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Transforming Education for Resilience: Leveraging E-Learning and Digital Innovation in Zambia's Competence-Based Curriculum

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Abstract

This study investigates the impact of digital innovation on implementing Zambia's Competency-Based Curriculum (CBC) in primary and secondary education. Using a mixed-methods approach, the research examines how digital technology access, teacher preparedness, infrastructure, and equity influence e-learning integration in CBC. The findings showed that although stakeholders agree that digital tools can foster learner-centered learning, collaboration, and critical thinking, practical implementation is challenged by inadequate infrastructure, limited internet access, and insufficient teacher training, particularly in rural areas.

Analysis reveals that teacher competence and proficiency with internet platforms are stronger predictors of successful digital integration than internet access alone. The study concludes that ongoing professional development, equitable online resource access, and alignment of digital tools with CBC goals are crucial for harnessing e-learning's transformative potential in Zambia. It recommends policy reforms focusing on teacher capacity-building, inclusive digital strategies, and integrated monitoring systems to enhance education quality, accountability, and resilience.

Keywords: Competency-Based Curriculum, Digital Innovation, E-Learning, Teacher Readiness, Education Equity, Zambia, ICT in Education, Professional Development

1. Introduction and Contextual Background

Education is the pillar of sustainable, resilient, and inclusive development. In a world faced with pandemics, climate change, and technological advancements, future-proof education systems are essential (UNESCO 2021) ^[17]. Zambia's adoption of the Competency Based Curriculum (CBC) is a strategic step towards the cultivation of 21st century skills like digital literacy, teamwork, critical thinking, and creativity (Ministry of Education 2013; Mulenga and Kabombwe 2019 ^[11]). The CBC prioritizes learner-centeredness, applied knowledge, and lifelong learning above other content-based models.

Achieving the aims of the CBC requires systemic changes in pedagogy, assessment, and classrooms practice. Zambia took the first steps with the implementation of digital technologies for facilitating enhanced access and quality in education, especially in rural schools (MoE 2022; Bwembya *et al.* 2024) ^[8, 2]. The Ministry of Education, through the Directorate of Open and Distance Education, has adopted ICT-oriented initiatives like radio and TV lessons, mobile learning, and learning management systems. These have been crucial during disruptions like the COVID-19 pandemic and recent climatic losses (Mwansa and Ndhlovu 2022; UNESCO 2021) ^[13, 17].

But the effective roll-out of CBC continues to be faced with challenges. Some of these are limited digital capacity for instructors, inadequate infrastructure, and unequal access to the internet and devices, particularly in rural settings (World Bank 2020; Phiri and Mweetwa 2023) ^[21, 14]. The study investigates how digital innovations are utilized in facilitating improvement in CBC implementation and determinants that enable or limit the development of inclusive, resilient, and scalable digital learning in Zambia's basic education.

2. Problem Statement

Adoption of the Competency-Based Curriculum (CBC) in Zambia aims to enhance 21st century competencies in critical thinking, creativity, and digital literacy (Mulenga & Kabombwe, 2019 ^[11]; Ministry of General Education, 2023). However, its implementation is hindered by infrastructural gaps, inadequate access to digital resources, and inadequate teacher preparation,

especially in rural areas (World Bank, 2020; Mwansa & Ndhlovu, 2022) ^[21, 13]. Despite the Ministry of Education having introduced digital interventions through the Directorate of Open and Distance Education (MoE, 2022) ^[8], uptake is uneven due to socio-economic and geographical disparities (Kalobo & Mwansa, 2022; UNESCO, 2023) ^[6, 18]. Further, the lack of empirical evidence regarding how digital technologies support CBC gets in the way of evidence-based policy response. This study bridges that gap by examining how digital innovation can enhance CBC implementation, promote equity, and increase resilience in Zambia's education sector.

3. Research Objectives

1. To examine the extent to which digital innovation is being integrated into the implementation of the Competency-Based Curriculum (CBC) in Zambia's basic education system.
2. To assess the infrastructural readiness of digital learning tools and platforms deployed under the Directorate of Open and Distance Education (DODE).
3. To evaluate teachers' readiness to utilize digital technologies in support of CBC-aligned pedagogies.
4. To identify the equity implications of current digital initiatives to learners.
5. To generate evidence-based recommendations for strengthening policy and practice toward the implementation of the CBC in Zambia.

4. Justification of the Study

This study is driven by the pressing need to understand how digital innovation can most effectively enhance the implementation of Zambia's Competency-Based Curriculum (CBC), given longstanding challenges of unequal access to quality education, inadequate infrastructure, and limited teacher capacity. As the education sector increasingly relies on technology to promote inclusivity, flexibility, and resilience, assessing the effectiveness, scalability, and limitations of current digital initiatives is crucial. By examining programs led by the Directorate of Open and Distance Education and relevant stakeholders, this research provides timely insights to inform policy, improve practice, and support the successful achievement of CBC objectives in Zambia's basic education system.

5. Theoretical Framework

The theoretical foundation of this study draws on the Constructivist Learning Theory and Technology Acceptance Model (TAM). Constructivist theory, as developed by Piaget (1972) ^[15] and built on by Vygotsky (1978) ^[20], is premised on the assumption that learners construct knowledge through active engagement with the surroundings, peers, and teaching materials. This is in alignment with the Competency Based Curriculum (CBC) values of Zambia that emphasise learner-Centered practice, critical thinking, and problem-solving within context (Ministry of Education 2013; Mulenga and Kabombwe 2019 ^[11]). Constructivism in digital learning spaces requires the inclusion of interactive technologies to promote exploration, autonomy, and collaboration to assist learners to build meaning from authentic experience (UNESCO IBE 2017) ^[16].

In addition, the study employs the Technology Acceptance Model proposed by Davis (1989) ^[5], which explains how users adopt and implement technological innovations. TAM

employs perceived usefulness and perceived ease of use as determinants that impact users' attitudes and plans to use technology. TAM is particularly well-adapted in explaining how Zambian learners and educators respond to digital tools implemented to facilitate CBC implementation. Applying TAM, the research explores the psychological and environmental factors behind supporting or hindering the implementation of e-learning in basic education. Constructivist Learning Theory and TAM both provide a robust analytic framework for examining the pedagogical and systemic ramifications of digital innovation within Zambia's emerging educational context.

6. Literature Review

This section examines existing research relevant to the study, exploring how digital innovation can facilitate the implementation of Zambia's Competency-Based Curriculum. The review focuses on key themes, including the resilience of education systems, effective integration of digital tools, teacher capacity building, and equitable access to learning opportunities. Through a critical analysis of current literature, this review identifies significant gaps and opportunities for enhancing CBC delivery and learning outcomes through technology, providing a foundation for the study's investigation.

a) Education, Resilience, and the Call for Change

Education is globally recognized as being among the pillars of national resilience, especially at times of crisis (UNESCO 2021) ^[17]. Resilient education systems can bounce back and redevelop post-shocks while ensuring quality and equitable learning (Anderson 2020) ^[1]. The COVID-19 pandemic, droughts caused by climate change, and the economic slump in Zambia have exposed weaknesses in the education system (Mwansa and Ndhlovu 2022) ^[13]. The situation demands an inclusive and adaptive education policy. The Resilience Theory is an apt conceptual framework for analysing how education systems can learn and innovate in the face of adversity. It advocates for adaptive systems, active citizenship, and creative utilization of resources, which all feed Zambia's vision for a revolutionary education system using the CBC.

b) The Competency-Based Curriculum in Zambia

The CBC was introduced in Zambia to transform from the traditional content-based learning to a skills-oriented and learner-focused one (Ministry of Education 2023; Mulenga and Kabombwe 2019) ^[7, 11]. The latter focuses on developing critical thinking, collaboration, and computer literacy. Rollout of this curriculum is still unequal, with limited infrastructure, poor incompetent teaching training, and unequal resources between urban and rural schools (World Bank 2020; Chishimba and Mfuno 2021) ^[21, 3]. To reduce these challenges, the Zambia Ministry of Education has promoted the use of digital technologies through programs such as the Alternative Modes of Education Provision and projects spearheaded by the Directorate of Open and Distance Education (MoE 2022) ^[8].

c) Digital Innovation and E-Learning as Enablers of Transformation

Technology resources are increasingly being utilized to facilitate implementation of CBC through greater access to learning and teacher-improvement practice. E-learning

platforms, educational broadcasting, and mobile apps facilitate interactive and flexible learning (Bwembya, Botha and Daka, 2024) [2]. The resources facilitate differentiated instruction and assist in the delivery of learner-Centered content by teachers.

The Directorate of Open and Distance Learning has led the development of multimedia materials as well as teacher capacity in ICT. Community and partner models also supplemented infrastructure development as well as digital inclusion in the country.

d) The TPCK Framework and Teacher Capacity in Digital Environments

Technological Pedagogical Content Knowledge theory underpins the combination of pedagogy, content, and technology for instruction (Mishra and Koehler 2006) [10]. Teachers need to be able to select proper tools and design effective learning activities to succeed in teaching CBC using digital media. However, teacher preparedness is the underlying issue. Research indicates that many Zambian teachers lack digital literacy and pedagogical training to effectively integrate e-learning tools (Chishimba & Mfuno, 2021) [3]. To address this, context-specific training and professional development programs should be implemented to enhance teacher capacity, aligning with the Technological Pedagogical Content Knowledge (TPCK) framework.

e) Digital Equity, Inclusion, and Adaptive Learning Environments

It is crucial that there is equity in online learning to avoid widening current gaps. Rural and peri-urban learners frequently face challenges in accessing electricity, computers, and the internet. Alternative Modes of Education Provision addresses these issues by blending face-to-face teaching with radio, print, and offline e-learning resources (MoE 2022) [8]. Online learning spaces can also support learners with varying needs in terms of personalization, accessibility features, and continuous formative assessment. These are in congruence with the CBC imperatives to realize inclusive and experiential learning.

f) Gaps and Opportunities in the Zambian Context

Though advancement is being observed, there are shortfalls in measuring digital ventures, equating instruments with CBC results, and policy coordination across levels of the education system. There is sparse empirical evidence on educators' and learners' experiences of going digital.

This study bridges these gaps by considering the role of digital innovation in making it easier to implement CBC and in building system resilience. It posits that technology is not only desirable but also if the education sector in Zambia's rapidly evolving context needs to be transformed.

7. Methodology

This study employed an embedded mixed-methods research design, integrating both qualitative and quantitative approaches to provide a comprehensive understanding of the research problem. The methodology consisted of three distinct phases, allowing for a systematic and rigorous examination of digital innovation in the context of the Competency-Based Curriculum (CBC) in seven districts of Zambia's Eastern Province.

7.1 Participant Distribution and Sampling Strategy

The six districts selected, namely Chipata, Katete, Mambwe, Nyimba, Petauke, and Lundazi, were purposively selected in a bid to acquire the different educational and infrastructural environments that are found in the Eastern Province. These districts have both urban, peri urban, and rural environments, thus enabling the study to acquire different differences in digital preparedness, adoption of the competency-based curriculum, as well as equitable access to educational technologies. Purposive sampling was used to identify participants with ample information, i.e., curriculum developers, education administrators, and Directorate of Distance Education officials. Additionally, stratified sampling was used to obtain teachers, learners, and education officers from every district well represented. The multi-level approach guaranteed study findings validity and generalisability in the province.

Table 1: Participant Distribution by Method and District

Data Collection Method	Target Group	Participants per District	Total (6 Districts)	Remarks
Survey	Teachers and School Administrators	35	210	Supports quantitative analysis (correlation, regression) DEBS staff, planners, ESO – ODL
	Education Officers / Policymakers	4	24	
Key Informant Interviews	Curriculum Developers, DODE Officials, Education Administrators	N/A	25	Provincial and national-level insights
Focus Group Discussions	Teachers (1 FGD of 6 per district)	6 per group	36	One teacher FGD per district
	Learners (1 FGD of 10 per district)	10 per group	60	One learner FGD per district
Total			355	

Source: Field data, 2026

7.2 Participant Distribution and Sampling Strategy

For representativeness and data richness, the study employed a grand total of 355 sample participants drawn from six districts of the Eastern Province in Zambia, that is, Chipata, Katete, Mambwe, Nyimba, Petauke, and Lundazi. The sample was subjected to a mix of stratified sampling and purposive sampling to capture a cross-section of diversity of the education stakeholders involved in implementing the Competency Based Curriculum. The

participants were unevenly distributed in three prominent data collection processes that included surveys, interviews, and focus group discussions. This was to maximize the depth, and the scope of information collected in order to secure qualitative and quantitative answers.

7.3 Data Collection

Data collection for this study involved a multi-faceted approach, utilizing a range of methods to gather rich and

nanced data from a diverse group of participants, ensuring a comprehensive understanding of the research topic.

Surveys: These were carried out with policymakers and educators to gain quantitative data on their experiences, issues, and attitudes towards digital tools and CBC implementation.

Interviews: Qualitative in-depth data were collected through key informant interviews with curriculum developers, education administrators, and the Directorate of Open and Distance Education officials.

Focus Group Discussions (FGDs): The stakeholders such as educators and learners were interviewed through FGDs to share common experiences and perceptions in a discursive and reflective environment.

Desk Review

A systematic review of existing literature on e-learning, digital innovation, and the CBC was carried out. This phase established theoretical foundations for the study and ascertained prevailing research gaps. Key documents included scholarly publications, policy papers, government reports, and international standards on digital learning and education revitalization.

7.4 Data Analysis

Qualitative Data Analysis: Thematic analysis of interview transcripts and FGD summaries was employed. It helped in ascertaining common patterns, perceptions, and barriers towards efficient digital integration.

Quantitative Data Analysis: Inferential and descriptive statistical analyses were used to analyse survey data. This allowed for the creation of trends, correlations, and demographics as factors affecting the use and effectiveness of digital tools in CBC delivery.

This scripted approach permits data source and method triangulation, enhancing the validity and reliability of findings. Despite potential challenges such as time limitations and resources availability, the strategy ensured an in-depth, evidence-based, and context-oriented understanding of the study objectives.

8. Findings and Discussion

This study investigated the effect of digital innovation on the adoption of the Competency Based Curriculum in the basic education system of Zambia. Relying on constructivist learning theory and technology acceptance models, the study investigated access to digital technology, teacher readiness, infrastructure challenges, and the equity effects of digital learning. Drawing on both quantitative and qualitative information, the findings introduce the extent of utilization of digital platforms in schools, key drivers of their uptake, and their influence on the achievement of Competency Based Curriculum goals of learner centered pedagogy, collaboration, and critical thinking. The next section summarizes the key lessons and discusses the policy and practice implications for supporting inclusive and technology-enabled learning in Zambia.

a. Access to Digital Tools and E-Learning Platforms

Digital tool and connectivity access is a fundamental but occasionally fulfilled requirement for effective e-learning incorporation in CBC adoption. While 55 percent of the respondents possessed smartphones, only 25 percent

enjoyed consistent internet access in learning environments. Further, 40 percent employed platforms such as WhatsApp and Moodle, suggesting spontaneous teacher-led adoption as opposed to institutional formal integration.

Further, a teacher in Petauke explained, "*We are essentially utilising WhatsApp to send homework because our learners have no computers,*" indicating reliance on mobile based technology.

The school manager in Chipata observed, "*The computer laboratory is there but power outages keep it down,*" pointing to electricity unreliability. Also, the Lundazi teacher reported, "*Sometimes we wait for days to be networked or use internet cafés in town,*" exhibiting infrastructural deficits. Such results attest to coping teachers adapting and reflect endemic infrastructural deficits. The results affirm the necessity to improve digital infrastructure and institutional backup for scalable e-learning which is in line with Mwansa and Ndhovu (2022) [13] study findings which proposed that e-learning is only achievable with digital infrastructure.

b. Experience with CBC and Digital Integration

Sixty percent (60%) of the respondents agreed that e-learning improves CBC results, but 35 percent of them reported not being effectively trained in online integration. This disparity validates the low impact of sporadic training and the necessity for ongoing focused capacity building.

According to a Mambwe Rural teacher, "*The CBC is promising, yet without digital infrastructure, especially in remote regions, it risks remaining theoretical rather than a practical reality.*" which tells a lot about the discrepancy between CBC ambitions and working conditions. Another in Petauke opined, "*We understand what CBC demands, but trying to implement it without ICT tools is like building a house without bricks.*" A school official in Katete also contributed, "*Training was provided, but there is a need for follow up mentorship,*" highlighting the absence of ongoing professional assistance. These observations underscore the importance of frequent mentorship and training to boost implementation effectiveness. Mulenga and Kapombwe (2019) also in their study recommended capacity building through Continuous Profession Development programmes so as to mentor more teachers with technological skills.

c. Correlation Analysis

CBC support was most strongly related to ICT training ($r = 0.612$) and platform experience ($r = 0.537$), and less so to internet access ($r = 0.472$) as shown in table 1 below. These results indicate that teacher competence and experience with digital tools are more potent predictors of CBC aligned e-learning than infrastructure. Further, the correlation analysis indicated that ICT training ($r = 0.612$) and platform experience ($r = 0.537$) were most significantly correlated with CBC-aligned e-learning support, suggesting teacher capability and familiarity with technology as key drivers of success. Internet access, although moderately correlated ($r = 0.472$), was less important. These results suggest that building teacher capacity through training and hands-on experience is more critical than infrastructure to attain effective digital integration in Zambia's education system. Chishimba and Mfuné (2021) [3] also echoed that digital training requires hands on type of training.

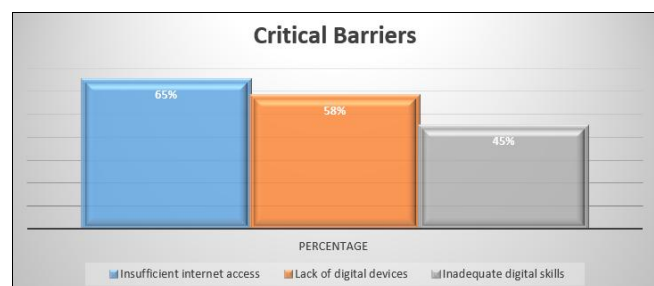
Table 2: Correlation Analysis of Factors Influencing Support for CBC-Aligned E-Learning

Variable	Correlation Coefficient (r)	Strength of Relationship	Interpretation
ICT Training	0.612	Strong positive	Strongest correlation with support for CBC through e-learning
Platform Experience	0.537	Moderate to strong positive	Meaningful correlation; experience boosts confidence and engagement
Internet Access	0.472	Moderate positive	Important but less influential than training and experience

Source: Field data, 2026

d. Barriers to Digital Integration

Critical barriers encountered were insufficient internet access 65 percent (65%), no devices 58 percent (58%), and inappropriate digital skills (45 percent). These constraints were quite high in rural schools. While there was a desire among teachers to apply digital tools, systemic constraints inhibited their successful utilisation. Further, the findings show internet access to be the most frequently reported challenge as also reported in the study by Mwelwa and Kapombwe (2019), followed closely by the lack of equipment, and a significant proportion also reporting inadequate digital competencies as seen in the study by Chishimba and Mfuno (2021) [3]. These challenges were especially acute in rural schools, where infrastructural and capacity shortages are more serious.



Source: Field data, 2026

Fig 1: Critical Barriers to Digital Integration Reported by Teachers

A head teacher from Nyimba highlighted, "We have the will but not the infrastructure," highlighting a mismatch between motivation and infrastructure. A Katete teacher said, "Even

where gadgets are donated, there's no electricity or the devices aren't enough." Another in Sinda added, "Power cuts and poor network hinder our capacity to conduct any consistent e-learning activities." These qualitative insights highlight the need for complementary interventions in infrastructure and capacity building to facilitate meaningful digital transformation.

e. Regression Analysis: Findings and Discussion

ICT training ($\beta = 0.598$) and platform experience ($\beta = 0.402$) were identified through regression analysis as determinants of the perception that e-learning reinforces CBC, not statistically significant from internet access ($p < 0.001$). The evidence is in support of teacher preparedness as the main element of success in digital integration rather than infrastructure as can be seen in the table below. ICT training ($\beta = 0.598$) and platform experience ($\beta = 0.402$) were identified as the most reliable predictors by the regression analysis that teachers' perception CBC implementation is facilitated by e-learning. Internet access, although statistically significant, was less impactful, suggesting that teachers' skills and knowledge of digital platforms are more critical than infrastructure. The implications of these findings stress the need for ongoing professional development and experiential exposure to digital applications as highlighted by Bwembya, Botha and Daka (2024) [2]. Policy actions should thus focus on building teacher capacity rather than investing solely in infrastructure to effectively integrate technology into Zambia's education system.

Table 3: Regression Analysis of Predictors of Perceived Effectiveness of E-Learning in Supporting CBC Implementation

Predictor Variable	Unstandardized Coefficient (β)	Significance Level (p-value)	Interpretation
ICT Training	0.598	< 0.001	Strong positive influence; statistically significant predictor
Platform Experience	0.402	< 0.001	Moderate positive influence; statistically significant predictor
Internet Access	Not specified	< 0.001	Less influential compared to training and experience; still statistically significant

Source: Field data, 2026

f. Teachers' Digital Readiness and Continuing Professional Development

Despite underpinning ICT training, many teachers reported low levels of confidence with the use of digital tools. Variance of digital competencies, lack of refresher training, and reliance on peer learning were recurring themes. An Education Officer in Lusaka noted, "Digital literacy varies quite significantly among teachers even WhatsApp is difficult for some." A Deputy Head teacher in Sinda observed, "There are no refresher courses. Once trained, that is it." A teacher in Katete interjected, "We learn mostly from each other," pointing to the absence of formalised capacity building. These findings emphasise the necessity of constant context sensitive professional development and systematic mentorship to equip digital readiness

enhancements which was the major recommendation in the study by Bwembya, Botha and Daka and also in the study by Chiwoya, Daka and Mulenga - Hagane (2025) [4].

g. Equity and Inclusion in Digital Learning: Results and Discussion

Consistent gaps in access to digital were found cutting across geographic as well as gender lines. Rural learners and girls were disproportionately disadvantaged. Further, one teacher in Petauke said, "Many of our girls' miss classes because their brothers are using the home phone" a sign of gendered access impediments. Katete observed another, "CBC using digital ways may be for urban learners; it is not succeeding for our rural pupils." A Mambwe school councillor relayed, "Some learners get disappointed. They

watch others who have devices and feel excluded." These findings indicate the urgent need for inclusive digital education policy that responds to access to devices, gender equality, and rural disadvantage as also stated in the Ministry of Education 2023 [7] Curriculum Framework (MOE, 2023). Without specific intervention, digital integration threatens to worsen current educational inequalities.

9. Conclusion

In conclusion, this study highlights the potential of digital innovation to transform Zambia's Competency-Based Curriculum, while also underscoring the need for strategic investments in teacher capacity building, infrastructure development, and equitable access to technology. By addressing these challenges and prioritizing teacher preparedness, educators and policymakers can create more inclusive, effective, and sustainable learning environments. Ultimately, this research underscores the importance of a holistic approach to integrating digital innovation in Zambia's education system, one that empowers learners to thrive in the 21st century.

10. Implications of the Study

The findings of the study have a series of important implications:

1. **Policy Formulation:** The Ministry of Education and stakeholders are not just required to prioritise the provision of digital tools but also their accessibility and integration into CBC-conformant pedagogical practices. Policies should prioritise constant teacher training and the introduction of mentorship systems for the adoption of digital learning.
2. **Training of Teachers and Capacity Building:** Given the high level of ICT training reliance on effective CBC implementation, it is essential to establish scalable, context-specific professional development programs. A one off workshop is insufficient. Instead, there is a need to establish a structured and continuous system of adaptive training aimed at developing and sustaining teacher competence.
3. **Digital Equity and Gender Inclusion:** This study emphasises that digital initiatives must prioritize bridging existing gaps in access to avoid exacerbating current inequalities. Targeted interventions are essential to ensure that all learners, particularly girls and those in rural areas, can equally benefit from digital learning opportunities.
4. **System Resilience:** Online platforms are crucial for ensuring educational continuity during emergencies like pandemics or natural disasters. By integrating digital technology more deeply into schools, the education system can become more resilient and adaptable.

11. Recommendations

1. **Build Stronger Teacher Professional Development:** The government must implement continuous ICT training in accordance with the CBC. Teacher education institutions must integrate digital literacy into the course curriculum. Additionally, schools must implement mentorship programs that support peer teaching and digital pedagogy.
2. **Invest in School-Level Infrastructure:** There is need to have investment in essential infrastructure such as

digital devices, reliable electricity, and solar-powered gadgets, along with internet access, particularly in rural areas. Low-bandwidth, mobile-friendly learning platforms will be vital to ensure learners in underserved communities can access educational resources effectively.

3. **Encourage Inclusive Digital Policies:** Education policy must include equity-informed approaches to address gender and geographic inequities. Communities need to be involved to encourage shared use of devices and shared digital learning spaces.
4. **Monitor and Evaluate Digital Interventions:** A robust monitoring and evaluation framework must be established to assess the impact of digital tools on educational outcomes. The insights gathered should be used to enhance the quality of content delivery and ensure that interventions remain relevant and effective.
5. **Incorporate Digital Tools into Curriculum Delivery:** Digital solutions should be strategically aligned with the objectives and framework of the Competency-Based Curriculum (CBC). Schools must be supported and encouraged to formally institutionalise the use of digital learning platforms within their instructional practices, moving beyond ad hoc or inconsistent application toward systematic and sustained integration.

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