ANALYSIS OF THE EFFECT OF INTEGRATING ICT IN THE TEACHING PROCESS IN PRIMARY SCHOOLS IN KISUMU COUNTY

BY

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ABSTRACT

In September 2006 the Ministry of Education (MOE)introduced Information and Communication Technology (ICT)syllabus in curriculum of Primary 1 Teacher (P_1T) education, to equip the teacher trainees with understanding of ICT skills, tools and devices, that were supposed to enhance teaching of various subjects in Primary schools. This was informed by important decisions arising from several policy papers and reports done by the Government of Kenya in collaboration with donors/development partners, aimed at enhancing ICT use in improving teaching process efficiency in Kenya.This thesis therefore, presents results based on comparison of teaching process efficiency between teachers with ICT skills, who integrate ICT in teaching process and teachers without ICT skills in primary schools in Kisumu City. The research tested the effect of integrating ICT in teaching process. Equal proportions of teachers with ICT skills and those without ICT skills were sampled making up 102 respondents. The data collected using questionnaire administration to teachers in selected Primary schools was analyzed. The deductions from the results led to rejection of the null hypothesis; that there was no difference in teaching process efficiency between teachers with ICT skills and teachers without ICT skills. The alternative hypothesis; that teachers with ICT skills were more efficient than teachers without ICT skills was hence accepted. A binomial regression equation was therefore modelled .

CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Information Communication Technology (ICT) is increasingly becoming a necessity in all aspects of human life globally. It is playing a critical role in: economies, governance, businesses, sports, social interactions and education to many people world over. There has been a global concern that ICT be included in teaching and learning at all levels of Education.

In line with this new development, the Government of Kenya formulated National ICT policy in January 2006 that, aimed to improve the livelihoods of Kenyans by ensuring the availability of accessible, efficient, reliable and affordable ICT services. One of the sections of this policy is the ICT use in schools, colleges, universities and other educational institutions in the country so as to improve the quality of teaching and learning.

The Ministry of Education (MOE) in June 2006 introduced National ICT strategy for education and training. This strategy initiated integration of ICT in education as well as capacity building and professional development. In September 2006, based on this strategy, the Ministry of Education introduced ICT syllabus in curriculum of Primary Teacher Education (P1T) as a service subject to equip the teacher trainees with understanding of ICT skills, tools and devices, that were supposed to enhance teaching and learning of various subjects. The syllabus placed emphasis on how the computer can be used to carry out different tasks to facilitate teaching and learning. The syllabus therefore sought to answer the question, âĂIJwhat technology, skills and concepts are the teachers expected to have in order to use computer and its related technologies to support the instructional process in their various teaching subjectsâĂİ.

It is now six years since the introduction of ICT subject in Primary Teachers Training Colleges and by now 5 groups of new teachers with these Computer skills and tools have graduated from these Colleges in the years: 2008, 2009, 2010, 2011 and 2012 respectively.

Another category of teachers, have also acquired ICT skills when undertaking in-service diploma in education, and others also in the course of pursuing degree programs in education. The purpose of the study was therefore, to assess the effect that ICT skills created in enhancing efficiency in teaching process in various subjects as well as management of teaching in Primary schools in Kisumu City.

1.2 Statement of the Problem

There have been several policy papers and reports done by the Government of Kenya in collaboration with development/donor partners, aimed at enhancing use of ICT in improving efficiency in teaching processes in Kenya. A lot of important decisions arising from these policies and reports have been implemented, in many learning institutions. However, less or nothing had been done to follow up with scientific based evidence to confirm if indeed using ICT skills and tools, improves teaching in various institutions, in particular Primary schools in Kenya.

This study therefore focused on assessing the effect of using ICT skills and tools by Primary teachers in their subject areas in Kisumu city. It aimed to evaluate whether using ICT, helped teachers deliver quality teaching to the learners efficiently. Besides, it also evaluated the extent in which ICT has helped teachers in managing the processes involved in teaching and learning not only efficiently but also effectively.

1.3 Objectives of the Study

(i) To determine the extent primary school teachers use ICT in lessons preparations and acquiring new information relevant in their subject areas.

(ii) To investigate how primary school teachers use ICT in content delivery and exams preparations.

(iii) To determine the extent primary school teachers use ICT in results analysis and keeping learning related records.

1.4 Hypotheses

The null hypothesis:-

H_0: There is no difference in teaching efficiency between teachers with ICT skills and teachers without ICT skills.

$H_0 : \beta_1 = 0, \beta_2 = 0, \beta_3 = 0, \beta_4 = 0$

H_1: Teachers with ICT skills are efficient than teachers without ICT skills.

$H_1 : \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq 0$

1.5 Significance of the Study

The study aimed to show the relationship between using ICT skills and teaching delivery by primary school teachers. The results from the analysis of variables were used to produce a binomial regression model,which could be used in future to predict the outcome of using ICT skills at various levels in teaching.

1.6 Overview of the Chapters

In **Chapter 1**, essential elements of the study are given. These include background information to the problem investigated and the statement of the problem, significance of the study, the objectives of the study, hypotheses and significance of the study.

In **Chapter 2**, the literature about the findings and reports on previous studies on ICT integration in education sector from various countries are highlighted. The pieces of literature brought forward in the this chapter gave impetus and necessity to carry out this research.

In **Chapter 3**, the methodological approaches used to carry out this study are highlighted. These include:type of study, study population and target population, sampling procedure, sample size calculation, data collection methods and statical analysis approaches adopted.

In **Chapter 4**, Results arising from statistical analysis of data are presented and discussed. The model goodness of fit for the data was done using using various tests. Hypotheses were tested and logistic regression model equation was built from the results.

Finally in **Chapter 5**, Conclusions and recommendations based on research findings are presented. The idea that ICT skills enhances teaching process is validated and areas for further studies highlighted.

CHAPTER 2

LITERATURE REVIEW

2.1 Communication and Information

Communication and information are the ingredients of educational processes. ICT use in education decades back, played an important role in both formal and informal education, through programs set by Governments, NGOs, secular and religious groups. This was done by use of films, radio, telephone and television. However, not much has been achieved especially by enhancing computer technology fully into education system.

The World Educational report (UNESCO, 1998a, 2000) elaborates in certain terms that, education worldwide is facing a significant challenge in preparing students and teachers for future âĂIJknowledge-based societyâĂİ during a time when teachers are not prepared to use ICT, and the majority of existing school buildings, even in the most developed countries are not equipped to integrate the new information and communication technologiesâĂİ.

Still there are no comprehensive data on ICT in schools and other learning institutions world over, but it is apparent that many learning institutions in many countries are being equipped with computers. The (UNESCO, 1998) report on Africa, part of the UNâĂŹs harnessing ICT for development initiative, clearly shows a resolution of the organization , that it would equip a maximum of four TTCs in each of 20 African countries with computers and full access to the internet. The project also mentioned funding teacher training curriculum development.

There are huge suggestions from many reports that, various countries and world organizations did realize the power of ICT in the sense that it could help enhance quality of teaching and learning. The (UNESCO, 2000) clearly states that, ICT has the potential to be used in support of new educational methods, as tools enabling students learning by doing. It goes further to reinforce that ICT can make it possible for teachers to engage students in self-paced, self-directed problem-based or constructivist learning experiences;

and also test student learning in new, interactive and engaging ways which may better deep understanding of content and processes.

2.2 ICT Training for Teachers

Modern learning methods emphasize critical thinking, problem solving, social negotiation of knowledge and collaboration. This changes the role of the teacher from disseminator of information to learning facilitator. To achieve this, it is necessary to provide ICT training for teachers as a way of creating ICT- enabled teaching, (UNESCO, 2000; Guskin, 1996). Reinforcement of this argument is clear from the Great Britain which made it a requirement to have training in ICT use for one to earn a teaching credential (Teacher Training Agency, 1998).

The training of teachers in ICT must have proper focus on goal it aims to achieve. McDougall and Squires (1997) did identify four areas of considerations in their framework for organizing ICT training for teachers as: skills with particular applications, integration into curricula, changes in teacher role and underpinning theories of education. They noted that most ICT training mistakenly focuses entirely on the first issue. Besides,(Osin, 1998) when summarizing the experiences of projects, meant to introduce computers into the educational systems of developing countries, offered advice. He warned against beginning a project by purchasing computers, which often results in âĂIJa waste of money that could be put to a better use âĂIJ. Instead, he advocated on an eight step planning process, beginning with gathering together the necessary expertise in an advisory committee, which will define and implement a plan beginning with the careful execution of pilot projects. He recommended training a cadre of instructors for teacher training, introducing computers into teachers colleges and conducting both formative and summative evaluation of the pilot projects, before attempting a large-scale ICT implementation.

2.3 Policies for ICT in Education

Several research materials on importance of ICT in education, emphasizes the need to have policy framework on how to move with implementation. For instance, (Jones, 2003; Kozma, 2003a) emphasizes the importance of National ICT policies by various Governments as indicated below in parts;

Strategic policies can provide a rationale, a set of goals, and a vision for how education systems might be with the introduction of ICT and how students, teachers, parents and the general population might benefit from its use in schools. These strategic policies can motivate, change and coordinate disparate efforts so as to advance the nationâĂŹs overall educational goals. Kozma (2005.p9), further recommends alignments of national ICT policies with other strategic and operational policies. He says, âĂŸstrategic policies that emphasize pedagogical reform should be aligned with ICT training that provides teachers with new pedagogical skills, not just new technology skillsâĂŹ.

2.4 Operational components of ICT Policies

McLaughlin and Talbert (2001); Bransford, Darling-Hammond and page (2005); Fishman and Davis (2006), in their findings did recognize the role of teachers in ICT based Teacher training is critical and must form the core segment of policy framework for educational reforms. They said,âĂŹ teacher training is a key element to education reform, particularly training which focuses on classroom practices and engages in a community of professional practice and developmentâĂŹ.

2.5 ICT in Education in Kenyan context

The Government of Kenya through the MOEST formulated (sessional paper No.-2004. Pp. 73-75). It stated, the Government appreciates and recognizes that, an ICT literate workforce is the foundation on which Kenya can acquire the status of knowledge economy. Against this background, the Government will make education the natural platform for equipping the nation with ICT skills in order to create a dynamic and sustainable economic growth.

The Government therefore formulated a National information and Communication technology policy. The sessional paper went further to say, a number of international organizations have developed or started developing partnerships with MOEST to facilitate the use of ICT in Government offices and educational institutions.

The sessional paper also observed that, education and training sector has a major role to play in the implementation of the proposed ICT policy. First the sector itself is a major user of ICT, not only in education, training and research but also in the management of the sector. Secondly, success in the use of ICT in all sectors will require sufficient and a competent human resource that is well developed and equipped in the education and training sector. Thirdly, successful introduction and use of ICT in education and training institutions will play a major role in disseminating skills to the wider society and thus create positive impacts in the economy. The sessional paper emphasized that, to facilitate faster dissemination of ICT skills in the country, MOEST will with other stakeholders establish ICT capacities across the country. In doing so MOEST will facilitate the use of education institutions as hubs of ICT dissemination in rural areas.

The sessional paper also recognized that, ICT has a direct role to play in education and if appropriately used, ICT can bring many benefits to the classroom as well as education and training process. Its use will provide new opportunities for teaching and learning, including, offering opportunities for more students centered teaching, opportunities to reach more learners, greater opportunity for teacher-to-teacher and student-to-student communication and collaboration, greater opportunities for multiple technologies delivered by teachers, creating greater enthusiasm for learning amongst students, and offering access to a wide range of courses.

The MOE (2005), developed KESSP which featured ICT as one of the priority and areas with the aim of mainstreaming ICT into teaching and learning process. KESSP intent was then embedded in (National ICT policy, Jan 2006) as a national priority. The policyâĂŹs aim was to âĂIJimprove livelihood of Kenyans by ensuring the availability of accessible, efficient, reliable, and affordable ICT services.âĂİ It had several sections. However, it is the section on information technology that sets out the objectives and strategies pertaining to ICT and education. The relevant objective in this section stated in parts;

That government will encourage âĂę the use of ICT in schools, colleges, universities, and other educational institutions in the country so as to improve

the quality of teaching and learning. The National policy therefore, provided the impetus for the MOE to develop its sector policy in education. This was followed by the development of (National ICT strategy for Education, June 2006). This document called the ICT policy for the education sector, had the following components which are critical for purposes of this study:

1. ICT in education policy

2. Integrating of ICT in education

3. Training (capacity building and professional development)

4. Research and development

There was evidence from research, reports and policy documents from various governments which supported using ICT tools and skills to improve teaching process efficiency in schools, colleges, universities and other institutions in education. However, a clear gap was also evident from various literatures that little or no scientific research had been done to evaluate the effect that ICT, had indeed created in improving efficiency and effectiveness of teaching and learning in learning institutions. This research therefore was necessary for trying to fill the existent gap.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Type of Study

This was a comparative study which adopted quantitative approach and analyzed the effect of integrating ICT skills in teaching process, in primary schools in Kisumu City. The research compared teaching process efficiency between two groups of teachers (teachers who learnt ICT skills and integrate these skills in teaching process and teachers without ICT skills) in primary schools in Kisumu City.

3.2 Setting

The study was carried out in Kisumu city. It focused on Primary schools teachers within Kisumu city, which were divided into nine zones according to Kisumu city directorate of Education data (June, 2012).

3.3 Study Population

The study population for the purposes of this research was practicing Primary schools teachers in all the schools from nine zones in Kisumu city. From Kisumu city directorate of Education data (June, 2012), the total teacher population was 1432, which constituted 493 male teachers and 939 female teachers. The target population was therefore the group of teachers in these schools who went through ICT training (516), in TTCs between September, 2005 to July, 2009 and were already teaching, those teachers who went for in-services diploma in Education and managed to learn ICT, and those teachers already working who enrolled for degree programs in Primary teacher education, or any degree in education at various Universities and learnt ICT skills.

3.4 Sampling Strategy

The survey used multi-stage random sampling at three levels, combined with stratified simple random sampling. The first stage (primary sampling unit), was the nine zones from which five zones were picked randomly to enter into the survey. The second stage of sampling was the Primary schools from these five zones, which were selected to enter into the survey. The third stage sampling unit constituted individual teachers selected from each school, who participated in the survey as respondents.

Stratification was used to group teachers into two categories of those with ICT skills and those without ICT skills. This was done at school level for schools which were selected to enter into survey. It therefore created two strata, one stratum being teachers with ICT skills and the second stratum being teachers without ICT skills.

Simple random sample was then used to select two schools, from each of the five zones, to enter into survey. Finally, simple random sampling was again used to select, a proportion of teachers with ICT skill in each school selected to enter in survey as respondents. Equal number of teachers without ICT skills were also selected from the same schools entered in survey for comparisons, see (table 3.1).

Table 3.1 showing sampled teachers from five zones in Kisumu city.

Zone	Schools	ICT skills	Non - ICT skills	Total
Southern	Pandpieri	7	7	14
	Victoria	7	7	14
Central	MMshah	8	8	16
	Arya	8	8	16
Manyatta	Migosi	5	5	10
	Kondele	4	4	8
Nyahera	Bar Union	3	3	6
	Ogada	2	2	4
Ragumo	Ogango	3	3	6
	Nyamasaria	4	4	8
Total		51	51	102

3.5 Sample Size

The proportion estimate of Primary teachers in Kisumu city with ICT skills, according to data obtained from Kisumu City directorate of education (June, 2012) was 36% , which constituted 516 of total teachersâĂŹ population of 1432, this meant 916 teachers equivalent to 64% were without ICT skills.

The sample size was calculated using Joseph L. Fleiss formula for proportion difference power/sample size calculation. This formula is based on the power probability. The power of research is the probability that it can detect a study effect, if it is present. In a controlled research like this one, the aim is usually to compare two proportions of subjects (Exposed group and none exposed group), and a âĂIJnull hypothesisâĂİ that there is no difference between the proportions, the study aims to disprove the null hypothesis. It is the probability of detecting a predefined statistical significance in the study; meaning that the study has a high chance of detecting a difference between proportions if it exists.

A power analysis is used to control a false negative, also known as a Type II error or beta error. The power is usually and arbitrarily set to 0.8 or 0.9 (i.e., the research seeks an 80% or 90% chance of finding statistical significance if the specified effect exists). Note that (1-power), symbolized as β , is the chance of obtaining a false-negative result ((i.e., the experiment will fail to reject an untrue null hypothesis, or to detect the specified treatment effect). The power was set at 80% for this study.

The approximation for the sample size needed to have 80% power at the 0.05,that is to have an 80% chance of getting $p < 0.05$ when comparing two equal- size groups (N samples in each group), when the true proportions are teachers with ICT skills (p_0) and teachers without ICT skills (p_1). The calculation was as below:

$N = \frac{16 \times P \times (1-P)}{D^2}$

In the formula, the power is used through the value, 16 which is the approximate multiplier for a two sided sample when the power is $(1-\beta)$. For: $\alpha = 0.05$, $z\alpha = 1.96$, $\beta = 0.02$, $z\beta = 0.84$

The multiplier $= 2(z\alpha + z\beta)^2 = 2(1.96 + 0.84)^2 = 15.68) = 16$ (approximately)

Where N is the estimated sample size in each proportion, P is the average proportion, D is the effect size (the difference between the two proportions). The proportion of teachers with ICT skills,$p_0 = 0.36$ and the proportion of teachers without ICT skills $p_1 = 0.64$.

The average proportion:$P = \frac{(p0+p1)}{2}$;

$$P = \frac{(0.36 + 0.64)}{2} = \frac{1}{2} = 0.5$$

The effect size

$$D = (p1 - p0) = (0.64 - 0.36) = 0.28$$

Sample size for each proportion:

$$N = 16 \times P \times \frac{(1-P)}{D^2}$$

$$= 16 \times 0.5 \frac{(1-0.5)}{0.28^2}$$

$$= 8 \times \frac{0.5}{0.0784}$$

$$= \frac{4}{0.0784}$$

$$= 51.020408$$

N = 51 respondents per proportion

Total sample size is therefore

$$2N = 51 \times 2$$

$$= 102$$

3.6 Data Collection

Data collection involved equal proportions (51) for both teachers who had ICT skills and those without ICT skills as respondents. Data was collected using survey method of questionnaire administration. Questionnaire with specific questions addressing the objective items were administered to individual teachers selected in each school entered into survey, to help get their honest and accurate self-evaluation.

There were no group works from the side of the respondents when answering the questions as illustrated from the questionnaire, each teacher selected as respondent was advised to respond to questions independently, so as to get accurate and independent answers from the respondents.

The data were collected during school days and hours. This was the best time for most if not all teachers were readily available in schools. Before getting the actual respondents to answer the questions, a contact were made with them so as to avoid getting them unaware.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Descriptive Results

Data collected was subjected to exploratory analysis before formal analysis, to scrutinize them for oddities and for curious patterns that could be missed in formal analysis. Means (standard deviations) or medians (inter-quartile ranges) were used to summarize continuous.

The formal analysis used maximum likelihood ratio test to reject or fail to reject the null hypothesis, in which the likelihood of full model and the likelihood of reduced model were compared.The likelihood of a set of data is the probability of obtaining that particular set of data, given the chosen probability distribution model.The principle of maximum likelihood estimation (MLE), states that the desired probability distribution is the one that makes the observed data most likely, one must therefore seek the value of parameter vectors that maximizes the likelihood function. This necessitated modeling a binomial logistic regression. Univariate analysis was done which assisted in the identification of factors that were fit into the logistic regression model .The level of significance was set at 95% percent. This concentrated on defining the relationship that exist between Teaching process as response variable, and a set of independent variables: ICT skills proficiency, ICT in managing learning process, ICT application in teaching subject and ICT application in collaborating teaching.

The analysis also looked into which interaction level of independent variables, had close relationship with the response variable-Teaching process.Finally, the formal analysis focused on answering the hypotheses, whether the null hypothesis was to be rejected for alternative or upheld.

4.1.1 Age of Respondents

The summary statistics showed the mean age of teachers who had ICT skills and used these skills to enhance teaching efficiency was 32 years and their median age was 30 years; therefore the measure of the central age of teachers with ICT skills fell between the mean and the median values respectively. However, there were a few ages of respondents skewed to the right of the middle towards 50 years in age, which seemed to drag the mean in the direction of the skew, hence the different value of the mean.The median value was therefore taken to be the appropriate measure of central age of the teachers with ICT skills.

4.1.2 Interquartile Range (IQR)

Calculated by taking the difference between the upper and lower quartiles (the 25th percentile subtracted from the 75th percentile). A good indicator of the spread in the center region of the data and more resistant to extreme values than the range.

The 25th percentile = 27 and the 75th percentile = 35

$$IQR = 35 - 27$$
$$= 8$$

The interquartile range of 8 gave an indication that most teachers with ICT skills were within the age brackets of 8 years of the median or middle age of 30 years, (see table 4.1).

Table 4.1 Measure of central tendencies and dispersions for ages of teachers with ICT skills

	Mean	Median	S.d	Variance	Range	Percentile
Age of ICT skilled teachers	32.29	30.00	6.344	40.25	27	25th-27 50th-30 75th-35

4.1.3 Access to Computers by teachers with ICT skills

All the schools which were randomly selected for this research had at least one computer for use by teachers. However, only 27 (26.5 percent) teachers out 102 teachers both with ICT skills and without ICT skills had personal computers (desktop or laptops). In terms of those with ICT skills, this was 52.9 percent of 51 teachers having personal computers. Teachers therefore could still access and use computers for enhancing teaching efficiency in theirs subjects, from schools despite not owning one,see table 4.2.

Table 4.2 How teachers access computers.

		Frequency	Percentage
School has computer	Yes	102	100.0
	No	0	0.0
Own personal computer	Yes	27	59.9
	No	24	47.1

4.1.4 ICT applications in enhancing teaching process

The teachers with ICT skills used those skills variedly in delivering teaching in their subjects. Microsoft word was used mostly by teachers, 45 (88.2%) of teachers with ICT skills used this application for preparing: lesson notes, lesson plan, schemes of work, teaching aids and examinations.

Microsoft excel was used by 44 (86.3%) of teachers with ICT skills to analyze and produce examination results for pupils. Another 43(84.3%) of teachers with ICT skills used Internet application for searching notes and learning materials for their teaching subjects as well as linking up with other teachers from neighboring schools, when sharing ideas in their subjects. 42(82.4%) of these teachers indicated using Microsoft access for keeping pupils results and learning related records.

Microsoft PowerPoint and desktop publisher applications had the least application rates. Only 10 (20%) of teachers with ICT skills were using PowerPoint for lesson presentation to pupils in their class, while 7 (13.7%) of them were using desktop publisher application. See figure 4.1.

Teachers with ICT skills and those without ICT skills were in agreement that using ICT

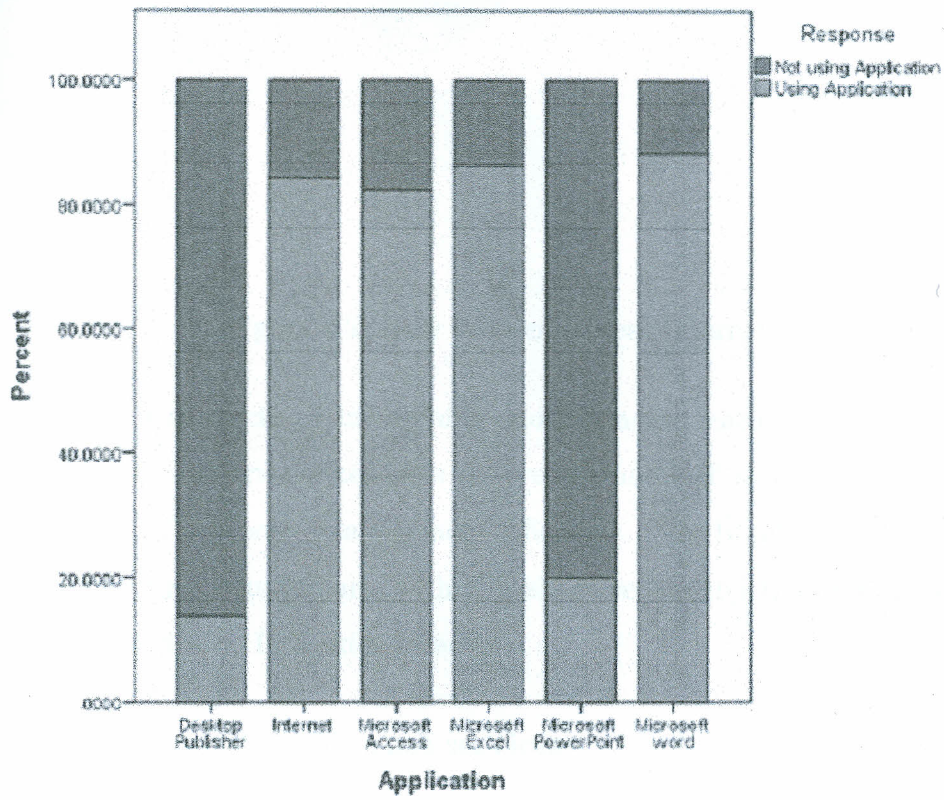

Figure 4.1: How teachers with ICT skills use computer applications

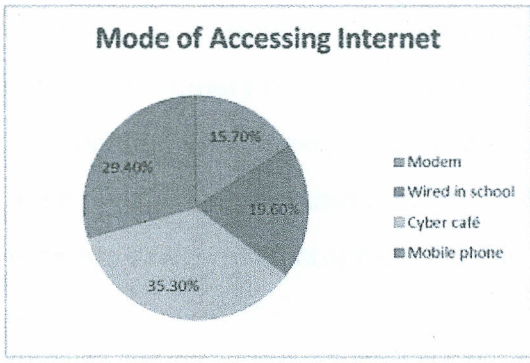

Figure 4.2: How teachers access Internet

applications enhances efficiency in teaching and managing learning process. 100% (102) responses by both categories of teachers confirmed that ICT skills application improves teaching and learning process management efficiency. Nearly all teachers without ICT skills did felt that their counterparts with ICT skills were better than themselves in many aspects of delivery due to ICT skills leverage.

4.1.5 Mode of Accessing Internet services

The teachers with ICT skills accessed internet in varied ways while in schools or at home. The mode of accessing internet included cyber cafÃĺs, internet wired in schools, modems and mobile phones. Eight (15.7%) teachers of 51 sampled with ICT skills were using either personal modems or modems owned by their schools to access internet, 10 (19.6%) of these teachers were using internet services wired in their schools. Cyber cafe was however the most popular mode of internet access as 18 (35.3%) of them said they were getting the services from Cyber cafe. Another 15 (29.4%) were getting internet services from their mobile phones. The results were as in fig 4.2.

4.2 Inferential Statistics

The response variable had a binary outcome so logistic transformation was necessary, to account for range restrictions, heterogeneous error variances, and other problems that would be encountered while using ordinary regression when $y_i = 0$ or 1. Logistic regression model which models the probability (nonlinear) or, equivalently, the odds (nonlinear) or logit (linear) of the outcome of an event was used and the probability of integrating ICT in teaching process was between 0 and 1; Christopher Manning (Nov 2007). The predictor variables were denoted as:

1. ICT skills proficiency- x_1
2. ICT application in teaching subject-x_2
3. ICT in application in managing teaching-x_3
4. ICT application in collaborative teaching-x_4

Parameter estimate values were as below:

1. β_0 âĂŞ is the y intercept
2. β_1 âĂŞ is the Coefficient of x_1
3. β_2 âĂŞ is the Coefficient of x_2
4. β_3 âĂŞ is the Coefficient of x_3
5. β_4 - is the Coefficient of x_4

The output was transformed to probabilities by using a logit link function, so the odds varied on the scale of zero to positive infinity , and the log odds varied on the scale of negative infinity to positive infinity . For a real-valued predictor variable x_i, the intuition is that a unit additive change in the value of the variable should change the odds by a constant multiplicative amount.

Since $log\frac{p}{(1\text{âĹŞ}p)}$ is the natural parameter for the Bernoulli and binomial distributions, then the model for binary response variables y_i was:

Logit(P)= $log\frac{P}{(1-P)} = \beta_0 + \beta_1(x_1) + \beta_2(x_2) + \beta_3(x_3) + \beta_4(x_4)$

4.2.1 Univariate results for ICT skills proficiency

Univariate analysis was done for each predictor variable to select the predictors necessary for the logistic regression model. The results were interpreted based on the p-values for each predictor variable and likelihood ratio test (deviance).

The analysis results from the summary table 4.3, produced a p-value of $4.69 \times 10^{-}6$. This value was less than 0.05, so the coefficient of ICT skills proficiency as predictor variable was highly statistically significant-meaning null hypothesis could be rejected as the coefficient of ICT skills proficiency was significantly different from zero.

Table 4.3 Univariate result ICT skills proficiency.

	Estimates	Std.Error	Z value	$Pr(>\|Z\|)$
(Intercept)	-9.0406	1.86740	-4.8408	1.30e-06***
skills	3.7241	0.8134	4.578	4.69e-06***

Signif. codes: 0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

Examining this variable (ICT skills proficiency)further while looking at deviance (likelihood ratio test), being analogous to the sum of squares in linear regression, and used to measure lack of fit to the data in a model. That is deviance is the difference between a given model and the saturated model (theoretically perfect fit model). Smaller values of deviance indicate better fit as the fitted model deviates less from the saturated model (theoretically perfect fit model). From the deviance table 4.4, the model deviance of 44.339 was smaller compared to Null deviance of 141.402. This difference of 97.063 meant that ICT skills proficiency predictor variable improved model fit.

Table 4.4 Analysis of Deviance Table for ICT skills proficiency.Response: Integrating ICT in teaching process

	Df	Deviance Resid.	Df	Resid.Dev	$Pr(> Chi)$
Null		101	101	141.402	
skills	1	97.63	100	44.339	2.2e-16***

Signif. codes: 0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

4.2.2 Univariate result for ICT applied in teaching subject

The p-value for ICT application in teaching subject was larger than 0.05, however when looked at from the analysis of deviance table, this predictor variable was significant with a p-value of $2.2 \times 10^{-}16$. This value was less than 0.05, so the coefficient of ICT application in teaching subject predictor variable was statistically significant-meaning null hypothesis could be rejected as the coefficient of ICT skills proficiency was significantly different from zero,see table 4.5

Table 4.5 Univariate result ICT applied in teaching subject.

	Estimates	Std.Error	Z value	$Pr(>\|Z\|)$
(Intercept)	-50.65	9780.21	-0.005	0.996
subject	23.74	4890.11	0.005	0.996

The deviance examined as from table 4.6,for ICT application in teaching subject predictor variable indicated small value for model deviance of 8.397 compared to Null deviance of 141.402. This difference of 133 revealed that ICT application in teaching subject improved the model fit.

Table 4.6 Analysis of Deviance Table for ICT application in teaching subject.Response:Integrating ICT in teaching process.

	Df	Deviance Resid.	Df	Resid.Dev	$Pr(> Chi)$
Null			101	141.402	
subject	1	133	100	8.397	2.2e-16***

Signif. codes: 0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

4.2.3 Univariate result for ICT application in Managing teaching Process

The analysis results as indicated in table 4.7, produced a p-value of $4.20 \times 10^{-}06$. This value was less than 0.05, so the coefficient of ICT skills in managing teaching process predictor variable was high statistically significant-meaning null hypothesis could be rejected as the coefficient of ICT skills proficiency was significantly different from zero.

Table 4.7 Univariate result ICT application in Managing teaching Process.

	Estimates	Std.Error	Z value	$Pr(>\|Z\|)$
(Intercept)	-9.4352	1.9524	-4.832	1.35e-06***
managing	3.8494	0.8366	4601	4.20e-06***

The deviance examination for ICT skills in managing teaching process variable as indicated in table (4.8), had small value for model deviance of 40.328 compared to Null deviance of 141.402. This difference of 101.07 revealed that ICT in managing teaching process improved the model fit. Smaller value for model deviance indicated better fit as the fitted model deviated less from the saturated model (theoretically perfect fit model).

Table 4.8 Analysis of Deviance Table for ICT application in managing teaching process.Response integrating ICT in teaching process.

	Df	Deviance Resid.	Df	Resid.Dev	$Pr(> Chi)$
Null			101	141.402	
managing	1	101.07	100	40.328	2.2e-16***

Signif. codes: 0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

4.2.4 Univariate result for ICT application in collaborative teaching

The p-value for ICT application in collaborative teaching was larger than 0.05, however when looked at from the analysis of deviance as shown in table 4.10, this predictor variable was significant with a p-value of $2.2 \times 10^{-}16$. This value was less than 0.05, so the coefficient of ICT application in collaborative teaching predictor variable was statistically significant-meaning null hypothesis could be rejected as the coefficient of ICT skills proficiency was significantly different from zero.

Table 4.9 Univariate result ICT application in collaborative teaching.

	Estimates	Std.Error	Z value	$Pr(>\|Z\|)$
(Intercept)	-47.82	6474.21	-0.007	0.994
collaborative	3.8494	0.8366	0.007	0.994

The deviance examination for ICT in application in collaborative teaching variable, revealed a small value for model deviance of 14.41 compared to Null deviance of 141.402. This difference of 126.99 indicated that ICT application in collaborative teaching improved the model fit. Smaller value for model deviance indicated better fit as the fitted model deviated less from the saturated model (theoretically perfect fit model).However this predictor variable (ICT application in collaborative teaching), when put in any other combination with other three predictor variables including interaction levels led to non-convergence of the model. This indicated that the coefficients were not meaningful because the iterative process was unable to find appropriate solutions, (see table 4.10).

Table 4.10 Analysis of Deviance Table for ICT application in collaborative teaching.Response:integrating ICT in teaching process.

	Df	Deviance Resid.	Df	Resid.Dev	$Pr(> Chi)$
Null			101	141.402	
collaborative	1	126.99	100	14.41	2.2e-16***

Signif. codes: 0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

4.3 Binomial Logistic Regression with all predictor variables

The response variable had a binary outcome so logistic transformation was necessary, to account for range restrictions, heterogeneous error variances, and other problems that would be encountered while running ordinary regression when $y_i = 0 or 1$.

The coefficients did not converge so the full model could not be analyzed and therefore collaborative teaching as predictor variable was removed from the modeling analysis. This was so due to the fact that whenever this collaborative teaching variable was included in the model equation with any other predictor variables combination, the coefficients or parameters failed to converge suggesting that the coefficients were not meaningful to the model as the iterative process was unable to find appropriate solutions. The main reason for non-convergence was due high unacceptably multi-collinearity between ICT application in collaborative teaching predictor variable with the other three predictors. This was revealed when a separate linear regression was run between ICT application in collaborative teaching and other predictors. Linear model assumptions diagnostics such as Q-Q plot and histogram plot were run and confirmed the same.

This meant that, as multi-collinearity increased, coefficients remained the same but standard errors increased and the likelihood of the model convergence decreased.

4.4 Logistic Regression Parameters without variable Collaborative teaching

The deviance table 4.12, produced for full model with all the three predictor variables, suggested small value for model deviance of 2.773 compared to Null deviance of 141.402. One measure of model fit is the significance of the overall model. This test investigates whether the model with predictors fits significantly better than a model with just an intercept (i.e., a null model). The test statistic is the difference between the residual deviance for the model with predictors and the null model. The test statistic is distributed chi-squared with degrees of freedom equal to the differences in degrees of freedom between the current and the null model (i.e., the number of predictor variables in the model),.

Table 4.11 Full Model with three Predictor Variables.

	Estimates	Std.Error	Z value	$Pr(>\|Z\|)$
(Intercept)	-149.232	50295.260	-0.003	0.998
skills	18.341	95488.512	0.000	1.000
manage	42.113	14764.883	0.003	0.998
collaborative	3.328	94240.439	0.000	1.000

AIC: 10.773, 'log Lik.' -1.386294 (df=4)

The chi-square of 138.6294 with 3 degrees of freedom and an associated p-value of less than 0.001 revealed that the model with predictors as a whole fitted significantly better than an empty model.

Several interaction levels between different sets of predictor variables were run and tested considering order and arrangement of variables in different regression equations. No interaction term between the three predictors of: ICT skills proficiency, ICT application in teaching subject and ICT in managing learning process was statistically significant to be included in the final logistic regression model equation.

Table 4.12 Analysis of Deviance Table for full model without collaborative teaching variable.Response:integrating ICT in teaching process.

	Df	Deviance Resid.	Df	Resid.Dev	$Pr(> Chi)$
Null			101	141.402	
skills	1	97.063	100	44.339	2.2e-16
subject	1	41.566	99	2.773	1.14e-10***
manage	1	0.000	98	2.773	1

Signif. codes: 0 âĂŸ***âĂŹ 0.001 âĂŸ**âĂŹ 0.01 âĂŸ*âĂŹ 0.05 âĂŸ.âĂŹ 0.1 âĂŸ âĂŹ 1

4.5 Model Goodness of Fit

4.5.1 Akaike Information Criterion (AIC)

Is a measure of model fit that penalizes for the number of parameters. Smaller values of AIC shows the model fits better. When AIC for the full model with three predictor variables was compared to the reduced model with only one predictor variable each, the AIC for full model with three predictor variables was much smaller than the AIC for each individual predictor variable modeled alone. Therefore, the full model with three predictors variables combined was good and better fit than reduced model with only individual predictor variables,(see table 4.13).

Table 4.13 akaike information criterion for predictor variables.

Predictor variables	AIC
ICT skills proficiency	48.339
ICT application in teaching subject	12.397
ICT application in managing teaching process	44.328
skills+subject+manage	10.773

4.5.2 Pseudo-R-Squared

In linear regression the squared multiple correlations, R-Squared are used to assess goodness of fit as it represents the proportion of variance in the criterion that is explained by the predictors. In logistic regression analysis, there is no agreed upon analogous measure, but there are several competing measures each with limitations. However two of the measures (Cox and Snell R-squared and Nagelkerke R-squared) analogous to multiple R-Squared were analyzed and produced the results as in table 4.14.

Cox and SnellâĂŹs R-Squared usually has a maximum less than 1 making it difficult to indicate the strength of the model, but from the table above a value of 0.743 was strong enough for the association between response variable and the predictors to be considered as good fit for the model.

Nagelkerke R-Squared has a higher value than Cox and SnellâĂŹs and is the most reported pseudo R-Squared estimate of the proportion of variance in the criterion explained by the predictors. Therefore a higher value of 0.991 indicated strong relationship between predictors and the response variable.

Table 4.14 Pseudo-R-Squared results

Cox and Snel R-Squared	Nagelkerke R-Squared
0.743	0.991

4.5.3 Homsmer and Lemeshow Test

The Homsmer âĂŞ Lemeshow probability test is based on a chi-square test (Hosmer, D. 2000). This parameter tests the assumption that the model distinguishes the explained variable better. The actual Null hypothesis is that the model is insignificant and the test tries to break this hypothesis. Values for this test should be higher than 0.5. The significant code for the Homsmer- Lemeshow parameter is 1.000 which is higher than 0.5, therefore the predictors distinguishes the response variable well - meaning the model is significant and as such the Null hypothesis was rejected,see table 4.15.

Table 4.15 Homsmer and Lemeshow Test information.

Step	chi-square	df	Sig.
1	0.000	5	1.000

4.5.4 Omnibus test of Model Coefficients

The overall test of the model (in the "Omnibus Tests of Model Coefficients" table) produced Chi-square and Sig. - this is the chi-square statistic and its significance level. The statistics for the Step, Model and Block were the same because stepwise and blocking logistic regressions were not used. The value given in the Sig. column is the probability of obtaining the chi-square statistic given that the null hypothesis is true. In other words, this is the probability of obtaining this chi-square statistic (138.629) if there is in fact no effect of the independent variables, taken together, on the dependent variable. This is, of course, the p-value, which was compared to a significance level of .05 to determine if the overall model was statistically significant. Therefore the results revealed the model was statistically significant because the p-value was less than .000, the were as in table 4.16.

Table 4.16 Omnibus test of Model Coefficients results.

	Chi-square	df	Sig.
Step	138.629	3	0.000
Block	138.629	3	0.000
model	138.629	3	0.000

4.6 Quantifying predictive ability

Area under ROC Curve (AOC) -gives a good indication to model performance (values are between 0.5and 1). This variable should be as high as possible with some restrictions. Typical values indicate the following:

1. 0.5 - No distinguish ability (the model has no meaning).
2. (0.51 âĂŞ 0.7) - Low distinguish ability (not a very good model yet the model can be used).
3. (0.71 âĂŞ 0.9) - Very good distinguish ability.
4. (0.91 âĂŞ 1) - Excellent distinguish ability

AOC as in figure below shows that ICT skills proficiency has approximate value of 0.89, meaning ICT skills predictor variable had very good distinguishing ability to the response variable. ICT application in teaching subject has approximate value of 0.97 which show excellent distinguishing ability to the response variable. ICT application in managing learning process has approximate value of 0.91 meaning an excellent distinguishing ability to the response variable. The three predictor variables are therefore good for the model as indicated by their performance on area under curve, with values close to 1 indicating that the model would have good predictive ability,(see fig 4.3).

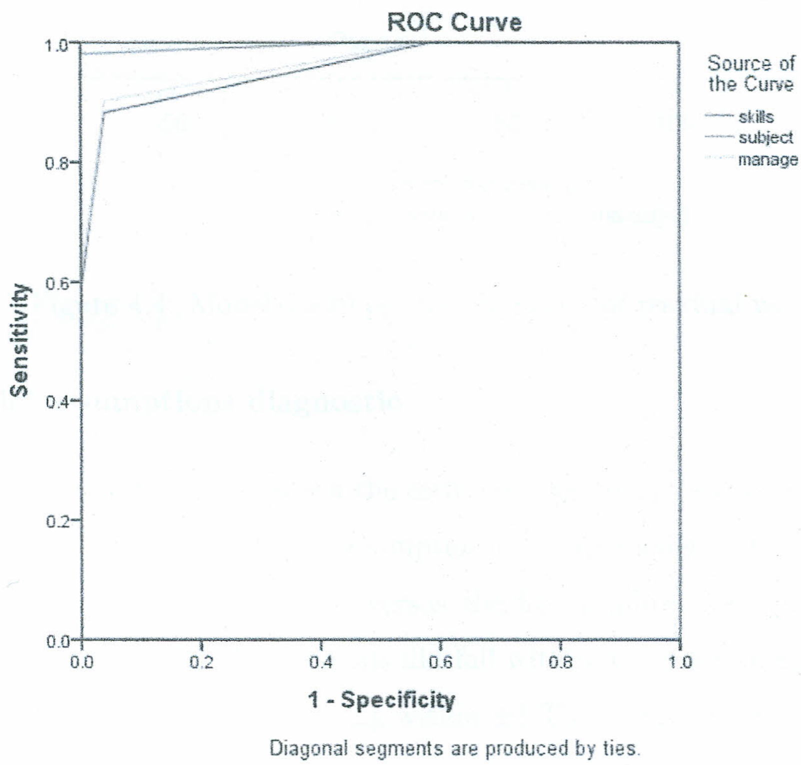

Figure 4.3: Area under curve quantifying predictive ability

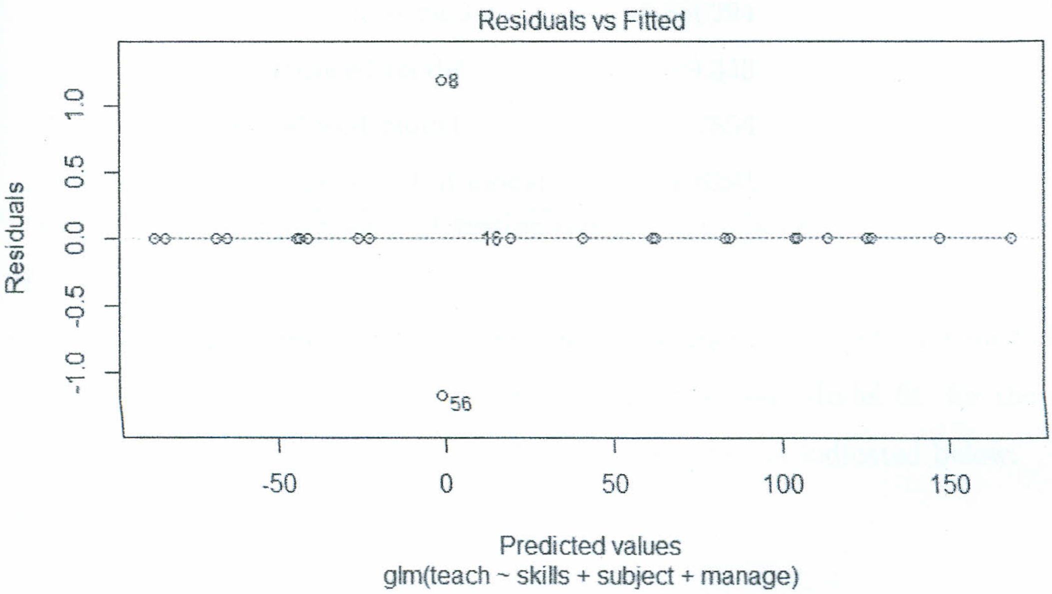

Figure 4.4: Model assumptions diagnostic of residual vs. fitted

4.7 Model assumptions diagnostic

The residuals-the difference between the estimated and observed values of the dependent variable was used to check logistic assumption that the model fit the data (BIOST 515, Feb 2004). The estimated residuals versus the fitted values were plotted. The model assumption was correct as the residuals did fall within an area representing a horizontal band, with most of the residuals falling within ± 1.The results were as in fig 4.4

4.8 Testing hypotheses

In logistic regression the response variables are Bernoulli distributed so the hypotheses on significance of explanatory variables are tested using (log) likelihood ratio statistic (often referred to as the -2 Log Q statistics) and the Wald statistic (BIOST 515, Feb 2004). The likelihood statistic is superior to the Wald statistic (in the sense that it gives more reliable results), hence for this research, (log) likelihood ratio statistic was used over Wald statistic.

Table 4.17 the log likelihood for three sets of reduced models and the full model.

Model	log likelihood
(subject + manage)-reduced model	-8.386294
(skills + manage)-reduced model	-19.343
(skills + subject)-reduced model	-3.7854
(skills + subject + manage)-full model	-1.386294

The overall logistic regression at testing the null hypothesis:

$H_0 : \beta_1 \neq \beta_2 \neq \beta_3 \neq 0$

Computations for comparisons between the log likelihood-'Model fit' for the full model, containing all explanatory variables, with the log likelihood-'Model fit' for the reduced model, excluding one explanatory variable were calculated as indicated below:

$H_0 : \beta_1 \neq 0$

Model fit for the full model

$= -1.386294 \times -2 = 2.772588.$

Model fit for the reduced (excluding ICT skills proficiency)

$= -8.386294 \times -2 = 16.772588$

The log likelihood statistic (the difference between the two model fits);

$$D = (-2logLreduced) - (-2logLfull)$$

$$= 16.772588 - 2.772588$$

$$= 14$$

The difference between the reduced model and the full model 14 was much larger-meaning the full model explained the data much better than the reduced model. The null-hypothesis that the coefficient of ICT skills proficiency predictor variable was not different from zero and hence not significant was therefore rejected.

$H_0 : \beta_2 \neq 0$

Model fit for the full model $= -1.386294 \times -2 = 2.772588.$

Model fit for the reduced (excluding ICT application in teaching subject) model

$= -19.343 \times -2 = 38.686$

The log likelihood statistic (the difference between the two model fits);

$$D = (-2logLreduced) - (-2logLfull)$$

$$= 38.686 - 2.772588 = 35.913412$$

$$= 35.91$$

The difference between the reduced model and the full model 35.91 was much larger- meaning the full model explained the data better than the reduced model. The null-hypothesis that the coefficient of ICT application in teaching subject predictor variable was not different from zero and hence not significant was therefore rejected.

$H_0 : \beta_3 \neq 0$

Model fit for the full model

$= -1.386294 \times -2 = 2.772588.$

Model fit for the reduced (excluding ICT application in managing teaching process) model

$= -3.7854 \times -2 = 7.5708$

The log likelihood statistic (the difference between the two model fits);

$$D = (-2logLreduced) - (-2logLfull)$$

$$= 7.5708 - 2.772588 = 4.798212$$

$$= 4.80$$

The difference between the reduced model and the full model 4.80 was larger- meaning the full model explained the data better than the reduced model. The null-hypothesis that the coefficient of ICT in managing teaching process predictor variable was not different from zero and hence not significant was therefore rejected.

The Null hypothesis âĂŞ H_0: There is no difference in teaching efficiency between teachers with ICT skills and teachers without ICT skills.

$H_0 : \beta_1 = \beta_2 = \beta_3 = 0$,was rejected and the alternative hypothesis;

H_1: Teachers with ICT skills are more efficient than teachers without ICT skills.

$H_0 : \beta_1 \neq \beta_2 \neq \beta_3 \neq 0$,was accepted

4.9 Model Equation

The response variable had a binary outcome so logistic transformation was necessary, to account for range restrictions, heterogeneous error variances, and other problems that would be encountered while using ordinary regression when $y_i = 0$ or 1. Logistic regression model which models the probability (nonlinear) or, equivalently, the odds (nonlinear) or logit (linear) of the outcome of an event was used and the probability of integrating ICT in teaching process was between 0 and 1; Christopher Manning (Nov 2007). The predictor variables were denoted as:

The output was transformed to probabilities by using a logit link function, so the odds varied on the scale of zero to positive infinity , and the log odds varied on the scale of negative infinity to positive infinity . For a real-valued predictor variable x_i, the intuition is that a unit additive change in the value of the variable should change the odds by a constant multiplicative amount.

The predictor variables were denoted as:

1. ICT skills proficiency- x_1
2. ICT application in teaching subject-x_2
3. ICT in application in managing teaching-x_3
4. ICT application in collaborative teaching-x_4

Parameter estimate values were as below:

1. β_0 âĂŞ is the y intercept
2. β_1 âĂŞ is the Coefficient of x_1
3. β_2 âĂŞ is the Coefficient of x_2
4. β_3 âĂŞ is the Coefficient of x_3
5. β_4 - is the Coefficient of x_4

Since $log\frac{p}{(1âĹŠp)}$ is the natural parameter for the Bernoulli and binomial distributions, then the model for binary response variables y_i was:

Logit(P)= $log\frac{P}{(1-P)} = \beta_0 + \beta_1(x_1) + \beta_2(x_2) + \beta_3(x_3) + \beta_4(x_4)$

The coefficient estimate for ICT application in collaborative teaching having been removed the equation reduced to:

Logit(P)= $log\frac{P}{(1-P)} = \beta_0 + \beta_1(x_1) + \beta_2(x_2) + \beta_3(x_3)$

Logit(P)= $log\frac{P}{(1-P)} = -149.232 + 18.341(x_1) + 42.113(x_2) + 3.328(x_3)$

Logit(P)= $log\frac{P}{(1-P)} = -149.232 + 18.341 \times (x_1) + 42.113 \times (x_2) + 3.328 \times (x_3)$

Logit(P)= $log\frac{P}{(1-P)} = -149.232 + 18.341(x_1) + 42.113(x_2) + 3.328(x_3)$

In terms of probabilities, the equation changed to:

P $=\frac{\exp(-149.323+18.341(x_1)+42.133(x_2)+3.328(x_3))}{(1+\exp(-149.232+18.341(x_1)+42.113(x_2)+3.328(x_3)))}$

P $=\frac{\exp(-149.323+18.341(x_1)+42.133(x_2)+3.328(x_3))}{(1+\exp(-149.232+18.341(x_1)+42.113(x_2)+3.328(x_3)))}$

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

This thesis produced results which indicated that ICT had positive effect on teaching process efficiency, as teachers with ICT skills were more efficient in delivery than the teachers who were short of ICT skills. Teachers with ICT skills integrated the skills well in: lessons preparations, making lesson notes, making schemes of work, making teaching aids and using internet services to search new teaching/learning materials.

ICT was also integrated well by the teachers and had a positive effect on examinations preparations. The teachers who were ICT compliant were efficient and effective in internal exams production not only in their subjects but also to their respective departments and their schools in general.

Managing pupils exams results and learning related records as well as analysis of examinations, was easier using computer applications than manual ways. The teachers who were not ICT compliant also agreed that it was easy to tabulate and analyze pupils results using computers than doing the same manually and that their counterparts with ICT skills have been most helpful on that area.

The teachers with ICT skills were therefore more efficient in handling teaching process than their counterparts without ICT skills. The null hypothesis- that there was no difference in teaching efficiency between teachers with ICT skills and teachers without ICT skills was rejected. The alternative hypothesis- that teachers with ICT skills were more efficient than teachers without ICT skills was accepted.

Finally a logistic regression equation was modeled with integrating ICT in teaching process as response variable; ICT skills proficiency, ICT application in teaching subject and ICT application in managing teaching process as independent variables respectively. The fourth independent variable, ICT application in collaborative teaching was dropped from the model.

5.2 Recommendations

This research largely focused on efficiency of teaching process being aided by ICT skills. The study did not incorporate the effects on the learners, that is whether it produced good results in terms of learners or pupils performance in academics. The researcher therefore recommends, that further research be carried out in future to evaluate the effect of integrating ICT in teaching on the academic performance of the pupils or learners.

The research findings revealed a trend in which most Primary schools teachers in the age of 45 years and above, were not trained in ICT and as such did not apply ICT skills in teaching. Based on this, the researcher recommends that policy makers in the ministry of education should formulate ways of motivating or organizing ICT service courses for this category of teachers. This the researcher feels will enable full integration of ICT in Primary schools teaching, especially now that the government of Kenya is introducing ICT lessons in Primary schools.

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