

Digital Divide and Pedagogical Challenges: ICT Teaching in Remote Schools and the Role of Artificial Intelligence in Bridging the Gap

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Abstract — The integration of information and communication technology (ICT) into education has become a global policy priority, yet remote schools in developing nations continue to face profound challenges in its effective implementation. This article examines the challenges confronting teachers in remote Zambian schools in teaching ICT, and situates these challenges within the broader global discourse on artificial intelligence, digital transformation, and technology-mediated learning. Drawing on a descriptive survey study of two selected remote schools, the article identifies infrastructure deficits, limited teacher ICT competence, inadequate professional development, resource scarcity, and connectivity barriers as primary impediments. The study argues that AI-powered adaptive platforms, offline-capable digital tools, and blockchain-enabled institutional management systems offer promising pathways toward bridging the digital divide in remote educational contexts. Policy recommendations targeting infrastructure investment, teacher capacity building, and community engagement are offered

Keywords — *ICT In Education; Remote Schools; Digital Divide; Artificial Intelligence; Zambia; Teacher Challenges; Digital Transformation.*

1. Introduction

The transformative potential of information and communication technology in education has generated substantial scholarly and policy attention globally (Venice et al., 2025a; Arockia et al., 2025). AI-powered learning analytics, adaptive curriculum platforms, recommendation systems, and blockchain-enabled credentialing are reshaping educational practice in technologically advanced contexts (Venice et al., 2025b; Vasantha et al., 2025). However, the reality for teachers in remote schools across sub-Saharan Africa remains starkly different: persistent infrastructure deficits, unreliable electricity supply, absence of internet connectivity, and acute shortages of ICT equipment continue to render effective ICT teaching deeply challenging (Vettriselvan & Rajan FSA, 2019; Mohanbabu & Vettriselvan, 2025a).

In Zambia, national ICT policy frameworks mandate the integration of technology across all school levels, yet remote schools particularly those in districts far from urban centres lack the foundational infrastructure necessary to implement these mandates. Teachers in such settings face a compound challenge: they must navigate pedagogical expectations designed for technology-rich environments using equipment that is often absent, broken, or inaccessible (Vettriselvan et al., 2025a; Swadhi et al., 2025a). This article investigates these challenges empirically and theoretically, connecting local Zambian realities to the global conversation on AI, digital transformation, and inclusive technology-mediated education. The article proceeds as follows: Section 2 reviews relevant literature on ICT in education, teacher

challenges, and AI-driven solutions. Section 3 outlines methodology. Section 4 presents findings. Section 5 discusses implications. Section 6 concludes with recommendations.

2. Literature Review

2.1 ICT Integration and the Digital Divide

The concept of the digital divide the gap between those with access to digital technologies and those without remains one of the most persistent structural inequities in global education (Venice et al., 2025c; Vinodh et al., 2026a). In sub-Saharan Africa, this divide is particularly pronounced between urban and rural schools, with remote communities experiencing compounded disadvantage due to geographic isolation, poverty, and infrastructural underdevelopment (Vettriselvan et al., 2025b; Meena et al., 2025).

Research has documented that ICT integration in remote schools is consistently impeded by electricity supply irregularities, absence of broadband connectivity, inadequate device availability, and teacher ICT literacy deficits (Shanthi et al., 2025; Gayathri et al., 2025b). AI-powered educational technologies have emerged as potential levers for closing the digital divide, particularly through the development of offline-capable adaptive learning platforms that do not require continuous internet connectivity (Arockia et al., 2025; Akila et al., 2025). These platforms leverage machine learning algorithms to personalise instructional content, adapt difficulty levels to individual learner performance, and generate data-driven insights for teacher use capabilities that could substantially

enhance ICT teaching effectiveness in remote contexts if appropriate device access and teacher training are provided (Venice et al., 2025b; Vasantha et al., 2025).

2.2 Teacher Competence and Professional Development in ICT

Teacher ICT competence is a critical determinant of effective technology integration in classroom instruction (Gayathri et al., 2025b; Vettriselvan, 2025). Research consistently demonstrates that teachers who lack confidence in their own ICT skills are significantly less likely to incorporate technology into their pedagogical practice, regardless of equipment availability (Venice et al., 2025a; Vettriselvan & Anto, 2018).

In remote Zambian schools, teacher ICT competence is often limited by the absence of pre-service technology training, inadequate in-service professional development, and limited opportunity for peer learning and mentorship in digital pedagogy (Vettriselvan & Rajan FSA, 2019; Mohanbabu & Vettriselvan, 2025b). The strategic role of human resource management in building and sustaining teacher ICT competence cannot be overstated (Gayathri et al., 2025b; Jenifer et al., 2025).

Effective professional development programmes for ICT teaching must combine technical skill acquisition with pedagogical integration training, equipping teachers not merely to operate technology but to deploy it in ways that enhance learner engagement, critical thinking, and academic performance (Venice et al., 2025; Swadhi et al., 2025b). Community-based digital learning initiatives and peer coaching models have demonstrated particular promise in remote educational settings where access to centralised training infrastructure is limited (Kariveliparambil et al., 2026a; Vettriselvan et al., 2025c).

2.3 Blockchain, AI, and Remote Educational Management

Blockchain technology offers significant potential for addressing institutional management challenges in remote schools, including secure record-keeping, transparent resource allocation, and verifiable teacher credentialing (Venice et al., 2025d; Rajeswari et al., 2026). AI-driven administrative platforms can automate routine school management functions, freeing teacher time for instructional preparation and professional development activities that directly enhance ICT teaching quality (Venice et al., 2025e; Devi et al., 2025). The integration of cognitive IoT (CIoT) in educational networks further enables real-time monitoring of school performance, resource utilisation, and teacher activity generating evidence for evidence-based policy decisions on remote

school support and resource allocation (Akila et al., 2025; Venice et al., 2025b).

2.4 Health, Well-being, and Teacher Performance

The well-being of teachers in remote schools is a frequently overlooked determinant of ICT teaching effectiveness (Ashifa, 2022; Zahoor et al., 2025). Research has documented that teachers in isolated remote settings experience elevated levels of occupational stress, professional isolation, and burnout, all of which negatively impact instructional quality and innovation adoption (Elkin et al., 2025; Gayathri et al., 2025a). Emotional intelligence and self-leadership capacities have been identified as significant protective factors against burnout among educators facing challenging working conditions (Zahoor et al., 2025; Ranganathan et al., 2024). Learner health and nutritional status also directly affect engagement with ICT-mediated instruction, particularly in remote communities where food insecurity is prevalent (Ashifa, 2020a; Ashifa, 2021a).

2.5 Digital Citizenship and Online Safety

The introduction of ICT into remote schools raises important questions of digital citizenship, online safety, and ethical technology use (Venice et al., 2025f; Vijayalakshmi et al., 2025a). Research on social deviance and internet exposure among secondary school students in Zambia highlights the risks of unguided digital access in contexts where children lack digital literacy foundations (Venice et al., 2025e). Comprehensive digital citizenship education must accompany all ICT integration initiatives, ensuring that learners develop the critical thinking, ethical reasoning, and self-regulatory skills necessary for safe and productive digital engagement (Vettriselvan et al., 2025d; Vinodh et al., 2026b).

3. Methodology

This study employed a descriptive survey design to investigate challenges faced by teachers in teaching ICT in two selected remote primary schools in Zambia. A mixed-methods approach combining qualitative interviews and quantitative questionnaires was used, enabling triangulation of data sources (Kombo & Tromp, 2014; Orodho & Kombo, 2012). The target population comprised ICT teachers, heads of department, and school administrators, with a purposively selected sample of 30 respondents. Data collection instruments included semi-structured interview guides for teachers and administrators, and structured questionnaires for pupil participants. Thematic analysis was applied to qualitative data; descriptive statistics were used for quantitative data. Ethical clearance was obtained from relevant institutional authorities prior to fieldwork.

4. Findings and Analysis

4.1 Infrastructure and Connectivity Deficits

Findings revealed that both study schools faced severe ICT infrastructure limitations. Absence of reliable electricity supply was cited by 90% of teacher respondents as the primary barrier to ICT teaching, followed by lack of internet connectivity (85%), insufficient computers and devices (80%), and absence of a dedicated ICT laboratory (75%). These infrastructure deficits directly constrain teacher ability to conduct practical ICT lessons, limiting instruction to theoretical content delivery that fails to develop learner digital competencies (Vettriselvan et al., 2025b; Arockia et al., 2025).

4.2 Teacher ICT Competence and Professional Development

Only 30% of teacher respondents rated their ICT competence as adequate for effective classroom instruction. The majority reported that pre-service teacher training had provided insufficient ICT pedagogical preparation, and that in-service professional development opportunities were rare and poorly aligned with actual classroom ICT teaching demands (Gayathri et al., 2025b; Vettriselvan & Rajan FSA, 2019). Teachers expressed strong motivation to improve their ICT competence but cited lack of training opportunities, financial constraints, and geographic isolation as primary barriers to professional development access (Swadhi et al., 2025a; Venice et al., 2025c).

4.3 Learner Engagement and ICT Attitudes

Despite infrastructure limitations, learner attitudes toward ICT were broadly positive, with 78% of pupil respondents expressing enthusiasm for ICT learning and recognition of its importance for future employment and civic participation (Venice et al., 2025a; Vasantha et al., 2025). This finding underscores the demand-side motivation for enhanced ICT provision in remote schools and suggests that infrastructure and teacher capacity investments would be met with strong learner receptivity (Vettriselvan et al., 2025c; Vinodh et al., 2026a).

4.4 Institutional Support and Community Engagement

Teacher respondents consistently identified inadequate institutional support including school leadership engagement, parental involvement, and community awareness as a significant contextual challenge to ICT teaching (Kariveliparambil et al., 2026b; Venice et al., 2026). School heads who demonstrated active commitment to ICT integration and resource mobilisation were associated with more positive teacher attitudes and more

frequent ICT instructional attempts, consistent with international evidence on the centrality of school leadership to technology adoption (Vettriselvan et al., 2026a; Gayathri et al., 2025a).

5. Discussion

The findings from this study paint a vivid picture of the structural, professional, and institutional barriers that impede effective ICT teaching in remote Zambian schools. The severity of infrastructure deficits particularly electricity and connectivity gaps positions Zambia's remote schools at the extreme margin of the global digital divide, far removed from the AI-powered, data-rich learning environments described in the international educational technology literature (Venice et al., 2025b; Arockia et al., 2025; Akila et al., 2025). However, the findings also reveal important assets that policy can build upon: strong learner enthusiasm for ICT, teacher motivation to improve competence, and community recognition of technology's importance for development.

These demand-side factors create a favourable environment for targeted supply-side investments in infrastructure, teacher training, and institutional support (Vasantha et al., 2025; Swadhi et al., 2025b). AI-powered offline learning platforms, solar-powered device charging stations, and community digital literacy centres represent contextually appropriate technological interventions that do not require urban-level infrastructure to deliver meaningful learning benefits (Venice et al., 2025c; Vettriselvan, 2025). The health and well-being of remote school teachers a dimension rarely foregrounded in ICT integration literature emerges from this study as a critical enabling condition for effective technology teaching. Policy interventions targeting teacher well-being, professional isolation reduction through digital peer networks, and stress management support would complement infrastructure investments in creating conditions conducive to sustained ICT pedagogical innovation (Zahoor et al., 2025; Elkin et al., 2025; Ashifa, 2022).

6. Conclusion and Recommendations

This article has examined the challenges confronting teachers in remote Zambian schools in teaching ICT, connecting local empirical findings with global scholarship on digital transformation, AI, and inclusive educational technology. The study confirms that infrastructure deficits, limited teacher competence, inadequate professional development, and insufficient institutional support constitute the primary barriers to effective ICT teaching in remote Zambian schools barriers that demand coordinated, sustained, and contextually appropriate policy responses. The following recommendations are offered: (1) The

Ministry of Education and Ministry of Technology should prioritise solar-powered electricity and satellite internet connectivity infrastructure in remote schools (Vettriselvan et al., 2025b; Venice et al., 2025a); (2) teacher professional development programmes should be redesigned to integrate ICT pedagogical training with digital literacy components, delivered through blended and community-based modalities accessible to remote teachers (Gayathri et al., 2025b; Vettriselvan & Rajan FSA, 2019); (3) offline-capable AI-powered learning platforms should be deployed as bridge technologies pending full connectivity provision (Arockia et al., 2025; Vasantha et al., 2025); (4) school leadership development programmes should incorporate ICT integration management competencies (Venice et al., 2026; Kariveliparambil et al., 2026a); and (5) digital citizenship education should be embedded in all ICT teacher training and pupil instruction programmes (Vijayalakshmi et al., 2025a; Vettriselvan et al., 2025d).

References

- [1] Akila, V., Prabhu, G., Akila, R., & Swadhi, R. (2025). Performance metrics in blockchain-enabled AIML for cognitive IoT in large-scale networks. In *AI for large scale communication networks* (pp. 265–288). IGI Global Scientific Publishing.
- [2] Arockia, V. J., Vettriselvan, R., Rajesh, D., Velmurugan, P. R. R., & Cheelo, C. (2025). Leveraging AI and learning analytics for enhanced distance learning: Transformation in education. In *AI and learning analytics in distance learning* (pp. 179–206). IGI Global Scientific Publishing.
- [3] Ashifa, K. M. (2020a). Effect of substance abuse on physical health of adolescents. *European Journal of Molecular & Clinical Medicine*, 7(2), 3155–3160.
- [4] Ashifa, K. M. (2021a). Analysis on the determinants of health status among tribal communities. *Journal of Cardiovascular Disease Research*, 12(3), 531–534.
- [5] Ashifa, K. M. (2022). A situation analysis of the social well-being of elderly during the COVID-19 pandemic. *International Journal of Health Sciences*, 6(3), 10156–10163.
- [6] Devi, M., Manokaran, D., Sehgal, R. K., Shariff, S. A., & Vettriselvan, R. (2025). Precision medicine, personalized treatment, and network-driven innovations: Transforming healthcare with AI. In *AI for large scale communication networks* (pp. 303–322). IGI Global.
- [7] Elkin, N., Mohammed, A. K., Kılınçel, Ş., Soydan, A. M., Tanrıver, S. Ç., Çelik, Ş., & Ranganathan, M. (2025). Mental health literacy and happiness among university students. *Frontiers in Psychiatry*, 16, 1541316.
- [8] Gayathri, R. K., Vettriselvan, R., Rajesh, D., Balakrishnan, R., Kumar, R., & Kavitha, J. (2025a). Striking a balance: Mental health challenges and work-life integration among women faculty in Indian B-Schools. *Texila International Journal of Public Health*, 13(2).
- [9] Gayathri, R. K., Vettriselvan, R., Rajesh, D., Balakrishnan, R., Kumar, R., & Kavitha, J. (2025b). Strategic role of human resource management in enhancing occupational health and safety practices in business schools in India. *Texila International Journal of Public Health*, 13(2).
- [10] Jenifer, R. D., Vettriselvan, R., Saxena, D., Velmurugan, P. R., & Balakrishnan, A. (2025). Green marketing in healthcare advertising: A global perspective. In *AI impacts on branded entertainment and advertising* (pp. 303–326). IGI Global.
- [11] Kariveliparambil, A., Rasi, R. A., Ahmad, M. S., Öztaş, N., & Ayan, F. S. (2026a). Evolving social capital in indigenous communities. *Journal of Social Service Research*, 52(1), 147–166.
- [12] Kariveliparambil, A., R. A., R., Ahmad, M. S., Ramesh, S., & Kuriakose, A. (2026b). Invisible burdens of platform work: A qualitative study of food-delivery riders' lived experiences in urban India. *International Journal of Qualitative Studies on Health and Well-Being*, 21(1).
- [13] Kombo, D. K., & Tromp, D. L. A. (2014). *Proposal and thesis writing: An introduction*. Paulines Publications Africa.
- [14] Meena, G., Vettriselvan, R., Rajesh, D., & Velmurugan, P. R. (2025). Diversity and inclusion: Harnessing the power of inclusivity for business success. In *Security and strategy models for key-solving institutional frameworks* (pp. 203–234). IGI Global Scientific Publishing.
- [15] Mohanbabu, S., & Vettriselvan, R. (2025a). Focusing supply chain and container terminal challenges from the lens of Indian industries' perspectives. *International Journal of Procurement Management*, 24(1), 92–114.
- [16] Mohanbabu, S., & Vettriselvan, R. (2025b). Will machine learning resolve the issues in container management in ports and logistics industries? *International Journal of Process Management and Benchmarking*, 20(4), 559–575.
- [17] Orodho, J. A., & Kombo, D. K. (2012). *Research methods*. Kenyatta University Press.
- [18] Rajeswari, M., Rohini, V., Sathya Aarthi, R., Rameshkumar, V. P., & Arul Krishnan, S. (2026). Blockchain 2.0 for secure, transparent, and autonomous logistics systems. In R. Vettriselvan & N. Suresh (Eds.), *Intelligent motion control for human-centered systems* (pp. 233–258). IGI Global Scientific Publishing.
- [19] Ranganathan, M., Jacob, A., Ashifa, K. M., Kumar, G. J., Anthony, M., Vijay, M., & Kumari, R. B. (2024). An investigation of the effects of chronic stress on attention in parents of children with neurodevelopmental disorders. *Universal Journal of Public Health*, 12(1), 37–50.
- [20] Shanthi, H. J., Gokulakrishnan, A., Sharma, S., Deepika, R., & Swadhi, R. (2025). Leveraging artificial intelligence for enhancing urban health: Applications, challenges, and innovations. In *Nexus of AI, climatology, and urbanism for smart cities* (pp. 275–306). IGI Global.
- [21] Swadhi, R., Gayathri, K., Suresh, N. V., Catherine, S., & Velmurugan, P. R. (2025a). Leveraging machine learning for enhanced patient engagement and outcomes. In *Impact of digital transformation on business growth and performance* (pp. 313–340). IGI Global Scientific Publishing.
- [22] Swadhi, R., Velmurugan, P. R., Gayathri, K., & Catherine, S. (2025b). Evolving critical themes in advanced human resource management. In *Critical aspects in advanced human resource management* (pp. 75–102). IGI Global Scientific Publishing.
- [23] Vasantha, S., Swadhi, R., Gayathri, K., Selvalakshmi, V., & UmaDevi, A. (2025). Fostering personalized learning and achieving equity in education: The role of AI-powered curriculum development. In *Transforming education with AI-powered personalized learning* (pp. 201–236). IGI Global Scientific Publishing.
- [24] Venice, J. A., Arivazhagan, D., Suman, N., Shanthi, H. J., & Swadhi, R. (2025a). Recommendation systems and content personalization: Algorithms, applications, and adaptive learning. In *AI for large scale communication networks* (pp. 323–348). IGI Global Scientific Publishing.
- [25] Venice, J. A., Vettriselvan, R., Jain, S., Madusudanan, K., & Aarth, C. C. J. (2025b). Performance evaluation and metrics in blockchain powered AI/ML: Data analytics for cognitive Internet of Things (CIoT). In *Transforming education with AI-powered personalized learning* (pp. 143–178). IGI Global Scientific Publishing.
- [26] Venice, J. A., Vettriselvan, R., Rajesh, D., Suresh, N. V., & Abirami, P. (2025c). Enabling personalized learning and adaptive systems through strategic management. In *Bridging academia and industry through cloud integration in education* (pp. 49–72). IGI Global Scientific Publishing.

- [27] Venice, J. A., Vettriselvan, R., Rajesh, D., Xavier, P., & Shanthi, H. J. (2025d). Optimizing performance metrics in blockchain-enabled AI/ML data analytics. In *Enhancing automated decision-making through AI* (pp. 97–122). IGI Global.
- [28] Venice, J. A., Sripathi, S. K., & Moonga, B. (2025e). Social deviance and the influence of internet exposure: A study of secondary school students in Lusaka. *ASET Journal of Management Science*, 4(SI-1).
- [29] Venice, J. A. A., Jio, W., Kant, S., Sharda, S., & Mittal, S. (2025f). Ethical leadership effect on the regulation of AI in cyber security. In *Ethical challenges of AI and warfare* (pp. 133–152). IGI Global Scientific Publishing.
- [30] Venice, J. A. A., Muthuraman, M., Kant, S., & Mittal, S. (2026). Community engagement effect on school leadership through digital volunteerism. In *Strengthening community engagement and school leadership through digital volunteerism* (pp. 85–114). IGI Global Scientific Publishing.
- [31] Vettriselvan, R. (2025). Harnessing innovation and digital marketing in the era of industry 5.0. In *The future of small business in industry 5.0* (pp. 163–186). IGI Global.
- [32] Vettriselvan, R., & Anto, M. R. (2018). Pathetic health status and working condition of Zambian women. *Indian Journal of Public Health Research & Development*, 9(9), 259–264.
- [33] Vettriselvan, R., & Rajan FSA, A. J. (2019). Occupational health issues faced by women in spinners. *Indian Journal of Public Health Research & Development*, 10(1).
- [34] Vettriselvan, R., Deepan, A., Jaiswani, G., Balakrishnan, A., & Sakthivel, R. (2025a). Health consequences of early marriage: Examining morbidity and long-term wellbeing. In *Social, political, and health implications of early marriage* (pp. 189–212). IGI Global.
- [35] Vettriselvan, R., Velmurugan, P. R., Varshney, K. R., EP, J., & Deepika, R. (2025b). Health impacts of smartphone and internet addictions across age groups. In *Impacts of digital technologies across generations* (pp. 187–210). IGI Global.
- [36] Vettriselvan, R., Velmurugan, P. R., Suresh, N. V., & Catherine, S. (2025c). Strategies, best practices, and pitfalls in the era of digital transformation. In *Impact of digital transformation on business growth and performance* (pp. 67–98). IGI Global Scientific Publishing.
- [37] Vettriselvan, R., Selvi, K., Kumar, A. S., Ranjani, R. D., & Varshney, K. R. (2025d). Ranking methodologies: Criteria and controversies in global higher education. In *Global university ranking systems: Methodologies, impact, and repercussions* (pp. 109–140). IGI Global Scientific Publishing.
- [38] Vettriselvan, R., Ramya, R., Selvalakshmi, V., Jyothi, P., & Velmurugan, P. R. (2026a). Empowering patients through knowledge: Educational strategies in rehabilitation. In *Holistic approaches to health recovery* (pp. 263–290). IGI Global Scientific Publishing.
- [39] Vijayalakshmi, M., Subramani, A. K., Vettriselvan, R., Catherin, T. C., & Deepika, R. (2025a). Sustainability and responsibility in the digital era: Leveraging green marketing in healthcare. In *Digital citizenship and building a responsible online presence* (pp. 285–306). IGI Global.
- [40] Vijayalakshmi, M., Subramani, A. K., Vettriselvan, R., Velmurugan, P. R., & Hasine, J. (2025b). Strategic collaborations in medical innovation and AI-driven globalization. In *Navigating strategic partnerships for sustainable startup growth* (pp. 85–110). IGI Global.
- [41] Vinodh, N., Subramani, A. K., & Vettriselvan, R. (2026a). Navigating ethics, society, and governance in the digital age. In *Ethics, justice, and governance in the age of AI and digital societies* (pp. 1–26). IGI Global Scientific Publishing.
- [42] Vinodh, N., Subramani, A. K., & Vettriselvan, R. (2026b). Transforming the future of management and medical education: AI-driven innovations in curriculum design. In *AI education strategies for future-proofing curriculum design* (pp. 459–476). IGI Global Scientific Publishing.
- [43] Zahoor, H., Mustafa, N., Ashifa, K. M., Safaei, M., & El Gamil, R. (2025). Unlocking resilience: Emotional intelligence and self-leadership shape stress perception among health students. *International Journal of Innovation and Learning*, 38(4), 395–419.