Journal of Tertiary Education and Learning (JTEL)

ISSN: 2994-4015 (ONLINE)

VOLUME 4 ISSUE 3 (2026)

PUBLISHED BY
E-PALIU PUBLISHERS, DELAWARE, USA

Journal of Tertiary Education and Learning (JTEL)
Previous Title: Journal of Student and Education (JSE)

Volume 4 Issue 3, Year 2026
ISSN: 2994-4015 (Online)
DOI: https://doi.org/10.54536/jtel.v4i3.7737
https://journals.e-palli.com/home/index.php/jtel

The Integration of ICT in Chinese Primary Education: Strategies and Challenges

Letisia Tuyambeka Shilongo[1*], Keneilwe Ben[1], Kante Drissa[1]

Article Information

Received: March 02, 2026

Accepted: May 12, 2026

Published: September 14, 2026

Keywords

Chinese Primary Education, Digital Divide, ICT Integration, Teacher Professional Development

ABSTRACT

This study examines the integration of Information and Communication Technology (ICT) in Chinese primary education, analyzing policy implementation, adoption patterns, and classroom practices through a systematic review of secondary data. Drawing on the Education Informatization 2.0 Action Plan and Double Reduction Policy, the research identifies significant rural-urban disparities in infrastructure access, with 32% of western provincial schools lacking stable connectivity and only 12% of rural schools possessing VR/AR devices compared to 65% in urban areas. Teacher competency gaps persist, as 53% of educators use ICT solely for content presentation rather than interactive pedagogy, while 72% of teachers aged 50+ report technology-related anxiety. The study reveals multifaceted equity barriers encompassing socioeconomic status, gender disparities, and accessibility limitations for students with disabilities. Through comparative analysis of regional case studies - including Hangzhou's AI-powered smart classrooms and Yunnan's mobile learning buses-the research proposes evidence-based strategies encompassing tiered funding mechanisms, sustained professional development programs, portable ICT learning kits for remote areas, and curriculum reforms embedding computational thinking and project-based learning. These findings contribute to global discourse on sustainable digital transformation in primary education, offering actionable insights for policymakers, educators, and technology developers seeking to advance equitable ICT integration in centralized education systems.

INTRODUCTION

The 21st century has witnessed ICT emerging as a cornerstone of educational innovation worldwide, with its transformative potential reshaping teaching and learning paradigms across disciplines and age groups (Anderson, 2020; UNESCO, 2021). In China, recognizing the critical role of digital literacy in cultivating future-ready citizens, the government has strategically positioned ICT integration as a core component of its educational reform initiatives (Ministry of Education [MOE], 2022). The country's rapid economic development and growing global competitiveness have amplified the need for a tech-savvy workforce, prompting policymakers to prioritize digital skills from the foundational stages of education.

Policies such as the Education Informatization 2.0 Action Plan (MOE, 2018) and the Double Reduction Policy (State Council, 2021; Mendoza, 2022) exemplify this commitment, advocating for technology-driven enhancements in teaching efficiency, personalized learning, and the reduction of unnecessary student workload. The Education Informatization 2.0 framework, in particular, outlines a vision for "intelligent education environments" that leverage big data, cloud computing, and AI to foster innovative teaching models (MOE, 2018). Concurrently, the Double Reduction Policy emphasizes using ICT to optimize in-class instruction, thereby minimizing the reliance on after-school tutoring a goal that necessitates effective integration of technology to enhance engagement and learning outcomes (Li & Zhou, 2022).

At the primary education level, where foundational cognitive, social, and emotional skills are nurtured, the adoption of ICT tools such as interactive whiteboards, adaptive learning platforms (like the Zhixue.com), and AI-powered educational applications has become both an opportunity and a challenge. Young learners, often described as "digital natives," exhibit natural aptitude for technology, making them receptive to gamified, visual, and interactive learning experiences (Prensky, 2001). A study by Wang *et al.* (2020) shows that gamified math apps like Kumon Math can improve arithmetic fluency by 18% among primary students through sustained engagement. However, this potential is juxtaposed with systemic barriers, including unequal access to infrastructure, teacher training gaps, and curricular misalignment (UNESCO, 2022; Zhang *et al.*, 2021).

This period of transition demands a nuanced understanding of how technology can be effectively integrated to support cognitive development while addressing systemic barriers. Research from countries like South Korea and Finland highlights that early-stage ICT integration correlates with long-term digital literacy and problem-solving skills (Lee *et al.*, 2019; Sahlberg, 2019). In the Chinese context, however, the centralized education system's push for standardized outcomes must be balanced with regional diversity, particularly in rural and urban divides. For instance, while urban schools in Shanghai and Beijing experiment with AI-driven smart classrooms, rural schools in Yunnan and Gansu often lack basic internet connectivity (MOE, 2023; UNESCO, 2022).

[1] College of Education, Zhejiang Normal University, Jinhua, Zhejiang, China
[*] Corresponding author's e-mail: letieshilongo@gmail.com

Moreover, the socio-cultural context of Chinese education rooted in exam-oriented traditions, presents unique challenges. Teachers face pressure to align ICT use with curriculum standards and high-stakes assessments, often limiting experimentation with innovative pedagogies (Cai, 2020; Yuan & Ye, 2021). Meanwhile, parents in urban areas increasingly invest in edtech tools for their children, exacerbating the digital divide between privileged and under-resourced families (Li & Wang, 2020).

Against this backdrop, the study seeks to decode the complex interplay between policy, practice, and pedagogy in China's primary education ICT landscape. By examining both macro-level policy implementations and micro-level classroom dynamics, the research aims to provide a comprehensive analysis of what drives successful integration and what hinders it, offering insights that are both context-specific and globally relevant.

Significance of the Study

The findings of this research hold multifaceted practical implications for diverse stakeholder groups, offering actionable insights to advance ICT integration in primary education both within China and globally. For policymakers, the study provides a granular understanding of the effectiveness of existing initiatives such as the Education Informatization 2.0 Action Plan and regional smart classroom projects alongside identifying critical gaps in implementation, such as rural-urban infrastructure disparities and teacher training inconsistencies. This analysis can inform the design of more targeted policies, including tiered funding models for underserved regions, incentives for schools to adopt equity-focused ICT practices, and regulatory frameworks to standardize digital literacy benchmarks across primary curricula.

For educators, the study serves as a critical resource for enhancing technological pedagogical content knowledge (TPACK). Through detailed analyses of successful classroom practices such as AI-driven adaptive learning in Hangzhou and mobile learning solutions in Yunnan teachers gain evidence-based strategies to transform passive technology use into interactive, student-centered experiences. For example, insights into how peer mentorship programs in Shanghai increased classroom ICT adoption by 35% can inspire grassroots initiatives to build teacher capacity, while case studies on gamified math apps demonstrate how to align technology with foundational skill development.

Technology developers stand to benefit from the study's focus on real-world needs and user experiences. By documenting gaps in current tools such as the lack of multilingual interfaces for ethnic minority students or outdated hardware in rural schools the research provides a roadmap for designing more inclusive and contextually relevant solutions. The findings on the effectiveness of solar-powered tablets in Yunnan could inform the development of low-cost, offline-capable devices for low-connectivity areas, while feedback from teachers on the complexity of AI tools may drive the creation of more intuitive, user-friendly platforms.

Internationally, the research contributes significantly to comparative education and educational technology discourse by offering a deep dive into how a large, centralized education system like China's navigates digital transformation. Unlike many Western studies that focus on decentralized models, this analysis of China's top-down policy implementation paired with grassroots innovations provides a unique case study for regions grappling with scaling ICT in resource-diverse environments. The insights into how China balances standardized curriculum requirements with regional pilot projects (VR/AR in Zhejiang) can inform countries in Southeast Asia and Africa as they design their own ICT integration strategies.

Ultimately, by bridging policy, practice, and pedagogy, the research positions itself as a catalyst for sustainable change. It challenges the narrative that ICT integration is merely a technological upgrade, arguing instead that it requires a holistic rethinking of educational systems from teacher training to curriculum design to technology accessibility. In doing so, the study not only addresses the immediate challenges of Chinese primary education but also contributes to a global agenda for using technology to create more equitable, innovative, and future-ready learning environments for young learners everywhere.

Research Questions

The study aims to answer the following questions:

1. What are the current patterns of ICT integration in Chinese primary schools, including policy implementation, technological adoption rates, and classroom practice models?
2. What challenges do teachers, students, and school administrators face in integrating ICT for educational improvement, and how do these challenges vary across urban-rural divides, socioeconomic statuses, or teacher demographics?
3. What theoretically and empirically supported strategies can enhance ICT integration in Chinese primary education to align with educational goals and equity objectives, and how might these strategies be adapted to different regional contexts?

LITERATURE REVIEW

Policy and Infrastructure Development

China's investment in educational technology infrastructure reflects a nationwide commitment to digital inclusion, underpinned by strategic policy frameworks and sustained fiscal prioritization. The Education Informatization 2.0 Action Plan (MOE, 2018) established a roadmap for integrating ICT into every layer of the education system, with primary education identified as a critical frontier for early-stage digital literacy cultivation. By 2023, statistical data from the MOE (2023) indicates that 98% of primary schools have access to high-speed internet, while 85% are equipped with multimedia classrooms, marking a 15% increase from 2018 figures. This progress is further

evident in the proliferation of "Smart Campus" initiatives, which leverage cloud-based platforms to unify teaching, administrative management, and parent engagement systems. The National Public Service Platform for Education launched as part of the "Three Alls, Two Haves, and One Big Platform" policy (MOE, 2019; Asare *et al.*, 2023) has become a cornerstone of digital resource equity. Hosting over 5 million educational assets, including interactive lesson plans, VR simulations, and AI-driven assessment tools, the platform serves over 120 million users nationwide, with rural schools accessing 35% of its resources via offline caching mechanisms (MOE, 2020; Wang & Li, 2021).

Regional pilot projects have further demonstrated the scalability of infrastructure investments. In Guangdong Province, the "Digital Village School" initiative deployed 5G-enabled classrooms in 2,300 rural primary schools, enabling real-time synchronous lessons with urban counterparts. A 2022 evaluation by the provincial education department found that participating rural students' engagement in interactive science activities increased by 48%, compared to a control group (Guangdong MOE, 2022). Similarly, Beijing's "Smart Classroom of the Future" project introduced haptic feedback devices and eye-tracking technology in 50 primary schools, allowing teachers to adjust instructional strategies based on real-time student engagement data. Preliminary results show a 22% improvement in knowledge retention rates for math concepts taught using these tools (Beijing Municipal Education Commission, 2023).

However, infrastructure development remains uneven across China's geographic and socioeconomic divides. While first-tier cities like Shanghai and Shenzhen allocate 8-10% of their education budgets to ICT upgrades, western provinces such as Gansu and Qinghai spend less than 3% on technology, prioritizing basic infrastructure needs (Liu & Chen, 2020). A 2023 UNESCO report highlights that 28% of primary schools in Tibet and Xinjiang still rely on 4G networks for internet access, with 19% lacking functional multimedia projectors. These disparities underscore the need for targeted policy interventions, such as the Central Government's "Rural ICT Empowerment Fund," which since 2021 has allocated ¥5 billion ($700 million) to upgrade infrastructure in 832 poverty-stricken counties (State Council, 2021).

The government's focus on infrastructure also extends to emergency preparedness. The COVID-19 pandemic accelerated the adoption of hybrid learning frameworks, with the MOE (2022) mandating that all primary schools maintain "dual-mode" teaching capabilities supporting both in-person and online instruction. This policy led to the rapid deployment of cloud-based learning platforms like KeTang and Tencent Classroom, which recorded over 200 million daily active users during nationwide lockdowns. While urban schools seamlessly transitioned to virtual classrooms, rural institutions faced challenges: a survey by the China Education Development Foundation (2022) found that 34% of rural primary students lacked personal devices for online learning, relying on shared smartphones or televisions instead.

Pedagogical Applications

The pedagogical landscape of Chinese primary education is undergoing a profound transformation driven by ICT, with innovations spanning personalized learning, gamified instruction, and hybrid teaching models. Adaptive learning platforms have emerged as a cornerstone of this shift, with tools like Zhixue.com leveraging machine learning algorithms to analyze real-time student performance data such as error patterns in math problem-solving or vocabulary retention in language arts and deliver tailored learning paths. In a pilot program across 500 primary schools in Jiangsu Province, students using Zhixue.com showed a 23% improvement in math proficiency over one academic year, with the platform's targeted exercises reducing time spent on mastered concepts by 40% (Zhang *et al.*, 2023). Such platforms also enable teachers to identify systemic gaps in understanding, allowing for proactive classroom interventions.

Gamified applications have revolutionized engagement with foundational subjects, particularly in numeracy and literacy. Kumon Math, a leading gamified tool, incorporates interactive puzzles, progress-tracking badges, and peer competition elements to make arithmetic practice more engaging. A study by Wang *et al.* (2021) in Shandong Province found that students using the app for 30 minutes daily showed a 19% increase in mental calculation speed compared to a control group, with 82% of participants reporting higher motivation to learn math. Similarly, Lingxi Reading, a gamified literacy app, uses story-based quests and voice recognition technology to improve reading fluency, resulting in a 15% improvement in phonics skills among first-grade students in Guangzhou (Chen & Li, 2022).

The COVID-19 pandemic acted as a catalyst for adopting online teaching tools, accelerating integration of hybrid learning models. Platforms like Tencent Classroom and ClassIn became indispensable, offering features such as virtual whiteboards, real-time polling, and breakout rooms. A longitudinal study by Li *et al.* (2022) across 2,000 primary schools nationwide found that classes using these platforms reported a 15% increase in student participation in interactive activities such as virtual science experiments and collaborative storytelling compared to traditional classrooms. In Wuhan, where lockdowns were most severe, primary schools implemented "smart attendance" systems via ClassIn, which used facial recognition to monitor participation and provided instant feedback to teachers on student engagement levels (Wuhan Education Bureau, 2021).

Beyond pandemic-driven adaptations, ICT is reshaping assessment and feedback mechanisms. AI-powered tools like YiZhiTong automate the grading of written assignments, providing instant feedback on grammar, structure, and creativity. In a trial at Beijing Normal University attached Primary School, this tool reduced

teacher grading time by 60% while improving students' self-editing skills by 28%, as measured by revised draft quality (Sun *et al.*, 2023). Additionally, augmented reality (AR) applications are transforming hands-on learning: in Shanghai primary schools, AR chemistry kits allow students to simulate lab experiments safely, with a 2022 survey showing that 73% of students preferred AR tools over traditional textbooks for understanding abstract concepts (Shanghai Municipal Education Commission, 2022).

However, pedagogical innovation remains uneven. A 2023 survey by the MOE (2023) revealed that only 41% of primary teachers in rural areas use ICT for formative assessment, compared to 78% in urban schools. Moreover, while 65% of urban classrooms integrate gamified tools weekly, this drops to 18% in rural settings due to limited device access and teacher training gaps (UNESCO, 2022). These disparities highlight the need for targeted professional development programs and subsidized access to low-cost devices, such as the MOE's RuralEdTech Voucher Scheme, which since 2022 has provided ¥500 ($70) vouchers to rural families for purchasing tablets (State Council, 2022).

Government Initiatives

The "Three Alls, Two Haves, and One Big Platform" policy (MOE, 2019) serves as the cornerstone of China's strategic vision for ICT integration, articulating ambitious goals to ensure universal digital literacy, comprehensive classroom technology adoption, and centralized resource coordination. This policy framework, which emphasizes "all teachers and students capable of using digital tools, all classrooms equipped with ICT facilities, and one integrated platform for resource sharing," has catalyzed nationwide initiatives to align primary education with 21st-century technological demands. By 2023, the MOE reported that 89% of primary schools had achieved basic compliance with these standards, though regional variances persist (MOE, 2023).

Pilot projects in economically advanced provinces like Zhejiang and Jiangsu have emerged as innovation hubs, showcasing cutting-edge applications of VR/AR technologies to enrich disciplinary learning. In Zhejiang, the "Smart History Classroom" initiative deployed AR-based historical reenactments in 200 primary schools, allowing students to interact with 3D-rendered artifacts such as ancient bronze vessels and dynastic maps. A quasi-experimental study by Wang and Zhang (2021) found that students in these classrooms demonstrated a 22% improvement in knowledge retention of historical timelines compared to peers using traditional textbooks, with qualitative feedback indicating heightened engagement through immersive storytelling. Similarly, Jiangsu's "VR Science Lab" project introduced virtual chemistry and biology experiments to 300 primary schools, enabling students to simulate lab procedures safely and repetitively. A 2022 evaluation by the Jiangsu Provincial Education Department revealed that 76% of participating students showed improved understanding of scientific concepts, with teachers reporting a 35% reduction in time spent on pre-lab safety briefings (Jiangsu MOE, 2022).

Beyond technology deployment, the government has prioritized teacher training through initiatives like the "National ICT Teaching Expertise Program," which selects and certifies master teachers to develop curriculum modules for ICT integration. Since its launch in 2020, the program has trained over 50,000 educators in designing AI-assisted lesson plans, with a follow-up survey showing that certified teachers were 2.3 times more likely to incorporate interactive tools like digital whiteboards and educational apps into daily instruction (MOE, 2021). Additionally, the "100 Schools, 100 Models" campaign highlights exemplary institutions, such as Shanghai's Pudong Primary School, which uses AI-driven analytics to tailor homework assignments for individual students, reducing workload by 30% while maintaining academic performance (Shanghai MOE, 2023).

o address rural-urban divides, the Central Government established the "ICT Empowerment for Rural Schools" fund in 2020, allocating ¥3 billion ($420 million) to subsidize technology upgrades in underdeveloped regions. In Gansu Province, this funding supported the deployment of solar-powered mobile learning labs portable kits containing tablets pre-loaded with offline educational content in 1,500 remote primary schools. A mid-term evaluation by UNESCO (2023) found that these labs increased student access to digital resources by 58%, with girls' participation in ICT activities rising from 32% to 49% due to targeted gender-inclusive content design.

However, challenges in policy implementation remain. A 2023 audit by the National Audit Office (NAO) revealed that 17% of allocated ICT funds in western provinces were misused or delayed, leading to incomplete infrastructure projects. Moreover, while urban schools often exceed policy benchmarks, rural institutions face persistent gaps in technical maintenance and teacher buy-in. For example, in Yunnan Province, 43% of primary schools reported malfunctioning VR headsets due to a lack of local repair services, despite successful initial deployments (NAO, 2023).

MATERIALS AND METHODS

This study employs a systematic review grounded in desk research, leveraging existing policy documents, empirical studies, and case reports to address the research objectives. As the paper is prepared exclusively from secondary data, the methodology focuses on systematic synthesis and critical interpretation of publicly available resources.

Data Sources

Policy Documents: National and provincial policy frameworks (e.g., Education Informatization 2.0 Action Plan, Double Reduction Policy), annual reports from

the Ministry of Education (MOE), and fiscal allocation records.

Empirical Research: Peer-reviewed journal articles, conference papers, and technical reports (e.g., UNESCO's global education monitoring reports, China Education Technology Association surveys) analyzing ICT integration in primary education.

Case Studies: Published evaluations of successful ICT models (e.g., Hangzhou's smart classrooms, Yunnan's mobile learning buses) and regional pilot projects.

Statistical Databases: MOE's educational informatization annual reports, China Education Finance Research Institute (CEFRI) budget analyses, and UNESCO's equity gap assessments.

Data Analysis

Thematic analysis of policy texts and case studies to identify patterns in ICT infrastructure, teacher training, and curricular adaptation. Key themes include urban-rural disparities, teacher competency gaps, and technology-driven pedagogical innovation.

Synthetic review of statistical data (e.g., internet access rates, device ownership ratios) to quantify challenges and progress. For example, rural schools' 32% unstable internet rate (UNESCO, 2022) and urban students' 3.2× higher access to personal devices (MOE, 2023) are contextualized within policy failures.

Comparative Analysis: Cross-regional comparisons of ICT adoption (e.g., Zhejiang's VR/AR pilots vs. Gansu's solar-powered labs) to evaluate the impact of policy variations and regional resources.

Limitations

Data Dependency: Reliance on existing literature may overlook unpublished grassroots initiatives or emerging trends not captured in formal reports.

Generalization Challenges: Regional disparities in China's vast education system limit the universality of findings, though comparative case studies mitigate this by highlighting context-specific strategies.

Ethical Considerations

All data sources are publicly available and properly cited in compliance with academic integrity standards. No primary data collection involving human subjects was conducted, ensuring alignment with ethical research practices.

This methodology ensures a rigorous, evidence-based analysis of ICT integration in Chinese primary education, drawing on diverse secondary resources to inform policy recommendations and theoretical insights.

RESULTS AND DISCUSSIONS

Challenges in ICT Integration

Technological and Infrastructure Barriers

Despite national progress, stark disparities persist between urban and rural educational settings, with technological infrastructure serving as a critical bottleneck for equitable ICT integration. A 2022 UNESCO report revealed that 32% of primary schools in western provinces such as Gansu, Yunnan, and Tibet lack stable internet connectivity, a rate five times higher than in eastern coastal provinces (UNESCO, 2022). Compounding this, 45% of schools in these regions operate with outdated hardware, including non-interactive projectors, slow desktop computers from pre-2015 generations, and classroom displays that lack touchscreen functionality (Liu & Chen, 2020). Such devices are incompatible with modern educational apps and cloud-based platforms, limiting teachers to basic presentation tools rather than interactive learning modules.

Maintenance issues further exacerbate these challenges. Rural schools often lack dedicated IT support staff, with 68% of primary institutions in Qinghai Province relying on general administrative staff or local technicians with limited expertise for device repairs (MOE, 2023). This results in prolonged downtime: a survey by the China Education Technology Association (2022) found that malfunctioning equipment in rural classrooms takes an average of 14 days to repair, compared to 2.3 days in urban schools. For example, in a Gansu primary school, a broken interactive whiteboard remained unrepaired for two months, forcing teachers to revert to traditional blackboard instruction during that period (CEATA, 2022).

The cost of upgrading infrastructure poses another barrier. Urban schools in Shanghai or Beijing typically allocate 10-15% of their annual budgets to ICT maintenance and upgrades, while rural schools in Guizhou have the same budget for all operational costs, leaving less than 2% for technology (Liu & Chen, 2020). This disparity is evident in the adoption of advanced tools: only 12% of rural primary schools have access to VR/AR devices, compared to 65% in urban areas (MOE, 2023).

Teacher Competency and Training Gaps

Teacher readiness remains a critical bottleneck in ICT integration, rooted in generational skill gaps, inadequate training structures, and systemic curricular omissions. Studies on preparing educators for AI-augmented learning environments highlight that teacher competency and professional readiness significantly influence the effective use of digital tools in teaching (Huot & Loch, 2025). A survey by Zhang *et al.* (2021) of 10,000 primary school teachers nationwide found that only 58% felt competent using AI-powered teaching tools, such as adaptive learning platforms or automated assessment systems. This disparity is particularly pronounced among educators aged 50+, of whom 72% reported anxiety about mastering complex technologies, compared to just 34% of teachers under 35 (Zhang *et al.*, 2021). In a rural school in Henan Province, a 55-year-old Chinese language teacher struggled to use a digital whiteboard for six months before abandoning it, citing difficulties with touchscreen navigation and software compatibility (Liu & Chen, 2020).

Professional development programs, while widely

implemented, suffer from structural limitations that hinder skill retention. A MOE (2022) analysis of 5,200 training initiatives revealed that 70% of workshops last fewer than three days, with 85% lacking post-training follow-up support, such as mentorship or access to online resource libraries. This brevity leads to superficial knowledge acquisition: a follow-up study by Li *et al.* (2023) found that teachers who attended short-term workshops forgot 62% of ICT-related skills within three months, compared to a 28% oblivion rate among those in year-long programs with monthly refresher sessions. Rural teachers face additional barriers, as 41% of training events are held in urban centers, requiring costly travel that many cannot afford (MOE, 2022; Mkojera, 2025).

Pre-service teacher education compounds these challenges by rarely integrating ICT pedagogy into core curricula. A review of 30 teacher training colleges by Wang *et al.* (2021) found that only 12% offered mandatory courses on technology-enhanced teaching, with most programs dedicating fewer than 15 hours to ICT-related topics across four years of study. Consequently, newly qualified teachers often enter classrooms lacking the TPACK (Technological Pedagogical Content Knowledge) framework needed to design effective ICT-integrated lessons. In a 2022 survey of first-year teachers in Guangxi, 68% admitted feeling "overwhelmed" when asked to incorporate educational apps into their lesson plans, citing a lack of practical experience during training (Cai, 2020).

The consequences of these gaps are tangible: a national classroom observation study by the MOE (2023) found that 53% of primary teachers use ICT solely for content presentation like projecting slides, while only 18% engage students in interactive activities like gamified quizzes or collaborative digital projects. This "substitution without transformation" (Yuan & Ye, 2021) limits the educational potential of technology, as teachers default to familiar practices rather than exploring innovative pedagogies enabled by ICT.

Equity and Access Issues

The digital divide extends beyond school infrastructure to encompass home-based inequities, gender disparities, and accessibility challenges, creating a multifaceted barrier to inclusive ICT integration. Students in low-income households, particularly those in rural and remote areas, often lack essential personal devices required for out-of-class learning. A 2022 UNESCO report highlights that 41% of primary students in western provinces live in households without tablets or laptops, forcing them to rely on shared smartphones (with an average screen size of 5.5 inches) or televisions for online homework, which undermines learning efficiency and causes visual strain (UNESCO, 2022). In Gansu Province, a survey by the Provincial Education Bureau (2023) found that 58% of rural families earning below ¥30,000 ($4,200) annually prioritized food and healthcare over digital devices, leaving students unable to access platforms like Zhixue.com for supplementary exercises.

Gender disparities exacerbate these inequities, reflecting deep-rooted societal norms. Li and Wang (2020) documented that rural boys are 23% more likely to have access to advanced tech tools like coding platforms or educational robots than their female peers, with parents often justifying this gap by citing "boys' greater aptitude for technology." In Yunnan Province, a case study of 100 primary schools revealed that only 32% of girls participated in after-school coding clubs, compared to 68% of boys, despite equal interest levels reported in surveys (Li & Wang, 2020). Such disparities begin early: gamified math apps like Kumon Math are marketed predominantly to boys through gendered advertising, reinforcing stereotypes about who "belongs" in tech-driven learning spaces (Chen *et al.*, 2021).

Students with disabilities face additional barriers due to the lack of inclusive ICT design in mainstream classrooms. Nationwide, only 19% of primary schools have screen readers, braille displays, or adaptive touchscreens for visually impaired students, while less than 10% offer voice-activated tools for those with motor disabilities (China Disabled Persons' Federation, 2022). For instance, a deaf student in Guangzhou struggled to participate in online Chinese lessons because the school's video platform lacked sign language interpretation or real-time captioning, leading to a 40% drop in academic performance compared to peers (Sun *et al.*, 2023). These gaps violate the Education Law of the People's Republic of China, which mandates accessible education for students with disabilities, highlighting systemic neglect in tech infrastructure design.

Socioeconomic status further intersects with these issues: urban students from high-income families are 3.2 times more likely to have access to private edtech tutors or AI-powered learning assistants than their rural counterparts (MOE, 2023). This "second-level digital divide" referring to disparities in how technology is used for learning means that even when low-income students have devices, they often lack the guidance to leverage them for deep learning, instead using them primarily for basic task completion (Hargittai, 2017).

Pedagogical and Curricular Adaptation

Many educators currently use ICT as a mere substitute for traditional teaching methods such as, projecting slides instead of writing on blackboards without fully exploiting its interactive and collaborative potential (Yuan & Ye, 2021). This phenomenon of "substitution without transformation" is rooted in systemic gaps between technological availability and pedagogical innovation. A national survey of 3,000 primary school classrooms by the MOE (2023) found that 67% of teachers use ICT primarily for content delivery like displaying pre-made presentations, while only 12% incorporate interactive features like real-time polling or digital breakout rooms. For instance, in a Guangdong primary school, a math teacher used an interactive whiteboard solely to project

arithmetic problems, missing opportunities to use its touchscreen capabilities for student-led problem-solving sessions (Chen & Li, 2022).

This superficial adoption stems partly from the lack of clear curricular guidelines on ICT integration. Subject-specific curricula in Chinese, mathematics, and art rarely specify how technology should be woven into learning objectives, leading to inconsistent and superficial implementation (Cai, 2020). The Compulsory Education Curriculum Standards(2022), while mentioning "digital literacy" in general terms, provide no subject-specific protocols for integrating tools like educational apps or coding platforms. As a result, teachers in Jiangsu Province reported spending an average of 4.2 hours per week improvising ICT-based activities, compared to 1.1 hours in provinces with pilot curricular frameworks (Wang *et al.*, 2021).

Furthermore, assessment systems often fail to account for digital literacy skills, discouraging teachers from prioritizing technology-driven activities. Standardized tests, such as the primary school leaving exams, rarely include questions assessing computational thinking or online collaboration, while teacher evaluation metrics still emphasize traditional classroom management over innovative tech use (MOE, 2022). In a case study of Shandong Province, teachers reduced ICT use in exam preparation periods by 58%, citing pressure to focus on test-taking skills over digital competencies (Li & Zhang, 2020; Olajide *et al.*, 2024).

Curricular inflexibility also limits the integration of emerging technologies. AI-powered language learning tools that offer personalized pronunciation feedback are rarely used in Chinese classes because they do not align with textbook-based lesson plans (Yuan & Ye, 2021). Similarly, coding education a key component of digital literacy is often treated as an extracurricular activity rather than a core subject, with only 23% of primary schools offering structured coding courses (Cai, 2020).

Strategies for Enhancing ICT Integration

Policy and Financial Support

To address infrastructure inequities, governments must adopt a multi-layered approach to funding that combines targeted subsidies, fiscal incentives, and public-private partnerships. Targeted funding for rural and under-resourced schools remains critical: case studies from Guizhou Province demonstrate that subsidized tablet programs, paired with monthly internet data subsidies of ¥30 ($4.20) per student, improved rural students' digital literacy scores by 27% within two years (MOE, 2023). Building on this model, the "Rural Digital Inclusion Fund" could be expanded to cover not only hardware but also renewable energy solutions (solar-powered charging stations) for schools in off-grid areas, a strategy proven effective in Nigeria's rural schools (World Bank, 2021).

Policymakers should also implement tiered incentive systems to drive teacher innovation. Drawing inspiration from Singapore's Learning Innovation Fund which allocates SGD 10,000 ($7,300) per school for evidence-based tech integration projects China could establish a national "ICT Pedagogy Innovation Grant" offering up to ¥50,000 ($7,000) for teachers who design scalable models of technology use. For example, a primary school in Zhejiang that developed an AI-assisted peer review system for writing classes saw a 35% improvement in student editing skills and received provincial funding to replicate the model in 20 neighboring schools (Zhejiang MOE, 2022). Such grants could be tied to specific outcomes, such as increased student engagement or reduced homework burdens, aligning with the Double Reduction Policy objectives (State Council, 2021).

To ensure long-term sustainability, financial strategies must include maintenance and upgrade budgets. A 2023 survey by the China Education Finance Research Institute (CEFRI) found that rural schools spend 8% of their ICT budgets on maintenance, compared to 22% in urban schools, leading to rapid obsolescence of devices. Introducing a "technology lifecycle fund" that mandates 15% of annual ICT allocations be reserved for upgrades could address this, as seen in Finland's school technology framework (Sahlberg, 2019). Additionally, public-private partnerships with companies like Huawei and Tencent could leverage corporate CSR funds to provide discounted cloud services and technical support to rural schools, mirroring Microsoft's "Airband Initiative" in underserved regions (Microsoft, 2020).

Policy frameworks should also incorporate equity audits to monitor progress. The ICT Integration Equity Index, modeled on UNESCO's Education for All Global Monitoring Framework, could assess metrics like device ownership parity, teacher training access, and curricular integration across regions. In Jiangsu Province, schools failing to meet rural-urban equity targets would face budget reallocations until gaps are closed, a strategy that reduced digital device disparities by 40% within three years (Jiangsu MOE, 2023).

Teacher Capacity Building

Sustained teacher training is essential to bridge competency gaps, requiring a multifaceted approach that addresses both pre-service preparation and in-service development. Modular training programs, combining self-paced online modules with hands-on workshops, offer a scalable solution that accommodates diverse teaching schedules and regional constraints. For example, the "National Teacher ICT Competency Program" piloted in Sichuan Province uses a hybrid model: teachers complete 20 hours of online learning on AI-driven classroom tools (automated attendance systems, adaptive learning platforms) followed by two days of in-person workshops where they design tech-integrated lesson plans. A follow-up survey showed that 78% of participants increased ICT use in classrooms within three months, compared to 32% in traditional short-term workshops (Sichuan MOE, 2023).

Finland's model of integrating ICT into pre-service teacher education where student teachers spend 15% of

their curriculum mastering digital tools and pedagogical frameworks provides a replicable framework (Sahlberg, 2019). In China, this could translate to revising teacher training college curricula to include mandatory courses on "Technology-Enhanced Active Learning," which cover topics like gamified assessment design and data-driven differentiation. A pilot at East China Normal University reduced traditional pedagogy coursework by 10% to make room for ICT modules, resulting in graduating teachers who designed 40% more interactive lessons during their first year compared to peers from non-pilot programs (ECNU, 2022).

Peer mentorship programs, such as Shanghai's "ICT Ambassador" initiative, have proven effective in fostering grassroots innovation. In this model, tech-savvy teachers receive specialized training to support colleagues in adopting new tools, such as virtual reality (VR) history simulations or coding platforms. Schools implementing this initiative reported a 35% increase in classroom ICT use, with mentors providing ongoing feedback during weekly "tech clinics" (Wang, 2022). Expanding this model nationally could address rural-urban training gaps: in Yunnan Province, pairing urban ambassadors with rural schools via video conferencing led to a 28% improvement in teachers' ability to use offline educational apps, even in low-connectivity areas (Yunnan MOE, 2023).

To address generational skill gaps, targeted training tracks for older educators could emphasize low-threshold tools and emotional support. A Jiangsu Province program offered "Silver Tech Workshops" with peer mentors aged 50+ who used simplified interfaces and storytelling techniques to teach colleagues how to use digital whiteboards. Participating teachers showed a 55% increase in confidence using basic ICT tools, compared to 22% in mixed-age workshops (Jiangsu MOE, 2022). Additionally, integrating micro-credentials such as badges for mastering specific tools like ClassIn or Zhixue.com could motivate teachers to engage with training voluntarily, as seen in the U.K.'s "Digital Educator" certification program (DfE, 2020).

Infrastructure Upgrades and Equity Promotion

In rural areas, mobile and modular learning solutions offer scalable pathways to mitigate infrastructure limitations, particularly in regions with unstable connectivity or scarce fixed infrastructure. India's "Hole-in-the-Wall" project, which deployed solar-powered tablet kiosks in remote villages and empowered students to engage in self-directed learning, demonstrated a 25% improvement in basic literacy and numeracy skills within one year (Sanghavi, 2009). Building on this model, China could introduce portable ICT learning kits compact, solar-powered units containing pre-loaded tablets, offline educational software, and rechargeable batteries targeted at schools in western provinces like Tibet and Qinghai. A pilot program in Gansu Province testing this approach found that students in remote villages accessed educational content 40% more frequently than before, with math proficiency scores rising by 18% over six months (Gansu MOE, 2023).

To address urban-rural divides in hardware access, the "Digital School Bus" initiative could deploy retrofitted vehicles as mobile learning centers. Equipped with high-speed Wi-Fi, 3D printers, and VR headsets, these buses could serve multiple rural schools weekly, providing hands-on access to advanced technologies often unavailable in fixed locations. In Yunnan Province, a similar project reached 50 remote primary schools, enabling students to participate in virtual field trips to museums and science labs, which boosted their interest in STEM subjects by 31% (Yunnan MOE, 2022).

Inclusive design must also prioritize students with disabilities and linguistic diversity. Technology developers should adopt frameworks like Microsoft's Inclusive Design Toolkit (Microsoft, 2021) to create tools with multilingual interfaces (e.g., Mandarin, Cantonese, and ethnic minority languages like Yi and Tibetan) and accessibility features such as voice-controlled navigation, screen readers, and haptic feedback for visually impaired learners. A Beijing-based edtech company recently developed a "Smart Braille Tablet" that translates digital text into tactile braille in real time, improving reading speed by 40% for visually impaired students in a pilot study (Beijing Disabled Persons' Federation, 2023).

Government policies should mandate equity audits for all ICT infrastructure projects, ensuring that at least 15% of new devices are allocated to rural schools and 5% are reserved for students with disabilities. In Jiangsu Province, such audits reduced the urban-rural digital device gap from 3:1 to 1.5:1 within two years, while also increasing the availability of adaptive tools in mainstream classrooms by 65% (Jiangsu MOE, 2023). Additionally, subsidized "family digital packs" including low-cost tablets and data plans could be offered to low-income households, modeled on South Korea's "Digital Inclusion Voucher" program, which reduced home device disparities by 38% (Ministry of Science and ICT, South Korea, 2021).

Curriculum Design and Student-Centered Approaches

Revising curricula to explicitly require ICT integration can guide pedagogical innovation, shifting focus from technology as a supplementary tool to an integral component of disciplinary learning. A foundational step involves embedding computational thinking into core subjects like mathematics and science. Introducing basic coding concepts such as algorithm design and logical sequencing in mathematics classes can cultivate problem-solving skills. In a Shenzhen pilot program, third-grade students engaged in weekly coding activities using block-based platforms like Scratch, demonstrating a 19% improvement in problem-solving scores on standardized assessments compared to a control group (Li, 2020). Expanding such initiatives nationally could align with global trends: countries like England and Singapore have mandated coding in primary curricula since 2014, reporting long-term gains in student engagement with

STEM fields (Department for Education, U.K., 2013).

Project-based learning (PBL) frameworks offer another pathway to deepen ICT integration, enabling students to apply digital tools to real-world challenges. For instance, a primary school in Hangzhou tasked fifth-grade students with creating digital storytelling campaigns about local environmental issues using video editing software and social media platforms. Over a 12-week period, students developed interactive presentations, conducted online surveys, and launched microblog campaigns, resulting in a 35% increase in self-reported confidence in using ICT for research and communication (Wang & Chen, 2022). Research from the United States supports this approach: a meta-analysis of 50 PBL studies found that students in ICT-integrated projects outperformed peers on creativity assessments by 28% and demonstrated 22% higher technical proficiency (Thomas, 2000).

To ensure consistency, curricular reforms must include subject-specific guidelines for ICT use. The Chinese Language Curriculum Standards could specify how AI-powered speech recognition tools (e.g., Tencent's "WeSpeak") can be used to practice pronunciation, while art curricula might incorporate digital illustration platforms like Procreate to teach visual design principles. A 2023 survey of 800 primary teachers in Zhejiang Province found that schools with detailed curricular protocols for ICT integration were 2.5 times more likely to report sustained, innovative use of technology compared to those without (Zhejiang MOE, 2023).

Assessments must also evolve to measure digital literacy skills, such as data analysis, online collaboration, and ethical tech use. In Jiangsu Province, the "Digital Competency Assessment Rubric" was introduced in 2022, evaluating students on criteria like "effective use of educational apps" and "responsible online behavior." Pilot schools reported a 41% increase in teacher attention to ICT skills after the rubric's implementation, with students in these schools scoring 15% higher on national digital literacy tests (Jiangsu MOE, 2022).

Student-centered approaches further require inclusive curriculum design that accommodates diverse learning styles. For instance, gamified platforms like Kahoot! can make vocabulary memorization interactive for kinesthetic learners, while virtual labs (e.g., Labster) allow visual learners to simulate science experiments. A study in Guangdong Province using adaptive learning algorithms to tailor curricula to individual paces found that students with learning disabilities achieved a 29% reduction in academic gaps compared to traditional instruction (Chen *et al.*, 2021).

Case Studies: Successful Models of ICT Integration

Smart Classroom Ecosystem in Hangzhou

A primary school in Hangzhou spearheaded the implementation of an AI-powered smart classroom ecosystem, leveraging advanced technologies to create a data-driven learning environment. The system integrates facial recognition software, real-time analytics, and adaptive learning algorithms to monitor student engagement and tailor instruction dynamically. Facial recognition technology tracks metrics such as eye gaze, head posture, and micro expressions to generate instant engagement reports for teachers, who can then adjust lesson pacing, introduce interactive activities, or provide one-on-one support during class (Chen *et al.*, 2022). For example, when the system detected low engagement during a geometry lesson, teachers incorporated AR-based shape recognition games, increasing student participation by 30% within 15 minutes.

The ecosystem's adaptive learning component analyzes student responses to quizzes and homework, using machine learning to identify knowledge gaps and generate personalized practice sets. In a comparative study, students in smart classrooms demonstrated a 19% improvement in end-of-term math scores compared to peers in traditional classrooms, with particularly significant gains in problem-solving skills (Chen *et al.*, 2022; Palmerola *et al.*, 2024). The system also reduces teacher workload by automating routine tasks, such as grading multiple-choice assessments and generating progress reports, allowing educators to focus on high-value interactions like mentoring and curriculum design.

Beyond academic outcomes, the smart classroom fosters metacognition by providing students with access to their own engagement data. Through a dedicated dashboard, students can review patterns in their attention levels and set goals for improvement, such as maintaining focus during complex topics. A survey of 300 students in Hangzhou found that 78% reported increased awareness of their learning habits, with 62% actively using the dashboard to adjust study strategies (Hangzhou Education Bureau, 2023).

To ensure scalability, the Hangzhou model includes a peer-sharing network where schools contribute anonymized engagement data to refine the AI algorithms collectively. Participating institutions in Zhejiang Province have formed a "Smart Classroom Consortium," which has reduced implementation costs by 25% through bulk purchasing of hardware and shared training resources (Zhejiang MOE, 2023). This collaborative approach addresses one of the key challenges in tech integration resource allocation while maintaining a focus on student-centered learning.

Rural Mobile Learning Initiative in Yunnan

In Yunnan Province, the "Mobile Learning Bus" project has emerged as a transformative model for addressing connectivity and resource gaps in remote primary education. Launched in 2021 by the Yunnan Provincial Education Department in collaboration with UNESCO, the initiative deploys retrofitted buses equipped with solar-powered tablets pre-loaded with offline educational content spanning literacy, science, art, and life skills. Each bus serves 5-8 rural schools weekly, providing students in areas with limited internet access to interactive modules, such as gamified Mandarin pronunciation exercises,

virtual science experiments, and digital art studios.

The project's design prioritizes equity through inclusive content development. For context, literacy modules include bilingual materials in Yi and Hani ethnic minority languages, reflecting the region's cultural diversity. Gender-sensitive content ensures equal representation in STEM activities, with characters in science apps split evenly by gender. Over one year, participating students in remote villages demonstrated a 22% increase in reading comprehension scores on standardized tests, with girls achieving identical gains to boys—a significant shift from baseline data showing a 15% gender gap in tech engagement (UNESCO, 2023).

A critical component of the initiative is teacher capacity building. Local educators receive intensive training on using tablets for differentiated instruction, such as assigning personalized reading lists based on student proficiency levels. Teachers also learn to leverage the buses' offline data storage to track student progress and adapt lessons, even in areas with no internet. In a survey of 120 teachers, 89% reported improved confidence in integrating technology into core subjects, with 73% incorporating tablet-based activities into daily lesson plans (Yunnan MOE, 2022; UNESCO, 2023).

Scalability is achieved through a modular hardware design: buses can be reconfigured based on regional needs, with some units featuring 3D printers for STEM projects or braille embossers for visually impaired students. Since its expansion in 2022, the initiative has reached over 50,000 primary students across 300 villages, reducing the digital divide in Yunnan's primary education by 25% as measured by the Provincial Education Equity Index (Yunnan MOE, 2023).

CONCLUSION

The integration of ICT in Chinese primary education represents a transformative yet uneven journey marked by significant achievements in policy framework development and smart classroom innovation, while persistent challenges in rural-urban infrastructure disparities, teacher competency gaps, and educational equity continue to hinder holistic progress. The evidence demonstrates that successful ICT integration requires moving beyond mere technological substitution toward pedagogical transformation, necessitating sustained investment in targeted rural infrastructure, modular teacher training programs that bridge generational skill divides, and curriculum redesign that embeds digital literacy as a core competency rather than an add-on. Ultimately, China's experience offers a critical case study for global education stakeholders: sustainable digital transformation in primary education demands not only advanced technologies but also inclusive policy alignment, collaborative innovation ecosystems, and unwavering commitment to ensuring that no student—regardless of geography, gender, or socioeconomic status—is left behind in the digital age.

REFERENCES

Anderson, R. (2020). The role of ICT in transforming education: A global perspective. *Journal of Educational Technology International, 45*(2), 123–138.

Asare, S., Amponsah, A., Owusu-Mintah, C., Abrefah-Mensah, E., & Osei Frimpong, K. (2023). Analysis of policy frameworks for integrating ICT in Ghanaian education: Implications for teacher education and professional development: A systematic review. *American Journal of Education and Technology, 2*(3), 123–128. https://doi.org/10.54536/ajet.v2i3.1888

Beijing Disabled Persons' Federation. (2023). *Adaptive ICT tools for students with disabilities*. Beijing: BDPF Publishing.

Beijing Municipal Education Commission. (2023). *Smart classroom innovation project evaluation*. Beijing: BMEC Publishing. Beijing: MOE Publishing.

Cai, Y. (2020). Challenges and strategies of ICT integration in basic education. *Journal of Educational Technology, 15*(2), 45–62.

Chen, H., & Li, S. (2022). Interactive whiteboard use in primary math classrooms. *Journal of Educational Technology in China, 18*(3), 45–59.

Chen, H., & Li, S. (2022). Mobile gamified reading apps and literacy development. *Chinese Journal of Applied Linguistics, 45*(3), 345–362.

Chen, H., (2021). Gendered marketing of educational technology in China. *Journal of Educational Innovation, 7*(4), 112–125.

Chen, L., (2021). Adaptive learning algorithms and inclusive curriculum design. *Journal of Educational Innovation, 7*(3), 98–111.

Chen, L., (2022). Smart classroom applications in primary education: A case study. *Chinese Journal of Educational Innovation, 8*(3), 78–91.

China Disabled Persons' Federation. (2022). *Report on ICT accessibility in primary education*. Beijing: CDPF Publishing.

China Education Development Foundation. (2022). *Report on digital equity in primary education*. Beijing: CEDF Publishing.

China Education Finance Research Institute (CEFRI). (2023). *Rural school ICT budget allocation report*. Beijing: CEFRI Publishing.

China Education Technology Association (CEATA). (2022). *Rural school ICT maintenance report*. Beijing: CEATA Publishing.

Department for Education (DfE, U.K.). (2020). *Digital Educator Certification Framework*. https://www.gov.uk

Department for Education, U.K. (2013). *Computing at school: A guide for primary teachers*. https://www.gov.uk

East China Normal University (ECNU). (2022). *Pre-service teacher ICT training pilot evaluation*. Shanghai: ECNU Publishing.

Gansu Ministry of Education. (2023). *Rural mobile ICT kits effectiveness report*. Lanzhou: Gansu MOE Publishing.

Guangdong Ministry of Education. (2022). *Annual report on rural ICT education in Guangdong*. Guangzhou:

Guangdong MOE Publishing.
Hangzhou Education Bureau. (2023). *Smart classroom student survey report*. Hangzhou: HEB Publishing.
Hargittai, E. (2017). The digital divide turns 20: Looking back, moving forward. *First Monday, 22*(9). https://doi.org/10.5210/fm.v22i9.7061
Huot, S., & Loch, S. (2025). Educating in the age of AI: Preparing Cambodian teachers and students for an AI-augmented learning future. *Journal of Educational Technology and E-Learning Innovations, 1*(2), 31–38. https://doi.org/10.54536/jeteli.v1i2.5170
Jiangsu Ministry of Education. (2022). *Aging teachers ICT training effectiveness report*. Nanjing: Jiangsu MOE Publishing.
Jiangsu Ministry of Education. (2022). *Digital competency assessment in primary schools*. Nanjing: Jiangsu MOE Publishing.
Jiangsu Ministry of Education. (2022). *VR/AR in primary science education: Jiangsu pilot results*. Nanjing: Jiangsu MOE Publishing.
Jiangsu Ministry of Education. (2023). *Equity audit implementation in Jiangsu primary schools*. Nanjing: Jiangsu MOE Publishing.
Lee, S., (2019). Early childhood ICT education and cognitive development: A longitudinal study in South Korea. *Computers & Education, 138*, 103721.
Li, J. (2020). Computational thinking development through primary school coding education. *Educational Innovation Research, 6*(4), 56–73.
Li, M., & Zhou, X. (2022). Policy analysis of China's "Double Reduction" initiative: Implications for educational equity. *China Education Review, 9*(1), 67–84.
Li, X., & Wang, Y. (2020). Digital divide in Chinese primary schools: A multilevel analysis. *Educational Research Review, 25*, 112–125.
Li, X., & Zhang, W. (2020). Assessment barriers to ICT integration in Shandong primary schools. *Modern Education Management, 36*(6), 78–85.
Li, X., (2023). Long-term impact of ICT teacher training duration. *Journal of Educational Technology Research, 19*(2), 89–104.
Liu, S., & Chen, W. (2020). Rural teacher ICT competency challenges. *Chinese Journal of Educational Economics, 33*(3), 89–105.
Talahiban, M. J. L., Malabarbas, G. T., Amoto, B. L., & Mendoza, J. B. (2022). Teaching competencies and coping mechanisms in the new normal education among public elementary teachers. *American Journal of Multidisciplinary Research and Innovation, 1*(3), 63–71. https://doi.org/10.54536/ajmri.v1i3.373
Microsoft (2020). *Airband Initiative: Connecting underserved communities*.
Microsoft. (2021). *Inclusive design toolkit for education*. https://www.microsoft.com
Ministry of Education (MOE). (2018). *Education Informatization 2.0 Action Plan*. http://www.moe.gov.cn
Ministry of Education (MOE). (2022). *National report on teacher digital literacy*. Beijing: MOE Publishing.
Ministry of Education (MOE). (2022). *Report on curriculum and assessment in ICT education.*
Ministry of Education (MOE). (2023). *Annual report on educational informatization in primary and secondary schools*. Beijing: MOE Publishing.
Ministry of Education (MOE). (2023). *Regional disparities in educational technology report*. Beijing: MOE Publishing.
Ministry of Education. (2021). *National ICT teaching expertise program evaluation report*. Beijing: MOE Publishing.
Ministry of Science and ICT, South Korea. (2021). *Digital Inclusion Voucher Program evaluation*. Seoul: MSIT Publishing.
Mkojera, I. C. (2025). Merits and demerits of social assistance programs to poor people. Journal of Rural Sociology, *Microfinance, and Poverty Studies, 2*(1), 1–4. https://doi.org/10.54536/jrsmps.v2i1.4209
National Audit Office (NAO). (2023). *Special audit report on educational ICT fund utilization*. Beijing: NAO Publishing.
Ng, E., (2019). Teacher innovation funds: Catalyzing technology integration in Singapore schools. *Teaching and Teacher Education, 83*, 103–115.
Olajide, A. O., Sangotoro, T. K., & Adegoke, M. A. (2024). Assessing the effect of acculturation program on academic achievement of French students in colleges of education in Nigeria. *Journal of Innovative Research, 2*(2), 34–39. https://doi.org/10.54536/jir.v2i2.3173
Palmerola, E. D., Amorado, K. K. T., & Arabilla, K. A. T. (2024). A comparative study of learning modalities and academic performance in a private senior high school in Southern Philippines. *American Journal of Multidisciplinary Research and Innovation, 3*(6), 42–48. https://doi.org/10.54536/ajmri.v3i6.3653
Prensky, M. (2001). Digital natives, digital immigrants. *On the Horizon, 9*(5), 1–6.
Sahlberg, P. (2019). Finnish education: The power of equality and technology. *Journal of Educational Change, 20*(2), 145–163.
Sanghavi, S. (2009). Hole-in-the-wall: Bridging the digital divide through self-organized learning. *International Journal of Emerging Technologies in Learning, 4*(3), 50–56.
Shanghai Municipal Education Commission. (2022). *AR/VR in primary science education survey*. Shanghai: SMEC Publishing.
Shanghai Municipal Education Commission. (2023). *Case study: AI-driven homework customization in Pudong Primary School*. Shanghai: SMEC Publishing.
Sichuan Ministry of Education. (2023). *Hybrid teacher training model impact study*. Chengdu: Sichuan MOE Publishing.
State Council. (2021). *Implementation guidelines for the Double Reduction Policy*. http://www.gov.cn
State Council. (2021). *Notice on strengthening rural ICT education infrastructure*. http://www.gov.cn
State Council. (2021). *Opinions on further reducing the burden of homework and off-campus tutoring for primary and secondary school students*. http://www.gov.cn

State Council. (2022). *Guidelines on promoting rural edtech access*. http://www.gov.cn

Sun, Y., (2023). Accessibility barriers in Chinese primary e-learning. *Disability & Society, 38*(5), 987–1003.

Sun, Y., (2023). AI-assisted writing feedback in primary education. *Educational Technology Research, 18*(1), 78–91.

Thomas, J. W. (2000). A review of research on project-based learning. *AECT Monograph Series, 4*(1), 1–16.

UNESCO. (2022). *Global Education Monitoring Report: Technology in education*. Paris: UNESCO Publishing.

UNESCO. (2023). *Rural ICT education in China: Gansu mobile labs impact assessment*. Paris: UNESCO Publishing.

United Nations Educational, Scientific and Cultural Organization (UNESCO). (2022). *Global Education Monitoring Report: Technology in Education*. Paris: UNESCO Publishing.

Wang, F., & Zhang, H. (2021). VR/AR applications in primary school history education. *Journal of Educational Technology Research, 12*(1), 34–49.

Wang, L., (2021). Gamification in primary arithmetic education: A quasi-experimental study. *Journal of Educational Innovation, 7*(2), 89–102.

Wang, Y., & Chen, S. (2022). Digital storytelling in primary PBL: A Hangzhou case study. *Chinese Journal of Educational Technology, 42*(5), 67–75.

Wang, Y., & Li, X. (2021). Access and utilization of digital educational resources in rural China. *Journal of Rural Education, 37*(2), 45–61.

Wang, Y., (2020). Gamified learning in primary mathematics: A meta-analysis. *Educational Research Review, 28*, 100492.

Wang, Y., (2021). Curricular guidelines and ICT integration: A provincial comparison. *Educational Research Monthly, 497*(4), 67–74.

Wang, Y., (2021). Pre-service teacher education and ICT integration. *Teacher Education Research, 33*(4), 56–63.

Wang, Z. (2022). Peer mentorship and ICT integration: A mixed-methods study in Shanghai primary schools. *Teaching and Teacher Education, 110*, 103892.

World Bank. (2021). *Rural education technology in Nigeria: A solar-powered model*. Washington, DC: World Bank Publishing.

Wuhan Education Bureau. (2021). *Report on hybrid learning in Wuhan primary schools*. Wuhan: WEB Publishing.

Yuan, L., & Ye, S. (2021). Substitution vs. transformation: A typology of ICT use in Chinese classrooms. *Educational Technology Research and Development, 69*(3), 1235–1254.

Yunnan Ministry of Education. (2022). *Mobile learning bus project impact assessment*. Kunming: Yunnan MOE Publishing.

Yunnan Ministry of Education. (2022). *Mobile Learning Bus teacher training evaluation*. Kunming: Yunnan MOE Publishing.

Yunnan Ministry of Education. (2023). *Provincial Education Equity Index report*. Kunming: Yunnan MOE Publishing.

Yunnan Ministry of Education. (2023). *Rural-urban peer mentorship in ICT integration*. Kunming: Yunnan MOE Publishing.

Zhang, L., (2021). Rural-urban disparities in ICT adoption: Evidence from Chinese primary schools. *Journal of Rural Education Development, 37*(4), 56–72.

Zhang, W., (2021). Teacher competency in ICT integration: A national survey. *Modern Education Technology, 31*(5), 34–41.

Zhang, W., (2023). Effectiveness of adaptive learning platforms in primary mathematics. *Modern Education Technology, 33*(4), 56–63.

Zhejiang Ministry of Education. (2022). *ICT innovation grant case studies*. Hangzhou: Zhejiang MOE Publishing.

Zhejiang Ministry of Education. (2023). *Curricular guidelines for ICT integration: Zhejiang experience*. Hangzhou: Zhejiang MOE Publishing.

Zhejiang Ministry of Education. (2023). *Smart Classroom Consortium impact assessment*. Hangzhou: Zhejiang MOE Publishing.