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Original Research Article

E-Learning Readiness in Public Secondary Schools, Tharaka-Nithi County: The Effect of ICT Infrastructure Costs and Availability of Skilled ICT Personnel

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Abstract

The adoption of e-learning in public secondary schools is a critical aspect of modernizing education and enhancing learning outcomes. Despite significant government investments aimed at integrating ICT in education, many schools still face challenges in adopting e-learning. This study investigates the role of ICT infrastructure costs and the availability of skilled ICT personnel in determining the e-learning readiness of public secondary schools Meru South Sub-County, Tharaka-Nithi County, Kenya. This study is guided by the Diffusion of Innovation Theory, developed by Everett Rogers in 1962. The study employed a descriptive research design and gathers data from 22 schools in the county, with a total of 154 respondents. Purposive sampling technique was used to select the schools while simple random sampling was used to select the respondents. The data was collected using structured questionnaire which was first piloted to determine its validity and reliability. Descriptive and inferential statistics was used to analysed the data. The study found a significant relationship between the cost of ICT infrastructure and the readiness of public secondary schools in Tharaka-Nithi County to adopt e-learning (χ^2 = 16.692, df = 4, $p < 0.05$, Exp (B) = 70.266) indicating that high ICT infrastructure costs are a major barrier to e-learning adoption. Further, results indicated a significant relationship between the availability of trained

ICT personnel and the readiness of schools in Meru County to adopt e-learning (χ^2 = 18.514, df = 4, $p < 0.05$). The study concluded that both the high cost of ICT infrastructure and the availability of trained ICT personnel are significant factors affecting the readiness of schools in Tharaka-Nithi and Meru Counties to adopt e-learning. The paper offers recommendations for addressing these challenges in schools.

Keywords: ICT, E-learning, school, infrastructure, Skilled ICT personnel

Introduction

Over the last couple of decades, there has been a sea change in many aspects of human life brought about by rapid technological advancement (Brynjolfsson & McAfee, 2014). Computers and other forms of ICT have greatly transformed conventional teaching-learning practices, changing the role of the teacher from "sage on stage" to "guide by the side." (Bajunid, 2019; Shirey, 2013; Chen, 2005). New methods of learning, such as e-learning, have come into existence wherein students learn by themselves through online platforms or other digital means (Bandyopadhyay et al., 2021: Bonk, 2016). E-learning incorporates flexibility, inclusivity, and skills development, thus locating it as a critical driver in the 21st-century education systems.

E-learning has a number of benefits for students and teachers alike. It improves academic performance; increases access to educational opportunities and enhances digital literacy (Mothibi, 2015; Rafi, JianMing & Ahmad, 2019). It provides flexibility in learning schedules, which allows students to seek an education despite financial or logistical difficulties, according to Moubayed et al. (2018). Additionally, e-learning encourages independent learning, allowing students to identify their strengths and weaknesses and explore personalized pathways to success (Xu et al., 2014). For educators, it reduces the burden of direct classroom engagement, freeing time for research, professional development, and administrative tasks (Belanger & Jordan, 1999). In Kenya, ICT adoption has been recognized as a potential solution to challenges such as overcrowded classrooms, high student-teacher ratios, and limited teaching resources, particularly in science and mathematics (Kyambi, 2019; Nyamai, 2015).

However, e-learning adoption in Kenya is still slow despite its promising potential for transformation. Whereas the government has heavily invested in e-learning, such as funding ICT infrastructure, rolling out electricity in schools, and expanding internet access through fiber optic connectivity, many public secondary schools are not yet ready to fully adopt the shift (Ngugi, 2015). Programs, for instance, such as the National ICT Integration and E-learning Strategy, and projects in the pipeline through Vision 2030,

have the intention to include e-learning in the very core of education. However, challenges such as high costs of ICT infrastructure and inadequately trained ICT personnel remain insurmountable.

This, indeed, has been the kind of challenges that have faced other counties in Kenya. Take, for example, Tharaka-Nithi County, which has also benefited from huge government investments geared at incorporating ICT in educational facilities but has similarly failed to incorporate the learning practice through e-learning. Such occurrences prompt questions concerning the e-readiness of these institutions towards ICT adoption regarding financial, infrastructure, and stakeholder ability, especially teachers, learners, and administrators (Bowles, 2004). Readiness also entails the motivation and ability of learners to afford technological platforms and adapt to self-paced and collaborative modes of training (Chau, 2018).

Scholars insist that educational institutions should shift from the traditional classroom-based approach to technology-based systems if they are to remain relevant in the contemporary world (Means, Bakia & Murphy, 2014; Serdyukov, 2015). Traditional teaching models, initially designed for societies with low levels of literacy and resources, have many limitations, hence the need for urgent change (Ferri, Grifoni & Guzzo, 2020). In integrating e-learning, schools can tap into several advantages: individualized learning experiences, interactivity in content delivery, and resource efficiency. This study explores the state of e-learning readiness in Tharaka-Nithi County, a region in which little research has been done. It examines two very important aspects that are crucial for the successful implementation of e-learning: the cost of ICT infrastructure and the availability of skilled ICT personnel. It is expected that the findings from this study will provide useful insights for policymakers, educators, and stakeholders interested in removing these barriers and facilitating the implementation of e-learning in public secondary schools in Tharaka-Nithi County.

Theoretical Framework

This study is guided by the Diffusion of Innovation (DOI) Theory, developed by Everett Rogers in 1962 (Shiels, 2018; Byambaa et al., 2015). Rogers argues that diffusion is the process by which an innovation is communicated through certain channels over time among the participants in a social system (Miller, 2015). The DOI theory explains how, why, and at what rate innovations spread through a community or social system (García-Avilés, 2020). The theory identifies four key elements that influence this process: the innovation itself, the communication channels used to share information about the innovation, the time taken for adoption, and the characteristics of the social system where the innovation is introduced (Miller, 2015). The

application of DOI theory in this study is significant for several reasons: First, it lays down a framework that indicates how innovations such as e-learning are perceived and adopted within public secondary schools in Meru County. Secondly, it indicates the interplay of economic, social, and organizational factors that influence adoption decisions. Among these, the high cost of ICT infrastructure and limited availability of skilled ICT personnel are some critical barriers that need to be addressed in order to enhance readiness for e-learning adoption. This study, therefore, seeks to investigate e-learning adoption dynamics in public secondary schools in Tharaka-Nithi County by focusing on Rogers' DOI theory.

Methodology

The study was conducted in Tharaka-Nithi County, Kenya, covering an area of 2,609 km^2 with a population of 393,177 (2019 census). A descriptive research design was used, targeting public secondary schools in Meru South sub-county, which has 43 schools. These schools are categorized as boys' boarding, girls' boarding, mixed boarding, and mixed day. Purposive sampling was used for the two boys' boarding schools, while random sampling selected three girls' boarding, two mixed boarding, and 16 mixed day schools, totaling 22 schools (50% of the county's schools). In each school, curriculum master, or ICT teacher, and simple random sampling was used to select six teachers, totaling 154 teachers, which is 50% of the 370 teachers in the county.

This study used questionnaire which were administered to teachers. Piloting was carried out in two schools with similar characteristics to those included in the study in Meru South Sub-County, Tharaka-Nithi County. Reliability was determined using the test-retest method, where the questionnaire was administered twice to the same group at an interval of two weeks. Data collected from the two occasions were analyzed using Pearson's Product Moment Correlation to establish the degree of reliability (*rho*, *r*). The *r* obtained was 0.74, which indicated that the instrument was reliable. This aligns with Kerlinger's (1970) assertion that a reliability score of 0.5 and above is acceptable.

Validity was ensured by verifying that the questions corresponded to the items on the questionnaire and consulting professionals and lecturers in the relevant departments. Construct validity was also used to validate the instrument. Two schools, different from those in the main sample but with similar characteristics, were randomly selected for this purpose. The results of the pilot tests were used to review and refine the instruments.

The data collected were coded onto a mark sheet, then fed into a computer and analyzed using the Statistical Package for Social Sciences (SPSS). Descriptive statistics, such as frequencies, tables, percentages, means,

and standard deviations, were used to analyze the data. Inferential statistics, including the Chi-square (X^2) test, were employed to test the hypotheses. Logistic regression was appropriate because the dependent variable was binary, assuming values of 1 (yes) or 0 (no). The results of the descriptive statistics were presented using statistical tools such as tables where necessary.

Results and Discussion

Response Rate

A total of 154 questionnaires were distributed to the ICT/Curriculum teachers and the school management. Out of the 154 questionnaires 120 (78%) were appropriately filled and returned. According to Mugenda (2003), a return of 50% and above is acceptable. Therefore, a return of 78% of the questionnaires was considered acceptable for this research.

Demographic Information

Sixty-two percent of the respondents were male, while 38% were female, indicating that the majority of teachers in Tharaka-Nithi County are male. Fifty-three percent of the respondents were aged 31–40 years, 24% were below 30, 13% were aged 41–50, and 9% were over 50 years. This shows that most teachers are under 41 years old. Forty-seven percent of the teachers are graduates, 37% hold diplomas, and 17% are form four leavers. This means that 84% of the teachers are trained, with the remaining 16% being untrained but assisting regular teachers.

Preparedness for E-Learning in Schools

Table 1 presents an overview of the factors influencing the readiness of schools for E-learning adoption in Meru South Sub-County. Results in table indicated that 62% of the respondents did not have a computer laboratory, while thirty-eight percent did, indicating that most schools are unprepared for E-learning due to the lack of this essential facility. Additionally, 67% of schools had fewer than ten computers, mainly used in offices, making it almost impossible to adopt E-learning. Eighty-three percent reported that the number of computers in their schools was inadequate. Sixty-nine percent of schools relied on donors to acquire computers, highlighting a dependency on external funding. While 45% of teachers were computer literate, this was insufficient for E-learning adoption, as many schools had fewer computer literate teachers. Moreover, 82% of schools had fewer than ten computer literate teachers, making it challenging to implement E-learning. Seventy-three percent of schools did not offer computer courses, and 80% of teachers had not attended any E-learning courses, reflecting a lack of preparation for

E-learning. Lastly, 81% of schools did not offer any form of E-learning, indicating that the majority are not yet ready to adopt this approach.

Table 1: Factors influencing the readiness of schools for E-learning adoption

Variables	Percentage
Presence of Computer Laboratory	
No Computer Laboratory	62%
Has Computer Laboratory	38%
Number of Computers in School	
Less than 10 computers	67%
More than 11 computers	33%
Adequacy of Computers	
Not Adequate	83%
Adequate	17%
Donor Assistance in Acquiring Computers	
Donor Help	69%
School Funded	31%
Computer Literacy	
Computer Literate	45%
Not Computer Literate	55%
Number of Computer Literate Teacher	
Less than 10 computer literate teachers	82%
More than 11 computer literate teachers	18%
Computer Courses Offered	
No Computer Courses	73%
Offers Computer Courses	27%
E-learning Courses Attended	
Not Attended E-learning Course	80%
Attended E-learning Course	20%
Use of E-learning	
No E-learning	81%
Some E-learning	19%

The Benefits Derived from Use of E-learning

This table 2 summarizes the responses from the study participants regarding the perceived benefits of e-learning in public secondary schools in Meru South Sub-County.

Table 2: Benefits of e-learning in public secondary schools

	Frequency	Percentage
Motivate students to learn	25	20.8
Solve problems of shortage of teachers	12	10
Simplify knowledge Acquisition by students	18	15.0
No benefit at all	65	54.2
Total	120	100

Table 2 results indicated that 54.2% of the respondents said that they do not benefit at all from E-learning simply because they have not adopted it, 21% use E-learning to motivate students to learn, fifteen per cent use it simply for knowledge acquisition by students while ten per cent use E-learning to solve problems of shortage of teachers. Many schools here do not find any meaningful use of E-learning and therefore cannot get ready perfectly well to adopt it since they derive no befit from it at all. Seminars, demos and in servicing courses should be organized by the ministry so as to show teacher the real benefits of E-learning.

Effect of Cost of ICT Infrastructure on Readiness of Public Secondary Schools in Tharaka-Nithi County to Adopt E-learning

Table 3 presents the results of a 5-point Likert scale survey assessing the perceived cost of ICT infrastructure in public secondary schools in Meru South Sub-County, Tharaka-Nithi County.

Table 3: Results of Cost of ICT Infrastructure

Variables	SD %	D %	U %	A %	SA %	Totals %
Schools have funds to equip computer lab	40	37	10	7	7	100
Schools are funded by donors to buy ICT facilities	17	3	13	27	40	100
ICT equipments are bought by fees paid by parents	29	38	20	8	7	100
CDF funds schools to buy computers	13	13	9	26	39	100
ICT equipments are not taxed by the government	27	40	18	11	5	100

Key: SD= Strongly Disagree, D= Disagree, U= Undecided, A=Agree, SA=Strongly Agree.

From table 3, 77% of the respondents disagreed that schools have enough funds to equip the computer laboratory, 10% were undecided while 14% agreed. This means that most schools do not have enough funds to buy infrastructure needed for e-learning to take place. 20% disagreed that schools are funded by donors to buy ICT facilities, 13% were undecided while 67% agreed. This means that donors' funds schools to buy ICT facilities needed to be able to adopt E-learning. 67% of the respondents disagreed that ICT equipment in schools are bought by fees paid by parents, 20% were undecided while 15% agreed. This means that fees paid by parents is not enough to purchase all the ICT equipment needed to be able to adopt E-learning. 26% of the respondents disagreed that CDF funds schools to buy computers, 9% were undecided while 65% agreed. This means that many schools that have got some ICT equipments have done so through CDF funds and a few through other means like harambees. 67% of the respondents disagreed that ICT equipments are not taxed, 18% were undecided while 16% agreed. This means that ICT equipments are taxed which makes them be more expensive and thus a major set back in adopting E-learning. Beside the cost of the hardware, softwares too were found to be very expensive. The government should liaise with software manufactures to provide software at an affordable cost to all the learning institutions. The above shows that cost of ICT infrastructure is a burden to many schools in Tharaka-Nithi County which merely depends on donors and CDF to help them acquire ICT infrastructures as they get ready to adopt E-learning.

To examine the relationship between the cost of ICT infrastructure and the readiness of schools in Tharaka-Nithi County to adopt e-learning, the null hypothesis stating that;

$H_0$1: There is no significant relationship between the cost of ICT infrastructure and the readiness of public secondary schools in Tharaka-Nithi County *to adopt e-learning.*

was tested using the chi-square (χ^2) statistical method. A comparison was made between the frequency scores for responses on ICT costs and the readiness of schools to adopt e-learning to determine if the relationship was statistically significant.

The critical chi-square value (χ^2 crit = 9.49) and the calculated chi-square value (χ^2 cal = 16.692*) were compared at $p < .05$ and df = 4. Using the decision rule, if the calculated value exceeds or equals the critical value, the null hypothesis is rejected. Based on this comparison, it was concluded that there is a significant relationship between the cost of ICT infrastructure and the readiness of public secondary schools in Tharaka-Nithi County to adopt e-learning.

The study indicated that the high costs associated with acquiring ICT infrastructure presented a significant challenge to the adoption of e-learning. The acquisition of ICT infrastructure was ranked first, with an Exp (B) value of 70.266 and a significance level of 0.054. This finding suggests that many schools, especially those that have not adopted e-learning, face financial barriers due to the high investment required for ICT infrastructure. Roszak et al. (2016) emphasize that e-learning requires substantial investment, and schools must be well-prepared to handle these costs. This is echoed by Twinning (2002), who notes that increased spending on technology can strain school finances, contributing to the reluctance of some institutions to adopt new technologies.

Further, Maloba (2019) state that schools must bear higher costs to adjust their organization and acquire the necessary infrastructure to benefit from e-learning. This aligns with the study's findings, indicating that high costs have been a significant barrier to the adoption of e-learning in Tharaka-Nithi County schools. As a result, a "digital divide" is emerging between schools that have made progress in integrating e-learning and those that have not, potentially affecting performance outcomes.

Poverty in schools, particularly in "CDF schools," has exacerbated the challenge. These schools are unable to afford the necessary ICT infrastructure or sponsor teachers for e-learning training. This situation is in line with the current policy in Kenya, where the responsibility for building physical infrastructure in secondary schools falls on parents. In many cases, parents are unable to provide the necessary resources, especially in arid, semi-arid, or urban slum areas, where schools are further constrained by limited funding. The lack of standardized software and the high costs associated with licensing education software also pose barriers to the integration of e-learning. Although open-source systems have been adopted in some cases, nearly 90% of educational software in use in Africa requires costly licenses and annual renewals, which are unsustainable in the context of high poverty levels.

To address these challenges, the Kenyan government launched the Education Sector Programme (ESP) in May 2011, which allocates funds to 1,050 schools across the country to purchase ICT infrastructure and improve internet connectivity. Additionally, 210 "computer champions" were trained to help teachers in their constituencies implement e-learning. This initiative aims to reduce the financial burden on schools, making e-learning more accessible and improving the adoption rate across the country.

Effect of Availability of Trained Personnel in ICT on Readiness of Public Secondary Schools to Adopt E-learning in Meru South Sub-County, Tharaka-Nithi County

Table 4 presents the results of a 5-point Likert scale survey assessing the perceived availability of trained Personnel in public secondary schools in Tharaka-Nithi County.

Table 4: Results for Availability of trained Personnel

Variables	SD %	D %	U %	A %	SA %	Totals %
Have attended E-learning courses	42	38	0	10	10	100
All ICT teachers in the school have undergone teacher training in ICT	23	43	13	12	11	100
School has adequate ICT trained personnel	38	12	9	17	25	100
Sch. mgt sponsors teachers to learn computer packages	47	28	17	4	5	100

Key: SD= Strongly Disagree, D= Disagree, U= Undecided, A=Agree, SA=Strongly Agree.

From table 4, 80% of the respondents have not attended E-learning in–service courses and only 20% have attended any. This means that many of the teachers in Meru South Sub-County, Tharaka-Nithi County have no any training in E-learning and thus would be unable to adopt it even if they wanted. Schools should sponsor teachers to attend E-learning courses to equip them with the right skills needed for E-learning to take place. 66% of the respondents disagreed that all ICT teachers have under gone teacher training in ICT, 13% were undecided while 23% agreed. This means that majority of ICT teachers in Meru South Sub-County, Tharaka-Nithi County are not trained and a few are trained in ICT teaching which is a major setback in adoption of E-learning. For E-learning to take place well many teachers should be trained in ICT .50% of the respondents disagreed that schools in Meru South Sub-County, Tharaka-Nithi County have adequate ICT trained personnel, 9% were undecided while 42% agreed. This means that schools in Meru South Sub-County, Tharaka-Nithi County do not have enough trained ICT personnel which is a major setback in adopting E-learning. 75% of the respondents disagreed that school management sponsors teachers to learn computer packages, 17% were undecided while 9% agreed. This means that school leaders in Meru South Sub-County, Tharaka-Nithi County have little interest in ICT and that's why they do not sponsor their teachers to learn computer packages. The above shows that schools in Meru South Sub-County, Tharaka-Nithi County do not have enough trained ICT personnel due

to lack of interest by the school's management which is a major setback in adopting E-learning.

To examine the relationship between the cost of ICT infrastructure and the readiness of schools in Meru County to adopt e-learning, the null hypothesis stating that;

$H_0$2: There is no significant relationship between the availability of trained personnel in ICT and the readiness of public secondary schools in Meru County to adopt e-learning.

was tested using the chi-square (χ^2) statistical method. The frequency of responses regarding the availability of trained ICT personnel and the readiness of schools to adopt e-learning was compared to evaluate the strength of the association. The critical chi-square value (X^2 crit = 9.49) was compared with the calculated chi-square value (X^2 cal = 18.514*), with a significance level set at $p < .05$ and degrees of freedom (df) equal to 4.

The decision rule was as follows: if the calculated chi-square value was greater than or equal to the critical value, the null hypothesis would be rejected, and the alternative hypothesis, which posits a relationship between the availability of trained ICT personnel and the readiness of schools to adopt e-learning, would be accepted.

Given that the calculated chi-square value (18.514) exceeded the critical value (9.49), the null hypothesis was rejected. This led to the conclusion that there is a significant relationship between the availability of trained ICT personnel and the readiness of public secondary schools in Meru South Sub-County, Tharaka-Nithi County to adopt e-learning.

Conclusion

The study investigated the factors that influenced the preparedness of public secondary schools to adopt e-learning in Meru South Sub-County, Tharaka-Nithi County. The results showed that most of the schools were facing significant challenges in infrastructure, trained personnel and financial constraints that impeded the adoption of e-learning. Most of the schools lacked important ICT infrastructures such as computer laboratories and enough numbers of computers. A lack of trained ICT personnel and limited availability/access to e-learning courses further contributed to poor integration. Financial hurdles included the high costs entailed in acquiring ICT infrastructure and software, funded either by donors or from limited government support. Consequently, almost all schools remained unprepared for e-learning, with the majority of their teachers and administrators unskilled and unmotivated to use it effectively. It also established that the ready availability of trained ICT personnel and access to adequate ICT infrastructure are the key determinants that ensure the successful adoption of e-learning.

Additionally, the cost of ICT infrastructure appeared to be a very important barrier, as most schools could not acquire the funds required to purchase e-learning resources. Also, the unavailability of uniform software and trained people increased the financial limitation and made the gap in digital division wider between schools in various socio-economic backgrounds.

Recommendations

1. The government should prioritize funding for ICT infrastructure in public secondary schools, particularly in disadvantaged areas. This includes providing subsidies for ICT equipment, such as computers and software, as well as ensuring that schools have access to affordable and standardized educational software.
2. Schools should sponsor teachers to attend e-learning and ICT training courses. This will ensure that a sufficient number of teachers are equipped with the skills needed to implement and support e-learning initiatives. In-service training programs should be organized regularly to enhance the ICT competencies of teachers.
3. Schools should explore partnerships with private organizations and non-governmental organizations (NGOs) that can provide financial support, ICT infrastructure, and expertise. This can help bridge the resource gap, especially in schools that lack the financial capacity to invest in ICT.
4. The government should collaborate with ICT manufacturers and distributors to reduce the costs of ICT equipment and software for schools. Additionally, tax exemptions on educational ICT equipment could help reduce the financial burden on schools

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