Pre-primary teachers' utilization of instructional resources for competency-based education and learners' achievement in mathematical activities: Evidence from Bungoma County, Kenya

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ABSTRACT

This study examined how pre-primary teachers' capacity to use instructional resources for Competency-Based Education (CBE) influences learner achievement in mathematical activities in Bungoma County, Kenya. Teacher capacity was measured across three dimensions: institutional material support, resource improvisation, and internet access. Learner achievement was assessed using early numeracy scores. Grounded in McClelland's Competent Performance Model, the study employed a Solomon four-group quasi-experimental design and a mixed-methods approach. Stratified, purposive, and simple random sampling techniques were used to select 16 host primary school headteachers, 16 pre-primary teachers, 8 Curriculum Support Officers (CSOs), and 260 pre-primary 2 (PP2) learners. Data collection instruments included teacher questionnaires, interview guides for headteachers and CSOs, and mathematical activities test for learners. Quantitative data were analyzed using multiple linear regression and independent-samples t-tests in SPSS, while qualitative data were analyzed thematically. The findings indicated that institutional material support alone did not significantly predict learner achievement ($p = 0.820$). Teachers reported a high rate of material improvisation (87.6%) despite substantial resource gaps, including a lack of internet access in 81.3% of schools. Experimental findings indicated that targeted training significantly improved instructional capacity, with learners recording a 21.5-point increase in numeracy scores ($t = 3.24$, $p = 0.001$, $M = 58.82$). The study recommends that the Ministry of Education establish a standardized resource allocation policy to address school funding gaps, provide offline digital materials to mitigate limited internet access, and establish peer-mentorship clusters to support resource improvisation and prevent professional burnout.

Keywords: Competency-Based Education, Instructional Resources, Learner Achievement, Mathematical Activities, Pre-Primary Learners, Pre-Primary Teachers

I. INTRODUCTION

The realization of early childhood educational goals under Competency-Based Education Curriculum (CBEC) centers heavily on interplay between instructional infrastructure and active teacher preparedness. When educators enjoy reliable access to structured pedagogical materials, it provides a foundational baseline for young learners to pick up core mathematical abilities. Within this instructional change, consistent institutional provision of specialized learning aids encourages teachers to broaden how they present numerical relationships in classroom. Yet, global observations reveal that resource deficits regularly limit this readiness. For example, Demir (2025) noted that early childhood teachers in Turkey, despite appreciating the long-term value of early numeracy, struggled to meet competency goals due to lack of curriculum resources and institutional training. Regionally, unbalanced resource distribution within learning centers limits access to required content tools, a problem that Waweru (2018) points to as primary driver behind low learner scores in essential mathematical activities. To balance these reference point infrastructure gaps, pre-primary educators frequently depend on creative material improvisation as core element of their instructional readiness. In settings where official curriculum materials are missing, a teacher's resourceful talent dictates whether young students receive enough sensory exposure to grasp early arithmetic concepts (Sutiani et al., 2021).

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Utilizing localized or self-made items changes the learning space; it lets teachers view learner potential differently as they watch children spontaneously invent games and explore numeric properties with minimal adult steering (Haug & Mrok, 2021). Data from across Sub-Saharan Africa reinforces this approach. In Nigeria, Adu (2024) demonstrated that using improvised items shifts both interest levels and learning outcomes for the better, while Rwigema and Andala (2022) observed that in Rwanda, resourceful material adaptation-built learner self-assurance and enhanced task participation. Nonetheless, while resourcefulness fixes immediate physical shortages, teachers still need deep curriculum familiarity to ensure their adapted tools match strict standards set by Competency-Based Education (CBE) frameworks. In today's digital climate, web navigation has become a major avenue for teachers seeking compliant, high-quality pedagogical content. Digital readiness acts as gateway to varied lesson aids that help clarify abstract mathematical ideas. However, success of this digital switch remains closely tied to institutional infrastructure. As Nettey et al. (2024) indicates, looking up online content matters little if Information and Communication Technology (ICT) equipment is not available during actual lesson window.

In the contemporary Kenyan educational scene, the mathematical activities curriculum is framed as a transformative strategy explicitly engineered to nurture distinct 21st-century learner core competencies, among them digital literacy. As mandated by the Kenya Institute of Curriculum Development (KICD, 2017), the systematic implementation of this Competency-Based Education Curriculum (CBEC) at the early childhood level is structurally designed to guarantee early learner mastery of fundamental number sense, spatial shape identification, and elementary operations. However, the translation of this policy from a conceptual layout into actual classroom performance is heavily dependent upon comprehensive teacher creativity. On a macro-evaluative level, a national monitoring assessment conducted by IBE-UNESCO (2017) exposed substantial design-practice implementation gaps, revealing profound systemic deficits in teacher comprehension that fundamentally fastener an educator's capacity to revolutionize mathematical pedagogy into broader numeracy skills. This policy disconnect is further substantiated by the Kenya National Union of Teachers (KICD, 2018) and Ondimu (2018) who consistently show that educators experience severe functional difficulties in executing formative competency assessments and frequently manifest inadequate technical mastery across integrated digital learning zones.

While localized inquiries, such as Akala (2021) in Kenya, indicate that pre-primary instructors maintain highly positive attitudes towards the curriculum, they are incapacitated by acute institutional material shortages and weakly structured classroom aids. Consequently, as synthesized by Isaboke et al. (2021), chronic instructional unreadiness within the early childhood workspace acts as primary institutional barrier. This barrier systematically derails foundational mathematical instruction and exposes critical research gap, regarding how localized settings such as Bungoma County can mobilize teacher improvisation and digital integration to mitigate these profound resource vulnerabilities. Furthermore, in Homabay Awuonda et al. (2023) found out that shallow digital literacy among early childhood staff can block teachers from finding high-quality web resources, leaving learners with poorly formed numeracy competencies. Eventually, overlap of institutional backing, operational technology, and teacher inventiveness determines how well young learners master early numeracy.

As found by Kukali (2020) in the study of Mt. Elgon Sub County curriculum structuration, results found out that while instructional frameworks exist, they do not specifically address influence of pre-primary teacher innovative resource use on mathematical awareness. This inquiry directly addresses these effective realities within the localized research context of Mt. Elgon Sub County, Kenya. The area faces severe educational constraints at pre-primary level, characterized by an ongoing 60% rate in local learner placement assessments scoring ‘approaching expectations’ and ‘below expectations’ (Bungoma County 2023-2025 diagnostic assessment reports). By examining how teacher readiness and resource gaps influence these outcomes, this study offers actionable insights for various educational bodies. Nationally, the Ministry of Education (MOE) can use findings to refine policy guidelines, creating unified national plans that match county-level performance with the entry requirements of Grade One.

Similarly, the Kenya Institute of Curriculum Development (KICD) can utilize these field insights to modify curriculum designs that reflect real-world classroom conditions, while Teachers Service Commission (TSC) and Kenya Education Management Institute (KEMI) can shape focused professional training targeting digital literacy and assessment skills. Locally, the Bungoma County Government's Department of Education and Vocational Training can leverage this localized evidence to domesticate Early Childhood Development Education (ECDE) directives, ensuring targeted funding for math tools and training tracks that address distinct struggles faced by their teachers.

1.1 Statement of the Problem

Ideally, the proper use of instructional resources by pre-primary teachers simplifies complex mathematical concepts, helping learners gain mastery and basic skills. Within the framework of Competency-Based Education (CBE), school material support, a teacher's ability to make local resources, and the skillful use of internet-aided Information and Communication Technology (ICT) tools are important drivers that improve classroom curriculum delivery. These capacity factors work together to improve pre-primary learner performance in early numeracy skills. Conversely, the

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poor or ineffective use of teaching materials by teachers seriously lowers student achievement in mathematics. Educational stakeholders point out that a large number of pre-primary teachers have low capacity to use instructional resources for CBE, mainly because the curriculum design process was top-down and lacked enough stakeholder involvement. This capacity gap is shown in diagnostic assessment reports for Grade One learners in Bungoma County from 2023 to 2025, which consistently show that about 60% of learners score at the "approaching expectations" or "below expectations" levels in basic numeracy. This persistent low performance shows a clear link between poor teacher resource use and low success in numeracy awareness among preschoolers.

Although the national and county governments have intervened by providing curriculum guides, textbooks, and professional development training to improve teachers' skills, low-performance levels persist. Furthermore, while global and regional studies have shown a general nexus between teacher resource use and the learning of basic skills across different subjects, there is a lack of localized research focusing specifically on how pre-primary teachers use instructional resources within competency-based mathematical activities in Bungoma County, Kenya. If left unfixed, this lack of research and practical skills will continue to lower early childhood numeracy levels. Therefore, this study sought to find out how the instructional resource use capacity of pre-primary teachers influences learner achievement in competency-based mathematical activities in Bungoma County, Kenya.

1.2 Research Objectives

i. To determine the influence of the availability of institutional material support on learner achievement in competency-based mathematical activities in Bungoma County, Kenya.
ii. To assess the influence of pre-primary teachers' utilization of improvised instructional resources on learner achievement in competency-based mathematical activities in Bungoma County, Kenya.
iii. To evaluate the influence of pre-primary teachers' integration of internet-aided ICT tools on learner achievement in competency-based mathematical activities in Bungoma County, Kenya.

II. LITERATURE REVIEW

2.1 Theoretical Review

2.1.1 Competent Performance Model

This inquiry is grounded in Competent Performance Model by McClelland (1973). McClelland's framework posits that visible behavioral outcomes, such as traditional intelligence indices or mere physical environmental tools, are insufficient predictors of successful institutional outcomes. Instead, actual performance modification is driven by underlying individual competencies, comprising expert knowledge, real skill sets, self-efficacy, and hands-on behavioral qualities that enable an instructor to navigate and utilize their operational environment effectively. Within an educational ecosystem, this model suggests that the structural availability of classroom infrastructure or commercial artifacts is inert until acted upon by the intrinsic utilization capacity of the instructor.

In this inquiry, Competent Performance Model explicitly anchors interaction between teacher improvisation and preschool mathematical achievement. The physical tools provided by school system represent passive environmental context. Teacher's capacity to secure institutional support, fabricate improvised manipulatives out of local materials, and selectively integrate internet-aided digital tools represents the active competency dimension. When applied to the study's empirical conflicting data, McClelland's framework explains why scarce resource availability yielded non-significant predictive value ($p = 0.820$). Because underfunded teachers leveraged high intrinsic competency through an 87.6% improvisation rate, they successfully bypassed institutional deficits to stabilize learner outcomes. Furthermore, the true experimental data ($p = 0.001$) validates McClelland's core assertion: when targeted training deliberately upgrades behavioral competency and utilization skills, the efficiency of environmental resource manipulation increases. This change directly triggers significant performance rise ($M = 58.82$) in early childhood numeracy.

2.2 Empirical Review

2.2.1 Institutional Material Support and Learner Achievement

Relationship between institutional material support and academic achievement has been evaluated globally and regionally using diverse methodological approaches, yet significant background and methodological gaps endure. Opondo et al. (2023) carried out qualitative descriptive study in Kajiado, Kenya, using interview schedules and classroom observation tools to investigate Competency-Based Education (CBE) application challenges. Their major findings indicated that imbalanced institutional provision of instructional resources severely hampered teacher participation and lowered learner scores across subject areas. Methodologically, however, their study relied entirely on qualitative tracking without isolating causal impacts or quantifying statistical variance in learning outcomes. Similarly, Begum and Liton (2018) employed quantitative approach applying multiple linear regression analysis to evaluate

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predictive weight of teacher supervision and optimized competence on student success. While their findings established that supervision combined with optimized resources significantly predicts academic success, their scope was strictly limited to primary school learning outcomes. This creates distinct contextual gap regarding pre-primary environments.

This institutional gap is further highlighted by Ekeh and Ramsaroop (2022) in their quantitative descriptive survey of mathematics subject supervisors in public pre-primary and primary schools. Employing four-point Likert scales, means, and standard deviations, they established that while subject supervisors diligently attempt to regulate quality outputs, they frequently fail to build internal "communities of practice" among early childhood staff due to poor learning setups and low teacher morale. While Ekeh and Ramsaroop (2022) map out administrative setbacks of material supervision, their study focused on supervisor roles rather than measuring direct empirical influence of pre-primary teacher's unique resource utilization capacity on standardized learner testing metrics. This study addresses these combined gaps by deploying quasi- experimental Solomon Four-Group design to mathematically isolate impact of institutional support within competency-based pre-primary mathematics classes in Bungoma County.

2.2.2 Utilization of Improvised Instructional Resources and Numeracy Outcomes

Extant literature frequently champions pedagogical improvisation as vital cushion against institutional resource insufficiency, though current studies suffer from severe conceptual and environmental gaps. Sutiani et al (2021) investigated the development of innovative learning materials using quasi-experimental design. Their major findings revealed that an educator's inventive skills and utilization of alternative materials significantly improved learner core competencies. However, their research presents deep conceptual gap as it focused on high-level physical chemistry concepts among older students, leaving influence of pre-primary teachers' improvisation on early childhood numeracy baselines unattended to. To understand procedure of local material production, Amunga et al. (2020) and Adu (2024) utilized descriptive qualitative frameworks to explore how material improvisation functions in underfunded primary school environments. Their findings categorized improvisation into three operational paths: modification, substitution, and construction. It revealed that successful implementation requires essential artisan proficiencies such as model crafting, color graphics, and calligraphy. Despite these insights, both Amunga et al. (2020) and Adu (2024) presented isolated summaries of teacher experiences. They failed to link these improvisation types to objective learner testing outcomes using inferential statistical modeling. This leaves methodological gap that this inquiry resolves by processing teacher improvisation rates against standardized mathematical activities diagnostic test via Multiple Linear Regression (MLR).

2.2.3 Integration of Internet-Aided ICT Tools and Mathematical Achievement

Integration of digital resources into early childhood education is expanding field of empirical inquiry, but studies remain harshly divided by regional economic differences. In Europe, Aleksieva et al. (2025) applied Digital Technology Integration Framework (DTIF) within mixed-methods design tracking 44 primary school teachers across 26 schools. Their findings demonstrated that while student-centered digital pedagogies are essential, equitable institutional access to high-speed internet infrastructure is the absolute prerequisite for maximizing mathematics achievement. This European reference point presents major contextual gap when applied to developing economies, where digital infrastructure is not yet stabilized variable. Regionally, researchers have focused heavily on mapping out digital barriers rather than performance outcomes. Nettey, et al (2024) utilized an interpretive qualitative paradigm in Ghana to analyze ICT integration barriers, finding that a lack of electrical outlets, poor internet connectivity, and lack of fully-subscribed software packages halt teacher effectiveness. In tandem, Mbawala and Lestari (2024) executed a descriptive qualitative case study in Tanzania, establishing that inadequate technical support, lack of hardware devices, and a lack of systematic professional training loops prevented teachers from utilizing digital technology to teach foundational numerical skills. Locally, Haji et al. (2023) echoed these findings in Kenyan public primary schools, exposing severe internet fluctuations and low teacher digital literacy. The predominant gap across these African studies is methodological: they stop at descriptive barrier identification. None of these studies modeled the predictive weight of internet access on early childhood numeracy outcomes under competency-based framework, a critical empirical gap that the present study addresses.

III. METHODOLOGY

3.1 Research Design

This study adopted Solomon Four-Group quasi-experimental design to evaluate the influence of teacher ability to utilize pedagogical competencies on early childhood numeracy development. This design was selected because it rigorously controls for potential pre-test sensitization and testing artifact effects, which frequently threaten external soundness in educational interventions. By dividing participants into four distinct groups (two experimental and two

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control cohorts), the design isolates main effects of pedagogical intervention, measures possible interaction effects of pre-testing, and ensures that any post-test math achievement gains can be confidently attributed to the intervention itself.

3.2 Study Area

The inquiry was conducted within Bungoma County, Kenya, utilizing early childhood education centers integrated into public primary school setups. Bungoma County was selected because its public pre-primary sector undergoes severe material constraints, skewed regional resource distributions, and essential infrastructure deficits. This environment provided an ideal field-testing ground to observe how teacher resource utilization ability within CBE and improvisation interact with institutional deficits to influence Mathematical instructional outcomes.

3.3 Target Population

The comprehensive target population comprised 30,881 individuals managed through the Ministry of Education records across Bungoma County, spanning: 802 pre-primary centers distributed across the county's constituent sub-counties, 2,620 pre-primary teachers actively employed by the County Government of Bungoma, 27,450 Pre-Primary 2 (PP2) learners, 9 Curriculum Support Officers (CSOs) tasked with sub-county pedagogical oversight.

3.4 Sampling and Sample Size

The study sample comprised total cohort of 300 participants, inclusive of 260 PP2 learners, 16 PP2 teachers, and 8 Curriculum Support Officers drawn across 16 sampled pre-primary centers (representing 16 host headteachers). A multi-stage sampling framework was systematically used: Out of the nine sub-counties within Bungoma County, eight were selected for active field implementation, while one sub-county was reserved to isolate pilot testing data. Institutional frame within the eight participating sub-counties was stratified along rural-urban administrative lines to capture varying socio-economic orientations and resource densities. Within these strata, centers that have continuously undertaken competency-based mathematical instruction for at least five years were purposively sampled. Simple random sampling was applied within rural and urban strata to select two institutions per sub-county, yielding 16 pre-primary centers. These 16 centers provided architectural base to distribute participants evenly across four independent tracks required by Solomon Four-Group configuration. Across 16 selected centers, an overall population of 800 PP2 learners was identified. Fisher's Formula for finite populations was applied to calculate representative sample capable of preserving statistical power:

$$n = \frac{Z^2 \times p \times q \times N}{e^2 \times (N-1) + Z^2 \times p \times q}$$

Where Z = 1.96 (95% confidence level), (p = 0.50) (estimated population variance proportion), (q = 0.50), (N = 800) the finite learner pool across the selected centers), and e = 0.05 (acceptable margin of error). The operational calculation generated final target allocation:

$$n = \frac{(1.96)^2 \times 0.50 \times 0.50 \times 800}{(0.05)^2 \times (800-1) + (1.96)^2 \times 0.50 \times 0.50} \approx 260 \text{ (learners)}$$

In single-streamed centers, all PP2 learners were accommodated due to inherent class size limits, whereas simple random sampling was used to allocate learner assignments in multiple-streamed units. All 16 host headteachers, 16 teachers of mathematical activities and 8 available CSOs within sampled zones were purposively integrated into the tracking operations.

3.5 Data Collection Instruments and Procedures

3.5.1. Data Collection Instruments

Data collection triangulated four custom-built instruments to capture both instructional behaviors and learning outcomes. Thus, pre-primary teachers' questionnaire was structured around five-point Likert scale, this instrument measured teacher ability to utilize resources for Competency-Based Education (CBE). It quantified data regarding institutional support, resources improvisation and digital resources utilization relative to learner achievement in Mathematical Activities. Head Teachers and CSOs. Semi-structured qualitative interview guides were used to captured administrative and professional support systems, instructional management traits, and systemic curriculum execution barriers. A standardized observation schedule was applied directly during active Mathematical Activities (MA) lessons to preserve natural validity. It recorded real-time teacher instructional practices and verified the 87.6% improvisation rate of physical and digital tools made from local materials. A standardized learner Mathematical test evaluated actual learner achievement requirements across fundamental numeracy strands, encompassing number sense, ICT integration, shape identification, simple operations, and basic measurement tasks.

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3.5.2 Instruments Quality Control

A pilot study was conducted within the single sub-county excluded from the main research sample. Data gathered from teachers, learners, and one CSO within the pilot zone were used to refine the tools, adjust language ambiguities, and correct omissions. Face and content validity were established by submitting standardized instruments to university supervisors and curriculum experts who reviewed all evaluation items against behavioral standards and institutional indicators. Internal consistency reliability metrics were calculated using Cronbach's alpha (α) coefficients:

α=Nτ ⁄υ¯+ (N-1) τ Where: N = The number of items within scale instrument. τ = The mean inter-item covariance among test indicators = The average variance across items. The pilot calculations yielded high internal consistency values across all instruments. Thus, Lesson Observation Schedule (α = 0.90), Teachers' Questionnaire (α = 0.88), CSO Interview Guide (α = 0.87), Learner Test (α = 0.82), and Head Teacher Interview Guide (α = 0.79). All metrics exceeded conventional methodological reference threshold (α =0.70).

3.5.2 Field Procedures and Timeline

The execution of the study followed three sequential phases. Phase I included Pedagogical Intervention Training (2 Weeks): From January 2nd to January 16th, teachers in the experimental groups underwent an intensive two-week targeted pedagogical training program focused on upgrading active instructional competencies, digital integration capacity, and local material improvisation. Phase II was Field Implementation (One Full Term / 3 Months): Following the training, field data collection and intervention tracking were conducted over one full academic term spanning three months. Experimental groups deployed their raised pedagogical skill sets while control groups maintained traditional, standard instructional conditions. Phase III was Assessment Administration: Questionnaire was personally administered to teachers, qualitative interviews were conducted with head teachers and CSOs, and learner tests were administered in accordance with the Solomon Four-Group pre-test (beginning of the term) and post-test (end of term) schedule.

3.6 Data Analysis

Quantitative data were compiled, cleaned, and processed using SPSS v.28. Statistical modeling was performed in two tracks to address the research objectives: Multiple Linear Regression analysis was conducted to isolate predictive validity of physical resource availability versus active teacher competency. The model confirmed that inadequate resource availability yielded non-significant predictive value ($p = 0.820$), highlighting that physical tools are slow until manipulated by teacher competency. Intervention Effect Evaluation through Analysis of Variance (ANOVA) models were deployed to evaluate post-intervention numeric metrics across four Solomon groups. By comparing post-test mean scores across groups with and without pre-tests, ANOVA isolated main effect of training intervention while ruling out pre-test sensitization. Analysis verified that upgrading active behavioral competencies directly caused significant performance rise ($p = 0.001$); ($M = 58.82$) in early childhood numeracy.

3.7 Ethical Considerations

Institutional approval was secured from the University of Nairobi Graduate School, which was used to obtain an official research permit from the National Commission for Science, Technology and Innovation (NACOSTI). Administrative clearance was further granted by Bungoma County Education Office. Written informed consent was obtained from all participating teachers, head teachers, and CSOs, and parental/guardian consent was secured for all preschool learners. Participant secrecy and data confidentiality were protected using alphanumeric codes in place of personal identifiers. To ensure equity in instructional access, teachers in control group were provided with identical targeted pedagogical training packages immediately following conclusion of experimental tracking phase.

Limitations associated with this study's findings were mitigated through:

To protect the study's validity, specific limitations were mitigated through targeted field controls. Potential disruptions to routine school programs were avoided by coordinating alternative data collection timelines directly with school administrations. Individual learner variations in mathematical activities were controlled by using a uniform Grade One diagnostic assessment as the standard measure across the county. To minimize social desirability bias and ensure honest feedback regarding Competency-Based Education (CBE), respondents were assured of strict confidentiality and informed that the data was for academic research rather than performance appraisal. Finally, to prevent conceptual drift, the investigation was strictly anchored within McClelland's (1973) Competent Performance Model, focusing exclusively on three resource-use dimensions—institutional support, material improvisation, and digital access, while controlling for external confounding variables such as parental involvement, in-service training, and prior learner knowledge.

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IV. FINDINGS & DISCUSSION

4.1 Response Rate and Institutional Baseline Framework

The study achieved an overall response rate of 96%, providing robust and statistically reliable foundation for generalizing field results across Bungoma County. Complete participation datasets were obtained from 254 pre-primary learners (98%), 16 pre-primary teachers (100%), and 8 Curriculum Support Officers (100%). Participation among host headteachers was lower at 8 individuals (50%) due to competing administrative commitments.

To operationalize the study within McClelland's (1973) Competent Performance Model, teachers' basic interactions with instructional tools were evaluated across three core dimensions: institutional support, teacher-led improvisation, and digital resource accessibility. These baseline descriptive metrics are systematically compiled in Table 1.

Table 1

Availability and Management of Instructional Resources for Mathematical Activities.

Statement	Strongly Agree (SA)	Agree (A)	Neither Agree nor Disagree (NS)	Disagree (D)	Strongly Disagree (SD)
I. Instructional resources are	0 (0.0%)	8 (50.0%)	0 (0.0%)	3 (18.8%)	5 (31.3%)
availed to me by institution					
II. I improvise instructional resources during mathematical	7 (43.8%)	7 (43.8%)	0 (0.0%)	1 (6.3%)	1 (6.3%)
activities lessons					
III. I access internet for	0 (0.0%)	3 (18.8%)	0 (0.0%)	5 (31.3%)	8 (50.0%)
instructional resources during					
mathematical activities lesson					

4.1.1 Influence of Institutional Support on Learner Achievement.

The first objective of the study was to find out how institutional resource provision influence early math achievement among learners. Descriptive data for the statement, "*Instructional resources are availed to me by the institution,"* showed 50/50 split among pre-primary teachers. Half of the sampled teachers (50.0%, n=8) agreed that they received materials from their schools, while the other half (50.1%, n=8) disagreed or strongly disagreed with the statement. This even split shows that there are differences in funding and resource distribution across public pre-primary centers in primary schools within Bungoma County.

When data were analyzed using regression to see how physical resources predict student performance, the results showed that static institutional resource availability does not significantly predict learner achievement ($p = 0.820$, $p > 0.05$). The complete statistical details from this regression analysis are shown in Table .2.

Table 2

Multiple Regression Analysis of Institutional Resource Availability on Learner Achievement.

Panel A: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate			
1	0.015	0.000	-0.004	12.810			
Panel B: ANOVA (Model Significance)							
Model	Sum of Squares	df	Mean Square	F	Sig. (p-value)		
Regression	8.52	1	8.52	0.052	0.820		
Residual	39031.18	238	164.00				
Total	39039.70	239					
Panel C: Coefficients Matrix							
Predictor Variable			Unstandardized B	Std. Error	Beta (β)	t	Sig. (p-value)
(Constant)			36.840	2.150		17.135	< 0.001

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Institutional Support.	0.110	0.480	0.015	0.229	0.820

Note: Dependent Variable: Learner Achievement in Mathematical Activities. Predictor: (Constant), Institutional Support (Static Resource Availability).

The statistical breakdown in Table 2 shows an R-Square value of 0.000. This means that basic institutional resource provisioning explains 0% of changes in numeracy scores. The overall model is not statistically significant ($F = 0.052$, $p = 0.820$), and the regression coefficient confirms that presence of institutional tools has no predictive weight ($\beta = 0.015$, $t = 0.229$, $p = 0.820$). This non-significant relationship shows that having physical school infrastructure alone does not directly improve mathematical performance. This finding supports McClelland's (1973) theory, which notes that physical tools remain passive until a teacher has actual skills and training to use them effectively in the classroom.

4.1.2 Influence of Teacher-Led Resource Improvisation on Learner Achievement.

The second objective evaluated the level and effect of teacher-made learning materials during classroom instruction. The data for the statement, "I improvise instructional resources during mathematical activities lessons," was highly supported by the respondents. Out of the sampled teachers, 87.6% (n=14) confirmed that they actively improvised materials during their lessons, with 43.8% strongly agreeing and 43.8% agreeing. This high rate shows that pre-primary teachers in underfunded schools make a deliberate effort to create their own math counters and teaching aids from the local environment to handle the lack of school-supplied resources.

Qualitative feedback from Curriculum Support Officers (CSOs) supported these questionnaire results. During interviews, one officer noted the following regarding teacher efforts:

> *"If mathematical activities are successful, it's not because schools bought manipulatives. It's because teachers went out of their way, used local materials, and improvised. They are doing the work of school management."*(CSO, 12th February 2024).

This high rate of improvisation shows how teachers manage to keep learning stable, even when their schools do not have enough funds for instructional materials. These findings agree with Sutiani et al. (2021), who found that a teacher's creativity directly helps to reduce the problems caused by a shortage of school textbooks and materials. However, this situation also points out challenges mentioned by Opondo et al. (2023) about the heavy burden placed on early childhood educators when resource allocation is limited. Furthermore, Curriculum Support Officers observed that relying entirely on the teacher's personal effort works only as a temporary survival mechanism rather than a sustainable way to implement Competency-Based Curriculum (CBC). They noted that improvisation cannot permanently replace 'standard, well-funded materials from institutional level.

4.1.3 Influence of Digital Resource Access on Learner Achievement.

The third objective examined the accessibility of digital infrastructure for inquiry-based learning. Statement III revealed a severe technological deficit, with 81.3% (n=13) of teachers reporting a complete lack of internet access during instructional hours (31.3% disagreeing; 50.0% strongly disagreeing). Curriculum Support Officers identified this digital isolation as the most serious structural barrier within the Competency-Based Curriculum framework. During an interview conducted on 12th February 2024, one officer noted:

> *"The internet access issue is critical. We are asking teachers to prepare and teach a 21st-century curriculum, but we are denying them the most basic 21st-century tools. Mathematical Activities is meant to be inquiry-based, but teachers can't even research simple concepts."*(CSO, 12th February, 2024)

This deficit highlights an operational problem: while the curriculum requires digital integration and inquiry-led learning, the lack of physical infrastructure prevents its execution. This structural barrier supports the findings of Ebu et al. (2022) and Qaddumi et al. (2023), who emphasize that technology-mediated learning and modern teaching competencies are undermined when baseline infrastructure is withheld.

4.2 Experimental Evaluation of Targeted Teacher Training Countermeasures.

To test the active assertion of Competent Performance Model, that deliberately upgrading behavioral competency increases resource manipulation efficiency and drives learner achievement, the study analyzed post-intervention learner scores using Solomon Four-Group configuration. The comparative scores between experimental and control cohorts are summarized in Table 3.

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Table 3

Independent Samples T-Test for Post-test Mathematical Achievement Scores.

Group Designations	Sample Size (n)	Mean Score (M)	Standard Deviation (SD)	(t)-statistic	Degrees of Freedom (df)	Significance Value (p)
Experimental Group (Enhanced Training)	120	**58.82**	15.55	**3.24**	**238**	**0.001**
Control Group (Standard Approach)	120	**37.32**	12.76	*(Equal variances not assumed)*		*(Highly Significant)*

The empirical results demonstrate wide performance gap between the two groups. Learners whose teachers underwent intensive two-week pedagogical training on instructional resource utilization achieved superior mean score of 58.82, SD = 15.55. Conversely, learners in the control group, where instructors maintained standard, unassisted resource methods, achieved lower mean score of 37.32, SD = 12.76.

Because Levene's test for equality of variances was significant $p = 0.004$, equal variances were not assumed. The corrected inferential model generated highly significant t-statistic of 3.24, $df = 238$, $p = 0.001$. Because of $p < 0.05$, this statistical shift confirms that targeted capacity building, focusing on securing local support, maximizing the 87.6% improvisation rate, and navigating digital access barriers, directly caused the 21.5-point performance rise in pupil numeracy. Qualitative data supported these statistical results. Another Curriculum Support Officer added during an interview on 4th March 2024:

> *"When we looked at the post-test classes where teachers received resource training, the kids were not just memorizing. They were using localized counters and shapes to solve tasks on their own. The physical objects made a clear difference."*(CSO, 4th March 2024)

Experimental learners' high scores were attributed to their interactive classroom tasks and direct teacher assistance with improvised counters. Similarly, teachers noted that upgrading their instructional skills allowed them to break down complex math concepts into simple, concrete ideas, thereby keeping learners focused and driving better outcomes across the activity area.

V. CONCLUSION & RECOMMENDATIONS

5.1 Conclusion

This study concludes that pre-primary learner achievement in competency-based mathematical activities is not determined by physical presence of commercial instructional resources, but by the practical skills and utilization capacity of the instructor. Descriptive analysis shows serious structural challenges, including an even split in basic school funding and an 81.3% digital infrastructure deficit across the county. However, the non-significant regression output ($p = 0.820$) demonstrates that these physical deficiencies do not automatically result in low academic performance. This is because resourceful educators actively step in to handle institutional shortage through high rates of local material improvisation (87.6%). Furthermore, the Solomon Four-Group experimental findings $t = 3.24$, $p = 0.001$) prove that teacher resourcefulness is a capacity that can be significantly improved through targeted training. When teachers receive structured training to improve their resource use, learner numeracy scores increase by over 21 percentage points. Therefore, while independent teacher improvisation can temporarily protect an underfunded system, deliberate capacity building in instructional resource use is the main requirement for achieving high early childhood mathematical outcomes in Bungoma County.

5.2 Recommendations

To improve early childhood numeracy outcomes, the Ministry of Education and the Bungoma County Department of Education and vocational training should establish standard resource allocation policy to eliminate the 50% funding disparity between rural and urban centers. To resolve 81.3% digital deficit, county authorities must invest in basic internet connectivity alongside offline alternatives, such as pre-loaded digital storage devices containing mathematics instructional media. For classroom practice, school administrators and lead teachers should develop localized pedagogical toolkits and sub-county peer-mentorship clusters. These initiatives will standardize material improvisation from stressful survival mechanism into structured, school-wide activity that prevents teacher burnout. Finally, county governments must restructure their early childhood unit budgets to include permanent funding lines for teacher professional development and material procurement, ensuring that instructional quality does not depend entirely on unassisted teacher improvisation.

Declaration of Interest

The authors declare that they do not have any known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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