

Beyond electricity and computers: How institutional information and communication infrastructure shapes teachers' digital technology use in public junior secondary schools in Kakamega County, Kenya

Paul Okemwa Makori¹
Judah Mualuko Ndiku²
Geoffrey Ababu Musera³

¹pmakori12@gmail.com

²jndiku@mmust.ac.ke

³gmusera@mmust.ac.ke

^{1,2,3}Masinde Muliro University of Science and Technology (MMUST), Kenya

<https://doi.org/10.51867/ajernet.7.4.89>

ABSTRACT

Access to functional digital infrastructure is a prerequisite for teachers to convert information and communication Technology (ICT) competence into classroom practice, yet the quality and distribution of infrastructure remain uneven in many developing education systems. This paper examined the effect of the status of institutional ICT infrastructure and digital tools on teacher use of digital technologies in public junior schools (JS) in Kakamega County, Kenya. Relying on the Theory of Organizational Information Processing, the study used a convergent parallel mixed-methods design involving 332 responding JSS teachers, 11 Sub-County Directors of Education and observations from 78 schools. Factor analysis of 12 infrastructure indicators produced a factor-based index of 3.500, interpreted as good, although important differences were evident across infrastructure components. Electricity, computer rooms, broadband connectivity, and technical support were relatively strong, whereas specialized digital tools, suitable educational software and security mechanisms were weaker. Teachers most frequently identified inadequate computers/devices (26.8%) and unstable or absent internet connectivity (22.9%) as the leading infrastructure challenges. Pearson correlation showed a significant positive moderate relationship between infrastructure status and technology use ($r = .417, p < .001$). In Model 1, infrastructure significantly predicted technology use ($B = .525, \beta$ approximately .417, $p < .001$; $R^2 = .174$). After adjustment for gender, age, education, teaching experience, subject and JSS enrolment, the detailed regression table reported $B = .579, \beta = .465, t = 7.94, p < .001, R^2 = .473$ and adjusted $R^2 = .451$. The null hypothesis was rejected. The paper concludes that functional infrastructure and appropriate digital tools are essential enabling conditions, but infrastructure development should address advanced tools, software, connectivity, maintenance and security rather than focusing only on basic provision. This study also recommends that the infrastructure budgets should move beyond hardware acquisition to include suitable educational software, specialized digital tools, maintenance, backups, antivirus protection and user-safety measures.

Keywords: Digital Tools; ICT Infrastructure; Junior Secondary Schools; Kakamega County, Technology Integration

I. INTRODUCTION

The key elements of digital transformation in education include the availability and capacity of teachers, but also the technological context of teaching. Whether teachers have access to digital resources when instructional decisions call for them depends on functional electricity, computing devices, connectivity, and software, and supporting facilities. The United Nations Educational, Scientific and Cultural Organization (UNESCO) (2018) states the importance of teacher competence, but the literature as a whole demonstrates that competence can only be put into practice when there is no or no sufficient material support for the use of technology. International experiences show that investing in infrastructure can unlock the broader potential of technology-enhanced teaching, but the quality of that infrastructure matters as much as its availability. Reliable and accessible devices, appropriate digital content, connectivity, and technical support are needed in schools. Infrastructure may be lacking, causing teachers to fall back into traditional methods even if they have the skills even if technology is available (Ertmer, 1999; Ertmer & Ottenbreit-Leftwich, 2010).

Infrastructure is a constant challenge to education technology in Africa. Computer problems and limited internet access in Nigeria, lack of ICTs in some Tanzanian schools, and ongoing challenges in infrastructure and human-resource capacity in East Africa (Komba, 2024) are among the evidence cited in the thesis. These circumstances make infrastructure a key policy concern, especially for public schools serving large, widely dispersed populations. As part of its ICT and education policy agenda, Kenya has prioritized investment in electricity connectivity, the expansion of broadband, and digital learning initiatives. The National ICT Policy and education programmes have tried to create an enabling space for



digital learning (Government of the Republic of Kenya, 2019; Ministry of Education, 2021). However, there are some indicators in Kenyan schools that availability is not consistent, and having a device doesn't necessarily mean it is effectively integrated in the classroom. Infrastructure should be user-friendly, accessible and be pedagogically suitable.

Kakamega County exemplifies the conflict between improved basic infrastructure and the absence of good advanced digital services. Adequate digital devices, internet connection and computer facilities have been documented in the county, but teachers can possibly have positive attitudes towards ICT at the same time (Shikomera, 2024; Shikomera et al., 2023). With the introduction of public JSS under CBC, this question becomes more pressing, as technology has become a key element in the expectations for teaching. The present paper therefore isolates the second objective of the doctoral thesis to determine whether the status of institutional ICT infrastructure and digital tools is associated with and predicts teacher use of digital technologies.

1.1 Statement of the Problem

While the government of Kenya has invested in ICT infrastructure, thus laying good foundation conditions for digital education, the benefits have been unequal at the classroom level. In Kakamega County, there are varying levels of availability and condition of computers, internet connectivity, software, and technical assistance and security measures at school level. While previous studies have revealed shortages in infrastructure, many of them have concentrated on availability of the resources without providing estimates of how overall infrastructure status influences the use of technology by the teachers. Moreover, most Kenyan studies have concentrated on primary or conventional secondary schools and not the public junior secondary schools in CBC. This study, therefore, seeks to bridge the existing gap on whether there are differences in ICT infrastructure and digital tools between institutions that lead to variations in the use of digital technologies by the teachers. It is important to establish the relation since infrastructure investments will be more targeted when there are clear indications of what works, what does not work and how the overall status of the infrastructure influences classroom technology use.

1.2 Research Objective

The aim was to examine the effect of the status of institutional ICT infrastructure and digital tools on teacher use of digital technologies in teaching and learning in public junior secondary schools in Kakamega County, Kenya.

II. LITERATURE REVIEW

2.1 Theoretical Review

The paper is theoretically informed by Organizational Information Processing Theory (Galbraith, 1973, 2005). In this framework, organizational performance depends on matching information-processing needs with information-processing capabilities. ICT-enhanced teaching increases information-processing requirements because teachers must access, process, store, communicate and manage digital information. Institutional ICT infrastructure and digital tools form the technological component of information-processing capability. Reliable electricity, computing devices, internet connectivity, software and appropriate facilities reduce bottlenecks and allow teachers to process instructional information efficiently. Conversely, inadequate or unreliable infrastructure creates an information-processing mismatch, limiting the practical value of teacher competence. The framework therefore provides a coherent explanation for why better infrastructure should be associated with greater technology use.

2.2 Empirical Review

Bariu (2020), examining ICT infrastructure in Kenyan secondary schools in Meru County, highlighted the importance of the status and adequacy of technological resources for teaching and learning. The study provides a Kenyan basis for viewing infrastructure as more than device ownership. However, its focus on conventional secondary schools leaves uncertainty about the infrastructure conditions of JSS under CBC and the statistical contribution of infrastructure to teacher technology use. Baako and Abroampa (2024) examined contextual influences on ICT integration in slum public basic schools in Ghana using teachers and learners. Their regression analysis showed that school resources and infrastructure were significantly related to teacher ICT beliefs and use. The study is particularly relevant because it demonstrates that context matters and that infrastructure should not be isolated from other school conditions. Its limitation is that it did not focus on junior secondary schools or the Kakamega context.

In Kenya's public schools, Mann and Tock (2025) found that there was a mismatch between the recognition of the need for ICT and access to resources to support the integration of ICT. Limited computers and unreliable electrical power and Internet were concerns. The study is valuable for providing qualitative evidence in Kenya, but its limited number of



schools (3) and quantitative estimation of relationship between infrastructure and use (no) creates a need for wider evidence. Wachira and Baraka (2025) explored resource readiness for the implementation of CBC in Taveta Sub-County, junior secondary schools in Kabale district. They discovered that the learning and teaching materials, computers, projectors, laptops and internet connections were lacking, particularly in public schools. The research area was directly applicable to the CBC/JSS context, but did not measure the impact of resource status on teacher technology use. The present study continues this evidence by measuring, correlating and regressing using factors.

Shikomera et al (2023), investigated computer facilities in Public Primary Schools in Kakamega County and concluded that the level of computer facilities were still low and inadequate for smooth integration of ICTs. In addition, Shikomera (2024) also demonstrated that teachers who have positive perceptions of ICTs may find that they are limited by training, devices and connectivity. These local studies provide a continuing infrastructure challenge at the county level but do not specifically count the contribution of infrastructure in the prediction of public JSS teachers. New international and African experiences support the importance of differentiating between basic and advanced infrastructure. Falloon (2020) highlights the digital competence involved in the productive use of digital environments, and Vanderlinde et al., (2010) define school e-capacity as a mix of technological and organizational capacity. The study evidence also demonstrates that electricity and computer rooms can be relatively strong while specialized tools, educational software and security can be weak areas. This deficit fuels a multidimensional infrastructure index and a direct measure of its relationship to teacher technology use.

III. METHODOLOGY

3.1 Research Design

A convergent parallel design was used for the mixed-methods research approach where a cross-sectional survey was used for the quantitative research, and an exploratory qualitative component was included. Both quantitative and qualitative data were gathered simultaneously and combined to achieve breadth, depth, and triangulation of data. A cross-sectional survey was the most appropriate technique for studying the interrelationships between different aspects of preparedness of institutions and teachers' use of technologies without any manipulation of the variables (Creswell & Creswell, 2018; Field, 2018).

3.2 Study location and Population

The research was carried out in Kakamega County in Western Kenya. This county has 13 sub counties with 907 public primary schools offering Junior Secondary education based on the Competency Based Curriculum. The sample population included 5,046 JSS teachers and 13 Sub County Directors of Education. Teachers were used as participants due to their responsibility for teaching in class, being key users and beneficiaries of ICT training; Sub County Directors provided institutional-level views.

3.3 Sample Size and Sampling

The sampling method used in this research entailed a multi-stage sampling process. The 13 sub-counties served as strata, and simple random sampling was used to choose schools and teachers as samples while Sub-County Directors were chosen purposively due to their supervisory roles. The calculated Yamane and FPC resulted in a total number of 346 teachers from about 58 schools and 13 Sub-County Directors as participants of 359.

3.4 Instruments

Data were collected using a Junior Secondary School Teachers Questionnaire, a semi-structured Key Informant Interview Guide for Sub-County Directors of Education, and an Observation Guide. The questionnaire measured teacher ICT training and skills, ICT infrastructure, administrative ICT support, teacher use of digital technologies, and demographic/control variables. The observation guide documented the availability, condition and functionality of ICT resources and visible evidence of technology use. Interviews were audio-recorded with consent and transcribed verbatim.



3.5 Pilot study

A pilot study involving approximately 35 teachers (10% of the targeted 346 teachers) from about six public junior secondary schools in neighbouring Vihiga County was conducted. Vihiga was selected to reduce pre-exposure effects while retaining comparable demographic, socioeconomic and educational characteristics. The pilot assessed clarity, relevance, comprehensiveness, completion time, data-collection procedures, and preliminary reliability and validity; feedback was used to refine the instruments.

3.6 Validity and reliability

Content validity was assessed by three experts in educational research and ICT integration at MMUST. Construct validity was strengthened through alignment of questionnaire sections with the conceptual framework and factor-analytic assessment. Internal consistency reliability was evaluated using Cronbach's alpha. The study reported alpha coefficients of .976 for teacher ICT training and skills (13 items), .800 for ICT infrastructure and digital technologies (12 items), .843 for administrative ICT support (10 items), and .933 for use of digital technologies (12 items), all exceeding the .70 threshold (DeVellis, 2017).

3.7 Data analysis

Quantitative data were coded and analyzed in SPSS. Frequencies, percentages, means and standard deviations summarized the data. Exploratory factor analysis using principal components analysis was used to construct parsimonious indices; KMO and Bartlett's test assessed factorability. Pearson correlation assessed bivariate relationships. Multiple linear regression was then used in two models: Model 1 contained the objective-specific predictor, while Model 2 added gender, age, highest educational level, teaching experience, teaching subject and JSS enrolment. Statistical significance was assessed at $p < .05$. Diagnostic assessment considered linearity, homoscedasticity, residual behaviour, influential cases and autocorrelation. Qualitative data from interviews, open-ended responses and observations were thematically analyzed and used to triangulate quantitative results (Field, 2018; Patton, 2015).

3.8 Ethical considerations

Participation was voluntary, informed consent was obtained, anonymity and confidentiality were protected, and data were reported in aggregate form. Participant codes were used in place of names, and identifying information was separated from the analytical data. The study followed the ethical and approval procedures.

IV. FINDINGS & DISCUSSION

4.1 Descriptive findings

Exploratory factor analysis of 12 infrastructure indicators yielded KMO = .861 and a significant Bartlett's test, $\chi^2(66) = 1,736.54$, $p < .001$. A single dominant factor was retained and rescaled to the original five-point metric. The resulting infrastructure index had a mean of 3.500 (SD = .717), interpreted as good/fairly good.

Table 1
Status of ICT Infrastructure and Digital Technologies

Status of ICT infrastructure	Poor	Fair	Good	Very good	Excellent	Mean	Std. Dev.
Number of computing devices (desktops, laptops, tablets)	9 (2.7%)	34 (10.2%)	121 (36.4%)	91 (27.4%)	77 (23.2%)	3.58	1.038
Age of computing devices (desktops, laptops, tablets)	13 (3.9%)	22 (6.6%)	193 (58.1%)	77 (23.2%)	27 (8.1%)	3.25	0.848
Availability of digital devices such as whiteboards, digital projectors	71 (21.4%)	37 (11.1%)	20 (6.0%)	63 (19.0%)	126 (38.0%)	3.43	1.620
Availability of digital tools such as data sensors, cameras, assistive devices, robotic tops (e.g. Beebots)	76 (22.9%)	88 (26.5%)	93 (28.0%)	18 (5.4%)	57 (17.2%)	2.67	1.350
Awareness of suitable software for teaching and learning	34 (10.2%)	81 (24.4%)	100 (30.1%)	88 (26.5%)	29 (8.7%)	2.99	1.128
Availability of suitable software for teaching and learning	39 (11.7%)	129 (38.9%)	48 (14.5%)	83 (25.0%)	33 (9.9%)	2.83	1.217
Broadband connection/speed	54 (16.3%)	26 (7.8%)	15 (4.5%)	58 (17.5%)	179 (53.9%)	3.85	1.532
Reliability and access to electricity	7 (2.1%)	25 (7.5%)	24 (7.2%)	18 (5.4%)	258 (77.7%)	4.49	1.050
Availability and accessibility of technical support staff	15 (4.5%)	14 (4.2%)	110 (33.1%)	59 (17.8%)	134 (40.4%)	3.85	1.137
Availability of computer room for use of digital technologies (desktops, laptops, tablets)	48 (14.5%)	18 (5.4%)	31 (9.3%)	37 (11.1%)	198 (59.6%)	3.96	1.488
Availability of security mechanisms like backups, antivirus for data security and antiglare devices	86 (25.9%)	33 (9.9%)	81 (24.4%)	44 (13.3%)	88 (26.5%)	3.05	1.528
Adequate and comfortable seats and tables for use with digital tools	33 (9.9%)	39 (11.7%)	61 (18.4%)	35 (10.5%)	164 (49.4%)	3.78	1.414

The strongest component was reliability and access to electricity ($M = 4.49$), followed by computer-room availability ($M = 3.96$), broadband connection/speed ($M = 3.85$) and technical support staff ($M = 3.85$). The weakest was availability of specialized digital tools such as data sensors, cameras, assistive devices and robotic tools ($M = 2.67$), followed by suitable software ($M = 2.83$) and awareness of suitable software ($M = 2.99$). The open-ended findings identified inadequate computers/devices as the most commonly reported infrastructure challenge (26.8%), followed by unstable or absent internet connectivity (22.9%) and unreliable electricity (16.3%). Teachers' leading improvement priorities were increasing computers/devices (33.7%) and improving internet connectivity (26.2%). The pattern indicates that basic infrastructure has improved but access to sufficient devices, connectivity, software and advanced digital tools remains uneven. The teachers' use of digital technologies was assessed using rating statements, where teachers were required to rate as N=Never; R=Rarely; OM=Once a month or periodically; Few=A few times a week; ED=Every day or almost every day. The table below shows the results.

Table 2*Teachers' use of digital technologies in teaching and learning*

Teachers' use of digital technologies	N	R	OM	Few	ED	Mean	Std. Dev.	Mode	CV (%)
I use internet for research of learning materials and teaching content	25 (7.5%)	44 (13.5%)	58 (17.5%)	88 (26.5%)	116 (34.9%)	3.68	1.281	ED	34.8
I use digital tools such as PowerPoint for classroom instruction	8 (1.8%)	21 (6.3%)	67 (20.2%)	138 (41.6%)	100 (30.1%)	3.92	.956	Few	24.4
I use of digital images and/or videos for classroom instruction	6 (1.3%)	64 (19.3%)	79 (23.8%)	90 (27.1%)	94 (28.3%)	3.61	1.133	ED	31.4
I use lesson simulation in classroom instruction	20 (6.0%)	64 (19.3%)	79 (23.8%)	98 (29.5%)	73 (22.0%)	3.43	1.193	Few	34.8
I use online programs/websites that teach students about topics	39 (11.7%)	62 (18.7%)	140 (42.2%)	62 (18.7%)	34 (20.4%)	2.98	1.114	OM	37.4
I use learning management systems to organize course materials	79 (23.8%)	57 (17.2%)	100 (30.1%)	61 (18.4%)	29 (8.7%)	2.69	1.259	OM	46.8
I use online assessment tools during classroom instruction	61 (18.4%)	63 (19.0%)	95 (28.6%)	78 (23.5%)	63 (19.0%)	3.14	1.349	OM	43.0
I use digital devices to prepare my lesson notes and plan	16 (4.8%)	35 (10.5%)	124 (37.3%)	63 (19.0%)	124 (37.3%)	3.83	1.102	OM/E D	28.8
I use digital platforms to provide personalized feedback to students	35 (10.5%)	5 (1.5%)	103 (31.0%)	62 (18.7%)	94 (28.3%)	3.54	.984	OM	27.8
I use educational apps/software to support differentiated learning	22 (6.6%)	38 (11.4%)	119 (35.8%)	63 (19.0%)	51 (15.4%)	3.30	1.025	OM	31.1
I use digital devices to manage student records and attendance	19 (5.7%)	77 (23.2%)	179 (53.9%)	52 (15.7%)	56 (16.9%)	3.43	1.295	OM	37.8
I use digital textbooks to source learning material and support instruction	6 (1.8%)	26 (7.8%)	141 (42.5%)	84 (25.3%)	69 (20.8%)	3.13	1.135	OM	36.3
Aggregate composite score						3.33	.910	OM	27.3

The modal response category across most items in Table 2 was "Once a month or periodically" (OM), indicating that teachers use digital technologies infrequently, typically once a month or periodically, rather than on a daily or weekly basis. For some of the items (e.g., use of PowerPoint for classroom instruction, lesson simulation), however, the modal category was "A few times a week" (Few), which indicates the technologies are used more frequently. The overall picture of technology use, as indicated by the aggregate composite mode of "Once a month or periodically," suggests that the frequency of technology use in teaching and learning is periodic, rather than frequent. The data showed the technology use composite score had a coefficient of variation (CV) of 27.3%, suggesting a moderate level of variation in technology in the sample. Use of learning management systems (CV = 46.8%) and online assessment tools (CV = 43.0%) showed the highest levels of variation, indicating significant variability in teacher adoption of these tools in that sense, with some teachers using them more often than others. Digital tools (PowerPoint CV = 24.4%) and digital platforms for personalized feedback (CV = 27.8%) had the lowest variation, meaning that they were used more consistently across teachers. These differences in mode and CV values between different technologies are indicative of the hierarchical structure of technology adoption – technologies with a low level of complexity will have low variability in the number of times and in the percentage of the time they are used, and technologies with a high level of complexity will have high variability.

4.2 Bivariate results

Pearson's correlation indicated a statistically significant, positive and moderate relationship between the status of institutional ICT infrastructure and digital tools and teacher use of digital technologies, $r = .417$, $p < .001$. The positive direction means that teachers in schools with better infrastructure tended to report greater use of digital technologies. The moderate coefficient also indicates that infrastructure is important but does not account for all variation in technology use.

Table 3*Pearson's Correlation Matrix*

Variable	Status of ICT Infrastructure	Use of Digital Technologies	
Status of ICT infrastructure	Pearson Correlation (r)	1	
	Sig. (2-tailed)		
	N	332	
Use of digital technologies	Pearson Correlation (r)	0.417**	1
	Sig. (2-tailed)	< .0001	
	N	332	332

4.3 Multivariate results: Multiple linear regression

Model 1 entered only the infrastructure index and explained 17.4% of the variance in teacher technology use, $F(1,330) = 69.63, p < .001$. The infrastructure coefficient was $B = .525$ and statistically significant ($t = 8.34, p < .001$). Thus, a one-unit increase in the infrastructure index was associated with an estimated .525-unit increase in teacher technology use before the control variables were introduced.

Table 4*Multiple Linear Regression Results for Status of Institutional ICT Infrastructure and Digital Tools and Use of Digital Technologies*

Predictor	Model 1 B	SE	β	t	p	Model 2 B	SE	β	t	p
Constant	1.543	0.219	—	7.05	<.001	1.218	0.302	—	4.03	<.001
ICT infrastructure index	0.525	0.063	0.417	8.34	<.001	0.476	0.061	0.378	7.80	<.001
Gender						0.082	0.037	0.097	2.22	.027
Age						0.011	0.005	0.096	2.20	.029
Highest educational level						0.058	0.031	0.078	1.87	.063
Teaching experience						-0.061	0.018	-0.121	-3.39	.001
Teaching subject						0.044	0.021	0.074	2.10	.036
JSS enrolment						-0.002	0.001	-0.089	-2.53	.012

Table 5*Model Statistics*

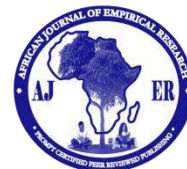
Statistic	Model 1	Model 2
R	0.417	0.559
R ²	0.174	0.313
Adjusted R ²	0.172	0.298
ΔR^2	—	0.139
F	69.627	21.071
df	1,330	7,324
p	<.001	<.001

Note: B = unstandardized coefficient; SE = standard error; β = standardized coefficient. Categorical variables were dummy coded.

In the detailed Model 2, the infrastructure coefficient increased to $B = .579$ ($\beta = .465, t = 7.94, p < .001$), while the model explained 47.3% of the variance and had an adjusted R^2 of .451. Holding gender, age, education, teaching experience, teaching subject and JSS enrolment constant, a one-unit increase in the infrastructure index was associated with a .579-unit increase in teacher use of digital technologies. The control variables increased explained variance by 29.9 percentage points relative to Model 1.

4.4 Diagnostic Tests

The diagnostics for the infrastructure regression revealed the absence of any problematic influential points: the largest value of Cook's distance is .119 while that of leverage is .390. The graph of residuals versus fitted values exhibited randomness in its dispersion around the horizontal axis zero line. Hence, homoscedasticity and proper linear fit were



evidenced. The Durbin-Watson statistic was 1.467, providing evidence against problematic residual autocorrelation. The infrastructure index was skewed at -0.699 and kurtotic at -0.520 with an IQR of $.958$ ($Q1 = 3.042$; $Q3 = 4.000$), indicating moderate dispersion and a slight concentration toward higher infrastructure ratings.

4.5 Hypothesis Test

H_{01} posited that institutional ICT infrastructure and digital tools had no statistically significant impact on teachers' use of technology, and because $p < .05$, H_{01} was rejected. It follows that there is a statistically significant positive impact of institutional ICT infrastructure and digital tools on teacher technology use.

4.6 Discussion

The overall infrastructure index of 3.500 signifies that public JSS in Kakamega are no longer completely lacking in technological preparedness, although item level results reveal that this is not evenly distributed. Electricity, computer rooms and broadband were relatively high, while specialized tools, appropriate software and security measures were low. This mirrors the thesis literature, where infrastructure development is typically in stages – basic connectivity is established before a higher level of pedagogical technology is used.

The positive moderate correlation ($r = .417$) provides evidence that better infrastructure is related to higher technology use by teachers. This result is in line with that of Baako and Abroampa (2024), who discovered that school resources and school infrastructure had a significant influence on the process of the integration of ICTs in public basic schools in Ghana. It is also consistent with the Tanzanian evidence provided in the thesis and that of Tondeur et al., (2019) who identified infrastructure as a school-level factor for technology integration.

The regression evidence supports the evidence of correlation more. The variance in Model 1 was accounted for by infrastructure (17.4%) and was still significant after adjustment. The coefficient's durability suggests that infrastructure influences teacher technology use in addition to teacher demographic and experience differences, and subject and school enrolment. For that reason, the teacher training without the functional devices and connectivity would basically leave a significant portion of the problem of technology use unsolved.

The statistical relationship is actionable because of the open-ended evidence. Teachers most often noted lack of devices/computers and poor internet connectivity as the significant issues and more devices and stronger internet connection as the changes they'd like to see. The convergence of perceived challenges and desired interventions implies that infrastructure planning should be based on the real challenges or bottlenecks, not just based on an overall indicator of ICT readiness.

The results also highlight the lack of a hardware-only approach to infrastructure. Digital tools and software for specialized applications, and security mechanisms, were still pretty weak. Gaps are important because tools for integrating ICTs for transformative learning should enable inquiry, collaboration, assessment, customization, and creation of digital content. Falloon (2020) and Vanderlinde et al., (2010) agree with a wider understanding of digital capacity that sees technology resources supporting teacher competence and organizational capacity.

Galbraith's OIPT offers a logical account of these results. Infrastructure is one of the components of the school's information processing capability: it allows teachers to gain access to, process and communicate digital information. The fit of the instructional information-processing requirements and school capability improves when devices, connections and software are reliable. In the absence of advanced resources or connection to the internet, they face bottlenecks and teachers might fall back on low-tech approaches. The evidence then suggests that investment in infrastructure is an enabling condition, and that infrastructure-only strategies are to be avoided.

V. CONCLUSION & RECOMMENDATIONS

5.1 Conclusion

Institutional ICT infrastructure status and digital technology plays a significant and positive role in determining the use of ICT by teachers in teaching and learning in public junior secondary schools in Kakamega County. It is evident that the general infrastructure status was high, but not equally high in terms of foundation and specialization. In terms of bivariate and multivariate analyses, there was a positive relationship between the independent and dependent variables while the null hypothesis was rejected. The main conclusion drawn from this research is that infrastructure forms an essential institutional base for teachers to use ICT skills in their classrooms.

5.2 Recommendations



The study recommends that the Ministry of Education should prioritize equitable provision of functional computers, tablets and other digital devices to schools with the largest infrastructure deficits, and that broadband connectivity should be strengthened and maintained, with particular attention to schools experiencing unstable or absent internet access. This study also recommends that the infrastructure budgets should move beyond hardware acquisition to include suitable educational software, specialized digital tools, maintenance, backups, antivirus protection and user-safety measures. Equally, schools should maintain ICT inventories, maintenance schedules and mechanisms for reporting and resolving ICT faults so that available infrastructure remains functional. Further, resource allocation should explicitly address rural–urban disparities identified through school observations, with targeted support for schools showing weaker connectivity, device availability and technical capacity.

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.

Funding Declaration

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

REFERENCES

- Baako, I., & Abroampa, W. K. (2024). Context matters: Exploring teacher and learner contexts in ICT integration in slum public basic schools in Ghana. *Cogent Education*, 11(1), Article 2342637. <https://doi.org/10.1080/2331186X.2024.2342637>
- Bariu, T. N. (2020). Status of ICT infrastructure used in teaching and learning in secondary schools in Meru County, Kenya. *European Journal of Interactive Multimedia and Education*, 1(1), Article e02002. <https://doi.org/10.30935/ejimed/8283>
- Buabeng-Andoh, C. (2012). Factors influencing teachers' adoption and integration of information and communication technology into teaching: A review of the literature. *International Journal of Education and Development Using Information and Communication Technology*, 8(1), 136–155.
- Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). SAGE Publications.
- DeVellis, R. F. (2017). *Scale development: Theory and applications* (4th ed.). SAGE Publications.
- Ertmer, P. A. (1999). Addressing first- and second-order barriers to change: Strategies for technology integration. *Educational Technology Research and Development*, 47(4), 47–61.
- Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2010). Teacher technology change: How knowledge, confidence, beliefs, and culture intersect. *Journal of Research on Technology in Education*, 42(3), 255–284. <https://doi.org/10.1080/15391523.2010.10782551>
- Falloon, G. (2020). From digital literacy to digital competence: The teacher digital competency (TDC) framework. *Educational Technology Research and Development*, 68, 2449–2472. <https://doi.org/10.1007/s11423-020-09767-4>
- Field, A. (2018). *Discovering statistics using IBM SPSS statistics* (5th ed.). SAGE Publications.
- Galbraith, J. R. (1973). *Designing complex organizations*. Addison-Wesley Publishing Company.
- Galbraith, J. R. (2005). *Designing the customer-centric organization: A guide to strategy, structure, and process*. Jossey-Bass.
- Government of the Republic of Kenya. (2007). *Kenya Vision 2030: A globally competitive and prosperous Kenya*.
- Komba, M. M. (2023). Exploring ICT integration in teaching practices at Vikenge Primary School in Tanzania: Challenges and opportunities. *African Journal of Empirical Research*, 4(2), 1370–1374. <https://doi.org/10.51867/ajernet.4.2.138>
- National Assembly of Kenya. (2019). *Report on Sessional Paper No. 1 of 2019 on policy framework for reforming education and training for sustainable development in Kenya*. Directorate of Committee Services.
- Patton, M. Q. (2015). *Qualitative research & evaluation methods: Integrating theory and practice* (4th ed.). SAGE Publications.
- Shikomera, M. B. (2023). Availability of computer facilities and integration of information communication technology in teaching and learning in public primary schools in Kenya. *International Journal of Recent Research in Thesis and Dissertation*, 4(2), 102–110.



- Shikomera, M. B. (2023). The influence of availability of internet connectivity on teachers' integration of information communication technology in teaching and learning in public primary schools in Kenya. *International Journal of Research and Innovation in Social Science*, 7(11), 1473–1480.
- Shikomera, M. B. (2023). Teacher training and integration of information communication technology in teaching and learning in public primary schools, Kenya. *International Journal of Research and Innovation in Social Science*, 7(8), 1613–1624.
- Shikomera, M. B. (2024). *Integration of information communication technology in teaching and learning in public primary schools in Kakamega County, Kenya* [Doctoral dissertation, South Eastern Kenya University]. South Eastern Kenya University Repository. <http://repository.seku.ac.ke/handle/123456789/7700>
- Tondeur, J., Scherer, R., Baran, E., Siddiq, F., Valtonen, T., & Sointu, E. (2019). Teacher educators as gatekeepers: Preparing the next generation of teachers for technology integration in education. *British Journal of Educational Technology*, 50(3), 1189–1209. <https://doi.org/10.1111/bjet.12748>
- UNESCO. (2018). *UNESCO ICT competency framework for teachers* (Version 3). <https://unesdoc.unesco.org/ark:/48223/pf0000265721>
- Vanderlinde, R., & van Braak, J. (2010). The e-capacity of primary schools: Development of a conceptual model and scale construction from a school improvement perspective. *Computers & Education*, 55(2), 541–553. <https://doi.org/10.1016/j.compedu.2010.02.016>
- Wachira, K. H., & Baraka, A. (2025). A study on resource preparedness for the implementation of competency-based education in public and private junior secondary schools in Taveta Sub County, Kenya. *International Journal of Research and Innovation in Social Science*, 9(9), 307–316.
- West, B. T. (2008). Statistical and methodological issues in the analysis of complex sample survey data: Practical guidance for trauma researchers. *Journal of Traumatic Stress*, 21(5), 440–447. <https://doi.org/10.1002/jts.20356>
- World Bank. (2017). *Kenya small towns and sanitation services improvement study: The monetization of access in secondary towns*.
- World Bank. (2020). *Kenya urbanization review: 59% of urban population in secondary towns*.
- Zizi Afrique Foundation. (2024). *The status of junior schools in Kenya*.