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Integration of Information Communication Technology for Effective Implementation of Competency-Based Education in Junior Schools in Rangwe Sub-County Homa Bay County, Kenya

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Abstract: *This study explores the role of digital literacy, which is recognized as a key competency in Kenya's new Competency-Based Education (CBE), by examining how effectively information and communication technology (ICT) is integrated in junior public schools in Rangwe Sub-County, Homa Bay County. The research focuses on two primary factors influencing this integration: availability of ICT infrastructure and teacher training. Anchored in Davis's (1986) Technology Acceptance Model, the study employed a mixed-methods approach, targeting 101 junior public schools, their head teachers, and teaching staff. A stratified random sample of 88 respondents (30 head teachers and 58 teachers) participated in the survey, which used questionnaires and interviews for data collection. Pilot tests, conducted in two schools, confirmed the validity and reliability of instruments through test-retest methods and expert reviews. Data analysis combined descriptive and inferential statistics for quantitative input and thematic content analysis for qualitative responses. Results revealed a strong correlation between access to ICT tools and quality of teacher training with successful CBE implementation. Key challenges included limited infrastructure, inconsistent training, and lack of ongoing support. The study recommends increased investment in ICT infrastructure, ongoing and adaptable professional development, hands-on training models, mentoring, school-based coaching, and collaborative peer-learning systems. These strategies aim to support sustainable ICT integration and shape more effective education policies, paving the way for enhanced digital literacy in Kenya's junior schools.*

Keywords: *Implementation, Integration, Information Communication Technology, Effective, Competency-Based Education. Rangwe Sub-County.*

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1. Introduction

Information and communications technology (ICT) is widely regarded as a catalyst for improving teaching and learning and broadening access to education, particularly in rural regions. The rise of a knowledge-based economy has intensified global competitiveness, prompting governments worldwide to invest in education (UNESCO, 2013). Globalization and rapid technological advancement

have spurred the integration of ICT into educational systems to equip learners with relevant 21st-century skills (Wambiri & Ndani, 2016). Countries such as South Korea, Finland, Singapore, and the Netherlands have achieved notable progress in educational outcomes by prioritizing ICT in their reforms (Sanchez et al., 2011; Kozma, 2003).

ICT is credited with numerous benefits, including enhanced engagement, accessibility, and learning quality. Kozma (1991, as cited in Karimi & Khawaja, 2023) highlights how audiovisual tools stimulate mental processing, enhancing meaning-making among learners. Similarly, Aktaruzzaman et al. (2011) argue that effective ICT use boosts both access and quality of education by fostering active student involvement. ICT also enables global knowledge exchange, giving learners opportunities to engage with international peers and experts (Omwenga et al., 2004; Redempta, 2012). It fosters lifelong learning (Hennessy et al., 2010) and has shifted pedagogy from teacher-centered to more learner-driven methods (Mingaine, 2013a; Mutua & Mwangi, 2014; Majumdar, 2005).

Kenya, like other Sub-Saharan African countries, has embraced ICT in its education sector (Muinde & Mbataru, 2019; Mariga et al., 2017). Though data on impact remains limited, the Education Sector Plan (2013–2018) emphasized ICT integration (Piper et al., 2015). Kenya's 2006 ICT policy supported affordable and reliable ICT access (Republic of Kenya, 2006). The 2006 policy laid the foundation for major digital initiatives in Kenya, such as the Digital Literacy Programme, Huduma Centres, and the growth of the tech ecosystem dubbed "Silicon Savannah." However, challenges like infrastructure gaps, limited rural access, and policy implementation delays still persist.The policy was later reviewed to align with emerging technologies and the Vision 2030 development agenda. Under Vision 2030, the government aimed to equip all Grade 1 pupils with tablets- an initiative which was partially successful but was hampered by inadequacy of finances, a move accompanied by curriculum reform to promote digital literacy and other 21st-century competencies (Langat, 2015; Maluei, 2019).

ICT tools such as online learning platforms, digital textbooks, and interactive whiteboards have transformed education, encouraging differentiated instruction, critical thinking, and problem-solving (Ghavifekr & Rosdy, 2015; Gomes, 2005). Teachers benefit through access to new pedagogical approaches and professional development (Hennessy, Harrison, & Wamakote, 2010). However, challenges such as digital inequality and weak infrastructure remain (UNESCO, 2011). While ICT helps make abstract concepts concrete (Kozma, 1991, as cited in Karimi & Khawaja, 2023), others argue its effectiveness depends on teacher pedagogy (Clarke, 1983, as cited in Kozma, 2001). Nevertheless, ICT investment in schools has grown, even in developing countries (Piper et al., 2015).

According to global innovation indices, Kenya ranks among the top three Sub-Saharan innovation hubs alongside Mauritius and South Africa. This highlights the need to explore how ICT is shaping education in these contexts. Kenyan policymakers view ICT as essential for knowledge acquisition, creativity, and skill development (Republic of Kenya, 2019). In line with Vision 2030, the Competency-Based Education (CBE) curriculum replaced the 8-4-4 system, embedding digital literacy as one of seven core competencies across all subjects (KICD, 2017).Ther competencies include: Communication and Collaboration; Critical Thinking and Problem Solving; Imagination and Creativity ; Citizenship; Learning to Learn and Self-Efficacy Previously, ICT was offered only as an elective in secondary schools and not as one of the key competencies.

Despite these strides, Kenya faces significant implementation hurdles. Barriers include limited teacher and administrative capacity, inadequate infrastructure, and negative attitudes toward ICT. The COVID-19 pandemic exposed these weaknesses, with nearly 20 million students out of school and many unprepared for the shift to online learning (Otieno & Brown, 2020). Studies like Karsenti et al. (2012) cite lack of equipment, technophobia, and inadequate teacher training as major impediments. In response, the government initiated a laptop project for first graders in 2013, but by mid-2018, only a portion of schools had received devices and fewer than a quarter of teachers had been trained (Mbataru & Muinde, 2019; Wanzala & Nyamai, 2018).

A Teachers Service Commission (TSC) survey of 1,200 educators revealed that 84.2% lacked the skills needed to integrate ICT into teaching effectively (Oduor, 2018; Wanzala & Nyamai, 2018). In many cases, training was rushed and overly theoretical, especially in the context of implementing the CBE curriculum in places like Rangwe Sub-County, Homa Bay. Research also points to demographic factors like age and gender affecting ICT adoption among teachers (Mwangi & Khatete, 2017).

In conclusion, successful ICT integration in CBE implementation requires robust infrastructure, ongoing teacher training, and positive attitudes toward technology. School leaders play a critical role in ensuring readiness across these dimensions (Yoo & Murthi, 2021). Against this background, the current study aims to examine how ICT is being integrated into teaching and learning for

effective CBE implementation in junior schools in Rangwe Sub-County, Homa Bay County.

1.1 Statement of the problem

Based on the 2021 Homabay County School Census Report (MOE, 2021), Majority of public schools in Rangwe Central Sub County use minimal to no technology in their engagement in learning and teaching programs. Additionally, the majority of teachers use cyber services to complete ICT-related tasks including evaluating test data and submitting yearly online reports to the commission for teachers. The current implementation of CBE in junior schools is likely to be jeopardized by teachers' sluggish adoption and usage of ICT, given the background of crowded classrooms, inexperienced facilitators, and limited ICT facilities in Rangwe Sub County, among other associated obstacles. Furthermore, some research has looked into how teachers integrate ICT into teaching and learning, primarily in secondary schools (Mingaine, 2013). However minimal studies have investigated junior schools' integration of ICT for effective implementation of CBE. It was on this context that this study investigated integration of information communication technology for effective implementation of the Competency-Based Education in junior schools in Rangwe Sub-County Homa Bay County, Kenya.

1.2 Research objectives

The specific objectives of the study were:

1. To establish the level to which the availability of ICT infrastructure influences the integration of ICT for effective implementation of CBE in junior schools in Rangwe Sub-County.

2. To find out the extent to which teachers' training in ICT influences integration of ICT for effective implementation of CBE in the junior schools in Rangwe Sub-County.

1.3 Theoretical Framework

The Technology Acceptance Model (TAM), developed by Davis in 1989 (Davis, 1989), provides a foundational framework for understanding how individuals come to accept and use technology. The model's core constructs are *Perceived Usefulness (PU)*—the belief that technology enhances performance—and *Perceived Ease of Use (PEOU)*—the belief that using the technology requires minimal effort. These perceptions influence a user's *Attitude Toward Using* (ATU), which in turn shapes their *Behavioral Intention to Use* (BI), ultimately leading to the *Actual Use* of technology.

In the context of the current study on ICT integration in Kenyan junior schools implementing Competency-Based Education (CBE), Technology Acceptance Model serves as a relevant analytical lens. The availability of ICT infrastructure directly influences Perceived Ease of Use PEOU; accessible and functional resources such as computers and internet connectivity reduce perceived barriers, making technology use more approachable for teachers. This in turn boosts their overall attitude and willingness to adopt ICT.

Training also plays a significant role in shaping Perceived Usefulness (PU) and Perceived Ease of Use (PEOU). Teachers with ICT training tend to find technology more user-friendly and beneficial, thereby reinforcing a positive attitude toward its integration. The study suggests that well-trained teachers are not only more likely to believe in ICT's usefulness in curriculum delivery but also more confident in its application—this speaks to their *self-efficacy*, a construct aligned closely with PEOU. Furthermore, teachers with high self-efficacy are more inclined to experiment with and apply ICT tools in the classroom, perceiving fewer obstacles and greater value. These attitudes, strengthened by administrative support and peer engagement, feed into a strong behavioral intention to use ICT, which is crucial for the successful implementation of CBE. Thus, TAM offers a clear framework for interpreting how beliefs, attitudes, and contextual factors converge to shape technology adoption in education.

2. Literature Review

This section covered theoretical and empirical literature based on the study objectives: Availability of ICT infrastructure and teacher training.

2.1. Status of ICT Infrastructure and Integration in Schools

Successful implementation of ICT in education depends significantly on the availability of adequate infrastructure and continuous support for both teachers and learners. Betz (2011) emphasized that the presence of sufficient facilities and ongoing professional development is vital for effective ICT adoption in schools. Similarly, Liang et al. (2005) underscored the importance of critical digital classroom elements like connectivity, projectors, learner devices, and support systems for optimal ICT use. Mingaine (2013b) added that electricity, software, hardware, and internet connectivity are core infrastructure requirements.

Advanced economies such as South Korea, Finland, and the United States have heavily invested in ICT infrastructure for education (Gorges, 2019). For instance, the U.S. E-Rate program offers affordable broadband to schools, Finland ensures seamless ICT access in every school, and South Korea promotes e-learning and digital textbooks to enable access anytime and anywhere.

In contrast, developing regions face numerous ICT-related challenges. For example, Yusuf, Maina, and Dare (2013) found that Nigerian secondary schools in Kaduna lacked ICT resources and that teachers were ill-prepared to integrate them into learning. They recommended government and NGO partnerships to provide ICT equipment and stable power supply. Similarly, Nwana, Ofoegbu, and Egbe (2017) found that secondary school teachers in Anambra, Nigeria, rarely used available ICT tools, with usage hindered by lack of preparedness. However, their study did not assess administrators' readiness, a gap addressed by the current study.

Furusa, Mapenduka, and Sibanda (2016) examined ICT resource use in Kwekwe, Zimbabwe, and found most digital tools like laptops, projectors, and interactive whiteboards were inadequate and underutilized. Barriers included insufficient skills, lack of electricity, and negative attitudes by the teaching staff. They proposed training programs, alternative energy sources, and technical support to enhance ICT use. Similarly, Amuchie (2015) reported that schools in Taraba State, Nigeria, suffered from high costs of ICT tools, lack of trained personnel, and poor electricity, leading to limited ICT integration.

In Kenya, Langat (2015) found that only 6% of surveyed primary schools had ICT facilities, while 94% lacked the basic infrastructure. Tonui et al. (2016) echoed these findings, citing poor computer access and a lack of customized digital learning environments. Obota, Oluoch, and Makani (2015) found that in Mumias Sub-County, there were too few radios and computers (typically 30 students per machine), making ICT-based instruction challenging. Similarly, Mbugua, Gori, and Tanui (2015) in Nakuru County identified inadequate ICT facilities and poor teacher ICT skills as key barriers.

The reviewed studies share common findings: insufficient infrastructure, lack of teacher training, and minimal ICT usage in teaching. However, many of them focused on post-primary institutions or general infrastructure without exploring critical components like attitude and self-efficacy. The current study, focused on junior schools in Rangwe Sub-County, addresses this gap.

2.2 Teacher Capacity for ICT Integration

Teacher expertise is a crucial determinant in the successful integration of ICT in education. Pelgrum (2003) ranked lack of teacher knowledge as the second most significant barrier to ICT use in schools. Knezek and Christensen (2000) noted that teachers with higher ICT proficiency levels tend to integrate technology more frequently and effectively, positively influencing student outcomes. Similarly, Berner (2003) found that teachers' confidence in their ICT abilities was the strongest predictor of classroom technology use.

UNESCO (2012) highlighted that the integration of ICT can nurture students' 21st-century skills, but only if teachers are digitally literate. However, studies in Kenya show that despite favorable ICT policies, classroom integration remains low (Piper et al., 2015). Langat (2015) found that most teachers in Kenyan primary schools lacked basic computer literacy and pointed to poor planning by the government to support in-service training.

Abobo (2018) also reported that two-thirds of Kiswahili teachers in a study could not use technology in their lessons. In contrast, Omolo et al. (2017) showed that after targeted training, Kiswahili student-teachers were more willing to use ICT in classrooms. These findings underscore that professional development is essential for ICT integration, a view supported by Higgins (2011), who linked lack of training to low ICT confidence and usage.

Twinomujuni (2011) studied ICT implementation in Ugandan higher institutions and found that most facilitators lacked even basic ICT skills. The study recommended training focused on computer-assisted instruction. The current study similarly focuses on teacher training, but in the Kenyan junior school context under the new curriculum.

Further research highlights the inadequacy of teacher ICT training. Mwangi and Khatete (2017) reported that most ICT training in Kenya covers only basic Office applications, which does little to help educators integrate technology pedagogically. Wambui and Ndanu (2016) criticized primary teacher training curricula for lacking practical ICT applications. Muinde and Mbataru (2019) found that although 85% of teachers in Machakos County received ICT training, 62.3% said the training was irrelevant to their teaching needs. These findings align with

Majumdar's (2005) assertion that time constraints often limit training content to basic computing skills.

Schaffer and Richardson (2004) argued that most teacher education programs focus more on teaching about technology than teaching with it. This leads to a lack of preparedness to apply ICT in classroom settings. They recommend that training programs include practical, subject-specific technology use. Their findings are supported by the current study, which investigates ICT integration in junior schools, beyond just general teacher training.

In Homa Bay County, Omito et al. (2019) found that while some teachers received government-facilitated digital training, they were expected to mentor peers, limiting the program's reach. Ngeno et al. (2020) observed similar patterns in Ainamoi Sub-County. Sharples and Moldeus (2014), in a multi-county Kenyan study, found that although 78% of teachers thought computers were easy to use, only 8% felt adequately prepared for regular ICT use in teaching. These findings reveal that training programs lack depth, leading to low ICT integration. The current study builds on this by exploring infrastructure, and teacher capacity training in Rangwe.

In the U.S., Baylor and Ritchie (2002) showed that professional development significantly influences teachers' effectiveness and morale in digital classrooms. However, despite numerous initiatives, many teacher education curricula still fail to incorporate adequate ICT components (Varsidas & McIsaac, 2001). This gap is addressed by the current study, which evaluates both teacher training and broader institutional support mechanisms in the Kenyan junior school setting.

McAlister (2005) found that there is a positive correlation between training and ICT usage. Teachers, as role models and primary change agents, require robust training and support. Agak (2010) reported that while 51% of Kenyan primary teachers had self-acquired ICT training, 55% had no formal training. In Rangwe Sub-County, many teachers reported feeling unprepared to integrate ICT in their schools, a concern the current study empirically addresses.

Overall, the literature reveals that ICT integration in education hinges on the availability of infrastructure and teacher capacity. Across both local and international contexts, recurring issues include inadequate facilities, limited training, and underutilization of technology. While previous studies focused primarily on secondary or post-primary settings, the current study aims to bridge contextual and geographical gaps by investigating ICT integration—particularly within junior schools in Rangwe Sub-County, Kenya—through the lens of infrastructure, training, self-efficacy, and teacher attitudes. This approach provides a more holistic understanding of the challenges and opportunities in implementing ICT under the Competency-Based Education (CBE).

3. Methodology

3.1 Research Design

Given the observational and survey-based nature of this research, a descriptive research design was employed. This design facilitates the comprehensive gathering of information regarding the variables within the specific research construct and measurement (Creswell & Creswell, 2018).

3.2 Target population, Sample size and sampling techniques

Rangwe Sub County has 101 Junior secondary schools divided into 6 zones namely, Rangwe, Nyawita, Randung, Ndiru, East Kochia, and West Kochia. The target population was 306 respondents comprising of 101 heads of institutions and 205 Junior facilitators within the Sub-County. The institutional heads were of interest since they are supposed to spearhead the integration of ICT in their classrooms and organize resources from several relevant partners. Additionally, given that facilitators are the ones integrating ICT in the classroom they are of interest too as shown in table 1

Table 1: Target Population

S/N	ZONE	SCHOOLS	HEAD OF INSTITUTION	TEACHERS	POPULATION
1	RANGWE	21	21	58	79
2	NYAWITA	14	14	29	43
3	RANDUNG	13	13	26	39
4	NDIRU	18	18	33	51
5	E.KOCHIA	17	17	31	48
6	W.KOCHIA	18	18	28	46
TOTAL		**101**	**101**	**205**	**306**

Source: Rangwe MoE 2024

3.3 Sample Size and Sampling Techniques

In this study, junior public secondary schools in Rangwe Sub County were divided into six strata using a stratified random sample technique. The institutions include; Rangwe, Nyawita, Randung, Ndiru, East Kochia, and West Kochia to guarantee that every school has an equal and independent chance of getting selected for the sample. Randomly chosen schools were chosen from each stratum. The heads of institutions and junior secondary school facilitators who took part in the study were chosen from the already sampled schools using a purposive sampling technique.

3.3.1 Sample Size

Gay, Mills, and Airasian (2009) assert that having a sample of the population between 10 and 30 % is recommended for sufficient and dependable results. Thus, 30 junior schools, or 30% of the 101 schools total, were involved in the study's sample. Utilizing a simple random technique, 30 schools were selected at random from each stratum. Every head of an institution from the thirty chosen schools was directly joined in the study. Furthermore, a sample of 30% of the 205 facilitators in the sub-county were included in the research. As a result, 62 facilitators from each stratum of the six zones in 101 schools will be chosen proportionately using a simple random procedure. The sampling matrix will entail 30 heads of institutions, 58 facilitators.

3.4 Research instruments

3.4.1 Teachers' Questionnaire

To assess the readiness of Heads of Institutions to integrate ICT in public junior schools in Rangwe Sub-County, both questionnaires and interview schedules were employed. The questionnaire enabled respondents to express themselves freely, reducing researcher bias while being cost-effective and allowing sufficient time for responses. It consisted of five sections: Section A captured demographic data, Section B addressed ICT facility availability, Section C explored teachers' attitudes toward ICT integration, Section D examined teacher training, and Section E assessed teachers' self-efficacy.

3.4.2 Head of Institutions' and Sub-County Director of Education Interview Schedule

The interview schedule, guided by Fraenkel, Wallen, and Hyun (2012), was designed to facilitate deeper insights through guided conversations. It targeted school heads and the Sub-County Director of Education to gather in-depth information about institutional readiness for ICT integration in the context of implementing Competency-Based Education (CBE). The interview questions were aligned with the study's objectives.

3.5 Pilot Study

This study piloted the instruments in two public junior schools from a neighboring sub-county. The aim was to test and adjust the research tools for accuracy and clarity. Based on Sahu's (2013) guideline, 10% of the main study's sample size was used: 10 teachers and 2 school heads. Teachers were selected using simple random sampling, while school heads were included automatically once their schools were chosen.

3.5.1 Validity of the Study Instruments

According to Sileyew (2019), validity measures how well an instrument captures the intended constructs. In this study, only relevant questions were included, and questionnaires were reviewed by content experts to assess their alignment with the study objectives. The **Content Validity Index (CVI)** was used to quantify the relevance of items, where items deemed valid by experts were retained. The process involved two stages: initially developing and organizing items based on objectives and then refining them through expert and supervisor feedback.

3.6 Reliability of the Data Collection Instruments

Reliability was tested using the **test-retest** method. The instruments were administered to two junior schools and repeated after two weeks with the same respondents. **Cronbach's Alpha** was calculated for both sets of responses. A reliability coefficient of **0.7**, as recommended by Mugenda and Mugenda (2003), was obtained and deemed acceptable, confirming the tools' internal consistency.

3.7 Data Collection Procedures

The researcher first obtained an introductory letter from the Graduate School and ethical clearance from Kisii University's **Institutional Science and Ethics Review Committee (ISERC)**. A research permit was secured from **NACOSTI** and presented to the Rangwe Sub-County Education Office. Upon approval, the researcher visited the selected schools to seek consent from heads of institutions. Teachers were issued questionnaires, while the researcher personally conducted interviews with heads of institutions and the Sub-County Director. A smartphone was used to record audio interviews, which were later transcribed.

3.8 Data Processing and Analysis

Collected data underwent cleaning and coding before analysis. Quantitative data was analyzed using descriptive statistics (frequencies, means, percentages, and standard deviations), following the approach of Mahuika and Mahuika (2020). Inferential statistics were applied to explore relationships between variables. Qualitative responses from open-ended questions were analyzed using content analysis, guided by Kothari (2014), to identify recurring themes and concepts. SPSS Version 26 was utilized due to its capacity to handle both small and large datasets (Greening, 2019). Findings were presented using tables and frequencies, for clarity and better comprehension.

3.9 Ethical and Logistical Considerations

Prior to data collection, the researcher secured necessary approvals from NACOSTI, ISERC, and the Graduate School at Kisii University. Permission was also obtained from the Rangwe Sub-County Education Office. Informed consent was sought from all participants, who were assured of voluntary participation and anonymity. Data confidentiality was strictly maintained, with respondents' identities protected and information used solely for academic purposes. The researcher also ensured participants' rights and dignity were upheld throughout the study.

4. Results and Discussion

4.1 Availability of ICT Infrastructure in Junior Schools in Rangwe Sub-County.

Results of the analysis aimed to assess the extent to which ICT infrastructure such as computers, internet access, projectors, and digital content is present and functional in the schools for teaching and learning process and are presented in Table 2.

Table 2: Availability of ICT Resources in Junior Secondary schools

S/N	ICT FACILITY	NA	RA	SA	AA	Valid	MEAN	STD DEV
1	Source of electric power	1	2	26	29	58	3.4561	0.62878
2	Wifi/Iternet connection	20	16	13	9	58	2.1579	1.06552
3	Tablets/computers for students	13	15	12	18	58	2.4717	1.11982
4	Laptops for teachers	25	12	19	2	58	1.9298	0.92311
5	Desktop PCs for usage by educators and students	29	11	15	3	58	1.8621	0.98138
6	Smartboards that interact	42	9	5	2	58	1.431	0.79719
7	Overhead projectors	27	10	12	9	58	2.0175	1.12585
8	Video decorder/player	31	14	6	7	58	1.7091	0.97511
9	Photocopy machine	22	7	12	17	58	2.4035	1.27978
10	Phot scanner	36	11	6	5	58	1.6552	0.98322
11	Digital camera	38	11	5	4	58	1.569	0.9198
12	Television	35	8	5	10	58	1.8276	1.17186
13	Radio	27	12	7	12	58	2.0526	1.2015
14	Video decorder/player	30	11	10	7	58	1.8772	1.08677
15	USB (memory) stick	20	12	13	13	58	2.3158	1.18258
16	Cell phone	3	3	10	42	58	3.5789	0.82261

A survey of 57 teachers and heads of institutions in Rangwe Sub-County revealed that while foundational ICT infrastructure exists in junior schools, major gaps remain. Electricity was the most consistently available resource (Mean = 3.4561, SD = 0.62878), with 50.9% reporting it as "Always Available." Mobile phones ranked highest in availability (Mean = 3.5789, SD = 0.82261), with 73.7% indicating constant access. However, internet access was limited (Mean = 2.1579, SD = 1.06552); 35.1% reported no access. Student tablets and computers (Mean = 2.4717) and photocopiers (Mean = 2.4035) showed mixed availability, with significant portions reporting them as unavailable. Critical digital tools like interactive smartboards (Mean = 1.4310), laptops (Mean = 1.9298), and desktop computers (Mean = 1.8621) were largely lacking, with over 70% reporting smartboards as entirely unavailable. These results highlight the urgent need to invest in ICT infrastructure to support effective digital learning and teaching.

An aggregate ICT resources availability index was computed by summing the individual Likert-scale responses across all availability-related items. Each item was rated on a 4-point scale ranging from 1 (Not available)

to 4 (Always Available). The resulting indices provide a composite measure of each teacher's rating on the availability of ICT resources in their schools. These ranged from 16 to 80, with higher scores indicating that the resources are more available. The corresponding descriptive statistics are provided in Table 3:

Table 3: Aggregated ICT Availability Scores

	N	Min	Max	Mean	Std. Dev	Skewness	Kurtosis
ICT Availability	58	18.00	61.00	34.277	11.329	.899	.059
Valid N (listwise)	58						

The analysis revealed ICT resource scores ranging from 18.00 to 61.00 out of 64, with a mean of 34.277, indicating moderate but inconsistent availability. Most resources, such as computers, projectors, and internet, were limited, while only electricity and mobile phones were consistently available. The distribution was right-skewed (skewness = 0.899), showing more schools with low availability, and a near-normal kurtosis (0.059). These findings reflect a broader rural Kenyan trend where foundational ICT infrastructure exists, but digital learning tools and internet access remain scarce (Odunga, 2024; Tabitha & Otieno, 2023), thus highlighting a persistent digital divide in junior schools.

The moderate availability of ICT resources in the schools studied is augmented by interview findings from headteachers on the ICT resources available in their schools which revealed a varied level of availability of different types of digital devices and are shown in Table 4.

Table 4: ICT Resources Available in Schools

		Responses		Percent of
		N	Percent	Cases
$ICT_Resources[a]	Laptops	11	12.8%	34.4%
	Tablets	7	8.1%	21.9%
	Projectors	13	15.1%	40.6%
	Smartphones	24	27.9%	75.0%
	Computers	31	36.0%	96.9%
Total		86	100.0%	268.8%

a. Dichotomy group tabulated at value 1.

Among 33 headteachers interviewed, 96.9% reported having computers, making them the most available ICT resource. Smartphones were also common, available in 75.0% of schools. However, projectors were present in only 40.6%, laptops in 34.4%, and tablets in just 21.9% of schools. These findings suggest that while desktop computers are widespread, portable devices like laptops and tablets remain limited. The relatively high smartphone use highlights their affordability and accessibility, pointing to disparities in ICT resource distribution across Rangwe Sub-County schools.

Further, the results on factors hindering ICT use in classrooms despite the availability of the tools are reported in Table 5.

Table 5: Hindrances to ICT Usage in Junior Secondary Schools in Rangwe Sub-County

		Responses		Percent of
		N	Percent	Cases
Hindrances to ICT Usage	Inadequate source of power	22	52.4%	71.0%
	lack of ICT Personnel	5	11.9%	16.1%
	inadequate ICT devices	8	19.0%	25.8%
	Internet Connectivity issues	4	9.5%	12.9%
	inadequate skills amongst teachers	2	4.8%	6.5%
	Nonfunctional ICT tools	1	2.4%	3.2%
Total		42	100.0%	135.5%

a. Dichotomy group tabulated at value 1.

Although 96.9% of schools have computers, 75.0% smartphones, and 40.6% projectors, effective ICT use remains limited due to challenges. Inadequate power supply was cited by 71.0% of headteachers as the top barrier. Additional issues included shortages of ICT personnel (16.1%), insufficient devices (25.8%), and poor internet connectivity (12.9%). These findings highlight that without reliable infrastructure and support; the educational impact of ICT resources remains constrained.

4.1.1 Relationship between availability of ICT infrastructure and integration of ICT for effective implementation of CBE in junior schools in Rangwe Sub-County

The availability of Information and Communication Technology (ICT) infrastructure plays a critical role in supporting the effective implementation of CBE, particularly in junior schools where learners are introduced to more structured technological engagements. The study further explored the relationship between the availability of ICT infrastructure and the effectiveness of ICT integration in junior schools. The analysis aimed to determine whether schools with better access to ICT resources exhibit higher levels of ICT use in support of CBE implementation. Results are shown in Table 6.

Table 6: Regression analysis results for the relationship between availability of ICT infrastructure and integration of ICT

Model Summary		**ANOVA**					
R	0.435	Source	SS	df	MS	F	
R Square	0.205	Regression	65.032	1	65.032	14.467	
Adjusted R Square	0.191	Residual	251.774	56	4.495	(0.000)	
Std. Error of the Estimate	2.120	Total	316.776	57			
Coefficients	Unstandardized B		Std. Error	Standardized Beta		t	Sig.
(Constant)	25.491		1.560			16.345	.000
ICT_Availability	.171		.045	.453		3.803	.000

The regression analysis revealed that the availability of ICT resources explains 20.5% of the variance in effective ICT integration ($R^2 = 0.205$). The model was statistically significant ($F(1,56) = 14.467$, $p = 0.000$), confirming that ICT infrastructure availability significantly predicts ICT integration for Competency-Based Education (CBE) implementation. The regression coefficient ($B = 0.171$, $p < 0.05$) indicates a positive, statistically significant relationship, each unit increase in ICT availability leads to a 0.171 increase in ICT integration. The standardized coefficient (Beta = 0.453) suggests a moderate effect.

The resultant regression model was formulated as follows:

$$\boldsymbol{ICT}_{\boldsymbol{Integration}} = \mathbf{25.491} + \mathbf{0}.171\,\boldsymbol{ICT}_{\boldsymbol{Availability}} \quad (\mathbf{1})$$

These findings affirm that ICT infrastructure is a key enabler of CBE implementation in Rangwe Sub-County, aligning with Achieng, Ogola, and Muchanje (2024), who noted that digital devices and internet connectivity

significantly supported digital literacy and CBE rollout in Homa Bay County. Despite explaining a modest variance, the results highlight the critical role of ICT infrastructure in education.

4.2 Teachers' Level of Training in ICT Amongst the Junior Schools in Rangwe Sub-County

The analysis in Table 7 provides insights into the extent to which teachers feel equipped with the necessary digital skills to integrate ICT into teaching and learning

Table 7: Teachers' level of training in ICT amongst the Junior Schools in Rangwe Sub-County

No.	Statement	SDA	DA	N	A	SA	MEAN	SD
1	ICT training opportunities are frequently made available to teachers in this sub-county.	16	16	16	7	1	2.30	.736
2	I was informed early enough to plan for ICT training participation.	0	18	26	10	4	3.00	.868
3	The training venues were easy to access from my school.	1	15	12	13	17	3.52	.814
4	The training times did not conflict with my teaching schedule.	17	12	18	8	3	2.45	.859
5	ICT training was accessible to all staff in my school, regardless of subject or role.	21	15	7	13	2	2.31	.876
6	I received support from the school leadership to attend ICT training.	3	9	11	19	16	3.62	.876
7	The trainers were well-prepared and experienced in ICT for education.	0	3	20	30	5	3.64	.718
8	The training content matched the teaching needs of the Competency-Based Education (CBE).	1	3	20	30	4	3.57	.775
9	I was given enough time to practice using ICT tools during the training.	0	5	23	28	2	3.47	.706
10	The training materials were well-structured and helpful.	0	4	26	23	5	3.50	.755
11	The training addressed challenges specific to rural or under-resourced schools.	0	5	32	19	2	3.31	.681
12	Post-training support or mentorship was available to help me implement what I learned.	0	4	29	22	3	3.41	.702

The findings reveal that access to ICT training remains a key challenge for teachers in Rangwe Sub- County. Training opportunities were rated as infrequently available (mean = 2.30), often clashing with teaching schedules (mean = 2.45), and perceived as limited in inclusivity across different staff roles (mean = 2.31). While teachers appreciated that training venues were accessible (mean = 3.52) and reported strong leadership support for participation (mean = 3.62), planning in advance was only moderately feasible (mean = 3.00), suggesting inconsistent communication. These access barriers align with findings by Dimo et al. (2022), who reported that only 37% of smallholder farmers had ever received ICT training, often once and through private initiatives. Similarly, Kiboye (2015) highlighted planning and institutional support issues limiting community access to training in Rangwe.

In contrast, the quality of ICT training received more favorable ratings. Teachers noted that trainers were experienced (mean = 3.64), content was aligned with Competency-Based Education (CBE) (mean = 3.57), and practical sessions were sufficient (mean = 3.47). Training materials were considered well-structured (mean = 3.50), although relevance to under-resourced school settings (mean = 3.31) and post-training mentorship (mean = 3.41) showed room for improvement. These quality indicators are consistent with Dimo et al. (2022), who praised the knowledge and practicality of trainers, while noting limited contextual adaptation and mentorship.

Overall, while the quality of ICT training in Rangwe is viewed positively, persistent access-related challenges—including irregular frequency, poor scheduling, and lack of inclusivity—limit its overall impact. Enhancing access

through improved planning, communication, and equity, while maintaining the current quality standards, is essential for bridging digital skill gaps among junior school teachers and supporting effective CBE implementation.

4.2.1 Effect of teachers' training in ICT on integration of ICT for effective implementation of CBE in the junior schools in Rangwe Sub-County

This section examines how the level of ICT training among teachers in Rangwe Sub-County influences their use of technology in teaching. The analysis aimed to determine whether training significantly contributes to the effective integration of ICT in junior schools as presented in table 8.

Table 8: Regression analysis results for the relationship between Teachers' ICT Training and integration of ICT

Model Summary		ANOVA					
R	**0.386**	**Source**	**SS**	**df**	**MS**	**F**	
R Square	**0.148**	**Regression**	**47.244**	**1**	**47.244**	**9.816**	
Adjusted R Square	**0.134**	**Residual**	**269.532**	**56**	**4.813**	**(.003)**	
Std. Error of the Estimate	**2.194**	**Total**	**316.776**	**57**			
Coefficients	**Unstandardized B**	**Std. Error**	**Standardized Beta**			**t**	**Sig.**
(Constant)	**27.482**	**1.261**				**21.799**	**.000**
TRAINING Index	**.120**	**.038**	**.386**			**3.133**	**.003**

The regression analysis examined the influence of teacher ICT training (TRAINING_Index) on effective ICT integration for Competency-Based Education (CBE) implementation in junior schools in Rangwe Sub-County. The R^2 value of 0.148 indicates that 14.8% of the variance in ICT integration effectiveness is explained by the level of teacher training. The model was statistically significant ($F(1,56) = 9.816$, $p = 0.003$), confirming training as a key predictor. A positive regression coefficient of 0.120 ($p < 0.05$) implies that a one-unit increase in training leads to a 0.120 increase in ICT integration effectiveness.

The standardized coefficient (Beta = 0.386) reflects a moderate relationship. The model is: **ICT Integration = 27.482 + 0.120 TRAINING Index.** These results highlight that teacher ICT training significantly supports effective CBE implementation, reinforcing the need for structured professional development. This aligns with Too, Kipkoech, and Keter (2024), who found that inadequate training hinders the effective use of digital tools in Kenyan public schools.

Teachers' effectiveness in ICT Integration for CBE Implementation

It was important to establish teachers' levels of effectiveness in integrating ICT into teaching and learning in Junior Secondary Schools within Rangwe Sub-County as a key variable.

The analysis in Table 9 highlights the degree to which teachers believe in their own competence to plan, implement, and manage ICT-based instruction.

Table 9: Teachers' levels of effectiveness in ICT Integration

STATEMENT	S	A	U	D	SD	MEAN	STD DEV
Confident that with the use of ICT in my classroom, I can help students grasp challenging concepts	26	27	2	2	1	4.2931	0.71941
I am sure that ICT will improve students conceptual understanding	26	27	1	3	1	4.2758	0.76376
I am confident in my capacity to create enriched my pupil`s learning experience with technology	29	20	6	1	2	4.2586	0.75227
I am confident in my capacity to connect with other educators and parents via WhatsApp	31	20	3	3	1	4.3275	0.81841
I am confident in my capacity to choose the right teaching software	23	26	4	4	1	4.1379	0.85437
I am confident in my capacity to use the internet to find educational resources	33	21	1	1	2	4.4137	0.63027
I am sure i can use ICT to introduce different teaching methods to my students	32	23	1	1	1	4.4482	0.63027
I am confident in my ability to communicate with parents and other teachers via email	32	18	2	4	2	4.2758	0.9697

The results indicate that teachers in Junior Secondary Schools in Rangwe Sub-County demonstrate high effectiveness in integrating ICT into their teaching practices. All mean scores for ICT-related competencies exceeded 4.0, suggesting strong confidence and capability. Notably, teachers showed the highest confidence in using ICT to introduce varied teaching methods (M = 4.45, SD = 0.63) and to access online educational resources (M = 4.41, SD = 0.63). High levels of confidence were also reported in using WhatsApp for communication with colleagues and parents (M = 4.33, SD = 0.82), selecting suitable teaching software (M = 4.14, SD = 0.85), and using email for professional correspondence (M = 4.28, SD = 0.97). The low standard deviations (mostly below 1.0) suggest consistent responses among teachers. An aggregate score of ICT integration effectiveness ranged from 8 to 40, with higher scores indicating stronger ICT integration. These findings suggest that teachers feel well-prepared to use ICT for instructional and professional purposes. This aligns with Koross (2024), who found that teachers in Turkana County similarly exhibited strong self-efficacy in using ICT for lesson delivery and communication, especially when supported by leadership. Overall, the data reflects a solid foundation in digital competence, with only minor areas needing further enhancement to ensure comprehensive ICT integration.

5. Conclusion and Recommendations

5.1 Conclusion

The study concludes that the ICT infrastructure availability is a *significant predictor* of ICT integration in junior schools within Rangwe Sub-County. In regard to objective two, the study concludes while the professional delivery and relevance of ICT training are acknowledged, structural and logistical barriers—such as infrequent sessions, poor timing, and limited inclusivity—continue to hinder equitable access. In a nutshell, enhanced teacher ICT training can significantly improve the integration of technology in CBE delivery, reinforcing the importance of professional development for educators.

5.2 Recommendations

Based on the study findings, the following are recommendations to enhance ICT integration for the effective implementation of the Competency-Based Education (CBE) in junior schools within Rangwe Sub-County:

1. **Improve ICT Infrastructure Equity**: Prioritize investments in essential ICT tools such as laptops, computers, smartboards, and reliable internet connectivity—particularly in under-resourced schools—to bridge access gaps and elevate the

composite ICT availability index beyond its current moderate mean of 34.277.

2. **Expand and Decentralize ICT Training**: Provide more frequent and flexible ICT training opportunities that are well-scheduled around teaching commitments. Tailor programs to accommodate all staff regardless of subject area, thereby addressing the low training accessibility scores as evidenced in Table 4.17 with a mean = 2.30.

3. **Embed Practical Application into Training Programs**: Reinforce ICT training with hands-on modules, post-training mentorship, and school-based coaching to improve the relevance and retention of digital skills, especially in under-resourced settings.

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