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ICT ADOPTION AND LEARNING EFFICIENCY IN PUBLIC TVET INSTITUTIONS WITHIN NAIROBI COUNTY

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ABSTRACT

In Kenya, Technical and Vocational Education Training (TVET) institutions have increasingly embraced the use of Information and Communication Technology (ICT) to enhance the delivery of education and training programs. Learning has become more interractive especially in TVET institutions in Kenya and it has been facilitated by several factors, including the government's commitment to investing in ICT infrastructure, the availability of affordable internet connectivity, and the growing demand for flexible and convenient modes of learning. Additionally, the proliferation of mobile devices and the popularity of social media platforms have made it easier for learners to access learning materials. Thus this study aimed to examine the role of ICT adoption on the effectiveness of learning in TVET institutions in Nairobi County. Specifically, the study aimed to analyze how ICT infrastructure and trainees attitude towards use of ICT influences learning efficiency in Public TVET institutions within nairobi county. The study used descriptive research design. The unit of analysis was 26 public TVET institutions within Nairobi County. The unit of observation was 40,000 trainees an 1540 trainers of the TVET institutions.. The sample size was 382 trainees and 14 trainers and cluster sampling was used to select the respondent from the sample. The study relied on primary data that was collected using the questionnaires. A pilot study was conducted with 40 respondents. The study used content and construct validity. Reliability was tested using Cronbach Alpha coefficient. The Statistical Package for the Social Sciences was used to analyze the collected data (SPSS). The study used descriptive and inferential statistics. Findings were tabulated. Results showed that; a moderate positive and statistically significant relationship between ICT infrastructure and learning efficiency ($r=0.323$, p-value= 0.000), and a strong positive and statistically significant relationship between trainees attitude towards ICT use and learning efficiency ($r=0.826$, p-value= 0.000). The recomemndations are; TVETs should formulate and implement clear and comprehensive ICT policies that guide and support digital learning integration, prioritize investments in modern ICT infrastructure including computers, projectors, smart boards, stable internet connectivity, and updated software, continuous professional development programs to enhance trainers' skills and capabilities in use of ICT tools and integrating them in pedagogy, and showcase the value and benefits of ICT in improving learning experiences and career readiness.

Key Words: ICT, ICT Adoption, ICT Infrastructure, Trainees Attitude, Learning Efficiency, Public TVET Institutions, Nairobi County

Background of the Study

All TVET sectors and other educational spheres have experienced a revolution in teaching methods during the last few critical decades because of the impact Information Communication Technology (ICT) has laid before it. With economies increasingly relying on technology the world over, there has been a paradigm shift in how vocational education is done today—a surge in demand for skilled workers. Efficient ICT integration into education is a necessity in building the skills necessary for 21st-century workforce, as stated by The United Nations Educational, Scientific and Cultural Organization (UNESCO, 2020).Many nations all over the world have acknowledged that ICT could enhance learning effectiveness, improve access to educational resources and promote more inclusive learning environments. International research provides evidence that ICT implementation in education often shifts pedagogy towards innovative techniques while increasing student interactivity and access to resources (Hwang et al., 2020).

Statement of the Problem

The application of Information Communication Technology (ICT) can potentially revolutionize education, especially in Technical and Vocational Education and Training (TVET) colleges by enhancing the quality of learning, enhancing the engagement of students and bridging skill gaps in the labor market (Bastola et al., 2019). However, ICT integration in Nairobi County TVET institutions faces significant challenges. One of the most significant hindrances to ICT adoption in Nairobi County's TVETs is a lack of technological infrastructur. In Oduor et al. (2021), inadequate ICT infrastructure is a key impediment towards successful digital learning in TVET institutions, impeding consistent and quality delivery of learning. This infrastructural gap has created a digital divide where a minority of well-resourced institutions can successfully integrate ICT while the majority of them are not able to fully exploit the capabilities of technology in learning. Mutai (2020) discovered that many TVET educators do not receive a proper training in order to incorporate digital techonolgy into pedagogical approaches ,thus resulting in an inability to maximize existing ICT infrastructures.

Inspite of such constraints ,efforts have been made to enhance the application of Information and Communication Technology (ICT)in Technical and Vocational Education and Training (TVET)colleges.As per The Star (2022)75% of the TVET colleges surveyed had internet connectivity,yet just 35% of them possesed teleconferencing software and applications that facilitate online learning, indicating that while fundamental internet connectivity exists a proper E-learning infrastructure is underdeveloped. Chelimo et al., (2022) added that 81.8% of TVETs trainers had received some form of technical training in e-learning but they still faced challenges due to the complexity of platforms and limited follow-up support.

Additionally, institutional policy implementation remains a major barrier. Although 76% of educational institutions have access to ICT tools, only 17% have fully implemented the National ICT Strategy for Education and Training (Ministry of Education, 2021). Academia.ed(2024) found that 84.1% of those surveyed velieved that ICT had not been integrated into the curriculum at their institutions and 70.8% believed ICT had not been integrated into learning and teaching processes,signifying a great gap in digital education adoption.The goverment and developmental partners have taken a range of actions to address these gaps .

In August 2021 UNESCO distributed ICT equiptments to six Kenyan TVET institutions unser the Better Education for Africa’s Rise (BEAR II)project to promote digital learning and technlogical skills development.Besides the strategic plan of the Ministry of Education for 2022-2027 set Ksh.1.55 billion for policy interentions to improve TVET programs and Kshs.588 Million was directed to improving governance and management in these institutions

with a focus on ICT development(The Star 2022). .Despite these efforts there remain a challange in terms of ICT infrastructure gaps ,digital literacy capacity and curriculum integration and it is essential to investigate the barriers to ICT integrationsuch as infrastructural deficiencies ,digitalilleteracy gaps,and trainers capacity building deficiencies affect the learning outcome.The findings ot this study will help researchers develop more informed understanding of ICT adoption in Nairobi TVET colleges as well as solutions to these obstacles,Through charting best practices and areas of improvement of paramount significance ,policy makers and educators can more effectively leverage ICT to imrpove learning efficiency ,the quality of education and equip learners with the needs of rhe modern job market.

Objectives of the Study

General Objective

To assess how ICT adoption enhances learning efficiency in Public TVET institutions within Nairobi County.

Specific Objectives

i. To examine the availability of ICT infrastructure in enhancing the efficiency of learning in the Public TVET institutions within Nairobi County.
ii. To establish the trainees attitude towards use of ICT in learning in the Public TVET institutions within Nairobi County.

LITERATURE REVIEW

Theoretical Review

Constructivist Learning Theory

According to constructivism learning theory, learning and knowledge construction is a process in which the learner engages, interprets and transforms information acquired through experiences to mean something. Instead of watching information being delivered to them, learners assimilate new knowledge within their contexts and construals. This approach affirms that learning occurs when the learner is actively involved, is social and is problem solving, thus making it meaningful and student centered. Learner-constructed knowledge is contrast to receptiveness of information in constructivism theory advanced by Piaget (1970) and Vygotsky (1978).In Constructivist Learning Theory, learners are seen to create knowledge themselves with the help of the environment in which they are situated. This theory is relevant in ICT integration in TVET institutions because it supports practical experience. These ICT tools like virtual labs, simulations, and e-learning offer students chances to active learning. With the help of these technologies, students can operate in real situations, involve tasks related to their vocational training, and exercise considered and tested theoretical knowledge, all of which concur with the constructivist paradigm of problematic and reflectively based learning.

Additionally, conceptual schemata acquisition is enhanced by ICT that enables the students to perform real life activities. Where practical skills are integral in the competency-based training offered within the TVET institutions, ICT facilitates learning and efficiency by offering the student geometric possibilities to work on pertinent, realistic exercises, and share them online with fellow students as well as cultivate life-like vocational skills (Liu & Chen, 2010). ICT also also enhance collaborative learning, one of the powerful tools of constructivism through use of forums, shared folder and virtual classes for conferencing. We find that these platforms integrate learners into teams and enhance teamwork, knowledge construction, and information sharing through collaborative efforts(Duffy&Jonassen,1992).

Further, ICT enables student-directed learning since learners can discover more information from the available online sources than the entire instructor or teacher country. Ideally, in

vocation education this flexibility enables the learners to build on knowledge aero where they are, revisit any theory where necessary and take charge of their learning process. For this reason, understanding plays the role of the self-directed aspect of learning especially at the TVET institutions since students will be required to understand both theoretical and practical domain knowledge to fit the job market (Mayer, 2004).

Conceptual Framework

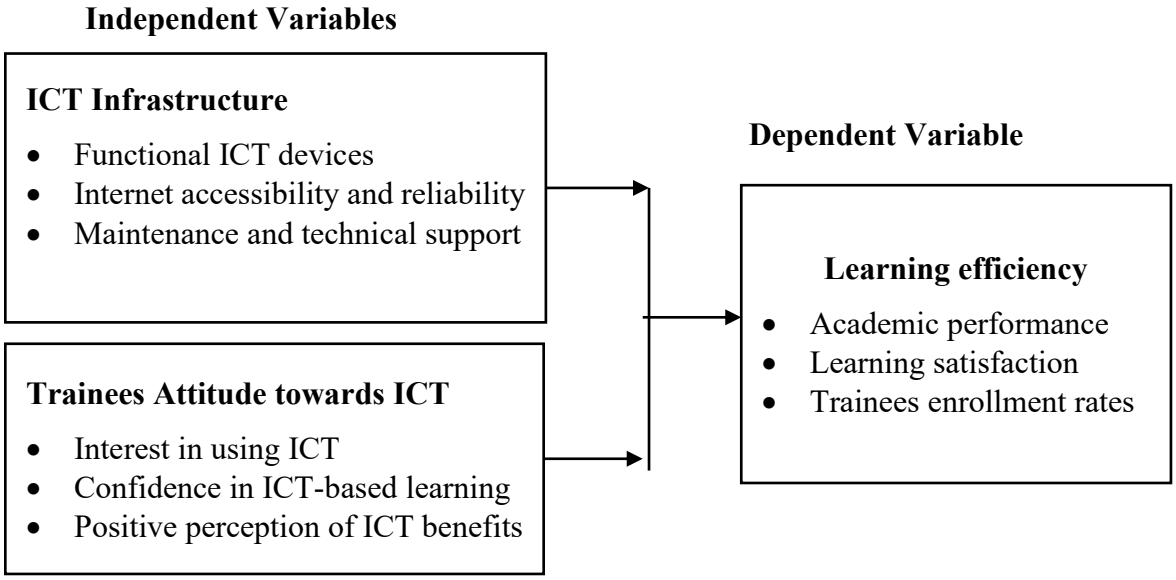

Figure 2. 1: Conceptual Framework

Empirical Review

ICT Infrastructure on Learning in TVET institutions

The Government of Kenya Sessional Paper on Policy Framework for Education and Training, published in June 2012, identified ICTs as the primary conduit for learning. The implementation of learning is dependent on a thriving ICT infrastructure, which in Kenya is far from adequate. When it comes to crucial ICT infrastructure and internet connectivity, the country has a wide digital gap between urban and rural regions that averages 69% (Ndungu, Lewis, and Mothobi, 2019). According to the Kenya Digital Economy Blueprint (2019), there are 580 sub-locations in Kenya with less than 50% GSM (Global System for Mobile communication) coverage, while around 160 sub-locations have no mobile signal at all. It goes on to claim that there are around 2,000 sub-locations with less than 50% 3G network coverage, with half of the population entirely cut off from 3G services.

Furthermore, it states that broadband network services cover a tiny geographical region corresponding to 17% of the country's size, leaving 83% of the country without broadband access. The same can be said about fiber optic lines, which span 17% of the landmass. However, the survey found that the digital divide is narrowing, although slowly. Earlier on Nyerere (2016), reported that institutions in key urban areas had good ICT infrastructure, while universities in suburban or medium sized towns had moderate ICT infrastructure and institutions in rural among others had low ICT infrastructure. This digital divide has been slowly diminishing with public and private sector initiatives such as the laying of the fiber optic infrastructure that has increased Internet bandwidth causing faster communications and enhanced use of learning (Communication Authority of Kenya, 2018).

One of the most challenges the government Ministries and institutions have is determining how to fund the technological infrastructure and offer the technical support activities necessary for ICT integration especially in areas where TVET has faltered. Years of neglect and a lack of finances have resulted in the inability to modernize existing technical infrastructure. Many African learning institutions are implementing ICT upgrades in stages, beginning with extending the use of existing accessible technology and progressively as new techniques become established in teaching practice. Despite high costs and unreliable electrical supply, there is evidence that TVET institutions are finding methods to purchase Internet access due to a belief in the technology's promise (Mead Richardson 2011).

Furthermore, because ICTs are fueled by energy, additional since ICTs are powered by electricity; the rural electrification Programme (REP) and the last mile electricity connectivity initiative are other government effort geared towards the expansion of the national ICT infrastructure. For instance, at the end of July 2015, the government had during the first phase of the plan, Kenya electricity and Lighting Company hoped to connect 314,200 non-commercial consumers, primary and secondary schools to the national electricity system (Kenya Power and Lighting Company, 2017). The number of REP connections grew from 1,269,500 in the 2016/17 fiscal year to 1,332,100 in the 2017/18 fiscal year (Kenya National Bureau of Statistics Economic Survey, 2019). When reviewing the country's ICT infrastructure, another factor to consider is the penetration of Internet Service Providers (ISPs) in the country; the July-September quarterly Communication Authority report of the 2018/19 fiscal year entitled indicated an increase in mobile phone subscription to 46.6 million users, up from 45.5 million users the previous year this expansion was related to ISP market expansion as well as the availability of low-cost mobile phones.

According to the same research, mobile data [Internet] subscriptions were at 42.2 million users over the same time, up from 41.1 million customers the previous year and this continuous decline in smartphone pricing was ascribed to this rise (Communications Authority of Kenya, 2018). Some colleges have low levels of ICT and learning infrastructure as a result of the significant expenses associated with procuring, deploying, and maintaining the ICT infrastructures required to provide a healthy learning environment (Nyerere, 2016). This, in turn, restricts access to learning since the present ICT infrastructure is not scalable to support the ever-growing number of e-learners seeking tertiary education, as well as the large amount of ICT resources required (Sabi, 2014). Also according to Kashorda and Waema (2014), they argued that the internet is needed for a vibrant learning environment, which is measured by use of two indicators: availability and affordability. Their study therefore recommended that individual institutions should take up the responsibility to draw up policy strategies to increase Internet access to the increased learner enrolment rates, in order to take advantage of the efforts by the Kenyan government aimed at continuously improving the ICT regulatory framework.

The Trainees Attitude towards ICT Adoption in Learning

According to Nyerere (2016), institutions in major cities had strong ICT infrastructure, while institutions in suburban or medium-sized towns had moderate ICT infrastructure and institutions in rural locations had poor ICT infrastructure. With governmental and private sector initiatives such as the installation of fiber optic infrastructure, Internet bandwidth has grown, resulting in speedier communications and increasing usage of learning (Communication Authority of Kenya, 2018).There are two sorts of digital divides: those caused by the use of ICT, which may result in greater disparities in access to TVET between urban and rural people, or wealthy and poorer students. The use of ICT in TVET has the potential to increase the gap between nations that can provide inexpensive bandwidth and ICT infrastructure and facilities and those that cannot. Despite the recent growth of subsea fiber cables throughout Africa's west and east coastlines, customers continue to pay significantly more. There is evidence that relevant technology may be made available through a planned and

focused strategy that engages Ministries, institutions, students, and development partners in a phased way. Of course, this should occur in the context of equally targeted employee development and adaptive organizational structures.

RESEARCH METHODOLOGY

The study adopted a descriptive research design to systematically examine how ICT is applied in learning across public TVET institutions in Nairobi County. This design enabled the researcher to document existing ICT tools, usage patterns and their relationship with learning efficiency. The target population comprised 26 public TVET institutions with a combined total of 41,540 trainers and trainees, forming the units of analysis and observation respectively. A sampling frame of 7,180 TVET staff was used, and cluster sampling was applied by treating each institution as a cluster. Using Slovin's formula at a 95% confidence level, a sample size of 396 respondents was determined, consisting of 382 trainers and 14 trainees.

Data were collected using structured questionnaires divided into demographic and thematic sections covering ICT infrastructure, and trainees' attitudes. The researcher obtained institutional permissions and a NACOSTI research permit, and administered the questionnaires using a drop-and-pick method to ensure anonymity and honest reporting. A pilot test involving 10% of the sample (40 respondents) was conducted to evaluate clarity, applicability, and comprehension of the instrument. Content and construct validity were confirmed through expert review and factor analysis, while reliability was established using Cronbach's Alpha, ensuring all constructs met the recommended threshold of 0.7–0.9.

Data analysis involved coding and processing the questionnaires using SPSS. Descriptive statistics such as frequencies, percentages, means and standard deviations were used to summarize ICT adoption trends. Inferential analysis employed Pearson correlation to determine relationships among variables and multiple linear regression to assess the influence of ICT policies, ICT infrastructure, trainers' digital skills and trainees' attitudes on learning efficiency. The regression model provided estimates of predictor effects, enabling the study to identify the extent to which ICT contributes to improved learning outcomes within TVET institutions.

RESEARCH FINDINGS AND DISCUSSIONS

The sample size of study was 396 respondents. The pilot test was conducted with 40 respondents representing 10% of the sample size. The pilot respondents were not included in the actual study hence 356 questionnaires were administered out of which 310 were answered successfully. The response rate was 87%. Kothari (2012) recommended that an adequate response rate is one that is greater than 50%, while an exceptional response rate is typically one that is greater than 70%.

Descriptive Analysis

This section presents the findings from the Likert scale questions where respondents indicated their level of agreement with various statements regarding ICT adoption and learning efficiency TVET institutions within Nairobi County. A 5-point Likert scale was used, with mean values and standard deviations calculated to interpret the findings. A mean value of 1.0-1.80 was strongly disagree1.80-2.60 disagree, 2.61-3.20 neutral, 3.21-4.20 agree and 4.21-5.00 strongly agree. On the other hand, a standard deviation lesser than 2.0, suggests that the responses had a close range of scores across the participants.

ICT Infrastructure

The first objective was to examine the availability of ICT infrastructure in enhancing the efficiency of learning in the TVET institutions within Nairobi County. The respondents were

asked to tick availability of ICT infrastructure procurement decentralization. Findings are shown in Table 1.

Table 1: ICT Infrastructure and Learning Outcome

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.
The current ICT infrastructure in this institution supports both theoretical and practical learning activities.	48.4	12.3	1.9	21.9	15.5	2.44	1.609
Inadequate ICT infrastructure hinders effective access to online learning resources and course materials.	15.2	1.6	7.7	20.3	55.2	3.99	1.437
The institution prioritizes and regularly invests in upgrading ICT infrastructure for improved learning outcomes.	50.0	23.2	3.5	13.9	9.4	2.09	1.389
Frequent ICT-related disruptions significantly hinder the ability to learn effectively.	15.2	1.6	4.8	9.0	69.4	4.16	1.467
Reliable access to ICT tools improves student engagement, learning speed, and overall academic performance.	14.8	8.7	6.5	17.4	52.6	3.84	1.502
There are enough computer labs to accommodate practical learning needs of all students.	69.4	9.7	1.6	14.8	4.5	1.75	1.286
The internet speed in this institution is fast and reliable for research and online learning.	59.4	21.9	1.9	1.6	15.2	2.58	1.662
Students can easily access ICT tools such as projectors, tablets, and printers to enhance their learning.	73.2	11.0	6.8	4.8	4.2	2.44	1.086
Average						**2.91**	**1.430**

Results show that the current ICT infrastructure in this institution does not supports both theoretical and practical learning activities (M=2.44, Std.=1.609) as strongly disagreed by 48.4% of the respondents. The low mean and strong disagreement indicates that there is inadequate ICT infrastructure to support theoretical and practical learning. This hinders learning efficiency, as TVETs depend on practical, hands-on training, and the weak infrastructure limits access to digital resources. Inadequate ICT infrastructure hinders effective access to online learning resources and course materials (M=3.99, Std.=1.437) as strongly agreed by 55.2% of the respondents. This confirms that the TVETs ICT infrastructure is limited and cannot meet the technology needs to all the tutors and the trainees. This limits students' ability to interact with digital course materials that are a key component of modern TVET curriculum.

The institution rarely prioritizes in upgrading ICT infrastructure for improved learning outcomes and the investments for the same are low (M=2.09, Std.=1.389) as strongly disagreed by 50% of the respondents.The lack of investment in ICT infrastructure limits learning efficiency as out-dated infrastructure may not support the evolving technology need in teaching and learning in the TVETs. Frequent ICT-related disruptions significantly hinder the ability to learn effectively (M=4.16, Std.=1.467) as strongly agreed by 69.4% of the

respondents. This implies that the TVETs frequently experience disruptions such as internet outages software, and hardware failure which slows down learning. Reliable access to ICT tools improves student engagement, learning speed, and overall academic performance (M=3.84, Std.=1.502) as strongly agreed by 52.6% of the respondents.This implies that ICT infrastructure improves learning efficiency when its available and adequate for use by all trainers and trainees.

The computer labs are not enough to accommodate practical learning needs of all students (M=1.75, Std.=1.286) as strongly disagreed by 59.4% of the respondents. This shows a severe shortage of computer labs which are important or TVETs practical training. The internet speed in this institution is low and unreliable for research and online learning(M=2.58, Std.=1.662) as strongly disagreed by 59.4% of the respondents. This indicates that the internet speed in the TVETs is generally low which slows down learning especially during online classes. The sstudents' cannot easily access ICT tools such as projectors, tablets, and printers to enhance their learning (M=2.44, Std.=1.086) as strongly disagreed by 73.2% of the respondents. This indicates scarcity in ICT tools in the TVETs which increases the costs of education since the students have to but their personal technology devices. The average mean which is below 3 shows a general negative perception of ICT infrastructure availability in the TVETs. Results supports Pelgrum (2021) who found that insufficient infrastructure is a key hindrance to ICT implementation in schools. Similarly, Ndiwa (2023) found that there was inadequate computer resources in the department of ICT. Internet speed was wanting, and there was no power backup. This hindered effective use of ICTs in teaching and learning.

Trainees Attitude Towards use of ICT

The second objective sought to establish the trainees' attitude towards use of ICT in learning in the TVET institutions within Nairobi County. The staff was asked to tick on the extent to which they agree/disagree with statements related to trainees' attitude towards use of ICT in learning. Findings are shown in Table 2.

Table 2: Trainees Attitude towards ICT integration

Statements	SD %	D %	N %	A %	SA %	M	Std.
The integration of ICT in learning makes lessons more interactive, engaging, and effective.	1.9	4.5	1.9	30.0	61.6	4.45	0.890
Students with better ICT access perform significantly better than those with limited access to digital resources.	2.9	7.1	4.5	37.1	48.4	4.21	1.017
I am confident in using digital tools to complete assignments, conduct research, and collaborate on projects.	11.0	18.4	3.5	21.3	45.8	4.33	1.200
I actively seek opportunities to improve my digital skills to enhance my learning experience.	11.0	10.9	0.9	30.6	46.5	4.02	1.165
The availability of ICT resources in this institution motivates me to explore more digital learning opportunities.	0.6	3.5	18.1	56.5	21.3	3.94	0.769
I believe that ICT skills are essential for my academic and future career success.	3.5	5.5	3.9	34.2	52.9	4.23	1.639
I feel comfortable asking trainers for help when I face challenges using digital tools.	5.8	17.4	1.6	16.5	58.7	3.82	1.492
I find digital assignments more engaging and useful than traditional paper-based assignments.	5.2	6.5	8.0	25.5	54.8	3.94	1.323
Average						**4.12**	**1.186**

The integration of ICT in learning makes lessons more interactive, engaging, and effective (M=34.45, Std.=0.890) as strongly agreed by 61.6% of the respondents. This implies that the trainees strongly believe that ICT enhances lesson interaction and effectiveness. This is a widely shared attitude among the students and tutors of various TVETs in Nairobi County. Students with better ICT access perform significantly better than those with limited access to digital resources (M=4.21, Std.=1.017) as strongly agreed by 48.4% of the respondents. This positive attitude highlights the ICT's role in improving academic performance which aligns with TVETs' focus on skills development.

Majority of the trainees are confident in using digital tools to complete assignments, conduct research, and collaborate on projects (M=4.33, Std.=1.200) as strongly agreed by 45.8% of the respondents. The confidence supports learning efficiency since it enables independent use of ICT for assignments and projects. The students actively seek opportunities to improve their digital skills to enhance their learning experience (M=4.02, Std.=1.165) as strongly agreed by 46.5% of the respondents. This attitude enhances learning efficiency by enabling self-directed learning which is essential for TVETs' practical focus.

The availability of ICT resources in this institution motivates students to explore more digital learning opportunities (M=3.94, Std.=0.769) as agreed by 56.5% of the respondents. This shows although the resources are inadequate, the students are willing to make good use of the available ICT resources at the school to improve on their ICT skills. The finding may also imply that inadequate resources demotivate students to adopt ICT in learning. The students believe that ICT skills are essential for their academic and future career success(M=4.23, Std.=1.639) as strongly agreed by 52.9% of the respondents. This positive attitude promotes learning efficiency through motivating skills acquisition which aligns with the goals of TVETs.

The students feel comfortable asking trainers for help when they face challenges using digital tools(M=3.82, Std.=1.492) as strongly agreed by 58.7% of the respondents. This implies that the trainers are approachable and willing to help students in need. They students find digital assignments more engaging and useful than traditional paper-based assignments(M=3.94, Std.=1.323) as strongly agreed by 54.8% of the respondents. This preference promoted learning efficiency by aligning with TVETs digital skills acquisition. The average mean shows that trainees perceive ICT as an important to learning and teaching in TVETs. The results show enthusiasm for digital learning which aligns with TVET' curriculum goals. Results concur with Nikolopoulou and Gialamas (2016) who found that students who believe ICT enhances future career prospects are more likely to embrace digital learning practices. Further, Nzuki (2013) found that both trainers' ICT skills and students' attitudes are important in successful ICT integration

Learning Efficiency

The respondents were asked to tick on the extent to which they agree/disagree with statements related to learning efficiency. Findings are shown in Table 3.

Table 3: Learning Efficiency

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.
ICT integration enhances my ability to complete learning tasks more efficiently.	5.2	3.5	5.8	27.4	58.1	4.00	1.467
The availability of ICT resources helps me manage my time more effectively	6.5	5.5	6.5	25.8	55.8	3.95	1.467
Using ICT tools reduces the time it takes to research, analyze, and complete assignments.	5.8	3.5	18.1	11.9	60.6	3.96	1.375
ICT-based learning platforms (e.g., e-learning portals) improve my ability to understand course concepts faster.	1.9	4.2	2.6	28.3	62.9	4.56	1.233
Interactive digital resources (e.g., videos, simulations) make it easier for to grasp complex ideas.	5.2	11.9	3.2	39.0	40.6	3.98	1.194
The use of ICT in learning increases my productivity and motivation to learn.	1.6	4.8	14.8	9.0	69.7	4.17	1.457
Access to online resources (e.g., journals, e-books) enhances the efficiency of learning process.	1.6	7.7	4.8	19.4	66.5	4.32	1.532
ICT integration allows collaboration on projects and assignments.	5.8	3.5	9.7	15.2	65.8	3.95	1.515
Average						**4.11**	**1.405**

Results show that ICT integration enhances my ability to complete learning tasks more efficiently (M=4.00, Std.=1.467) as strongly agreed by 58.1% of the respondents. The results suggest strong belief that ICT tools streamline learning processes and execution of various academic tasks. The availability of ICT resources helps me manage my time more effectively during learning activities (M=3.95, Std.=1.467) as agreed by 55.8% of the respondents. This implies that ICT tools support better planning and organization of academic work. Using ICT tools reduces the time it takes to research, analyze, and complete assignments(M=3.96, Std.=1.375) as strongly agreed by 60.6% of the respondents. This indicates that digital tools improve learning efficiency and ease of access to information. ICT-based learning platforms (e.g., e-learning portals) improve trainees ability to understand course concepts faster (M=4.56, Std.=1.233) as strongly agreed by 62.9% of the respondents. This shows that the digital platforms significantly enhance comprehension of concepts.

Interactive digital resources (e.g., videos, simulations) make it easier for the trainees to grasp complex ideas (M=3.98, Std.=1.194) as strongly agreed by 40.6% of the respondents. This confirms that digital tools are effective effective pedagogical aids especially for technical subjects. The use of ICT in learning increases trainees productivity and motivation to learn (M=3.92, Std.=1.512) as strongly agreed by 59.7% of the respondents. This shows that ICT not only helps with learning efficiency but also with learner engagement. Access to online resources (e.g., journals, e-books) enhances the efficiency of learning process (M=4.17, Std.=1.457) as strongly agreed by 69.7% of the respondents. The results highlights the essential role of digital academic content in improving learning practices. ICT integration allows collaboration on projects and assignments (M=4.32, Std.=1.532) as strongly agreed by 66.5% of the respondents. This implies that ICT enhances teamwork and interactive learning which are essential in TVET training. This high mean indicates that trainees strongly agree

that ICT enhances their learning efficiency, including better task completion, time management, understanding of content, and motivation. The moderate standard deviation suggests a generally consistent agreement among respondents, with minor variation

Correlation Analysis

The study used Pearson Correlation to measure the strength and the relationship between ICT adoption and learning efficiency in TVET institutions in Nairobi City County, Kenya. A correlation value of more than 0.5 shows a strong correlation, 0.30 - 0.49 moderate correlation while less than 0.29 shows a weak correlation. Significance is less than α=0.05. Correlation findings are presented in Table 4.

Table 4: Coefficient of Correlation

Variables		Learning efficiency	ICT infrastructure	Trainees attitude
Learning efficiency	Pearson Correlation	1		
	Sig. (2-tailed)			
	N	310		
ICT infrastructure	Pearson Correlation	.323**	1	
	Sig. (2-tailed)	.000		
	N	310	310	
Trainees attitude	Pearson Correlation	.826**	.344	1
	Sig. (2-tailed)	.000	.000	
	N	310	310	310

The Pearson correlation coefficient for ICT infrastructure and learning efficiency in TVET institutions is 0.323, with a p-value of 0.000. This indicates a moderate positive and statistically significant relationship between the variables. This suggests that the availability of infrastructure, such as computer labs, reliable internet, and digital tools, moderately enhances learning efficiency by enabling access to online resources and practical training. Findings concur with Ouma and Nkuyubwatsi (2019) who also reported a moderate correlation between ICT infrastructure and academic performance in Rwandan TVETs, noting that inadequate lab and unreliable internet hinder learning efficiency, similar to challenges in Nairobi.

The Pearson correlation coefficient for trainees attitude and learning efficiency in TVET institutions is 0.826, with a p-value of 0.000. This indicates a strong positive and statistically significant relationship between the variables. The results implies that trainees positive attitudes on ICT's , confidence in using the tools, and career relevance are key tools in learning efficiency. Findings are in support of Kiptalam and Rodrigues (2020) who also reported a strong correlation between students' ICT attitudes and academic outcomes in Kenyan technical institutions.

Regression Analysis

Regression analysis was conducted to understand how a unit change in ICT adoption may cause a change in learning efficiency in the TVET institutions in Nairobi County. The coefficient of determination shows how a statistical model is expected to predict future results.

Table 5: Regression Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
Constant/Y Intercept	6.616	.282		23.437	.000
ICT infrastructure	.506	.065	.360	7.750	.000
Trainees attitude	.771	.032	.704	24.128	.000

Learning efficiency = 6.616 + 0.506 (ICT infrastructure) + 0.771 (Trainees attitude).

ICT infrastructure has the second greatest effect on learning efficiency(β = .506, sig = .000). This shows that for a unit increase in ICT infrastructure , efficiency increases by 36%. This shows that availability and quality of ICT infrastructure (internet, hardware, software) moderately impact learning efficiency. This finding aligns with Obonyo et al. (2020) that access to reliable computers and internet significantly affects students' ability to complete assignments and engage with e-learning.

Results show that trainees attitude has the greatest effect on learning efficiency among the study variables (β = .771, sig = .000). This shows that for a unit increase in positive attitude towards ICT learning, efficiency increases by 70.4%. Results show that trainees' attitudes toward ICT are the strongest predictor of learning efficiency. Findings concur with Tadesse et al. (2021) that students' readiness and attitude toward ICT significantly affects the success of e-learning in developing countries

Conclusion

The results show that ICT infrastructure in TVET institutions within Nairobi County is inadequate and unreliable, hindering the efficiency of learning. Despite awareness of the potential benefits of ICT in education, students and staff face challenges such as slow internet, limited access to ICT tools, insufficient computer labs, and minimal institutional investment in infrastructure upgrades.

The findings show that trainers' digital skills have a strong positive effect on learning outcomes in TVET institutions in Nairobi County. Trainers effectively integrate and utilize digital tools to enrich the learning process. However, a key challenge exists in trainers' inability to troubleshoot ICT problems, which could disrupt lessons and reduce digital teaching efficiency. Despite this, the overall high ratings reflect a digitally proactive teaching force that significantly contributes to improved learner engagement and outcomes.

Recommendations

ICT Infrastructure

Results showed that there was inadequate ICT infrastructure in majority of the TVETs. The government should therefore prioritize investments in modern ICT infrastructure including computers, projectors, smart boards, stable internet connectivity, and updated software. The institutions should also partner with the private sector, NGOs, and development agencies to supplement funding and provision of ICT infrastructure in the TVETs. The institutions should as well appoint dedicated ICT support staff to help in managing and troubleshooting technology devices therefore reducing interruption during learning activities.

Trainees Attitude Towards use of ICT

The study showed positive attitudes towards use of ICT among trainees. The study recommends that the TVETs should showcase the value and benefits of ICT in improving learning experiences and career readiness. The institutions should organize digital orientation programs for all new students to build ICT use confidence. The institutions should also support student led digital initiatives such as clubs and competitions to encourage exploration and engagement with ICT tools.

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