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Review Article

ECDE Schools and Teachers Preparedness for Digital Integration under Competency Based Education in Kenya: A Systematic Review

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Abstract

The transition from Kenya's 8-4-4 system to the Competency-Based Education (CBE) framework has established digital literacy as a core pillar, mandating ECDE centers to evolve from traditional rote learning toward technology-mediated instruction. Despite the ambitious goals of the National ICT Strategy, a significant gap remains between policy formulation and classroom reality. Without a clear understanding of the level of institutional and teachers' preparedness, the promise of CBE risks being unfulfilled, potentially widening the inequality gap between well-resourced and marginalized schools. The study was anchored on the Unified Theory of Acceptance and Use of Technology (UTAUT) and the TPACK framework, utilizing a systematic review design guided by PRISMA protocols. A comprehensive search was conducted across Scopus, Web of Science, PubMed, Wiley Online Library, SpringerLink, ScienceDirect, Google Scholar, ERIC, African Journals Online, and university repositories, utilizing Boolean-refined keyword strings to source peer-reviewed studies and policy reports (2017–2026) for thematic analysis. The results reveal a profound disconnect between policy and practice. Digital infrastructure remains severely limited, with only 13.3% of ECDE centres possessing computers and over 86% entirely without such hardware. Internet connectivity affects merely 21% of public schools, dropping to 13% in rural and Arid and Semi-Arid Lands regions. Power supply ranges from 60% to 94% across regions, with over 50% of ECDE centres lacking adequate learning spaces. Software and digital content relevancy presents significant challenges, with 64% of schools reporting inadequate CBC-aligned digital content and less than 30% of Kenyan languages digitally

represented. Teacher digital competencies demonstrate moderate levels, with 68% possessing basic digital skills but only 42% effectively integrating tools into pedagogy. Self-efficacy shows strong correlations with implementation success, yet training adequacy correlates weakly with actual integration. Professional development programmes have reached over 291,000 teachers nationally, but 66.4% lack in-service ICT training and 62.3% report training inappropriateness for classroom application. Pedagogical integration remains partial, with 61% employing learner-centered approaches but only 35% aligning digital tools with lesson objectives. School leadership emerges as a critical determinant, with transformational leadership explaining significant variance in ICT integration success, though systemic governance deficiencies constrain operational capacity across 61% of institutions facing teacher shortages and 60% lacking adequate learning materials. The review concludes that digital integration in ECDE remains in a nascent stage, constrained by resource deficits and weak alignment between pedagogy and technology. Recommendations include adopting TPACK-based training, increasing budgetary allocations for localized digital content and promoting public-private partnerships to enhance school infrastructure.

Keywords: ECDE, Digital Integration, Competency-Based Education (CBE), Teacher Preparedness, Digital Literacy, Kenya Education Reforms

Introduction

Early Childhood Development and Education (ECDE) includes a comprehensive range of programs and services designed to support children's cognitive, social, emotional and physical development from birth through age five (Kitsao-Wekulo et al., 2023; Iruka, 2025). Research demonstrates that brain development during this period is more aggressive than at any other point in a person's life, with a newborn's brain growing to approximately 80% of adult size by age three and 90% by age five (Cognia, 2021). The National Research Council confirms that the quality of environment, interactions, and teachers during these formative years fundamentally shapes neural connections that persist throughout life (Cognia, 2021). Globally, digital integration in early childhood education has gained significant policy and research attention as countries shift toward competency-based and technology-supported learning systems. UNESCO (2021) emphasize that early exposure to digital tools supports foundational skills such as problem-solving, creativity and collaboration, which align with 21st-century competencies). International bodies such as UNESCO and UNICEF emphasize that digital literacy must begin in the formative years to bridge the AI divide and prepare children for a world increasingly defined by automation and digital connectivity (UNESCO, 2025). Research indicates that digital learning environments can improve

engagement and early literacy outcomes when supported by appropriate pedagogy and continuous teacher training (Dong et al., 2020).

Empirical research conducted across developed nations has established evidence supporting the cognitive and academic benefits of digital integration in early childhood education, particularly when implemented through well-designed, developmentally appropriate applications. A meta-analysis by Kim et al. (2021), synthesizing findings from 36 rigorous experimental and quasi-experimental studies involving 285 effect sizes, demonstrated that educational apps produce a mean weighted effect size of +0.31 standard deviations on overall achievement in literacy and mathematics for children from preschool through Grade 3, with effects being significantly larger for preschool-aged children compared to kindergarten through third-grade students. This finding was corroborated by a randomized controlled trial conducted in the United Kingdom, where children aged 4–5 years using interactive math apps for 30 minutes daily over 12 weeks showed learning gains equivalent to 3–4 months of additional mathematical development compared to standard classroom practice, with particularly pronounced benefits for low-achieving children who demonstrated effect sizes of 4.03 standard deviations (Outhwaite et al., 2019). Research from South Korea further elucidates how individual learning behaviors moderate digital literacy outcomes, finding that children with higher competence motivation and strategic learning approaches derive significantly greater benefits from home digital resources, suggesting that digital access alone is insufficient without supportive pedagogical scaffolding (Moon, 2025). A comprehensive systematic review of 35 international studies by Griffith et al. (2020) confirmed that interactive educational apps show the strongest evidence for supporting early mathematics skills, followed by language and literacy development including phonological awareness, letter knowledge, and vocabulary acquisition. Furthermore, research examining game-based literacy applications with 500 preschoolers demonstrated that specifically designed apps can successfully support literacy competency development across diverse socioeconomic and migration backgrounds, with moderate usage of approximately 30 minutes per week showing optimal benefits, particularly for girls (Schiele, 2025).

However, studies conducted in Europe, Asia, and North America show that many ECDE centers and households still face shortages of devices, unreliable internet connectivity, and inadequate technical support. For example, research by Acoba-Rivera (2025) reports that insufficient access to digital tools and poor connectivity significantly hinder effective technology use in early childhood classrooms. Similarly, Adela et al. (2025) found that in several education systems, student-to-device ratios remain high, which restricts meaningful engagement with digital content. These findings show that infrastructure gaps persist even in relatively well-resourced contexts and continue to affect equitable access to digital learning opportunities.

Another major challenge relates to teacher preparedness and digital pedagogical competence. Evidence shows that many ECDE teachers lack the skills required to integrate digital tools into developmentally appropriate teaching practices. Acoba-Rivera (2025) notes that teachers often struggle to align digital technologies with play-based and learner-centered pedagogies, resulting in superficial or ineffective use. In addition, Memari and Ruggles (2025) found that educators face difficulties in adapting to emerging technologies such as artificial intelligence due to limited training and lack of pedagogical guidance. These findings indicate that teacher competence remains a central determinant of successful digital integration in ECDE. Furthermore, infrastructure constraints and inequitable access to devices continue to widen the digital divide, particularly in low- and middle-income settings, despite international commitments to inclusive and equitable quality education under Sustainable Development Goal 4 (UNESCO, 2021).

Across Africa, efforts to integrate digital technologies into early childhood education have expanded, driven by increasing mobile connectivity and education sector reforms. Governments and development partners have introduced ICT-based learning platforms and digital literacy initiatives targeting foundational education. In South Africa, Mampane and Mampane (2025) conducted a comprehensive assessment of lecturer preparedness and student willingness to integrate academic e-portfolios in early childhood education higher education institutions, finding that lecturer preparedness encompasses digital literacy, assessment competency, and reflective mentoring skills, though significant gaps persist between policy expectations and institutional capacity due to financial constraints, data costs, and absence of standardized national policies. Their research further demonstrates that South African students' willingness to engage with digital tools depends on perceived usefulness, self-efficacy, and professional identity formation, while a pronounced urban-rural digital divide leaves rural students facing substantial barriers to access despite urban connectivity advantages. Research by Ogegbo and Aina (2020) indicates that early childhood development teachers generally possess a positive mindset and understand the strategic advantages of incorporating technology into the early years. However, despite this favorable attitude, the actual level of Information and Communication Technology (ICT) acceptance remains low. Teachers cite significant barriers to integration, including minimal parental and school support, a lack of essential technological resources, and a critical deficiency in practical training regarding developmentally appropriate technology for young children (Ogegbo & Aina, 2020). Similarly, a study by Mathebula et al. (2025) in the Tshwane West District found that while educators continue to acknowledge the pedagogical benefits of ICT, integration efforts are frequently derailed by institutional and technical hurdles. Specifically, insufficient training in pedagogical applications prevents teachers from moving beyond basic administrative use toward meaningful classroom engagement. These efforts are further complicated

by limited access to digital tools, unreliable internet connectivity, and a general lack of institutional support, which collectively stall the progress of digital integration in primary school settings (Mathebula et al., 2025). A systematic review of parental involvement in ECE across Sub-Saharan Africa by Mwoma and colleagues (2025) identified barriers including low levels of education, low socio-economic status and cultural challenges that limit parental capacity to support digital learning.

The transition from the traditional 8-4-4 system to the Competency-Based Curriculum (CBC) in 2017 marked a paradigm shift in Kenya's education sector. Unlike the previous rote-learning model, CBC often referred to as Competency-Based Education (CBE) prioritizes the acquisition of 21st-century skills, with digital literacy standing as one of its seven core pillars following earlier initiatives including the Kenya National ICT Policy (2006) and the Digital Literacy Programme (DLP) which sought to provide tablets to all grade one learners in public primary schools (Murithi & Yoo, 2021). At the Early Childhood Development and Education (ECDE) level, this integration is particularly critical, as it seeks to introduce learners aged 4 to 5 years to technology in a manner that is developmentally appropriate and foundationally sound for future academic success. However, the implementation of digital integration at the ECDE level faces unique structural challenges. Since the 2010 Constitution, ECDE has been a devolved function managed by the 47 county governments, while the national government retains control over curriculum development through the Kenya Institute of Curriculum Development (KICD). This dual governance has led to significant disparities in resource allocation. While some counties like Kirinyaga and Makueni have pioneered structured digital learning programs and equipped centers with ICT devices, many rural and marginalized areas continue to struggle with a lack of basic infrastructure, such as electricity, internet connectivity, and adequate learner devices. Murithi and Yoo (2021) conducted a large-scale survey of 532 public primary schools across Kenya, finding that 87.7% lacked internet connectivity, approximately 70% lacked projectors, and 80% of classrooms lacked necessary electrical infrastructure such as sockets and extension cables, despite government investments in digital infrastructure. Their study established that 77.7% of teachers had basic computer skills from pre-service training, yet 66.4% had not participated in in-service professional development for technology integration, and critically, 58.4% could not plan and integrate technology into their lessons, indicating that training focused predominantly on technical skills rather than pedagogical application (Murithi & Yoo, 2021).

The COVID-19 pandemic exposed and exacerbated existing weaknesses in Kenya's digital preparedness for ECE, forcing rapid adaptation that revealed systemic vulnerabilities. A study by Makudiuh and Ongeti (2019) in Busia County found that most ECDE centres lacked adequate teaching and learning materials, including ICT facilities, which constrained implementation of modern instructional approaches. The study established that resource inadequacy affected both teaching

quality and curriculum delivery. Similarly, Yussuf (2022) reported that many ECDE centres in Wajir County lacked electricity and basic infrastructure required to support ICT integration, particularly in marginalized regions. These findings indicate that infrastructure deficits remain a primary barrier to digital integration in ECDE.

Teacher preparedness emerges as the most critical variable determining digital integration success in Kenyan ECE contexts, with empirical studies consistently revealing capability gaps that undermine policy objectives. Murithi and Yoo (2021) found that despite government initiatives, only 70,000 out of over 300,000 teachers had received training by 2018, with most receiving only basic computer literacy rather than pedagogical ICT integration skills, while age and gender differences showed teachers in their 40s demonstrating higher perception of ICT usefulness than those in their 30s, suggesting that experience moderates technology acceptance. The phenomenon of "technophobia" among older teachers and the perception of ICT as time-consuming additional workload have been identified as persistent barriers, with the training cascade model where limited numbers of trained teachers are expected to train colleagues proving ineffective and resulting in low overall preparedness (Murithi & Yoo, 2021). Similarly, Oyieno et al. (2024) found that although digital competence significantly influenced instructional effectiveness among ECDE teachers, many teachers lacked adequate skills to utilize digital tools effectively. The study reported that limited exposure to ICT training reduced teachers' ability to integrate technology into language instruction. In addition, Okewa (2017), in a thesis on ECDE teacher performance in Kisumu County, identified lack of professional development opportunities as a major constraint, noting that inadequate training limited teachers' preparedness for new curriculum demands. These findings show that teacher capacity gaps continue to hinder digital integration under competency-based education.

Empirical evidence also highlights parental and household-related challenges affecting digital integration. Komen and Ongínjo (2024) found that many parents lacked digital literacy skills and access to ICT tools, which limited their ability to support children's learning at home. The study further established that low parental involvement in ICT-based learning disproportionately affected learners from less educated and low-income households. This suggests that digital integration in ECDE is not only a school-level issue but also depends on household capacity and socio-economic conditions.

Another significant challenge is weak institutional and policy implementation at the county level. Studies show that devolution of ECDE management has led to disparities in resource allocation and implementation capacity. Okewa (2017) reported that poor working conditions, inadequate funding, and staffing shortages at the county level negatively affected ECDE service delivery. Similarly, Makudiuh and Ongeti (2019) noted that lack of coordinated planning and insufficient support from local authorities limited effective implementation of ECDE

programs, including digital initiatives. These findings indicate that governance and institutional capacity gaps undermine digital integration efforts.

The literature further identifies inadequate instructional materials and misalignment with pedagogy as a challenge. Makudiuh and Ongeti (2019) observed that ECDE centres relied heavily on traditional teaching methods due to lack of appropriate digital content and tools. Oyieno et al. (2024) also found that even where digital tools were available, teachers struggled to integrate them into learner-centered approaches required under CBC. This reflects a disconnect between technology availability and pedagogical application in ECDE settings.

Additionally, socio-economic inequalities and regional disparities significantly affect digital integration. Yussuf (2022) demonstrated that arid and semi-arid regions face more severe infrastructure and resource constraints compared to urban areas. Komen and Ongínjo (2024) further showed that disparities in parental education and income levels influence access to ICT tools and support for learners. These inequalities contribute to uneven implementation of digital learning across ECDE centres in Kenya. Given that early childhood represents a foundational developmental period where digital literacy habits and pedagogical approaches are established, the lack of comprehensive assessment regarding ECDE schools' and teachers' readiness for digital integration under competency-based education represents a significant research and policy oversight that threatens Kenya's educational quality and equity goals.

Theoretical Framework

This study was guided by Technological Pedagogical Content Knowledge (TPACK) framework and complemented by the Unified Theory of Acceptance and Use of Technology (UTAUT).

Technological Pedagogical Content Knowledge (TPACK) framework

Developed by Mishra and Koehler in 2006, this framework extends Shulman's (1986) seminal work on Pedagogical Content Knowledge (PCK) by incorporating technology as a third critical dimension of teacher knowledge (Mishra & Koehler, 2006). The TPACK framework posits that effective technology integration in education requires more than merely adding technological tools to existing pedagogical approaches; rather, it demands a sophisticated understanding of the dynamic, transactional relationships between three core knowledge domains: Content Knowledge (CK), Pedagogical Knowledge (PK) and TPACK framework lies the recognition that these three knowledge domains do not exist in isolation but interact to form four additional intersecting knowledge types. Technological Content Knowledge (TCK) refers to understanding how technology can influence and transform disciplinary content, including which specific technologies are best suited for representing particular subject matter concepts (Mishra & Koehler, 2006).

Technological Pedagogical Knowledge (TPK) involves comprehending how various technologies can support or constrain specific pedagogical approaches, as well as understanding the affordances and limitations of different technological tools for teaching and learning. Pedagogical Content Knowledge (PCK), originally conceptualized by Shulman, represents the specialized knowledge of how to teach specific subject matter content, including knowledge of students' prior conceptions, common misconceptions, and effective instructional strategies for particular topics. The pinnacle of the framework, Technological Pedagogical Content Knowledge (TPACK), represents the integrated understanding of how technology, pedagogy, and content interact to produce effective teaching with technology in specific contexts.

The significance of the TPACK framework extends beyond its theoretical contributions to practical applications in teacher education and professional development. Koehler and Mishra (2009) emphasize that TPACK is inherently context-bound, meaning that effective technology integration varies across different educational settings, student populations, and subject matter domains. This contextual sensitivity distinguishes TPACK from more technocentric approaches that assume universal solutions for technology integration. Teachers possessing strong TPACK capabilities demonstrate flexibility in adapting their technological, pedagogical, and content knowledge to meet diverse learning objectives and student needs. Furthermore, the framework has informed the design of numerous teacher preparation programs and assessment instruments aimed at measuring and developing educators' technology integration competencies (Chai et al., 2013).

Despite its widespread adoption in educational research and practice, the TPACK framework has faced several critiques and challenges. Some scholars have questioned the measurability of TPACK as a construct, noting difficulties in assessing the complex interactions between its component knowledge domains (Cox & Graham, 2009). Others have argued that the framework may insufficiently address the sociocultural and institutional contexts that shape technology integration in schools, including issues of access, equity, and organizational support (Rosenberg & Koehler, 2015). This study applies the framework to investigate the instructional disconnect where teachers may possess devices but lack the integrated Technological Pedagogical Knowledge (TPK) required to facilitate learner-centered, interactive experiences.

Unified Theory of Acceptance and Use of Technology (UTAUT)

The Unified Theory of Acceptance and Use of Technology (UTAUT), developed by Venkatesh, Morris, Davis, and Davis in 2003, represents a comprehensive theoretical model that synthesizes elements from eight prominent information technology acceptance models to explain user intentions to use

technology and subsequent usage behavior. The theory integrates components from the Theory of Reasoned Action, Technology Acceptance Model, Motivational Model, Theory of Planned Behavior, Combined TAM and TPB, Model of PC Utilization, Diffusion of Innovations Theory, and Social Cognitive Theory, resulting in a unified framework with four core constructs: performance expectancy, effort expectancy, social influence, and facilitating conditions (Venkatesh et al., 2003). Performance expectancy refers to the degree to which users believe that using a system will enhance their job performance, while effort expectancy encompasses the perceived ease of use associated with the technology. Social influence involves the extent to which users perceive that important others believe they should use the system, and facilitating conditions represent the degree to which users believe that organizational and technical infrastructure supports system use. The model also incorporates four moderating variables such as gender, age, experience, and voluntariness of use that influence the strength of relationships between these constructs and behavioral intention or actual usage.

The Unified Theory of Acceptance and Use of Technology (UTAUT) has demonstrated strong explanatory power, accounting for approximately 70% of the variance in usage intention (Venkatesh et al., 2003). It has been widely applied across healthcare, mobile banking, e-learning and organizational settings (Williams et al., 2015). Its extension, UTAUT2, incorporated hedonic motivation, price value and habit to explain consumer technology acceptance (Venkatesh et al., 2012). However, concerns remain regarding its complexity and inconsistent construct operationalization (Bagozzi, 2007). In this study, UTAUT provided a framework for examining the behavioral and institutional factors influencing ECDE teachers' adoption of digital tools under CBC, particularly performance expectancy, social influence from school leadership and the Ministry of Education, and facilitating conditions relating to infrastructure and access to digital resources.

Methodology

This review employed a systematic literature review methodology to evaluate Early Childhood Development Education (ECDE) schools and teachers' preparedness for digital integration under Kenya's Competency-Based Education (CBE) framework. The systematic approach was selected to ensure transparency, replicability and comprehensiveness in identifying, appraising and synthesizing relevant empirical evidence. The review adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, adapted for narrative synthesis given the heterogeneity of study designs and outcomes in the existing literature.

A comprehensive search strategy was developed to identify relevant literature published between 2017 and 2026. The year 2017 was selected as the lower boundary because it marks the full implementation of the Competency-Based

Curriculum in Kenya, rendering earlier studies less relevant to the current policy context. The search strategy employed a combination of controlled vocabulary and free-text terms across multiple electronic databases.

The following databases were systematically searched: Scopus, Web of Science, PubMed, Wiley Online Library, SpringerLink, ScienceDirect, Google Scholar, ERIC, African Journals Online, and the Kenya Education Cloud repository. Additional searches were conducted on institutional repositories including the University of Nairobi Digital Repository, Strathmore University Repository, and the Kenya Institute of Curriculum Development publications database. Grey literature was sourced from the Ministry of Education, Teachers Service Commission, and ICT Authority Kenya reports.

The search string combined three conceptual domains using Boolean operators: (1) population terms ("early childhood education" OR "ECDE" OR "pre-primary" OR "foundation phase" OR "early years education"); (2) intervention terms ("digital integration" OR "ICT integration" OR "digital literacy" OR "technology integration" OR "digital learning devices"); and (3) context terms ("Kenya" OR "Competency-Based Curriculum" OR "CBC" OR "Competency-Based Education"). The search was conducted in English, reflecting the primary language of academic publication in Kenya.

Studies were included if they met the following criteria: (1) focused on public or private ECDE institutions in Kenya; (2) examined teacher preparedness, school readiness, or digital infrastructure for technology integration; (3) were published in peer-reviewed journals, institutional reports, or doctoral dissertations; (4) employed empirical research methods (quantitative, qualitative, or mixed-methods); and (5) were published between January 2017 and February 2025.

Exclusion criteria comprised: (1) studies conducted outside Kenya or focusing exclusively on non-ECDE levels without ECDE-specific data; (2) opinion pieces, editorials, or non-empirical commentaries; (3) studies examining digital integration in non-educational contexts; (4) publications in languages other than English; and (5) duplicate publications or multiple reports of the same study population.

During the screening phase, two independent reviewers examined titles and abstracts against the inclusion criteria. Full-text articles were obtained for all records meeting criteria or where eligibility was uncertain. In the eligibility phase, full-text articles were assessed for final inclusion, with disagreements resolved through discussion and consensus or consultation with a third reviewer when necessary.

A standardized data extraction form was developed and piloted on five randomly selected studies to ensure consistency and comprehensiveness. The form captured: (1) bibliographic information (author, year, publication type); (2) study characteristics (design, setting, sample size, participant demographics); (3) methodological approach (sampling strategy, data collection instruments, analytical

techniques); (4) key findings related to digital infrastructure, teacher competencies, training programs, and implementation barriers; and (5) reported limitations and recommendations.

Quantitative studies were evaluated using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Analytical Cross-Sectional Studies (Munn et al., 2020). Qualitative studies were assessed using the JBI Critical Appraisal Checklist for Qualitative Research. Mixed-methods studies were evaluated using the Mixed Methods Appraisal Tool (MMAT) version 2018.

Quality assessment considered: (1) clarity of research objectives; (2) appropriateness of study design; (3) sampling strategy and representativeness; (4) validity and reliability of measurement instruments; (5) rigor of data analysis; (6) management of confounding variables; and (7) clarity of findings and conclusions. Studies were not excluded based on quality scores; rather, quality assessments informed the weighting of evidence during synthesis and the interpretation of findings.

As this review analyzed publicly available secondary data, formal ethical approval was not required. However, ethical principles of research integrity were maintained throughout, including accurate representation of original findings, proper attribution of sources, and transparent reporting of limitations. Particular attention was paid to avoiding misrepresentation of contextual factors affecting digital integration in resource-constrained settings.

Results and Discussion

The systematic review identified 48 eligible studies published between 2017 and 2025 examining ECDE digital preparedness under Kenya's Competency-Based Curriculum. The findings are organized into key thematic areas including digital infrastructure, teacher competencies, professional development, school leadership and policy implementation.

Digital Infrastructure and Resource Availability

This review synthesizes Kenyan studies examining digital infrastructure and resource availability across four critical dimensions: computing devices and hardware, connectivity and internet access, power supply and physical facilities, and software and digital content relevancy.

(i) Availability of Computing Devices and Hardware

The scarcity of computing devices represents the most pervasive barrier to digital integration in Kenyan ECDE centers. While the National Government's Digital Literacy Programme (DLP) successfully distributed over 1.2 million devices to primary schools, research by Otieno et al. (2024) reveals that these distributions largely bypassed the Early Childhood Development and Education (ECDE) sections.

Because ECDE is a devolved function under the 47 County Governments, hardware procurement depends on fluctuating county budgets rather than national ministry allocations. This has led to a "policy silo" effect where Grade 1 learners may have access to tablets, while PP1 and PP2 learners in the same school compound are left without dedicated tools. Empirical evidence from Kenya shows that availability of computing devices and hardware in ECDE centres remains limited and uneven across regions. A national needs assessment conducted by Kenya Institute of Curriculum Development found that only 13.3% of ECDE centres had computers, 4.2% had laptops, and 3.3% had tablets, while over 86% lacked computers entirely. A related report further established that 96.7% of centres lacked tablets and projectors, and 95.8% lacked laptops, pointing to widespread shortages of digital hardware required to support competency-based learning approaches (Kenya Institute of Curriculum Development, 2017). These findings indicate that most ECDE centres operate without the basic technological infrastructure needed for effective digital integration. Recent national data shows that limited access to computing devices extends beyond schools into households, which directly affects ECDE learners' exposure to digital technologies.

A joint survey by the Communications Authority of Kenya and the Kenya National Bureau of Statistics reported that only 17.6% of households owned computers, with ownership dropping to 1.4% among households without electricity (Communications Authority of Kenya, 2024). Similarly, KICTANet reported that only 10.7% of households had computers, with rural access as low as 7.3% (KICTANet, 2025). These figures show that most learners have minimal interaction with computing devices both at school and at home, limiting early digital literacy development. At the county level, initiatives introduced between 2025 and 2026 show gradual progress in expanding access to digital devices, though coverage remains insufficient relative to learner populations. In Kilifi County, the distribution of 1,600 tablets across 812 ECDE centres serving approximately 62,000 learners reflects efforts to improve access, but the device-to-learner ratio remains low (Education News, 2025). In Elgeyo Marakwet County, implementation data indicates a sharing ratio of about 1 device per 23 learners, which restricts individualized use and limits meaningful integration into classroom practice (Kenya News Agency, 2025). Similar trends are observed in Nakuru and Kirinyaga counties, where ICT integration programmes are ongoing but have not yet achieved universal device coverage. Further evidence from West Pokot County shows that partnerships can help expand access, as seen in the distribution of 627 digital devices to ECDE centres in 2026. However, such interventions remain partial and localized, and they do not fully address the broader national shortfall in computing infrastructure (Education News, 2026). Overall, the evidence indicates that while recent initiatives show progress, availability of computing devices in ECDE centres remains low, with high learner-to-device ratios and significant disparities across regions.

(ii) Connectivity and Internet Access

Empirical research conducted in Kenya between 2017 and 2026 consistently demonstrates that internet connectivity serves as a critical determinant of successful ICT integration in early childhood and primary education, though significant disparities persist across regions and institutional contexts. Internet connectivity is essential for accessing the Kenya Education Cloud and other CBC digital resources. However, the results show that only approximately 21% of public schools have reliable internet connectivity (Sensei Institute, 2025). In rural and Arid and Semi-Arid Lands (ASAL) such as Mandera and Marsabit, internet penetration is as low as 13%, compared to 42% in urban centers like Nairobi and Kisumu (ChildFund Alliance, 2025). Most ECDE teachers rely on personal mobile data to download CBC teaching aids, as schools rarely provide institutional Wi-Fi or data stipends. Shikomera, Mulwa, and Mwania (2023) investigated the influence of internet connectivity on ICT integration among teachers in public primary schools in Kakamega County, finding that schools with stable internet reported significantly higher ICT integration rates, with over 70% of teachers in connected schools using online resources regularly. This finding establishes a direct causal relationship between internet connectivity and effective ICT integration in teaching practice. Extending this research, Shikomera (2024) examined broader factors influencing ICT integration among teachers and headteachers in Kakamega County, identifying limited connectivity as a major barrier to digital adoption while confirming that schools with reliable internet demonstrated substantially higher digital tool usage rates, thereby reinforcing connectivity as a key determinant of effective ICT utilization. Regional studies across Kenya corroborate these findings while highlighting persistent connectivity challenges. Karimi (2024) assessed the extent of ICT integration in teaching Geography in secondary schools in Tharaka Nithi County, reporting that schools experienced inconsistent internet access, which resulted in low integration levels particularly in poorly connected institutions, suggesting that weak connectivity specifically limits subject-specific digital integration. Similarly, Oichoe (2018) investigated ICT integration and accessibility in secondary schools in Kenyenya Sub-County, Kisii County, finding that while internet access existed in some form, its irregular nature and limited frequency of use negatively affected learning outcomes, thereby emphasizing that reliable internet access is required for consistent and effective ICT use. These regional disparities are further contextualized by baseline assessments; Kiptalam (2017) assessed internet utilization across 11 secondary schools nationally, revealing that only approximately 3% of schools had internet connectivity, though usage rates were significantly higher in connected schools, indicating that while internet access remains limited, its impact is highly consequential where available. National-level assessments and policy evaluations reveal both progress and persistent gaps in school connectivity infrastructure.

A study conducted at Mogeni (2020) examined ICT integration in NEPAD e-schools across Kenya, finding that the majority of schools lacked reliable internet access, with ICT use occurring less than once per month in many cases, concluding that limited internet access severely restricts digital learning opportunities. The Elimu Yetu Coalition (2024) conducted a comprehensive assessment of the digital ecosystem across 1,000 public primary schools in 10 counties, reporting that while 94.7% of schools had electricity infrastructure, internet connectivity remained unevenly distributed across regions, indicating that basic infrastructure exists but connectivity gaps persist as a distinct challenge. The Kenya ICT Authority (2026) evaluated ongoing digital connectivity expansion initiatives within the national education system, noting that while programs are actively expanding broadband access to schools, significant disparities continue to be reported between urban and rural areas, suggesting that policy efforts are improving connectivity but inequality remains entrenched. Recent large-scale interventions demonstrate the transformative potential of targeted connectivity investments while highlighting the scale of remaining needs. UNICEF and the European Union (2025) implemented the Last Mile Connectivity Project targeting 1,000 public primary schools across 14 counties, successfully connecting 363 schools and providing internet access to over 277,000 learners and 4,400 teachers, thereby demonstrating that expanding connectivity significantly improves access to digital learning resources at scale.

Complementing these efforts, UNICEF, Nokia, and Safaricom collaborated on school connectivity initiatives between 2021 and 2025, connecting over 90 schools in rural and informal settlement areas during earlier phases with ambitions for nationwide coverage, illustrating that public-private partnerships can effectively improve school connectivity in underserved contexts. Further empirical findings show that connectivity challenges extend beyond schools to households, affecting ECDE learners' exposure to digital environments. Komen and Ongínjo (2024) established that limited household internet access restricts the effectiveness of ICT-based ECDE learning, especially where home support is required. Supporting this, Odeke (2024) found that students with internet access demonstrated higher engagement in academic activities, indicating that connectivity has a measurable influence on learning outcomes.

(iii) Power Supply and Physical Facilities

Empirical evidence from Kenyan studies consistently demonstrates that inadequate physical infrastructure and unreliable power supply significantly constrain the quality and accessibility of Early Childhood Development and Education (ECDE). Kariuki and Ndani (2018) assessed the adequacy of ECDE infrastructure in Nakuru County, surveying 40 ECDE centres and 120 teachers, finding that the majority of centres lacked adequate classrooms and sanitation facilities, with significant proportions operating below recommended standards.

Their findings established a direct correlation between inadequate physical facilities and diminished ECDE quality and learning outcomes. Similarly, Okoth (2021) evaluated ECDE policy implementation in Siaya County, revealing that many centres reported insufficient classrooms, sanitation facilities, and teaching spaces, with infrastructure gaps primarily attributed to funding constraints that limit effective policy implementation.

The relationship between inadequate facilities and learner participation has been further substantiated by Mbaja (2020), who examined the influence of school levies on ECDE participation in Kisumu West, linking inadequate classroom and sanitation facilities to low enrolment and retention rates. This pattern of infrastructure deficit extends to primary education, as Tuiya (2011) documented in Eldoret Municipality, where many schools lacked electricity, adequate classrooms, staffrooms, and water facilities, concluding that such deficits constrain effective teaching and learning. The specific challenge of power supply has received increasing scholarly attention. Kazungu et al. (2019) conducted a cost-benefit analysis of energy sources across 30 schools in Makueni County, finding that only 60% of schools had electricity access, while others relied on firewood (100%), solar power (27%), and generators (13%), indicating that schools depend on mixed and often unreliable energy sources that limit ICT integration.

National-level assessments confirm these regional findings. The African Population and Health Research Center (APHRC, 2019) evaluated ECDE programme infrastructure through a national sample, reporting that only 66–75% of ECDE centres had functional electricity, with water access ranging between 48–67%, indicating that basic infrastructure remains inconsistent across ECDE centres. The Kenya Ministry of Education (2016) reported that while 80.5% of primary schools had electricity, 19.5% remained without power, suggesting that despite progress, a significant proportion of schools still lack essential electrical infrastructure. More recent evidence by Lee et al. (2023) examined the impact of electrification on rural primary schools in Kenya, documenting a substantial increase in electricity access from 56% to 94% between 2014 and 2016, which was linked to improved enrolment and completion rates, demonstrating that access to electricity improves educational outcomes and school functionality.

The implementation of Kenya's Competency-Based Curriculum (CBC) has further exposed infrastructure vulnerabilities. Odhiambo (2022) assessed physical facilities and ECDE quality in Western Kenya, finding that many centres lacked safe classrooms, toilets, and play facilities, with overcrowding reported as a significant challenge that reduces the effectiveness of competency-based learning. Ndirangu (2024) examined institutional preparedness for CBC implementation in Central Kenya, with schools reporting inadequate classrooms, limited sanitation, and insufficient play equipment; notably, over 50% of centres lacked adequate learning

spaces, confirming that physical infrastructure remains a major barrier to CBC implementation.

(iv) Software and Digital Content Relevancy

Reviewed studies reveals a significant gap between the ambitious objectives of the Digital Literacy Programme and the actual availability of teaching tools in classrooms. Although national policy aims to create a smooth digital learning environment, Otieno and colleagues (2024) point out a striking imbalance: public ECDE sections, which fall under county government jurisdiction, frequently operate without sufficient devices, with ratios reaching one device for every forty-five learners. This situation stands in sharp contrast to private centers, which generally maintain well-equipped computer laboratories and operational tablets (Karimi et al., 2025). Compounding this issue, much of the hardware already distributed lies unused or broken because of insufficient technical upkeep and localized support structures (Safaricom News, 2025).

Empirical data consistently points to a lack of relevant software as a primary barrier to Competency-Based Curriculum (CBC) implementation. In Uasin Gishu County, Kogei (2024) found that 64% of schools lacked CBC-aligned digital content, while 58% reported a complete absence of interactive software. This institutional weakness is echoed by Onyango and Ondiek (2021), who noted that over 60% of educational institutions lack specialized platforms for content delivery. National assessments further underscore this "content vacuum," with the USAID Digital Ecosystem Country Assessment (2020) and ECDPM (2023) both identifying a limited portfolio of locally relevant educational tools, resulting in a low uptake of advanced digital tools (only 15–18%) despite general infrastructure growth. A critical dimension of this relevancy gap is linguistic and contextual adaptation. Amol et al. (2024) and Mbogho et al. (2025) provide quantitative evidence of this exclusion, reporting that less than 30% of Kenyan languages are digitally represented in learning materials. This lack of localized content significantly hinders inclusivity and comprehension, particularly for early childhood learners who benefit most from instruction in their first language or familiar contextual settings. Without contextual adaptation, digital tools fail to meet the diverse needs of learners in rural and marginalized communities. Despite these systemic hurdles, targeted interventions demonstrate that well-structured software can bridge the infrastructure-pedagogy gap. The EIDU platform serves as a primary example of a practical solution; it provides an AI-driven, personalized learning system that delivers curriculum-aligned literacy and numeracy content. By using embedded assessments to adapt to individual learner needs, EIDU has been shown through independent Randomized Controlled Trials (RCTs) to significantly improve learning outcomes across Kenyan counties. This demonstrates how targeted, relevant software can transform hardware into meaningful instructional assets.

Further evidence supports this transformative potential across various regions. In Nakuru County (2025), the introduction of the EIDU system across 100% of ECDE centers led to qualitative improvements in CBC literacy outcomes (Kenya News Agency, 2025). Similarly, collaborative pilots by UNICEF and WAJIBU (2022) in Nairobi and Mombasa found that ICT programs increased reading scores specifically when the software was strictly aligned with curricular literacy goals. In Kirinyaga County (2025), KNATCOM reported that targeted training enabled 75% of teachers to create their own multimedia materials, demonstrating that teacher capacity is a prerequisite for content relevancy. Hence, the literature reveals three persistent patterns: a major shortfall in CBC-aligned interactive software, a critical lack of linguistic localization, and a clear correlation between relevant, adaptive digital content and measurable improvements in learner achievement. As noted by the Kenya ICT Authority (2026), software expansion must be matched with relevant learning content to achieve a lasting educational impact.

Teacher Digital Competencies, Preparedness and Self-Efficacy

Empirical evidence from Kenya shows that teacher digital competence significantly influences instructional practices under the Competency-Based Curriculum (CBC). Oyieno et al. (2024) examined 365 ECDE stakeholders in Upper Eastern Kenya and achieved a response rate of 93.15%. Their findings established a statistically significant relationship between teachers' digital competence and language instruction ($p < 0.05$), indicating that teachers with higher digital skills demonstrate more effective instructional delivery. However, the study also identified persistent gaps in training, suggesting that competence levels remain uneven across ECDE contexts. Similarly, Keter, Chepkwony, and Bii (2025) assessed 200 public primary school teachers in Bomet County and found a strong positive relationship between ICT self-efficacy and CBC implementation ($r = 0.58$, $p < 0.001$). Regression results ($\beta = 0.524$, $p < 0.001$) further confirmed that teacher confidence plays a central role in successful integration of digital tools. These findings align with Otieno, Odongo, and Aloka (2023), who reported a strong correlation between digital literacy and integration of technology ($r = 0.711$, $p < 0.05$) among 263 foundation phase teachers. Despite this, the relationship between training adequacy and integration remained weak ($r = 0.292$), showing that existing training programs do not adequately prepare teachers for practical classroom application. Murithi and Yoo (2021) also found that ICT use among Kenyan primary school teachers remains at low to moderate levels, largely influenced by access to infrastructure and individual competence.

In ECDE contexts, Ndiritu and Mwangi (2020) reported that although 395 preschool teachers in Kiambu County possessed basic ICT skills, they lacked the pedagogical ability to integrate these skills into teaching. This pattern confirms that operational knowledge does not automatically translate into effective instructional

use. Njuguna, Kimotho, and Nduku (2024) reinforced this position by demonstrating that ICT training significantly predicts ICT use in teaching (β = 0.274, p = 0.003), indicating that continuous professional development improves teacher preparedness. Further studies highlight the role of resource availability in shaping teacher readiness. Mumbe and Njagi (2024), in a study of teachers in Kilifi County, found that only 40.7% reported adequate ICT tools, while 32.2% reported sufficient instructional materials. These findings show that limited access to resources constrains teachers' ability to implement digital learning. In Makueni County, Kiarii (2023) established that ICT competence is a key determinant of teachers' capacity to implement the Digital Literacy Programme, reinforcing the argument that teacher skills remain central to digital integration efforts. Evidence from Migori County emphasizes the importance of self-efficacy and teacher perceptions. Anyehere (2022) found that more than 70% of teachers reported that technological competence influenced their instructional performance to a very great extent. The same study showed that over 65% of teachers perceived self-efficacy as a major factor influencing their effectiveness in CBC implementation. These findings are consistent with Ochogo (2023), who identified teacher knowledge, attitudes, and access to ICT resources as key determinants of successful integration in Homa Bay County. Studies examining instructional outcomes indicate that ICT competence improves teaching effectiveness but does not automatically lead to widespread adoption. Wafula (2020) found that competencies such as device operation, internet use, and content creation positively influenced student achievement in Makueni County. Kithungu (2020), in a large-scale study involving 3,600 teachers in Machakos County, reported that ICT-trained teachers demonstrated higher effectiveness in content delivery, assessment, and learner engagement compared to non-trained teachers. Despite this, Chepchumba (2019) found that adoption of digital learning in Uasin Gishu County remained low even where ICT resources were available, indicating that behavioral factors and preparedness gaps limit uptake. Across these studies, a consistent pattern emerges. Teachers in Kenya generally demonstrate basic digital literacy but lack the pedagogical competence required for effective integration in CBC classrooms. Self-efficacy shows a strong influence on adoption, with higher confidence levels linked to better implementation outcomes. At the same time, inadequate training, limited resources, and contextual constraints continue to hinder full preparedness.

Professional Development and Training Programmes

Evidence from Kenya shows that professional development programmes play a central role in shaping teacher preparedness for digital integration under CBC, though their effectiveness remains uneven. Sulunye, Kipchumba, and Nzisa (2025) examined teacher training and CBC performance in Narok South Sub-County using a mixed-methods design involving over 300 teachers and parents. The study

reported a positive and statistically significant relationship between teacher training and CBC performance ($r = 0.310$, $p < 0.01$; $\beta = 0.148$, $p < 0.05$), indicating that participation in training programmes improves curriculum implementation. The authors recommended continuous engagement in workshops, seminars, and peer learning to strengthen teacher capacity. However, several studies show that the reach and quality of professional development programmes remain limited. Murithi and Yoo (2021) found that 66.4% of teachers had not attended in-service ICT training, and 58.4% were unable to plan and integrate technology into lessons. Additionally, 62.3% of trained teachers reported that the training they received was not appropriate for classroom application. These findings show that while training exists, it often lacks practical orientation and fails to build real instructional competence. Similar gaps appear in studies focusing on inclusion and special needs education. Mutembei and Nyabisi (2023), in a study of 210 respondents in Kitui County, found that 76.7% of teachers had not attended any in-service training despite 63.33% rating themselves as having sufficient ICT skills. This mismatch between perceived competence and formal training suggests that many teachers rely on informal learning rather than structured professional development. Research on ICT-specific training reinforces the importance of continuous professional development. Njuguna, Kimotho, and Nduku (2024), in a study of 196 teachers in Nyandarua County, found that ICT training significantly influences ICT use in teaching ($\beta = 0.274$, $p = 0.003$). However, the study also reported that many teachers do not receive sufficient or ongoing training, which limits the effectiveness of digital integration efforts. At the national level, large-scale teacher training initiatives have been implemented to support CBC reforms. Data from the Teachers Service Commission show that over 291,134 teachers have undergone training on CBC implementation, including 229,292 primary school teachers and 60,642 junior secondary teachers. These programmes aim to strengthen teacher capacity and provide ongoing professional support, although disparities in training quality and follow-up support persist across regions.

Institutional capacity-building programmes further illustrate efforts to strengthen teacher competencies. The Centre for Mathematics, Science and Technology Education in Africa (CEMASTEA) has trained thousands of junior secondary teachers on ICT integration, focusing on the use of digital devices, e-learning resources, and content development. Despite these efforts, baseline findings indicated that many teachers still face challenges in sourcing and developing digital teaching materials, pointing to gaps in practical training outcomes. Other studies highlight the role of training resources and infrastructure in shaping professional development outcomes. Mumbe and Njagi (2024) found that only 40.7% of teachers reported adequate ICT tools and 32.2% reported sufficient textbooks during training programmes in Kilifi County. These limitations reduce the effectiveness of in-service training and weaken teachers' ability to

transfer acquired skills into classroom practice. Earlier studies also reveal systemic weaknesses in the design and delivery of professional development programmes. Research cited in Murithi and Yoo (2021) showed that only 8% of teachers felt adequately prepared to use technology in teaching despite 78% perceiving it as easy to use. This gap indicates that training programmes often focus on basic technical skills rather than pedagogical integration, limiting their impact on actual classroom practice. Across these studies, a consistent pattern emerges. Professional development programmes in Kenya have expanded significantly, both in scale and policy support, but they remain constrained by limited coverage, inadequate resources, and weak pedagogical focus. Many teachers either do not access training or receive training that does not translate into effective classroom practice. Hence, the literature shows that while professional development initiatives contribute positively to teacher preparedness, their effectiveness depends on continuous, practical, and well-resourced training models. Strengthening follow-up support, aligning training with classroom realities, and expanding access to all teachers will improve digital integration under CBC.

Pedagogical Integration and Curriculum Alignment

Empirical evidence from recent Kenyan studies indicates that the pedagogical integration of digital tools within the Competency-Based Curriculum (CBC) remains a work in progress, characterized by significant gaps between teacher awareness and classroom application. In Westlands Sub-County, Opicho et al. (2025) found that while over 68% of teachers possessed moderate digital skills, only 42% were able to integrate these tools effectively into lesson delivery. This suggests that digital competence in isolation does not guarantee pedagogical alignment. Similarly, Olum and Mwoma (2025) observed that in Mathare, Nairobi, 61% of teachers successfully adopted learner-centered approaches, yet only 35% could effectively align digital tools with specific lesson objectives. These findings point to a persistent "instructional disconnect" where technology is present but not yet woven into the constructivist fabric of the CBC. The transition from content-based to competency-based teaching is further complicated by structural and regional disparities. In Ndhiwa Sub-County, Ochogo (2023) reported that 65% of teachers cited inadequate ICT resources as a primary barrier, with 58% admitting to limited integration in their teaching practices. This lack of resource-pedagogy alignment is a national trend, as Kawinzi (2025) noted that over 70% of junior secondary teachers across Kenya still struggle to align their teaching methods with competency-based requirements. Kibet (2025) argues that addressing this requires more than just hardware; it necessitates robust pedagogical frameworks like TPACK (Technological Pedagogical Content Knowledge) to ensure that digital literacy serves mathematics and language instruction rather than being a standalone technical exercise. Despite

these hurdles, the literature highlights critical drivers of success, specifically teacher competence and administrative oversight.

Oyieno et al. (2024) found that in Upper Eastern Kenya, ECDE teachers with high digital competence achieved a performance improvement index of over 60% in language instruction delivery compared to their less-skilled peers. Furthermore, the role of supervision cannot be understated; Benson and Njuguna (2023) found that ECDE centers in Meru Central with frequent monitoring achieved over 70% compliance with CBC instructional requirements. Interestingly, Bartilol (2025) found no significant relationship between teacher attitudes and actual integration ($r=-0.111, p>.05$), suggesting that institutional support and practical training are far more influential than a teacher's personal disposition toward technology. Hence, while learners show high levels of enthusiasm with 72% of students in Busia County reporting improved engagement when using digital tools (Simiyu, 2025) the consistency of this exposure remains low at 38%. The consensus among Kenyan scholars is that for digital integration to be meaningful, the education system must move beyond "basic literacy" and focus on combined pedagogical-technological skills. As Nyakubiiha (2022) concluded after studying teachers in Migori, over 75% of educational outcomes are now dictated by the teacher's ability to blend these two competencies, making continuous professional development and instructional monitoring the most vital levers for curriculum alignment.

Schools Administrative Support and Governance/ Leadership Challenges

Empirical evidence consistently demonstrates that school leadership commitment constitutes a primary determinant of ICT integration success. Mingaine (2017) examined leadership challenges in Meru County and found that the majority of schools lacked proactive ICT budgeting mechanisms, with leadership commitment emerging as the strongest predictor of implementation success where present. Schools with principals who actively prioritized digital infrastructure and pedagogical innovation showed markedly higher adoption rates compared to institutions with passive administrative oversight. This finding aligns with Maithya (2025), who assessed headteacher leadership in Matungulu Sub-County and established that schools with strong leadership practices demonstrated significantly improved competency-based curriculum outcomes, whereas weak leadership correlated directly with poor CBC execution and fragmented digital integration. The mechanism through which leadership operates appears to be multifaceted, involving not merely resource allocation but also the establishment of institutional cultures that value technological innovation in teaching and learning. The availability and sustainability of technical support infrastructure presents mixed evidence regarding its influence on digital integration. Magare (2018) investigated leadership influence across 29 schools in Buuri Sub-County and found that while leadership support for infrastructure development and staff training positively

influenced ICT integration, technical maintenance systems alone did not significantly predict implementation success. This suggests that the presence of hardware without corresponding human resource capacity for troubleshooting and system maintenance creates sustainability gaps. Ochogo (2024) corroborated this finding in Ndhiwa Sub-County, where 65% of teachers cited inadequate ICT infrastructure as a primary barrier, noting that leadership support and policy implementation remained inconsistent across institutions. The disconnect between infrastructure provision and technical support capacity appears particularly pronounced in rural and marginalized regions where specialized ICT personnel are scarce and maintenance protocols are poorly institutionalized. Supervisory and evaluative frameworks emerge as among the strongest predictors of digital integration success in Kenyan schools. Kikuvi-Mbului, Kingi, and Kalai (2024) examined principal supervision practices among 296 teachers in Nairobi City County and established a robust positive correlation between supervision intensity and ICT integration ($r = 0.716$, $\beta = 0.850$), with the regression model explaining 51.3% of variance in integration outcomes. This finding indicates that active monitoring through lesson observation, feedback provision, and performance evaluation creates accountability structures that significantly enhance classroom technology use. The strength of this relationship suggests that monitoring and evaluation function not merely as compliance mechanisms but as professional development catalysts that reinforce pedagogical innovation. However, Murang'a and Barasa (2024) identified weak coordination and inconsistent monitoring frameworks as systemic governance gaps that hinder CBC alignment, indicating that effective supervision remains unevenly distributed across the education system. National-level evidence reveals structural governance deficiencies that constrain school-level leadership capacity.

The National Gender and Equality Commission (2024) conducted a comprehensive assessment across 19 counties and documented critical resource gaps: 61% of institutions reported teacher shortages, 60% lacked adequate learning materials, 55% faced inadequate funding, and 42% reported infrastructure deficits. These systemic constraints significantly limit school leaders' operational flexibility to implement digital integration initiatives, regardless of individual leadership competence. Kawinzi (2025) identified governance challenges in junior secondary schools, with over 70% of teachers reporting systemic implementation barriers including poor coordination between educational tiers and ambiguous policy directives that complicate local-level decision-making. Ijakaa and Kingi (2024) conducted a systematic review of leadership strategies and identified inadequate teacher training, poor stakeholder engagement mechanisms, and weak resource allocation systems as pervasive governance deficiencies that undermine CBC implementation. The professional preparation of school leaders represents a critical yet underdeveloped dimension of governance capacity. Ngare (2024) assessed

leadership effectiveness in ECDE centres across Kajiado County and found that many headteachers lacked formal leadership training, resulting in weakened decision-making capacity, inadequate resource management, and insufficient stakeholder coordination. This capacity gap becomes particularly consequential in early childhood contexts where leaders must navigate complex community relationships while managing limited resources.

Karanja and Gikonyo (2018), as cited in Ngare (2024), similarly documented lack of structured leadership preparation across ECDE institutions, suggesting that leadership deficits are systemic rather than localized. The absence of targeted professional development for school leaders regarding digital pedagogy and technology management appears to create a bottleneck where infrastructure investments fail to translate into instructional innovation. While direct empirical measurement of parental engagement remains limited in the reviewed literature, governance studies indicate weak stakeholder participation as a recurrent implementation barrier. Ochogo (2024) noted community resistance and limited parental involvement as factors complicating digital integration in rural contexts, while Ngare (2024) identified poor community collaboration as a consequence of leadership capacity gaps. The National Gender and Equality Commission (2024) findings regarding resource constraints suggest that schools lacking adequate funding and materials struggle to engage parents meaningfully in digital initiatives, as material scarcity limits opportunities for home-school technology partnerships.

Conclusion

The systematic review concludes that digital integration in Kenyan ECDE centers under the Competency-Based Curriculum (CBC) is currently defined by a "policy silo" effect, where a robust national framework is undermined by fragmented execution and severe resource disparities. Despite the successful distribution of over 1.2 million devices to primary schools, the devolved nature of ECDE has left 86.7% of centers entirely without computers, while internet access remains a luxury available to only 21% of public schools dropping as low as 13% in rural and ASAL regions. These infrastructure deficits are compounded by an unreliable power supply (ranging from 60% to 94%) and a lack of localized digital content, with less than 30% of Kenyan languages digitally represented. Although teachers demonstrate basic ICT literacy and 78% perceive technology as easy to use, a significant pedagogical gap persists; 66.4% of educators have not attended in-service ICT training, and 58.4% remain unable to integrate digital tools into active lesson planning.

Furthermore, while professional development has reached over 291,000 teachers, 62.3% of participants report that the training lacks classroom applicability. Ultimately, while proactive school leadership and monitoring explain over 50% of the variance in implementation success, chronic teacher shortages and a mismatch

between pre-service training and CBC realities continue to hinder the shift toward the learner-centered, constructivist digital environment envisioned by Kenyan policy.

Recommendations

To effectively bridge the digital divide in Kenya's foundational education, the Council of Governors (CoG) and individual County Governments must prioritize the synchronization of ECDE funding with national digital standards. The current "policy silo" has left over 86% of ECDE centers without basic computing infrastructure. It is recommended that county leadership ring-fence specific budget allocations for the procurement of CBC-compatible hardware and the maintenance of physical facilities. This shift from ad-hoc procurement to a structured, multi-year investment plan will ensure that the youngest learners are not bypassed by the technological advancements seen in primary and junior secondary levels.

The Ministry of Education (MoE) and the ICT Authority should accelerate the expansion of the "Last Mile Connectivity" project, specifically targeting the 79% of public schools that currently lack reliable internet. Policy interventions should focus on providing subsidized "Edu-Data" bundles for teachers and establishing community-based digital hubs in Arid and Semi-Arid Lands (ASAL) to address the stark 13% connectivity rate in these regions. Simultaneously, the Kenya Institute of Curriculum Development (KICD) must lead a "content revolution" by developing interactive, multimedia software that is not only aligned with CBC objectives but also localized into indigenous languages to address the current 70% deficit in linguistic representation in digital tools.

For the Teachers Service Commission (TSC), the focus must shift from mass technical literacy to specialized pedagogical integration. Since over 60% of trained teachers report that current programs lack classroom applicability, the TSC should move away from one-off workshops toward a school-based mentorship model. This includes integrating Digital Pedagogy as a core KPI within the Teacher Performance Appraisal and Development (TPAD) system, moving it from a compliance-based checkbox to a genuine incentive for instructional innovation. Furthermore, teacher training colleges must realign their pre-service curricula to ensure new graduates possess the practical skills to manage a digital classroom from day one.

Finally, School Boards of Management (BOM) and Headteachers must be empowered through formal leadership training in ICT governance. Given that leadership commitment explains over 50% of the variance in successful digital adoption, administrators should establish internal maintenance funds to address the high rate of non-functional hardware. Through promoting a culture of accountability and proactive budgeting at the school level, leadership can ensure that available digital resources are utilized for the learner-centered, constructivist activities envisioned by the CBC rather than remaining idle or underutilized.

Future studies should conduct longitudinal and comparative assessments of digital integration in public and private ECDE centres across Kenya's counties to establish how variations in infrastructure investment, internet connectivity, teacher preparedness, digital content availability and institutional leadership influence the effective integration of technology in CBC implementation. Such studies should also examine the pedagogical effects of localized digital learning resources, particularly those developed in indigenous languages, on learner engagement, participation and competency development.

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