Education Policy; Primary Education; Developing Countries; Systematic Review; Technology Adoption.

Introduction

Digital technology plays a critical role in improving education quality, particularly in developing countries facing challenges in basic education. National policies are typically structured to promote infrastructure investment (Khalilova *et al*., 2024), while Ventista *et al*. (2024) emphasize the importance of coherent digital policy frameworks for ICT success. However, implementation at the local level often faces obstacles, reducing the effectiveness of national policies. Solehudin (2024) highlights that uneven infrastructure deepens digital divides and educational access gaps. National policies frequently fail to be implemented locally due to resource and training limitations, as seen in Ukraine (Rossikhina *et al*., 2019b) and even developed nations like Norway and New Zealand (Thorvaldsen &

Madsen, 2021). Ethical challenges also emerge, where technology risks exacerbating inequality without clear ethical frameworks (Nkata & Dida, 2020). Despite the growing body of research on digital education policies, significant gaps remain. First, existing studies often focus on national-level policies while overlooking the disparities in local implementation, particularly in rural and underserved areas. Second, there is limited synthesis of the key factors that determine the success or failure of these policies across diverse contexts in developing countries. Third, the interplay between infrastructure development, teacher capacity building, and equitable access has not been thoroughly examined in a systematic manner. This systematic literature review addresses these gaps by providing a comprehensive analysis of digital technology-based policies, their implementation challenges, and their impact on primary education in developing countries. By doing so, the study aims to contribute actionable insights for policymakers and stakeholders to design more effective and inclusive digital education strategies.

On the other hand, the integration of digital technology into basic education policies holds significant potential to expand educational access across regions in developing countries. The widespread adoption of Information and Communication Technology (ICT) has served as a catalyst for transforming the educational landscape, particularly in areas historically underserved by traditional education systems. Numerous studies demonstrate that digital technology can be a key driver in creating more equitable and high-quality educational opportunities while addressing systemic inequalities entrenched in many regions (Ibrahim & Shiring, 2022; Abuya et al., 2021; Kushariyadi et al., 2024). The COVID-19 pandemic underscored the urgency of digital solutions in education, exposing technological access gaps while simultaneously accelerating the adoption of blended learning, which proved effective in Nigeria and ASEAN countries (Quimod et al., 2023; Jordan, 2020). Mobile technology has also emerged as a vital alternative, offering personalized learning for remote areas (M. Zhou, 2023) and overcoming the limitations of traditional methods (Misra, 2012). The implementation of Massive Open Online Courses (MOOCs) exemplifies how online learning platforms can democratize education by providing free or low-cost courses for those unable to access conventional schooling (Tian et al., 2021).

Nevertheless, significant challenges persist, particularly regarding infrastructure and the digital divide that hinder the optimal utilization of educational technology. Access to adequate devices and internet connectivity, especially in rural areas, demands sustained investment and policies prioritizing equitable technological access (Qaribilla et al., 2024; Hamka et al., 2024). These efforts must be accompanied by comprehensive strategies encompassing digital infrastructure improvement, teacher readiness to adopt and integrate technology into learning processes, and enhanced digital literacy among students (Chen, 2022; Abiddin et al., 2022). Policies emphasizing teacher training and resource allocation are crucial to maximizing the benefits of digital technology in basic education. All these initiatives must be aligned to ensure technology truly becomes an effective instrument for improving educational quality and access.

The integration of digital technology in basic education is widely recognized as crucial for enhancing educational quality and access, particularly in addressing systemic disparities, with initiatives like coding curricula promoting inclusivity and technological literacy among diverse socioeconomic backgrounds (Eke, 2024), while strategic digital resource integration strengthens human resource development in underprivileged regions (Siyi et al., 2023). However, developing countries face challenges such as infrastructure limitations, internet access issues, and educator shortages, as seen in Albania (Osmani & Tartari, 2024), with Lagstedt et al. (2021) emphasizing the need for sustainable strategies to maintain digital systems post-funding. The COVID-19 pandemic accelerated the demand for digital competencies (Hrytsenchuk et al., 2024), supporting UN Sustainable Development Goals (Parveen & Ramzan, 2024) and enhancing resilience through initiatives like digital education hubs (Hrytsenchuk et al., 2024), though successful integration requires understanding local cultural dynamics (Livingstone et al., 2020). While digital education holds transformative potential, its effectiveness depends on managing infrastructure, pedagogical adaptation, and policy sustainability, with national frameworks like Russia's proving essential for aligning digitalization with broader objectives (Kolbachev et al., 2019).

A similar trend is observed in countries developing coordinated national digital education policies focused on resource allocation and multi-stakeholder collaboration (Wang, 2023), such as China, where digital education has become

integral to reform (L. Zhou *et al*., 2023), though local implementation varies due to regional autonomy, as seen in Finland's diverse outcomes despite a national framework (Saari & Säntti, 2019). Challenges include resistance to change, digital literacy gaps (Rossikhina *et al*., 2019a), and persistent access disparities in less developed regions (Tiernan & O'Kelly, 2019), necessitating targeted interventions like digital literacy programs for underserved groups (Miftah & Prasetyo, 2024). The pandemic highlighted digital tools' role in maintaining learning continuity and fostering innovation (Y. Li, 2024), emphasizing the need for adaptive strategies (Sheikh & Berényi, 2023). In primary education, digital storytelling and multimedia improve teaching (Nair & Yunus, 2021), while interactive modules enhance retention (Tarigan *et al*., 2023), and ICT removes spatial-temporal barriers (Ateş, 2020), democratizing education (Kaharuddin *et al*., 2022) and ensuring pandemic-era continuity (Toan *et al*., 2021). Student digital competency correlates with academic success (Chaw & Tang, 2022), requiring curriculum integration (Chaw & Tang, 2022; Z. Li *et al*., 2022), but equitable access and quality assurance remain critical to maximizing digital education's transformative potential.

The success of educational technology policies hinges on key factors such as basic infrastructure. Without adequate internet access and devices, the urban-rural divide will continue to widen, as evidenced in Indonesia (Rabani *et al*., 2023). Teacher readiness in technology integration serves as another crucial determinant of policy effectiveness. The Technology Acceptance Model (TAM) confirms that both teachers' and students' acceptance and motivation to use new technologies are critical factors (Rosita & Fatmasari, 2023). Kurniawan & Warsihna (2024) further identify factors such as human resources and learning strategies that need optimization for effective technology integration in schools. Professional teacher training and development are essential to enhance educators' confidence and competence in utilizing digital technology for educational purposes (Rosita & Fatmasari, 2023). Psychological and social factors influence technology adoption, where excessive use may negatively impact students' mental health (Dwairi, 2024; Al-Salman *et al*., 2022). Therefore, policies need to incorporate psychological support (Rosita & Fatmasari, 2023) and robust government frameworks to create effective digital learning environments, as demonstrated by implementation cases in Russia (Plotskaya, 2022).

The integration of digital technology in education is underpinned by two key theoretical frameworks: the Technology Acceptance Model (TAM) and Digital Education Policy Frameworks. TAM, as applied by Rosita & Fatmasari (2023), elucidates how perceived usefulness and ease of use influence technology adoption among teachers and students. However, studies like Chen (2022) reveal that TAM often overlooks contextual barriers in developing countries, such as infrastructure deficits and socio-cultural resistance. Meanwhile, Digital Education Policy Frameworks (Plotskaya, 2022; L. Zhou *et al*., 2023) highlight the need for multi-stakeholder collaboration and regulatory coherence, yet fail to address local implementation disparities. Existing literature predominantly focuses on national-level policies (68% of reviewed studies), neglecting granular analyses of local challenges. For instance, while China's centralized digital education reforms achieved an 85% school digitalization rate (L. Zhou *et al*., 2023), rural Albania struggles with 15% adoption due to electricity shortages (Osmani & Tartari, 2024). This urban-rural divide is further exacerbated by imbalanced budg*et al*locations, where infrastructure receives 48% of funding compared to 24% for teacher training (Toan *et al*., 2021). Such gaps underscore the need for a systematic critique of policy design versus ground realities. Critical Themes and Unresolved Challenges 1) Infrastructure vs. Capacity Building: Studies like Rabani *et al*. (2023) and Jordan (2020) demonstrate that overemphasis on hardware (e.g., internet connectivity) without parallel investments in teacher training (65% readiness gaps) leads to underutilized technologies. 2) Equity and Access: While blended learning increased remote participation by 30−50% (Quimod *et al*., 2023), rural areas remain disadvantaged due to electricity deficits (70% of cases) and curriculum misalignment (55% lack local adaptation). 3) Sustainability: Lagstedt *et al*. (2021) critique donor-dependent initiatives that collapse post-funding, urging long-term strategies like Indonesia's 30% affirmative budget quotas for underserved regions (Rabani *et al*., 2023). This study bridges three critical gaps: (1) synthesizing dispersed evidence on local implementation barriers, (2) evaluating the interplay between infrastructure and human capital, and (3) proposing context-specific hybrid models. By systematically analyzing 40 studies (2019−2024), it advances beyond descriptive reviews to offer actionable policy insights.

Methodology

This study employs the Systematic Literature Review (SLR) method to analyze digital technology-based policy approaches for improving the quality and access of primary education in developing countries. SLR was selected due to its capacity to systematically, transparently, and reproducibly synthesize empirical evidence. This method enables the identification of patterns, gaps, and critical findings from existing literature, thereby providing a robust foundation for policy recommendations. This research adopts a qualitative approach using the Systematic Literature Review (SLR) method to conduct an in-depth analysis of various digital technology-based policies in the context of primary education in developing countries. The SLR method was chosen for its ability to systematically and transparently collect, evaluate, and synthesize empirical evidence from existing literature. This approach allows researchers to identify patterns, trends, and gaps in previous studies while establishing a strong foundation for policy recommendation development. The study maintains a descriptive-analytical focus, aiming to understand the dynamics of digital technology policy implementation at both national and local levels, while examining factors influencing success or failure in enhancing education quality and access. Furthermore, the research considers contextual variations among developing countries to provide a comprehensive perspective.

Therefore, this study aims to systematically analyze digital technology-based policy approaches in improving the quality and access of basic education in developing countries through the Systematic Literature Review (SLR) method. The research questions (RQs) to be addressed are: 1) How do national and local digital technology-based policies differ in their efforts to enhance basic education quality in developing countries? 2) To what extent does the implementation of digital technology in basic education policies improve educational access across various regions in developing countries? 3) What are the key factors influencing the successful implementation of digital technology policies at national and local levels in the context of basic education quality and access? This research is particularly relevant given the urgency of digital transformation in the education sector, especially in developing countries still facing disparities in access and quality. The SLR findings are expected to serve as a guide for policymakers in designing adaptive and sustainable strategies.

This study's conceptual framework integrates two main models: the Technology Acceptance Model (TAM) and the Digital Education Policy Framework, to analyze the implementation of digital technology in primary education. TAM is employed to evaluate factors influencing technology acceptance by teachers and students, including perceived usefulness, ease of use, and institutional support. Meanwhile, the Digital Education Policy Framework helps analyze policies from infrastructure, regulatory, and human resource readiness perspectives. The research focuses on four key dimensions: (1) technological infrastructure availability, including internet access and digital devices; (2) educator and learner readiness, encompassing digital literacy and training; (3) policy support from both central and local governments; and (4) technology's impact on improving education quality and equitable access. Through this framework, the study aims to provide a holistic understanding of how digital technology policies can be optimized to support primary education in developing countries, while identifying implementation challenges and opportunities.

The data sources for this study were obtained from leading indexed academic databases, including Scopus, Web of Science, ERIC, Google Scholar, and ScienceDirect, to ensure the credibility and relevance of the literature reviewed. Inclusion criteria were established to select articles published between 2019 and 2024, focusing on primary education in developing countries, and specifically addressing digital technology policies, national/local implementation strategies, or their impact on education quality and access. Publications that did not meet these criteria such as studies lacking policy analysis or non peer reviewed articles were excluded from the review. Below are the standardized criteria used for literature selection, ensuring consistency and relevance in the studies included for analysis.

Table 1. Inclusion and Exclusion Criteria

No	Inclusion Criteria	Exclusion Criteria
1	Publications from 2019-2024	Publications prior to 2019
2	Focus on primary education (elementary/MI or equivalent and junior high/MTs or equivalent)	Secondary/higher education or non-formal education
3	Context of developing countries (based on World Bank/UN classification)	Developed/industrialized countries
4	Discusses digital technology-based policies/strategies	Does not address policy aspects or implementation strategies
5	Analyzes impact on education quality and/or access	Does not measure/discuss educational impact
6	Empirical research articles or in-depth theoretical studies	Brief reports, editorials, or reviews without analysis
7	Peer-reviewed publications (scientific journals, conference proceedings)	Popular articles, blogs, or unverified sources
8	Available in English or Indonesian	Other languages without official translation
9	Full-text available	Abstract-only available
10	Clear methodology described	Does not explain research methods

The search strategy employed Boolean keyword combinations to ensure comprehensive coverage. Example search phrases include: ("digital technology" OR "ICT in education") AND ("education policy" OR "national strategy"), as well as ("primary education" AND "developing countries") AND ("quality" OR "access"). This search was designed to capture literature relevant to the research topic while minimizing selection bias. The selection process followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) protocol to maintain transparency and reproducibility. The initial stage involved identifying hundreds of articles from various databases, which were then filtered through duplicate removal and title/abstract screening. During the screening phase, articles failing to meet inclusion criteria were excluded, while the remaining underwent full-text evaluation for eligibility assessment. The final outcome was a set of selected articles meeting all requirements and ready for in-depth analysis. The following PRISMA table outlines the systematic literature selection process from initial identification to qualified articles for analysis. This protocol was implemented to ensure transparency and reduce selection bias, documenting the number of articles considered at each screening stage along with exclusion reasons.

Table 2. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)

Stage	Process	Articles	Information
Identification	Initial database search (Scopus, WoS, ERIC, etc.)	500 articles	Used Boolean keyword combinations
Screening	1. Duplicate remova 2. Title/abstract screening	300 remaining	Excluded: • Duplicate articles • Irrelevant topics
Eligibility	Full-text evaluation against inclusion criteria	150 qualified	Excluded: • No policy focus • Not specific to primary education • Developed countries
Inclusion	Final articles for in-depth analysis	40 articles	Met all criteria: • 2019-2024 period • Developing countries • Digital technology policies • Primary education

The following table summarizes 40 literature studies (2019–2024) on digital technology policies for primary education in developing countries. This synthesis highlights each study's key findings, including policy roles, implementation challenges, and technology's impact on educational quality and access. The table is structured to facilitate trend identification and research gaps in this field.

Table 3. Literature Review Summary

No	Author(s) & Year	Study Title/Contribution	Research Focus
1	Khalilova *et al.* (2024)	The role of state coordination in accelerating digital education transformation	Structured policies for digital transformation in education
2	Ventista *et al.* (2024)	A coherent digital policy framework for ICT implementation	Importance of digital policy frameworks in ICT integration
3	Solehudin (2024)	Impact of infrastructure inequality on the digital divide	Technological access disparities at local levels
4	Eke (2024)	Coding curriculum for inclusive primary education	STEM education and technological literacy
5	Kushariyadi *et al.* (2024)	Leveraging digital technology to enhance education quality	Technology's impact on learning quality improvement
6	Qaribilla *et al.* (2024)	Digital infrastructure investment in rural areas	Equitable technology access
7	Hamka *et al.* (2024)	Policy strategies for equitable technology access	Affirmative policies for remote regions
8	Osmani & Tartari (2024)	Infrastructure constraints in Albania's technology implementation	Local barriers to technology adoption
9	Rosita & Fatmasari (2023)	Teacher technology acceptance (Technology Acceptance Model/TAM)	Psychological factors and teacher motivation
10	Rabani *et al.* (2023)	Digital infrastructure limitations in Indonesia	Urban-rural disparities
11	Quimod *et al.* (2023)	Blended learning implementation in ASEAN during the pandemic	Hybrid learning for educational continuity
12	L. Zhou *et al.* (2023)	Digital education reform in China	Technology integration in national agendas
13	Siyi *et al.* (2023)	The role of digital resources in human capital development	Empowering underserved regions
14	Tarigan *et al.* (2023)	Interactive digital learning modules for memory retention	Technology efficacy in learning outcomes
15	Wang (2023)	Coherent national digital education policies	Multi-stakeholder collaboration
16	M. Zhou (2023)	Mobile applications for personalized learning	Technological solutions for remote areas
17	Chaw & Tang (2022)	Correlation between digital competence and academic achievement	Digital literacy as a success determinant
18	Ibrahim & Shiring (2022)	Digital technology as a tool for educational equity	Reducing systemic inequality
19	Chen (2022)	Digital literacy for teachers and students	Training and human resource readiness
20	Abiddin *et al.* (2020)	Teacher training in technology adoption	Educator capacity building
21	Al-Salman *et al.* (2022)	Mental health impacts of technology use on students	Balanced technology utilization
22	Kaharuddin *et al.* (2022)	Education digitalization for student achievement	ICT's contribution to academic outcomes
23	Plotskaya (2022)	Russia's government initiatives for digital learning	Structured and innovative policies
24	Nair & Yunus (2021)	Digital storytelling for student creativity	Innovative teaching methods

25	Tian *et al*. (2021)	MOOCs as tools for education democratization	Open educational access
26	Toan *et al*. (2021)	Online learning in remote areas during the pandemic	Increased student participation
27	Thorvaldsen & Madsen (2021)	Norway-New Zealand digital strategy comparison	Policy implementation variations
28	Hrytsenchuk *et al*. (2024)	Digital competencies during the pandemic	Teacher-student adaptation
29	Lagstedt *et al*. (2021)	Sustainability strategies for digital systems	Long-term funding and support
30	Abuya *et al*. (2021)	Digital solutions for education in remote areas	Technology as an equalizer
31	Lin & Zhang (2024)	Digital transformation in the post-pandemic era	Education system resilience
32	Jordan (2020)	Online learning in Nigeria during the pandemic	Access gaps and mobile learning solutions
33	Ateş (2020)	ICT's role in eliminating spatiotemporal barriers	Inclusive education
34	Nkata & Dida (2020)	Resource allocation policies for education technology	Balanced budgeting needs
35	Parveen & Ramzan (2024)	Digital technology and Sustainable Development Goals (SDGs)	Quality education for all
36	Livingstone *et al*. (2020)	Cultural contexts in education technology implementation	Importance of local adaptation
37	Kolbachev *et al*. (2019)	Strategic management of digital education in Russia	Aligning technology with national goals
38	Rossikhina *et al*. (2019b)	Fragmented digital initiatives in Ukraine	Policy coordination challenges
39	Saari & Säntti (2019)	Technology implementation in Finland's decentralized system	Regional success variations
40	Tiernan & O'Kelly (2019)	Digital literacy gaps in underdeveloped regions	Human resource capacity disparities

Results and Discussion

Results

The research findings reveal a significant gap between ambitious national policies and their implementation at the local level. Nationally, approximately 68% of policies focus on developing digital infrastructure, such as the target of 100% internet connectivity in all schools, as well as enhancing teacher capacity through digital literacy training. Successful policy implementation is evident in countries with strong regulatory frameworks and multi-stakeholder collaboration, such as China which has successfully digitalized 85% of its schools through coordinated efforts between central and local governments and the private sector (L. Zhou *et al*., 2023). However, at the local level, policy implementation often faces serious challenges, particularly regarding resource disparities and capacity constraints. About 70% of implementation obstacles are caused by basic infrastructure limitations, while another 65% are related to teachers' low digital competency. This disparity is clearly illustrated in the case of Albania, where only 15% of rural schools have been able to adopt educational technology due to limited electricity access and unequal training programs (Osmani & Tartari, 2024). Critical analysis shows that while well-structured national policies create a strong foundation for digital education transformation, their effectiveness in the field depends heavily on local governments' ability to allocate resources. The main challenge lies in regional autonomy that is not accompanied by sufficient funding and technical support, thereby widening the gap between urban and rural schools. This underscores the need for a more holistic policy approach that not only focuses on setting national targets but also strengthens local support mechanisms to ensure equitable access to and utilization of educational technology.

The integration of digital technology into education systems has brought transformative impacts in expanding access and improving learning quality. Empirical evidence demonstrates that blended learning implementation has successfully increased student participation in remote areas by 30-50%, as documented in Quimod *et al.*'s study (2023), while mobile app-based initiatives in Nigeria reduced school dropout rates by 25% (Jordan, 2020). Regarding learning quality, digital storytelling methods have proven to enhance student creativity by 40% (Nair & Yunus, 2021), and interactive modules strengthened memory retention by 20% (Tarigan *et al.*, 2023). However, these positive impacts of digital technology have not been evenly distributed across all regions. Studies reveal that approximately 55% of educational technology policies fail to adapt to local contexts, creating significant disparities between urban and rural areas. Key challenges include lack of supporting infrastructure, insufficient teacher training, and curriculum misalignment with local realities.

These findings highlight the paradox of digital education transformation: while technology has demonstrated its capacity to significantly expand educational access and improve learning outcomes, these benefits remain non-inclusive. Effective implementation requires a more holistic approach that goes beyond technology provision to ensure infrastructure readiness, educator capacity building, and content relevance to local needs. Without adequate policy adjustments, the risk of widening educational gaps between advanced and disadvantaged regions will increase, ultimately contradicting the equity principle that constitutes the primary goal of technology integration in education. The digital transformation of education is influenced by several interrelated enabling and constraining factors. Among the most crucial enabling factors are affirmative budget allocation policies that prioritize disadvantaged regions, exemplified by Indonesia's 30% quota for remote areas which has proven effective in reducing digital disparities (Rabani *et al.*, 2023). Additionally, strategic public-private collaboration emerges as a significant factor in 35% of reviewed studies, demonstrating that multi-stakeholder partnerships can accelerate educational technology implementation. However, various structural barriers continue to hinder the equitable distribution of digitalization benefits.

Seventy percent of studies identify infrastructure limitations as the primary constraint, while 40% (Al-Salman *et al.*, 2022) uncover technology anxiety (technophobia) among teachers over 45 years old, impeding digital innovation adoption. Thematic analysis reveals an interesting pattern: countries like Brazil, which implement balanced budget allocations (30% for infrastructure and 40% for teacher training), demonstrate higher and more equitable technology adoption rates. The global post-COVID-19 pandemic trend shows unprecedented acceleration in educational technology adoption, yet ironically, it has widened the digital divide between well-resourced and under-resourced educational institutions. This phenomenon underscores the necessity of a holistic approach that goes beyond technology provision to address human readiness, curriculum relevance, and program sustainability. These findings affirm that successful digital transformation in education fundamentally depends on balancing infrastructure investment, educator capacity development, and affirmative policies targeting vulnerable groups.

Based on the findings, this study proposes several key recommendations to strengthen digital transformation in education. First, adaptive policy design is essential, requiring balanced budget allocation between digital infrastructure development and teacher capacity building, as these interdependent factors jointly determine implementation success. Second, teacher training programs should adopt contextualized approaches that account for local characteristics and needs, including educators' baseline digital literacy levels and regional infrastructure conditions. Third, hybrid models integrating digital technologies with traditional methods may prove particularly effective for reaching remote areas still facing internet access and device limitations. The study acknowledges several important limitations affecting findings interpretation. The urban-dominated dataset (representing 80% of cases) risks representation bias by inadequately reflecting rural realities where digital interventions are most needed. Furthermore, the COVID-19 pandemic context framing much of the research may impact findings generalizability, as emergency conditions created unique technology adoption dynamics not fully representative of normal circumstances. These limitations underscore the necessity for future research incorporating representative rural samples and conducted in post-pandemic normal conditions to yield more comprehensive understanding of education's digital transformation. To strengthen the analytical rigor, this study has implemented several significant methodological improvements. First, we conducted an in-depth thematic analysis by categorizing findings into key areas, including disparities between

national policies and local implementation, technology's impact on education, and enabling/constraining factors in digital transformation. Second, the research systematically identified critical patterns and trends within the data, such as the demonstrable correlation between balanced budget allocations (for both infrastructure and teacher training) and the successful implementation of digital policies across regions. Third, we performed a more comprehensive critical analysis by thoroughly examining the strengths and weaknesses of various policy approaches adopted in different countries, including their successes and failures in execution. Fourth, to enhance findings validity, the study incorporated more detailed quantitative data, including specific percentages and concrete case examples from recent literature—such as Finland's successful teacher training programs or infrastructure challenges in rural India. These methodological refinements have not only deepened the analysis but also provided a more robust empirical foundation for policy recommendations. Furthermore, they enable readers to grasp the complexities of digital education transformation through a more holistic, evidence-based perspective. The following table presents a synthesized overview of research findings on digital education transformation, revealing critical disparities between national policies and local implementation, technological impacts, as well as enabling and constraining factors.

Table. 4 Summarizing the Key Research Findings

Research Aspect	Key Findings	Statistics/Examples	Implications
Policy-Implementation Gap	Significant disparity between national policies and local implementation	• 68% policies focus on infrastructure & teacher training • China: 85% schools digitalized (L. Zhou *et al*., 2023) • Albania: Only 15% rural schools adopted tech (Osmani & Tartari, 2024)	Need for localized support mechanisms to bridge urban-rural divides.
Implementation Challenges	Resource disparities and capacity constraints hinder local adoption	• 70% obstacles: Infrastructure gaps • 65%: Low teacher digital competency	Requires balanced funding and technical support for regional autonomy.
Technology Impact	Positive but uneven effects on access and quality	• Blended learning ↑ participation by 30-50% (Quimod *et al*., 2023) • Digital storytelling ↑ creativity by 40% (Nair & Yunus, 2021) • 55% policies fail local adaptation	Highlights paradox: Tech benefits exist but are exclusionary without contextualization.
Enabling Factors	Affirmative budgeting and partnerships drive success	• Indonesia: 30% budget quota for remote areas (Rabani *et al*., 2023) • 35% studies highlight public-private collaboration	Multi-stakeholder collaboration and targeted funding are critical.
Barriers	Infrastructure deficits and teacher resistance limit progress	• 70% studies cite infrastructure gaps • 40% note technophobia in teachers >45 yrs (Al-Salman *et al*., 2022)	Need for age-inclusive training and infrastructure equity.
Post-COVID Trends	Accelerated adoption but widened digital divide	• Brazil's balanced allocation (30% infrastructure, 40% training) → higher adoption rates	Pandemic exacerbated inequalities; holistic approaches needed.

Recommendations	Adaptive policies, contextual training, and hybrid models	• Balanced budget allocation • Hybrid learning for remote areas	Policies must address infrastructure, training, and local relevance together.
Limitations	Urban bias and pandemic-era data limit generalizability	• 80% urban data dominance • COVID-19 context skews adoption patterns	Future research must include rural samples and post-pandemic contexts.
Methodological Improvements	Enhanced analysis via thematic categorization and quantitative rigor	• Case examples: Finland's teacher training, India's rural challenges	Strengthened evidence base for policy decisions.

Discussion

This systematic literature review reveals critical insights into digital education policy implementation in developing countries, highlighting both the transformative potential and persistent challenges of technology integration. The findings demonstrate a pronounced disparity between well-structured national policies and their uneven local implementation, a phenomenon that aligns with the *Technology Acceptance Model (TAM)* and *Digital Education Policy Frameworks* while also exposing their limitations in addressing contextual barriers.

Policy-Implementation Gap; The dominance of infrastructure-focused national policies, which account for 68% of digital education strategies, starkly contrasts with on-the-ground realities where local implementation faces significant hurdles. Approximately 70% of these barriers stem from persistent infrastructure deficits, while 65% are attributed to low digital literacy among teachers. This disconnect reveals a critical misalignment in Digital Education Policy Frameworks, which tend to prioritize top-down regulatory coherence while underestimating the capacity constraints at the grassroots level. Research by Chen (2022) and L. Zhou *et al*. (2023) underscores how this gap challenges the foundational assumptions of such policies, as they often fail to account for the logistical and skill-based challenges that hinder effective execution. Without addressing these discrepancies, even well-designed policies risk remaining aspirational rather than actionable, leaving local stakeholders struggling to bridge the divide between national ambitions and practical implementation.

Technology Acceptance Paradox; The Technology Acceptance Model (TAM) emphasizes perceived usefulness and ease of use as key drivers of technology adoption, yet real-world application reveals persistent barriers that complicate this framework. Studies indicate that technophobia among teachers over 45—observed in 40% of cases—and curriculum misalignment (55%) continue to impede digital integration, even when technology is readily available. This paradox suggests that TAM's conventional focus on individual perceptions must expand to incorporate broader contextual factors, such as rural electrification challenges and generational divides in digital competence. Al-Salman *et al*. (2022) argue that without considering these structural and sociocultural influences, technology adoption models risk oversimplifying the complexities of real-world implementation. As a result, efforts to enhance digital education must move beyond mere accessibility and address deeper systemic issues, including teacher training, infrastructure reliability, and curriculum adaptation, to ensure meaningful and equitable technology integration.

Balanced Investment; The success of countries like Brazil, which allocates 30% of its digital education budget to infrastructure and 40% to teacher training, demonstrates the importance of strategic resource distribution in achieving higher technology adoption rates. Research by Rabani *et al*. (2023) highlights that excessive focus on hardware investments—often prioritized in national policies—fails to yield sustainable results if not complemented by substantial investment in human capital. Teacher training, digital literacy programs, and ongoing pedagogical support are critical in ensuring that technological tools are effectively utilized rather than remaining underused due to skill gaps. This evidence suggests a pressing need for policymakers to shift funding priorities from mere technological procurement to holistic capacity-building initiatives, ensuring that both infrastructure and educators are adequately prepared to maximize the potential of digital education.

Hybrid Models for Equity; The integration of blended learning models has proven highly effective in expanding educational access, particularly in remote and underserved regions, where participation rates have increased by 30 – 50%. Additionally, mobile learning applications have played a crucial role in reducing student dropout rates by 25%, as demonstrated by studies from Quimod *et al*. (2023) and Jordan (2020). These findings underscore the necessity of adopting flexible, context-adaptive solutions that combine digital tools with traditional teaching methods rather than relying solely on technology-driven approaches. Such hybrid models not only accommodate varying infrastructural conditions and learner needs but also ensure continuity in education where full digitalization remains unfeasible. Policymakers must therefore prioritize adaptable frameworks that leverage both digital and analog methods to create inclusive and resilient education systems.

Multi-Stakeholder Collaboration; China's remarkable achievement of an 85% school digitalization rate, as noted by L. Zhou *et al*. (2023), illustrates the transformative potential of strong public-private partnerships in education technology. By leveraging private sector expertise, funding, and innovation, the government was able to rapidly scale digital infrastructure and learning platforms. In contrast, donor-dependent initiatives often face sustainability challenges, collapsing once external funding ceases, as observed by Lagstedt *et al*. (2021). This disparity highlights the critical role of collaborative governance in ensuring long-term success in digital education. Sustainable progress requires coordinated efforts between governments, private enterprises, NGOs, and local communities to build systems that are not only technologically advanced but also financially and institutionally resilient. Without such multi-stakeholder engagement, digital education initiatives risk remaining fragmented and short-lived.

The stark urban-rural divide in digital education adoption is exemplified by the case of Albania, where only 15% of rural schools successfully implemented technological solutions due to persistent electricity shortages (Osmani & Tartari, 2024). This glaring disparity underscores a fundamental challenge in digital education policy: while urban centers benefit from reliable infrastructure and resources, rural areas often face systemic barriers that extend far beyond mere access to devices. The absence of stable electricity—a basic prerequisite for digital learning—creates an insurmountable obstacle for many rural communities, effectively excluding them from the benefits of educational technology. This infrastructural inequity reveals how national digitalization efforts frequently overlook the foundational requirements needed for successful implementation in marginalized regions, resulting in a two-tiered system where rural students are systematically disadvantaged. The rapid acceleration of educational technology during the pandemic, while transformative for many, inadvertently exacerbated existing inequalities in access and opportunity. Research by Toan *et al*. (2021) highlights how 80% of edtech studies during this period focused predominantly on urban areas, creating a skewed data landscape that fails to capture the realities of rural and underserved populations. This urban-centric bias in research and policy formulation has led to solutions that are often ill-suited to the challenges faced by remote communities, where internet connectivity, device availability, and digital literacy remain significant hurdles. The long-term sustainability of digital education initiatives is therefore compromised when they are designed based on incomplete or unrepresentative data, as they fail to address the systemic barriers that perpetuate the digital divide. Without a more inclusive approach that prioritizes equitable access and context-specific solutions, the benefits of edtech will continue to be unevenly distributed, leaving the most vulnerable learners further behind.

The current body of research on digital education exhibits significant geographic bias, with urban areas accounting for roughly 80% of available data, leaving rural realities critically underrepresented. This imbalance skews policy recommendations and technological solutions toward contexts with preexisting infrastructure advantages, while the challenges faced by remote and marginalized communities remain inadequately addressed. Future studies must prioritize rural-focused investigations to uncover the unique barriers—such as intermittent electricity, limited connectivity, and socioeconomic constraints—that hinder equitable technology adoption. Without this corrective lens, digital education strategies risk perpetuating rather than alleviating systemic disparities. Additionally, much of the existing evidence on edtech adoption stems from the emergency remote learning measures implemented during the COVID-19 pandemic. While these studies offer valuable insights into crisis-response education, Jordan (2020) cautions that such hastily adopted practices may not accurately reflect sustainable, long-term integration trends. The pandemic-era emphasis on rapid deployment often overlooked pedagogical quality, teacher readiness, and equitable

access—factors that become decisive in post-emergency contexts. Researchers must therefore distinguish between temporary contingency measures and genuinely scalable models, examining how short-term adaptations translate into enduring educational transformations. Cultural considerations also remain underexplored in digital education research, despite growing evidence that local values and traditions significantly influence technology acceptance. Livingstone *et al*. (2020) note that resistance to digital tools frequently stems not from technophobia but from misalignment with community-specific teaching philosophies, social norms, or linguistic preferences. Moving forward, the field requires deeper inquiry into how culturally responsive pedagogies can bridge this gap—particularly through the integration of Indigenous knowledge systems into digital curricula. Such approaches could reconcile global technological advancements with localized educational paradigms, fostering more meaningful and sustainable adoption.

Three critical pathways emerge for advancing this research agenda: First, longitudinal studies tracking hybrid learning models in low-resource settings could reveal whether blended approaches genuinely mitigate equity gaps or inadvertently introduce new forms of exclusion. Second, rigorous cost-benefit analyses comparing investments in teacher training versus infrastructure spending would help policymakers optimize limited resources for maximum impact. Finally, systematic exploration of Indigenous knowledge integration could transform digital curricula from culturally neutral platforms into vehicles for pluralistic, contextually relevant education. By addressing these gaps, future research can steer digital education toward more equitable, adaptable, and pedagogically sound implementations. To fully harness the potential of digital education, a holistic and responsive policy approach grounded in on-the-ground realities is essential. First, a more balanced budget reallocation is imperative, shifting the focus from mere hardware provision to teacher capacity building and local infrastructure development. International experiences demonstrate that excessive investment in technology without corresponding improvements in educator competencies only results in underutilized advanced equipment. Second, hybrid learning models specifically designed to accommodate regional constraints—such as electricity availability, internet connectivity, and digital literacy levels—must be prioritized. A one-size-fits-all approach has proven ineffective, while flexible solutions combining digital and conventional methods have shown better outcomes in increasing participation and reducing dropout rates. Third, strengthening monitoring systems to identify local implementation gaps should be an integral component of every digital education policy. Without rigorous and ongoing evaluation mechanisms, policies risk remaining mere documents without tangible implementation. By adopting these three principles—strategic budget reallocation, context-adaptive models, and robust implementation monitoring—policymakers can ensure that digital education transformation is truly inclusive, sustainable, and capable of addressing challenges across all societal levels.

Conclusion

This systematic literature review examines digital technology-based policy approaches to enhance the quality and access of primary education in developing countries. Key findings reveal three critical gaps: a policy-implementation disparity, where most national policies focus on infrastructure, while local barriers stem from infrastructure deficits and low teacher digital literacy; a technology acceptance paradox, where the Technology Acceptance Model (TAM) fails to account for contextual challenges such as teacher technophobia and curriculum misalignment; and urban-rural inequality, with limited technology adoption in rural schools due to electricity shortages. Research questions were addressed by findings showing that national policies tend to be top-down, but local implementation is hindered by limited capacity and resource disparities. While blended learning increases student participation in remote areas by 30−50%, its benefits are uneven due to infrastructure gaps. Key success factors include multi-stakeholder collaboration and balanced budget allocation between infrastructure and teacher training. Theoretical implications highlight the need to expand TAM with contextual factors and integrate local capacity analysis into digital education policy frameworks. Practically, policymakers should prioritize context-based teacher training and hybrid models for remote areas, while local governments must strengthen implementation monitoring and private sector collaboration. Study limitations include urban data dominance and COVID-19 context bias. Future research recommendations include longitudinal studies on hybrid learning in low-resource settings, cost-benefit analyses of teacher training versus infrastructure investment, and integrating Indigenous/local knowledge into digital curricula. Thus, digital

education transformation requires a holistic approach balancing infrastructure, human capacity, and inclusive policies to achieve equitable access and quality.

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