



## **Influence of Technology Infrastructure on Quality of Learning in Public Primary Schools Nyeri County, Kenya**

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### **Abstract**

*Provision of free primary education by the Kenyan government has been successful with regard to increased enrolment in public schools. However, a big concern has been on the quality education which is often seen in how pupils perform. The purpose of the study was to establish influence of technology infrastructure on quality of learning in public primary schools in Nyeri County, Kenya. The study was guided by the Multimedia learning theory and Diffusion of Innovation Theory. The study employed a descriptive research design. The target population for this study was 382 public primary schools in Nyeri County. The target respondents were the 382 head teachers and 3850 teachers. The study used simple random sampling and stratified random sampling. The study used Krejcie and Morgan (1970) Table to determine samples size and arrived at 38 head teachers and 362 teachers. This study used questionnaires to collect data from teachers and interview guides to collect data from head teachers. The quantitative data was analyzed using Statistical Package for Social Sciences (SPSS 28) software. The study used descriptive and inferential statistics. Qualitative data derived from interview guides was analyzed using content analysis. Findings were presented in tables. Findings show that there is a strong significant relationship between technology infrastructure and quality of learning in public primary schools in Nyeri County ( $r=0.541$ ,  $p=0.000$ ). The recommendations are; The ministry of education should ensure affordable, dependable, and easily accessible internet connectivity in all public schools, and school administrators should look for government funding to construct and furnish computer labs as well as buy additional Information Communication Technology equipment like scanners, photocopiers, and printers.*

**Keywords:** *Technology infrastructure, Quality of learning, public primary schools*

### **Introduction**

Education is the cornerstone of every contemporary society and the standard of a nation's educational system has a big impact on its socioeconomic development. Information Communication Technology (ICT) is seen as an important part of educational innovations and reforms at the elementary, secondary, and university levels (Ngobe, 2023). Technology has four purposes in the field of education: it is incorporated into the curriculum, serves as a system for delivering instruction, facilitates instruction, and is a tool to improve the learning process. Technology has facilitated changes in education; from passive to reactive and from aggressive to participatory (Park & Weng, 2021). Digital infrastructure for schools includes the tools and technologies that a school would need to establish itself in the digital realm of the internet. In the short and long run, they should be able to increase and improve their overall efficiency and effectiveness in addition to being able to carry on with business as usual when they were in a physical location (Bordia, 2022). ICT infrastructure creates a classroom environment where students may solve issues, think independently, and work together. Technology creates a learner-centered environment that motivates students through mixing text, music, color, and images to enrich information for simpler learning (Msafiri, Kangwa, & Cai, 2023). The adoption and integration of ICT in teaching and learning have been hampered by ICT infrastructure. In industrialized nations, there is typically one computer for every 15 pupils. However, the situation is different in Africa where the average computer-to-student ratio is extremely low, with Kenya having an average of 1:45 at the college level. ICT use for teaching and learning cannot be supported by this low infrastructure ratio (Arnold & Sangrà, 2018).

In India, Amutha (2020) showed that integration of ICT with teaching/ learning environment enhances quality education coupled with higher teacher productivity. Information communication technology is influencing all parts of life including schooling. In Australia, Fan and Yost (2019) established that when both parents and Early



Childhood Development Education (ECDE) tutors use digital media technologies, they enhance communication, teamwork, and family engagement. ECDE teachers believed that using Facebook and Twitter to interact with parents was more successful than other social media sites. According to Nueva (2019), educators in the Philippines are utilizing technology in the classroom for communication, information reference, and instructional support. However, due to the digital competency gap, their ICT proficiency differs.

ICT adoption in education is still in its infancy in Africa, and most of the continent's countries may not benefit from technology due to slow technology implementation in the educational systems (Lloyd, 2020). According to Buabeng-Andoh (2019), Ghanaian school administrators encourage ICT adoption in teaching and learning. The school administrators encourage instructors to keep using ICT to present content in a variety of methods. Moshi, Ndeke, Stephen, and Ngozi (2018) discovered that the Tanzanian municipality of Moshi has a high usage rate of digital media for student learning. Facebook and WhatsApp were the most popular digital media channels among the students, with LinkedIn, Instagram, and Twitter being additional noteworthy sites.

Kenya is working to improve technology adoption in education through the Ministry of Education Science and Technology (MoEST) in response to the needs of the global technology community. To encourage technology access in schools, the Ministry has mobilized resources in partnership with the commercial sector. These funds have been used to purchase ICT equipment, particularly computers, for a number of schools. The MoEST is working on curriculum digitalization through the Kenya Institute of Curriculum Development (KICD) as part of the National Education Sector Strategic Plan. The secondary school curriculum up to form two has been successfully digitized by KICD. Additionally, in order to provide current teachers with ICT capabilities, ICT has been incorporated into the curriculum for pre-service teacher training and capacity-building. Despite the gains of ICT in different sectors of the Kenyan economy, there is a lag in the education sector since only few primary schools are equipped with the necessary ICT infrastructure for teaching and learning (Bariu, 2021). Wanjiru (2020) added that primary schools in Nyeri County are relatively well equipped with teachers who are well versed and trained on technological training. It is against this background that the study sought to determine technology related factors influencing quality of learning in public primary schools in Nyeri County, Kenya. The study contributes to the importance of ICT to the Kenyan schools which may bring about a transformative way of teaching and learning. The study is expected to aid in policy reforms in the education sector, particularly the IT policy in Kenyan school curriculum to be in line with vision 2030 which recognizes ICT as a crucial and aims to integrate it into education to enhance teaching and learning.

### Materials and Methods

The study employed a descriptive research design. The target was 382 public primary schools in Nyeri County. The target respondents were the 382 head teachers and 3850 teachers as shown in Table 1.

**Table 1. Target Population**

Category	Target Population
Head teachers	382
Teachers	3850
<b>Total</b>	<b>4232</b>

The study sampled 10% of the schools therefore 38 public primary schools were sampled. The head teachers from these schools participated in the study hence 38 head teachers. In addition, Yamane 1967 formula was used to calculate the sample size of 362 teachers as shown in Table 2.

**Table 2. Sampling Frame**

Category	Target Population	Sample size	Sampling technique
Head teachers	382	38	Purposive
Teachers	3850	362	Proportionate stratified



<b>Total</b>	<b>4232</b>	<b>400</b>
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Questionnaires and interview guides were used to collect data which was analyzed using both quantitative methods and qualitative methods. The quantitative data was organized, and analyzed with the help of the Statistical Package for Social Sciences (SPSS 28) software. The study used descriptive and inferential statistics. Findings from quantitative data were presented in tables. Qualitative data derived from interview guides and open ended questionnaires were analyzed through content analysis.

### Results and Discussion

The study sought to establish the influence of technology infrastructure on quality of learning in public primary schools in Nyeri County, Kenya. The teachers were asked indicate the technology infrastructure available in their schools. Results are presented in Table 3.

**Table 3. Availability of Technology Infrastructure**

Technology	Yes		No	
	Frequency (F)	Percentage (%)	Frequency (F)	Percentage (%)
Computers and laptops	69	24.3	215	75.7
Mobile phones	284	100.0	0	0
CCTV Cameras	18	6.3	266	93.7
Internet connections	15	5.3	269	94.7
Un interrupted Power Supplies	194	68.3	90	31.7
Overhead projectors	20	7.0	264	92.9

N=284

Results in Table 3 show that the ICT infrastructure available in majority of schools are mobile phones as indicated by all teachers, and un interrupted power supply as indicated by 68.3% of the teachers. Majority of the public primary schools lack computers and laptops, Closed-Circuit Television (CCTV), stable internet connections, and overhead projectors. However, the schools are challenged with internet connections hence they are obliged to seek services from cyber cafes or use their mobile phone internet which may be costly. The results are in agreement with Nyongesa and Otieno (2020) that the most common ICT infrastructure in schools include internet and laptop accessories. Nyambane, Nzuki, and Korir (2020) also found that the school ICT infrastructure included ICT hardware, application software, internet connectivity and connectivity speed.

Teachers were further asked to explain how they used each of the technology infrastructure. Results are presented in Table 4.

**Table 4. Use of Technology in Teaching**

ICT Infrastructure	Use of technology in teaching
<b>Computers</b>	<ul style="list-style-type: none"> <li>• Provide access to electronic books, educational videos, and interactive learning platforms.</li> <li>• Support multimedia tools like animations, and powerpoint presentations which makes lessons engaging and easier to understand</li> <li>• Create detailed lesson plans and schedules</li> </ul>
<b>Mobile phones</b>	<ul style="list-style-type: none"> <li>• Help to manage pupils data, grades, and classroom attendance efficiently</li> <li>• Enable teachers to access e-books and educational websites</li> <li>• Educational Apps facilitate interactive learning and resource sharing</li> <li>• Educational Apps are free and others cheap to download reducing the costs of accessing educational materials as opposed to buying text books</li> </ul>
<b>CCTV</b>	<ul style="list-style-type: none"> <li>• Teachers use videos, podcasts, and animations to explain complex concepts in a more interactive manner</li> <li>• Cameras help to monitor pupils especially during their free time. This reduces teachers work load in classroom management</li> </ul>



- Significantly help to reduce disciplinary cases in schools as it is easier to identify pupils involved in disciplinary cases, punish them which serve as a lesson to other pupils who may be tempted to engage in some outrageous activities
  - CCTV promotes a safer school environment by identifying instances of indiscipline cases among the pupils
- Internet Connections**
- Access to online learning resources
  - Teachers are able to communicate with their colleagues and parents through instant messaging like WhatsApp
- Uninterrupted Power Supplies (UPS)**
- Live streaming educational content in classes
  - UPS keep devices such as computers, projectors, and smarboards running hence lessons continue without interruption
  - Ensure that there is stable internet connectivity for online classes
  - Ensures smooth printing of education materials such as exams and pupils take always
  - Prevents instant outages of the computers preventing loss of data
- Overhead projectors**
- Allow teachers to display images, videos, animations, and charts which makes concepts easier
  - Content displayed through projectors is visible to all pupils in the classroom
  - Help teachers to manage big classrooms
  - Make it easier to engage pupils who relate more with images and videos than text or “naked” explanations

The findings in Table 4 highlight how different forms of ICT infrastructure enhance the teaching and learning process across multiple dimensions: computers acts as gateways to digital learning resources making lessons more dynamic an accessible; mobile phones increase access to educational content which are often cost-effective and also empower teachers to explain complex ideas using engaging media formats; CCTV systems provide surveillance that supports classroom management by reducing the burden on teachers and also enhance discipline and safety contributing to a conducive learning environment; internet connectivity facilitates real-time communication between teachers, colleagues, and parents, and also support live streaming of lessons; Uninterrupted Power Supply (UPS) helps to prevent interruptions in digital learning and protects data by preventing sudden device shutdowns; overhead projectors enhance engagement especially in large classrooms. Results imply that integration of ICT infrastructure into teaching has significantly transformed classroom experiences. It enhances lesson delivery, facilitates access to diverse learning resources, promotes interactive learning, improves classroom management, and ensures continuity even in the face of power challenges. This digital support system empowers teachers and increases students’ engagement and comprehension.

The study further sought teachers’ opinion regarding technology infrastructure in their schools. Results are presented in Table 5.

**Table 5. Perceptions on School Technology Infrastructure**

*Key: SD=Strongly disagree, D=Disagree, N= Neutral, A=Agree, SA= Strongly agree, M=Mean, STD=Standard Deviation.*

Statements	SD %	D %	N %	A %	SA %	M	STD
There is appropriate technology hardware in the school.	55.6	11.3	6.3	21.5	5.3	1.90	1.397
Computers at the school are equipped with up-to-date antivirus software to ensure data security.	62.7	12.3	6.3	9.2	9.5	1.90	1.382
The school's internet connection is dependable and speedy.	45.8	31.3	7.7	2.1	13.0	1.95	1.340
In order, the school has a backup power source to prevent data loss during power outages	51.1	29.9	8.5	10.6	0	1.89	1.241
<b>Average</b>						<b>1.91</b>	<b>1.34</b>



N=284

Results in Table 5 show that the public primary schools are poorly equipped with ICT infrastructure. Lack of ICT infrastructure pose a significant barrier to use of ICT in teaching and learning particularly in underdeveloped countries like Kenya. ICT cannot be fully integrated in schools without the desired ICT infrastructure. The findings support Bariu (2020) that the majority of Kenyan schools invest little in ICT infrastructure because computer hardware, software, and related accessories are expensive. Nyambane, Nzuki, and Korir (2020) demonstrated that ICT hardware, application software, internet connectivity, and connectivity speed were essential ICT infrastructure in schools. Even though the majority of public schools had ICT infrastructure, most of them did not fully utilize them which left them dealing with outdated teaching and learning techniques, operational inefficiencies, and poor academic results.

Head teachers were also asked to describe the status of technology infrastructure in the school. Responses are presented in Table 6.

**Table 6. Head Teachers Responses on Technology Infrastructure**

<b>Theme</b>	<b>Sub-theme</b>
Electricity Access;	Through Rural Electrification, many public primary schools have been connected to the national grid and have reliable power supply
ICT Devices;	Many public primary schools have insufficient tablets and laptops and the devices are often shared among many pupils. The teachers sometimes use their mobile phones to search for educational content online
Limited Internet Connectivity	Majority of the schools do not have reliable internet connectivity which limits access to online educational resources
Disparity in technology adoption	Schools in urban centers are better equipped with technology than schools in the interior
<b>Main technology tools available in the school</b>	
<b>Theme</b>	<b>Sub-theme</b>
Pupils digital devices	Tablets provided to pupils as part of the digital literacy program
Teacher laptops	Some teachers are provided with laptops for lesson planning, content delivery, and administrative roles
Desktop computers	Some schools have computer labs used for teaching basic computer lessons
Projectors	Some schools have projectors though very few and mostly available in schools in urban centers
Network availability	Some schools have Wi-Fi that is accessible by all the staff members Other schools have No Wi-Fi and the staff use internet bundles Mobile Modems are used in schools to access internet via mobile networks
UPS	Power backups to ensure uninterrupted technology use in the schools
Solar panels	Schools without power connection use solar to power ICT tools and charge devices
Printers	Used for printing education materials, exam papers, and other documents used or administration

Results in Table 6 show that availability of electricity is a key enabler of integration of ICT tools in schools. Electricity allows for consistent use of digital devices in teaching and learning. Despite electrification, there is a significant shortage of digital tools, limiting the full utilization of technology in classrooms. Teachers' reliance on personal devices also points to a gap in institutional support for ICT integration. There is poor internet access which restricts online learning, remote collaboration, and exposure to global resources, stalling progress toward digital learning goals. Government initiatives like Digital Literacy Programme (DLP) helps to address the digital gap, though limited quantities hamper large-scale impact. Teacher laptops improve lesson preparation and delivery, but that provision is not universal, leading to inconsistencies. There's a step toward foundational digital skills, although the reach remains limited to schools with better infrastructure. The visual learning potential of projectors is underutilized due to limited availability, again showing urban-rural disparities. Connectivity solutions are uneven and often unreliable, limiting real-time online learning and collaboration. There are adaptive strategies to ensure power supply, indicating innovation in overcoming infrastructural challenges in rural settings. The findings reflect progress in the implementation of technology infrastructure in public primary schools, mainly supported by government initiatives such as rural electrification and the Digital Literacy Programme. However,



significant challenges persist, including device shortages, poor internet access, and pronounced disparities between urban and rural schools. These factors collectively hinder the full realization of technology’s potential in enhancing learning outcomes.

The study used Pearson Correlation in order to measure the strength and the relationship between technology factors and quality education. Correlation findings are presented in Table 7.

**Table 7. Coefficient of Correlation**

Variables		Quality education	Quality of learning
<b>Quality of learning</b>	Pearson Correlation	1	
	Sig. (2-tailed)		
	N	284	
<b>Technology infrastructure</b>	Pearson Correlation	.541**	1
	Sig. (2-tailed)	.000	
	N	284	284

\*\* . Correlation is significant at the 0.05 level (2-tailed).

The in Table 7 show that Pearson correlation coefficient between technology infrastructure and quality of learning in public primary schools in Nyeri County is 0.541, with a p-value of 0.000. This indicates a strong positive and statistically significant relationship between the variables. The strong correlation suggests that as the technology infrastructure increases, so does the quality of learning in public primary schools in Nyeri County. The findings are in agreement with Wang and Wang (2023) that there is a positive relationship between educational ICT resources and quality of learning. Nyongesa and Otieno (2020) shown that when teachers have the required hardware and software resources, they will feel more in charge of integrating technology into their lessons which improves quality of teaching and learning.

### Conclusion and Recommendations

The ICT infrastructure in public primary schools in Nyeri County is very low. Only a few schools are adequately equipped with technology devices. Teachers and school administrators lose valuable time in cyber cafés due to the unreliable power supplies and poor internet access that plague schools. Data loss is another consequence of power outages, particularly when desktop computers are involved.

The recommendations are; school managers should seek funding from government and well-wishers to construct and furnish computer laboratories and acquire additional ICT equipment such as printers, photocopiers, and scanners. The ministry of education should guarantee inexpensive, reliable, and accessible internet connectivity in all public schools in the country to reduce internet costs for the teachers and school administrators.

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