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DIGITAL INTEGRATION CHALLENGES AND THEIR EFFECT ON THE IMPLEMENTATION OF KENYA'S COMPETENCY-BASED CURRICULUM AMONG EARLY CHILDHOOD DEVELOPMENT TEACHERS

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ABSTRACT

Kenya's Competency-Based Curriculum places digital literacy among the core competencies expected of teachers from Pre-Primary Two onwards, yet the specific challenges that early childhood development teachers face in integrating digital tools into daily instruction remain poorly documented at the classroom level. This paper reports findings from a ten-month convergent mixed-methods study conducted across six Kenyan counties, examining the challenges early childhood development teachers encounter when integrating digital tools and testing whether these challenges predict effective implementation of the curriculum. Data were drawn from 51 early childhood development teachers who completed a structured questionnaire following school-level focus group discussions, and from 16 school heads who participated in semi-structured interviews. Tests of normality confirmed non-normal distributions across the composite scales, justifying the use of Spearman's rho. Descriptive analysis showed that limited device availability and weak administrative support were the most strongly endorsed challenges, at 66.7 percent and 62.8 percent respectively. Principal component analysis extracted two sub-constructs, Infrastructure and Technical Barriers and Institutional and Pedagogical Barriers, which

together explained 71.0 percent of variance. Contrary to expectation, the composite challenge score showed only a weak, non-significant association with effective curriculum implementation (rho = .171, p = .230). Qualitative data from focus group discussions and school head interviews corroborated the descriptive severity of the challenges while clarifying why challenge exposure does not, on its own, suppress implementation outcomes. The paper concludes that infrastructure investment alone is an insufficient policy lever and that digital integration challenges must be addressed alongside, rather than instead of, competency development.

KEYWORDS: Digital Integration Challenges; Early Childhood Development; Competency-Based Curriculum; Infrastructure Barriers; Kenya.

1. INTRODUCTION

Early childhood development constitutes a foundational phase of a child's cognitive and social growth, and the quality of instruction at this stage carries lasting consequences for later learning. Kenya's Competency-Based Curriculum, introduced from 2017, places digital literacy as a core competency from Pre-Primary Two onwards.[1] International frameworks such as UNESCO's ICT Competency Framework for Teachers.[2] and the ISTE Standards for Educators.[3] provide broad guidance on technology integration, while continental instruments including the Continental Education Strategy for Africa.[4] identify digital skills as essential for all teachers, including those working in early childhood settings. Despite this policy convergence, no study had systematically documented the specific challenges facing Kenyan early childhood development teachers as they integrate digital tools into Pre-Primary Two instruction under the curriculum mandate.

The problem this paper addresses is direct. Kenya's curriculum requires digital tool integration at Pre-Primary Two, yet early childhood development teachers operate in environments characterised by inconsistent infrastructure, varying competency levels, and insufficient professional development.[5] The absence of a standalone, measurable digital competency framework for this level weakens both policy implementation and monitoring.[6]

Before such a framework can be built, the specific challenges that shape teachers' digital practice must be identified, and their actual relationship with implementation outcomes must be tested empirically rather than assumed.

This paper reports the first objective of a larger study developing the Digital Competency Framework for Early Childhood Development Teachers in Kenya. The specific objective addressed here was to assess the challenges faced by early childhood development teachers in integrating digital tools into their teaching practices, and to establish whether these challenges significantly predict effective curriculum implementation. A companion paper examines the study's second objective, the essential digital competencies required for effective instruction and their relationship with implementation outcomes, while a third output reports the development of the resulting weighted competency framework.

2. Literature Review

This section reviews the theoretical and empirical literature bearing on digital integration challenges in early childhood education, situating the present study within existing scholarship on technology adoption, curriculum policy, and infrastructure constraints.

2.1 Theoretical framework

This study draws on three complementary theoretical positions. The Technological Pedagogical Content Knowledge framework.[7] holds that effective technology integration requires the intersection of technological knowledge, pedagogical knowledge, and content knowledge, and provides the primary lens for interpreting why structural challenges alone do not determine implementation outcomes. Rogers' Diffusion of Innovations theory.[8] explains the uneven adoption patterns documented across school types and locations, and accounts for the structural role that policy environments play in accelerating or impeding the spread of digital practice. Vygotsky's Zone of Proximal Development.[9] informs the pedagogical demands identified in this study, since digital tools function as effective scaffolds for young learners only when a sufficiently competent teacher mediates their use.

2.2 International and continental perspectives

Globally, several systemic challenges have been shown to hinder digital integration in early childhood settings. Teachers frequently lack the confidence and technical skill to use digital tools effectively.[10] and inconsistent access to internet, electricity, and devices remains a persistent barrier in low-income preschool contexts.[11] Concerns about excessive screen time for young children.[12] and the mismatch between available applications and the developmental level of pre-primary learners.[13] compound these structural constraints. Most existing research, however, focuses on primary or secondary education, leaving a gap in early-childhood-specific evidence.

Across Africa, digital integration in early learning remains uneven. Continental ICT policies exist, but their implementation at early childhood level is weak or absent in practice.[14] Significant gaps persist in both pre-service and in-service training on digital pedagogy for early childhood teachers.[15] and public centres receive limited funding, making device acquisition difficult.[16] Language barriers compound these constraints, since most digital tools are developed in English, excluding teachers and learners in multilingual contexts.

2.3 The Kenyan context

In Kenya, digital tool integration aligns with the curriculum's explicit information and communication technology mandate, though key challenges persist. Significant infrastructural disparities exist between urban and rural or marginalised counties.[17] many early childhood teachers report low proficiency in educational technology with minimal training support.[18] and negative teacher attitudes toward digital tools as a perceived threat to traditional teaching methods have been documented in some contexts.[19] Literature gaps include the absence of longitudinal studies on digital tool impact, limited research on parental involvement in technology use, and the absence of scalable models for rural digital integration. This paper responds to these gaps by testing, for the first time in this context, whether the challenges consistently described in the literature actually predict implementation outcomes, rather than assuming that they do.

3. METHODOLOGY

A convergent parallel mixed-methods design was employed [20], conducted across six purposefully selected Kenyan counties representing urban, peri-urban, and rural settings: Nairobi, Kisumu, Kakamega, Bungoma, Turkana, and Samburu. Early childhood development teachers first took part in school-level focus group discussions, after which they completed a structured questionnaire. A total of 51 teachers, drawn from two public and one private school per county, returned fully completed questionnaires. School heads, comprising ten public head teachers and six private centre managers or directors, participated separately in individual semi-structured interviews. County education officials were not interviewed during data collection; their involvement was limited to a later stakeholder validation stage.

The questionnaire's Section B measured digital integration challenges through seven Likert-scale items covering infrastructure adequacy, service interruptions, device availability, time constraints, technical support, pedagogical supervision demands, and administrative support. The focus group and interview guides were structured around the same constructs, enabling

systematic triangulation across the three data sources. Instruments were piloted at a single early childhood centre prior to the main data collection, which ran over a two-week window in late September and early October 2025. Ethical clearance and the required county approvals were obtained prior to data collection.

Quantitative data were analysed in IBM SPSS Statistics version 26. Scale reliability exceeded the conventional threshold of .70. Normality was tested using the Kolmogorov-Smirnov and Shapiro-Wilk procedures; both confirmed a significant departure from normality for the challenges composite, justifying Spearman's rho as the correlation measure.[21] Construct structure was explored through principal component analysis using varimax rotation with Kaiser normalisation. Qualitative data from the focus group discussions and school head interviews were analysed thematically.[22] and triangulated against the quantitative findings.

4. RESULTS

This section reports the study's findings in sequence: response rate and sample composition, descriptive findings on digital integration challenges, qualitative corroboration, construct extraction, and the relationship between challenges and effective curriculum implementation.

4.1 Response rate and sample composition

Table 1 presents the response rate achieved across the two respondent groups sampled for this study.

Table 1: Response rate by respondent group (Source: field survey, 2025).

Respondent group	Target (n)	Responded (n)	Response rate (%)
Early childhood development teachers	90	51	56.7
School heads (head teachers and centre managers)	18	16	88.9
Overall	108	67	62.0

All 90 targeted teachers took part in their school-level focus group session, while 51 subsequently returned completed questionnaires, giving a questionnaire response rate of 56.7 percent. Sixteen of the eighteen targeted school heads completed their scheduled interviews, a response rate of 88.9 percent. The sample was drawn predominantly from experienced practitioners, with 72.5 percent of respondents reporting more than six years of teaching experience, and was split 43.1 percent rural, 31.4 percent urban, and 25.5 percent peri-urban, reflecting the study's purposive design.

4.2 Descriptive findings on digital integration challenges

Table 2 presents the frequency and percentage distribution across the five response categories for each of the seven Section B items measuring digital integration challenges.

Table 2: Section B, digital integration challenges (n = 51) | SD = Strongly Disagree, D = Disagree, N = Neutral, A = Agree, SA = Strongly Agree (Source: field survey, 2025).

Statement	SD	D	N	A	SA
B1. My school has adequate digital infrastructure (devices, internet, electricity) to support digital teaching.	10 (19.6%)	13 (25.6%)	10 (19.6%)	12 (23.5%)	6 (11.8%)
B2. I often experience interruptions (power failures, internet outages) that prevent digital teaching.	6 (11.8%)	7 (13.7%)	8 (15.7%)	13 (25.5%)	17 (33.3%)
B3. Limited availability of devices prevents effective use of digital tools in PP2 teaching.	3 (5.9%)	5 (9.8%)	9 (17.6%)	15 (29.4%)	19 (37.3%)
B4. I lack sufficient time in my schedule to prepare and use digital teaching materials.	8 (15.7%)	15 (29.4%)	10 (19.6%)	15 (29.4%)	3 (5.9%)
B5. There is limited technical support in my school for troubleshooting digital tools.	3 (5.9%)	10 (19.6%)	10 (19.6%)	17 (33.3%)	11 (21.6%)
B6. Using digital tools is challenging because PP2 learners require close supervision.	8 (15.7%)	8 (15.7%)	6 (11.8%)	16 (31.4%)	13 (25.5%)
B7. There is limited administrative support for integrating digital tools in early learning.	0 (0.0%)	11 (21.6%)	8 (15.7%)	18 (35.3%)	14 (27.5%)

Limited device availability (B3) was the most strongly endorsed challenge, with 66.7 percent of respondents agreeing or strongly agreeing. Limited administrative support (B7) was endorsed by 62.8 percent, and no respondent strongly disagreed with this item, indicating universal recognition of this institutional constraint. Service interruptions (B2, 58.8 percent) and the supervision demands of PP2 learners (B6, 56.9 percent) followed closely, and limited technical support (B5) was endorsed by 54.9 percent. Infrastructure adequacy (B1) produced a contested distribution, with 45.2 percent disagreeing versus 35.3 percent agreeing, reflecting the documented rural-urban divide. Time constraints (B4) produced the most balanced distribution, with 35.3 percent agreeing and 45.1 percent disagreeing, indicating that time pressure is a secondary rather than primary barrier to digital integration in this context.

4.3 Qualitative corroboration

Head teachers in public centres consistently identified physical infrastructure as the most intractable barrier, citing unreliable electricity, absent internet connectivity, and a near-total absence of institutionally provided devices. This is a direct account from a rural county:

"We have one old laptop in this school and the electricity goes off almost every day. My teachers cannot plan digital lessons because they never know if the power will be there. We are just surviving with the CBC." ***(Head Teacher, Public ECD Centre, Turkana County)***

Centre managers in private schools presented a contrasting profile of better device access but weaker content alignment and mentoring. Focus group participants across rural counties were unanimous that device scarcity and unreliable power were their central constraints, often relying entirely on personally owned smartphones:

"I use my own phone for everything. The school has nothing. When the battery runs out during a lesson, the lesson just stops. I have to plan my whole lesson around the phone battery." ***(ECD Teacher, Public School FGD, Turkana County)***

A distinct pedagogical challenge emerged across all six county sessions: the supervision demands of Pre-Primary Two learners restrict independent or exploratory digital use, since young children cannot be left unattended while a teacher operates a device or troubleshoots a fault. This directly corroborates the quantitative B6 finding and strengthens the institutional and pedagogical barriers construct discussed below.

4.4 Construct extraction

Principal component analysis of the seven Section B items produced a Kaiser-Meyer-Olkin measure of .742 and a significant Bartlett's test of sphericity ($p < .001$), confirming the data were suitable for factor extraction. Two components with eigenvalues above 1 were retained, jointly explaining 71.0 percent of variance.

Table 3: Principal component analysis of digital integration challenges (Source: SPSS output, 2025).

Item	Component 1 (ITB)	Component 2 (IPB)
B3. Limited device availability	.821	
B2. Service interruptions	.794	
B1. Infrastructure adequacy	.776	
B5. Technical support availability	.724	

B7. Administrative and policy support		.847
B6. Supervision demands		.783
B4. Time and workload constraints		.641

The first component, labelled Infrastructure and Technical Barriers, captured physical and technical resource constraints, with an average loading of. 779. The second, labelled Institutional and Pedagogical Barriers, captured the human and institutional dimensions of challenge, with an average loading of. 757. These two sub-constructs together define the Digital Integration Challenges construct carried forward into the composite framework developed in the companion papers to this study.

4.5 Relationship between digital integration challenges and effective curriculum implementation

Table 4 presents the Spearman's rho correlation between the composite digital integration challenges score and effective CBC implementation.

Table 4: Spearman's rho, digital integration challenges and effective CBC implementation (n = 51) (Source: SPSS output, 2025).

Variable pair	Spearman's rho	N	Significance (2-tailed)
Digital integration challenges x effective CBC implementation	171	51	p = .230 (not significant)

Table 4 shows a small positive correlation that did not reach statistical significance (rho = .171, p = .230). This indicates that the composite challenge score is not significantly associated with curriculum implementation effectiveness. Exposure to challenges alone does not reliably predict whether a teacher implements the curriculum effectively using digital tools. This finding is consistent with Tondeur and colleagues' multi-country finding that teacher beliefs and pedagogical competency, rather than infrastructure barriers alone, are the decisive mediators of technology integration outcomes.[23] and with the Diffusion of Innovations principle that structural barriers are necessary but not sufficient explanations for non-adoption.[8] The positive but weak direction of the correlation may reflect challenge awareness among the most digitally active teachers, who both encounter more obstacles and achieve stronger curriculum delivery because their competency allows them to navigate those obstacles.

5. DISCUSSION

The central finding of this paper is a genuine and policy-relevant negative result. Digital integration challenges are severe, consistently reported, and corroborated across three independent data sources, yet they do not significantly predict effective curriculum implementation. This finding should not be read as evidence that infrastructure does not matter. Rather, it indicates that infrastructure investment alone, without a corresponding investment in teacher competency, does not translate into improved classroom practice. This interpretation is directly supported by the qualitative data, in which school heads across all six counties prioritised structured professional development over hardware provision when asked what additional support would most strengthen digital integration.

The two extracted sub-constructs, Infrastructure and Technical Barriers and Institutional and Pedagogical Barriers, carry near-equal empirical weight, indicating that physical resource constraints and institutional or pedagogical conditions are of comparable importance. Neither, however, was shown to predict implementation outcomes independently. This has a direct policy implication for Kenya's Ministry of Education, the Kenya Institute of Curriculum Development, and county education offices: a policy response that allocates resources to devices and connectivity without a parallel and adequately funded competency-building strategy is unlikely to improve curriculum delivery. A companion paper to this study reports that essential digital competencies do significantly predict implementation effectiveness, reinforcing the case for competency development as the primary strategic lever.

6. CONCLUSION AND RECOMMENDATIONS

This paper has documented the specific digital integration challenges facing teachers under the competency-based curriculum, and has tested their empirical relationship with implementation effectiveness. Limited device availability and weak administrative support were the most severe reported challenges. Two coherent sub-constructs, infrastructure and technical barriers and institutional and pedagogical barriers, were extracted through principal component analysis. Neither the composite challenge score nor its sub-constructs showed a statistically significant relationship with effective curriculum implementation, a finding with direct implications for how digital integration is resourced and evaluated in this sector.

The Ministry of Education and county education offices should treat infrastructure provision as a necessary but insufficient condition for effective digital integration, and should pair any infrastructure investment with a funded, structured professional development pathway.

Teacher training institutions should incorporate the institutional and pedagogical barriers identified here, particularly the supervision demands specific to Pre-Primary Two learners, into pre-service preparation. Future research should extend this analysis through a longitudinal design capable of testing the direction of causality between challenge exposure, competency growth, and implementation outcomes over time.

Compliance with ethical standards

This section confirms the ethical and disclosure standards followed in preparing this paper.

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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