ICT infrastructure and Pupils Learning Outcomes: A Case of Matete Sub-County Primary Schools, Kakamega County

Jacob Wambasi Kitari[1], Pamela Buhere[2] and Samuel Obaki[3]

Masinde Muliro University of Science and Technology P.O Box 190-50100, Kakamega, Kenya.

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Abstract- This study investigated the difference in academic performance of public primary schools with ICT infrastructure and those without between 2008 and 2016, focusing on the ability of public primary schools, to provide quality education through the utilization of ICT skills.The researcher adopted both qualitative and quantitative research methods. The study targeted all public primary schools that benefitted from World Vision ICT project and a similar number of schools that did not get the support for comparison purposes. Purposive sampling technique was used to identify18 head teachers and 18 teachers as key respondents in this study. Structured questionnaires were used to collect data from head teachers and teachers. Reliability of data collection instruments was established through test-retest technique whereby reliability coefficient score of 0.72 for the head teachers and 0.78 for the regular teachers' questionnaires attained were appropriate since these indices were above the minimum recommended value of 0.7. The research experts from the department of Educational Planning and Management of Masinde Muliro University of Science and Technology assisted the researcher to clarify the contents of the test items in the study instruments. The data collected was analyzed inferentially using Stata analytical programme. The results t(10.1131)=3.0031, P=0.013, indicated a statistically significant correlation between ICT infrastructure and the performance of primary schools in Matete Sub-County. Therefore, the researcher recommended that stakeholders in Education should develop more ICT infrastructure in public primary schools to promote hands on learning process. In this case, the government should mobilize and direct more resources to improve ICT infrastructure in all public primary schools.

I. INTRODUCTION

ICT has a direct role to play in education and if properly used it can bring many benefits to any learning scenario. Its functions give new opportunities for learner centered teaching approach. Greater opportunities for multiple information technologies delivered by teachers necessitate great enthusiasm for learning amongst the scholars (Sessional Paper No. 1 of 2005), in this case increased impetus in learning translate into improved academic achievement since the learners are able to access more information, hence, a wider range of learning experiences. Conway, (1997), asserts that supporting multiplicity of cognitive styles and learning behavior, unlike situations where content is presented to learners without the use of instructional materials, the modern forms of technology can be used to translate virtually any content into another media, making it more interesting and accessible to any kind of learners. SITE, (2002), observes that the brightest promise of technology in education is to be used as a support for new, innovative, and creative form of teaching and learning. This entails using multimedia cases to teach topics that have previously been addressed through lecture method. The Kenyan Government has emphasized the Policy in Education through the policy document of the Kenya National ICT Master plan – Towards a digital Kenya (April,2014).

A policy document published in 2008 for the parliament, the education council recognised that as a result of heavy investments, schools have acquired computers, internet connection and educational software at their disposal (Onderwjsraad, 2008); with the enormous amounts of public resources being invested in educational technology, a pertinent question is whether this investment has paid off in terms of higher efficiency and effectiveness in the entire school management practices, teaching and learning thus leading to improved performance in various activities being undertaken especially in public primary schools. In Netherlands, more pricey policy makers and stakeholders pose the same questions given the fact that they fail to understand how much school management and administration are making use of the available resources to perfect on the general academic performance of primary school learners. This is because in case ICT policy is well implemented, the ICT infrastructure in the daily organisation, the integration of ICT in teaching and above all, whether or not ICT has positively impacted on learner's academic achievement (European School net, 2006).

1.2 Statement of the Problem

In the current 21st century, Education determines livelihood and development intervention of individuals and Nations; however, the value of education is reflected in academic achievement of learners which is currently a global challenge. Kenya, a third world country on the African continent is currently a victim of low academic performance of public primary schools especially with the introduction of free tuition in basic education offered by the government of Kenya from pre-primary to secondary education levels in all public institutions. Through research studies, it was noted by Uwezo- Kenya (2010), that Kakamega County experiences low literacy levels in primary school classes relative to the acquisition of reading, writing and

arithmetic skills. Uwezo-Kenya tests were administered to assess literacy and numeracy levels among individual learners in kakamega County. The literacy test entailed letter sounds, reading a word, reading a paragraph and reading a short story. Numeracy tests involved number recognition, place value and performing basic operations of addition and subtraction. The findings revealed that less than one in three Grade 3 pupils passed any of the three tests. Specifically 29% of Grade 3 pupils passed the numeracy test, while 25% passed the literacy test. One in six or 16% pupils passed both the numeracy and literacy tests. Uwezo- Kenya (2010) further established that only 20% of 3-8 year old children were able to tackle basic or real life mathematical problems and those 2 out of 3 learners in standard two were unable to read.

Many pupils in Kakamega County are not acquiring basic competencies as per the demands of primary school curriculum (Uwezo- Kenya, 2013). This could have been as a result of weaknesses in the management of the available instructional resources which the researcher believes should have built a stronger foundation for performance in upper classes. One of the global interventions intended to address the challenge of low academic performance in schools is through integration of ICT in educational curriculum. Effective implementation of ICT requires appropriate policy frameworks. In pursuit of this, the Kenya government developed an ICT Policy towards improvement of academic performance. In response to this, World Vision, an international humanitarian organization which partners with Kenya to improve educational performance in public learning institutions, developed an intervention strategy to boost the implementation of ICT policy framework in the teaching and learning processes amongst public primary schools in Kakamega County through the World Vision ICT Project (WV-ICT Project) as from the year 2008- 2016.

II. Methodology

This was a survey study conducted in public primary schools that benefited from the world vision ICT project and those that did not in Kakamega County. The target population of the study comprised of teachers and head teachers from the identified 36 public primary schools. Teachers were key informants in this study because they utilize ICT skills during lesson instruction and have the potential to evaluate the actual use of ICT knowledge and skills in the target primary schools.18 teachers trained by World Vision in ICT and18 head teachers provided relevant data.
The sample size comprised of 18 head teachers and 18 teachers from both the World Vision ICT project supported and the same number of non-World Vision ICT project primary schools in Matete sub-county

Questionnaire was the main instrument designed and administered to the selected sample to collect the desired data. The collected data was collated; coded and analyzed using the basic/descriptive and non-parametric (inferential) statistics specifically Two tailed Independent sample t-test was used to compare school KCPE mean scores for the World Vision-ICT project and non World Vision-ICT project schools. Pearson's Moment Correlation Coefficient helped in determining the correlation between the Independent variables and the outcome variable within public primary schools in Matete Sub- County, Kakamega County.

III. Study Findings

The study was to establish the difference in academic performance of public primary schools with ICT infrastructure and those without. After subjecting collected data to the Pearson correlation coefficient statistical test with a significant level of 0.05, the outcome results are shown in Table 1.

Table 1: Correlation Matrix Between the Outcome Variable (z_s2tm), the Explanatory Variable (t23a3) and the Covariates for School Academic performance

Variable		z_s2tm	t21a1	t21a2	t22a1	t22a2	t23a1	t23a2
z_s2tm		1						
t21a1	A	0.150	1					
	B	0.383						
t21a2	A	-0.150	-1.000	1				
	B	0.383	1.000					
t22a1	A	-0.066	-0.060	0.060	1			
	B	0.701	0.729	0.729				
t22a2	A	0.066	0.060	-0.060	-1.000	1		
	B	0.701	0.729	0.729	0.000			
t23a1	A	0.018	0.109	-0.109	0.130	-0.130	1	
	B	0.915	0.529	0.529	0.451	0.451		
t23a2	A	0.319	0.120	-0.120	0.196	-0.196	-0.454	1
	B	0.058	0.488	0.488	0.251	0.251	0.005	
t23a3	A	-0.368	-0.200	0.200	-0.299	0.299	-0.109	-0.837
	B	0.027	0.242	0.242	0.077	0.077	0.529	0.000
t24a1	A	-0.208	-0.076	0.076	0.316	-0.316	0.041	0.181
	B	0.223	0.661	0.661	0.060	0.060	0.812	0.292
t24a2	A	0.208	0.076	-0.076	-0.316	0.316	-0.041	-0.181
	B	0.223	0.661	0.661	0.060	0.060	0.812	0.292
t26a1	A	-0.094	0.181	-0.181	0.263	-0.263	0.070	0.124
	B	0.587	0.291	0.291	0.122	0.122	0.684	0.473
t26a2	a	0.094	-0.181	0.181	-0.263	0.263	-0.070	-0.124

	b	0.587	0.291	0.291	0.122	0.122	0.684	0.473
t27a1	a	-0.014	0.135	-0.135	0.161	-0.161	-0.073	0.161
	b	0.937	0.433	0.433	0.348	0.348	0.672	0.348
t27a2	a	0.014	-0.135	0.135	-0.161	0.161	0.073	-0.161
	b	0.937	0.433	0.433	0.348	0.348	0.672	0.348
t28a1	a	-0.282	-0.086	0.086	0.154	-0.154	-0.140	0.000
	b	0.096	0.618	0.618	0.369	0.369	0.415	1.000
t28a2	a	0.282	0.086	-0.086	-0.154	0.154	0.140	0.000
	b	0.096	0.618	0.618	0.369	0.369	0.415	1.000
t29a1	a	-0.226	0.200	-0.200	0.060	-0.060	-0.109	0.060
	b	0.186	0.242	0.242	0.729	0.729	0.529	0.729
t29a2	a	0.226	-0.200	0.200	-0.060	0.060	0.109	-0.060
	b	0.186	0.242	0.242	0.729	0.729	0.529	0.729
t210a1	a	-0.281	-0.129	0.129	0.124	-0.124	0.070	-0.155
	b	0.097	0.452	0.452	0.473	0.473	0.684	0.368
t210a2	a	0.281	0.129	-0.129	-0.124	0.124	-0.070	0.155
	b	0.097	0.452	0.452	0.473	0.473	0.684	0.368
t211a1	a	-0.070	0.109	-0.109	0.130	-0.130	-0.059	0.130
	b	0.686	0.529	0.529	0.451	0.451	0.733	0.451
t211a2	a	-0.206	0.086	-0.086	0.154	-0.154	-0.140	0.000
	b	0.228	0.618	0.618	0.369	0.369	0.415	1.000
t211a3	a	0.228	-0.135	0.135	-0.210	0.210	0.161	-0.065
	b	0.181	0.433	0.433	0.220	0.220	0.349	0.709

Note: a=Pearson correlation coefficient; b=p-values (α=0.05); Pair-wise correlation: ≤0.35 = Weak correlation; 0.36-0.67 = Moderate correlation; 0.68-0.89=Strong correlation; ≥0.90 = Very strong correlation; Adapted from "Interpretation of correlation coefficient, " by R. Taylor, 1990, Journal of Diagnostic Medical Sonography, 6(1), p. 37

Source: Stata Output,2019

The test results shown in Table 1 indicated that the outcome variable was not significantly different. The output (*p*=0.2033) indicates that there is no statistically significant difference in academic performance of public primary schools with ICT infrastructure and those without. These findings contradict the results of the study by Harrison *et al* (2004) who identified statistically significant findings positively associating higher levels of ICT use with school performance at each stage and in English, Mathematics, Science, Modern foreign languages and design technology. An association between high ICT use and higher pupil attainment in primary schools was also reported in an earlier teacher training agency study by Moseley *et al* (1999. p82) though the interpretation by researchers was that more effective teachers, tended to use more innovative approaches or chose to use ICT resources that they had more appropriately, rather than that the technology itself was the cause of the differences in pupil's performance. The connection between technology and learning is fairly consistent and other studies have indicated a stronger association. The ICT test bed evaluation identified a link between high levels of ICT use and improved school performance whereby the rate of improvement was faster in ICT Test Bed local Authorities than in equivalent comparator local Authorities in KS2 English (Somekh *et al* 2007). The causal link could be the reverse, with high performing schools more likely to have better equipment or more prepared to invest in technology.

However, in this study the results revealed that WV-ICT schools have a higher mean of .2149262 compared with a lower mean of -.2149262 for non WV-ICT schools. These means are not statistically different from each other, *p*=0.2033. In other words, the difference of -.4298523 between the means are not statistically different. Given the fact that ICT infrastructure is key in educational processes and this is because Studies conducted by Kulik and Kulik (1991) analysed results from respondents on the question as to whether ICT usage results to better educational outcomes amongst learners of all age levels. It is noted that computer based instruction usually impacts the pupils outcomes positively with computer based teaching raising pupils' examination scores significantly. Moreover, it helps pupils in acquiring a more in depth understanding of subject material, challenge pupils' thinking and understanding and improves their problem solving skills.

Cox *et al* (2003) found evidence of a statistically significant and positive impact of ICT on pupil attainment in a lot of academic subjects. The evidence of a positive effect of ICT on the pupils' attainments appeared to be particularly robust in core subjects in the curriculum for instance Mathematics, Science and languages.

Furthermore, a study by Becta (2007) realised mixed results and concluded that there is no tangible evidence on the effectiveness of ICT in academic achievement. These findings contradicts to Cheung and Slavin (2013) who noted that ICT applications produce modest but positive impacts on mathematical achievements in comparison to traditional instructional methods.

These mixed reactions on the findings in relation to the variations in the KCPE performance of public primary schools with ICT- infrastructure and those without, prompted the researcher to conduct analysis of the dummy responses to establish more facts with regard to the effect of ICT infrastructure use on the performance of public primary schools in Kakamega County.

In this case the researcher ran a multiple linear regression coefficient model and the results are shown in Table 2:

Table 2: Multiple Linear Regression Coefficients of the Effect of World Vision ICT Infrastructure on School KCPE Mean Scores (z_s2tm)

Variable	Variable label	Model 1 (z_s2tm)			Model 2 (z_s2tm)			Model 3 (z_s2tm)
		U.Coef	*p*	B	U.Coef	*P*	B	U.Coef
t23a3	Strongly agree: Creating & using Microsoft offices in schools	-0.972	0	-0.368	-1.201	0.001	-0.454	-1.528
_Is16_1	School is WV-ICT covered				1.198	0.004	0.608	1.570
_It11_1	Male teacher							0.467
_It12_2	Teacher education: Diploma							-0.083
_It12_3	Teacher education: B.Ed degree							-0.699
_It14_1	Deputy H/Teacher							-0.326
_It15_3	Teacher's working exp in Kkg county: 6-10 yrs							-0.504
_It15_4	Teacher's working exp in Kkg county: 11-55 yrs							-0.106
_It15_5	Teacher's working exp in Kkg county: 16-20 yrs							0.324
_It15_6	Teacher's working exp in Kkg county: >20 yrs							-0.192
Constant		0.162	0.004	n/a	-0.733	0.027	n/a	-0.996
N		36			36			36
R^2		0.1351			0.3316			0.4886
Root Mean Squared Error (RMSE)		0.9436			0.8550			0.8636

Note. U.Coef=Unstandardized Coefficient; RMSE=Standard deviation of the regression model (the closer to zero better the fit)
Source: Stata output, 2019

The results shown in table 2 were presented using three sequential regression models. In Model-1, teachers who strongly agree that creating and using Microsoft office (t23a3) improves academic performance have a negative effect on their schools mean score by up to -0.97 standard deviation below the mean (p= 0.004). This result implies that Microsoft office impacts positively on the schools' mean scores. The implication of these findings explain up to 13.51% of the variations between variables which included the correlation of creating and using Microsoft office and the school KCPE mean scores. The results conform to the findings by Becta (2001) who asserts that educational institutions use intranets to perfect their management and organisation of teaching and learning processes. This entails potential application of ICT in reporting of the development of pupils in tests and assignments and monitoring pupils' performance and also sharing of information among the teaching staff members.

Model-2 controlled for the school feeding programme and the effect of t23a3 was still significant (p=0.001). These results meant that 33.16% of the respondents affirm that creating and using Microsoft office improves the schools' performance. In the final model, after controlling for school and teacher variables the effect of t23a3 on school mean scores remained significant (p<.001) at 95% confidence level. These findings explain 48.86% of the variations among the covariates in this study. In summary, the use of ICT infrastructure positively correlates with improved school performance. This is in line with the findings of Pilkington (2005) and the study by Price Waterhouse Cooper (2004) who approved the fact that ICT enhances improved administrative and teaching processes among the educational personnel. In both studies, the findings suggested that ICT applications help to address workload issues within educational institutions. This is achieved through improved communication with learners, parents and other relevant stakeholders within the local community.

Two Tailed Independent t-test Comparing school KCPE Mean Scores Between the Dummy Responses
When the research data were further subjected to a two tailed independent t-test comparing school KCPE mean scores between dummy responses, the results shown in Table 3 were realized.

Table 3: Two-tailed independent t-test comparing school KCPE Mean Scores (z_s2tm) for Dummy t23a3.

Group	Obs.	Mean	Std. Err.	Std. Dev.	[95% CI]
0=Otherwise	30	0.16	0.18	0.98	-0.21
1=Strongly Agree	6	-0.81	0.27	0.66	-1.50

Combined	36	0.00	0.17	1.00	-0.34
Difference		0.97	0.32		0.25
Cohen's *d* (measure of effect size)	1.0307				0.114

Note. Obs.=Observations; Std. Err=Standard Error; Std. Dev.=Standard Deviation; CI=Confidence Interval; t23a3: 0=Otherwise; 1=Strongly agree that creating & using Microsoft offices in schools improves KCPE mean scores; n=36; α=.05;
t (10.1131) = 3.0062, p=0.0130
Source: Stata output, 2019

When a two tailed independent t-test was conducted to compare school KCPE mean scores for dummy t23a3, the results indicated in Table 3, t(10.1131)= 3.0062,p=0.0130, were realized. The effect size based on Cohen's d: 1.0307, were statistically insignificant. The correlation coefficient indicated that there is insignificant correlation between the KCPE mean scores for non WV-ICT and WV-ICT schools. When interpreting the effect of an intervention the Cohen's d- effect size such as (0.2) is small,(0.5) medium and (0.8) is large were used. Cohen's d is an appropriate effect size used to indicate the standardized difference between two means (Cohen, 2003). In this study, it was used to determine the difference between mean scores for the dummy responses from the results of a two tailed independent t-test. The sign of Cohen's d depends on which sample means is labeled 0 and 1. If M0 is bigger than M1, the effect size will be positive and if the second mean is larger, the effect size will be negative (Hungi & Thuku, 2010; Ejakait et al, 2016a; 2016b).

For the case of this research study, the results were large (Cohen's d: 1.0307). Therefore the difference between KCPE mean scores of public primary schools with World Vision ICT Project and those without were statistically significant. These findings are in tandem with the results of the study by UNESCO (2014) found the effects of computer assisted instruction programme that is developed to remediate specified mathematical skills amongst learners with special needs. They found that the computer assisted instruction programme may be an effective tool for helping pupils with learning disabilities, mastering specific concepts easily. The same findings were recorded from the study by Serin (2011), Furkan and Kutluca (2012 and Garcia and Pacheco (2013), which confirmed the effectiveness of ICT in promoting pupils' attainment in mathematics and science subject areas, hence, improved school performance.

IV. Summary

On testing the research hypothesis that 'there is no statistically significant difference in academic performance of public primary schools with ICT infrastructure and those without,' Pearson Product-Moment correlation coefficient was conducted to establish the difference in academic performance in public primary schools with ICT infrastructure and those without. A two tailed independent t-test was conducted to compare public primary schools KCPE mean scores between dummy responses. The t-test results t (10.1131) = 3.0062, P= 0.013 indicated that there was a statistically significant correlation between ICT infrastructure and improved performance in KCPE mean scores. Therefore, the researcher rejected the null hypothesis and concluded that ICT infrastructure improved KCPE performance of public primary schools between the year 2008 and 2016 in Kakamega County.

V. Conclusion

From the findings of the study, the researcher drew the following conclusion: a two tailed independent t-test was conducted to compare KCPE mean scores between dummy responses. The results indicated t(10.1131)=3.0031, p=0.013. These findings showed that there was a statistically significant correlation between ICT infrastructure and KCPE performance of public primary schools in Kakamega County.

VI. Recommendation

The following recommendation was derived from the findings and discussions of the study. The findings on establishment of the difference in academic performance of public primary schools with ICT infrastructure and those without indicated t(10.1131)=3.0031, p=0.013.These results were statistically significant. This meant that there was a correlation between ICT infrastructure and improved KCPE performance in Kakamega County. Therefore, basing on the findings, the researcher recommended that stakeholders in Education should develop more ICT infrastructure in public primary schools to promote hands on learning process. In this case, the government through the Ministry of Education should mobilize and direct more resources to improve ICT infrastructure in all public primary schools. The infrastructure should include provision of both soft and hard wares, search engines and digital divide among others.

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AUTHORS

First Author – Jacob Wambasi Kitari, Masinde Muliro University of Science and Technology P.O Box 190-50100, Kakamega, Kenya., kitarijacob@gmail.com
Second Author – Pamela Buhere, Masinde Muliro University of Science and Technology P.O Box 190-50100, Kakamega, Kenya., pbuhere@mmust.ac.ke
Third Author – Samuel Obaki, Masinde Muliro University of Science and Technology P.O Box 190-50100, Kakamega, Kenya., samobaki@yahoo.com