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Teachers' innovative use of computer technologies in classroom: A case of selected Ghanaian schools

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ABSTRACT

This study was conducted to explore secondary school teachers' innovative use of computer technologies in classroom. Questionnaires were distributed to 273 teachers in fourteen schools comprising 5 urban schools, 5 semi-urban schools and 4 rural schools. 241 were returned, and 231 valid questionnaires were used for data analysis, representing 84.6% of total questionnaires. Descriptive statistics, multivariate analyzes of variances, independent samples t-tests and multiple regression were used to analyze data. Of the 231 teachers, 66% were males and 34% were females. The study found that male teachers (mean = 3.77, std = 1.36) have more access to computers than the female teachers (mean = 3.21, std = 1.28) but female teachers (mean = 1.85, std = .854) use ICT for evaluative purposes significantly more than male teachers (mean = 1.59, std = .798). Also a correlation analysis revealed high positive correlation between teachers' computer skills, computer experience and computer access ($r = .59$, $p < .001$; $r = .65$, $p < .001$). In addition, there was a high positive correlation between teachers' computer skills and computer access ($r = .65$, $p < .001$). Finally, it was revealed that computer access ($\beta = .42$) was the strongest determinant of teachers' computer skills.

Keywords: *innovative; implementation; transform; computer technologies; investment*

INTRODUCTION

The rapid growth in Information Communication and Technologies (ICT) have brought remarkable changes in the twenty-first century, as well as affected the demands of modern societies (Jamieson-Proctor, Burnett, Finger & Watson, 2006). ICT has transformed the way people communicate and conduct business during the past decade (UNESCO, 2002). Also, the manner people teach and learn is affected by ICT (Bayindir & Inan, 2009). ICT has the ability to change the nature of learning as well as educators and learners roles in teaching and learning process (UNESCO, 2002). Therefore, there is a growing demand on educational institutions around the globe to use ICT to teach the skills and knowledge students need for the 21st century (UNESCO, 2002).

Realizing the effect of ICT on the workplace and everyday life, today's educational institutions try to restructure their educational curricula and classroom facilities, in order to bridge the existing technology gap in teaching and learning. This restructuring process requires effective adoption of technologies into existing environment in order to provide learners with knowledge of specific subject areas, to promote meaningful learning and to enhance professional productivity (Tomei, 2005).

Global investment in ICT to provide schools with ICT infrastructure and equipments has been initiated by many governments. For example in United Kingdom, the government spending on

educational ICT in 2008–09 in the UK was £2.5bn (Nut, 2010), in United States, the expenditure on K-12 schools and higher education institutions was $6 billion and $4.7 billion respectively in 2009 (Nut, 2010) and in New Zealand, the government spends over $ 410 million every year on schools ICT infrastructure (Johnson, Calvert & Raggert 2009). In Ghana, the government has invested millions of dollars to equip secondary schools with ICT facilities. A huge amount of money has been spent on hardware, software and infrastructure such as computer laboratories, internet and science resource centres equipped with modern ICT facilities to support teaching and learning in science (e-Readiness assessment report, 2009).

Despite all these investments on ICT infrastructure, equipments and professional development to improve education in Ghana, it is clear that the potential for ICT to transform the way teachers teach and the way students learn has not been realized (e-Readiness assessment report, 2009). In exploring the literature about ICT integration into teaching and learning, the area of immense concern is the lack of research on innovative use of ICT in classroom by teachers in secondary schools in Ghana. Taking into consideration this concern, this research study was conducted to explore the innovative use of ICT by teachers in classroom. Therefore, this research was guided by the following questions:

(1) What is the frequency of teachers' innovative use of ICT in classroom?

(2) Are there any significant differences in teachers' innovative uses of ICT by gender, school type, teaching experience and computer experience?

(3) Are there significant differences in computer skills, computer experience and computer access between male and female teachers?

(4) What is the relative importance of factors such as computer experience and computer access in explaining teachers' computer skills in ICT?

METHODOLOGY

Instrument

A questionnaire was developed by the researcher to collect data from teachers in second-cycle institutions. Before the questionnaire was pilot-tested, the content validity was improved by experts in the field. The questionnaire was then pilot-tested with teachers in a second-cycle institution who were not participants of the study.

Comments from the teachers and experts after the pilot study were used to develop the final instrument for the study. The first section of the final version of the questionnaire focused on demographic information of the teachers based on gender, age, teaching experience, computer experience and frequency of computer use. The second section consisted of Likert-type questions. The teachers were asked to rate their knowledge and skills in the use of ICT in teaching to achieve professional objectives as well as indicating the factors which affected their use of ICT in teaching.

A reliability test was carried out to determine the internal consistency of items in the questionnaire using Cronbach's Alpha reliability test. Cronbach alpha's coefficient for the pilot questionnaire was .824 and the final questionnaire used for the study was 0.903. According to Kline (2005), alpha value of .90 is considered excellent, .80 very good and .70 acceptable. In this study, the observed variables had good internal consistency.

Data collection methods

A simple random sampling technique was used to select the teachers in second-cycle institutions who participated in this quantitative study. Before the questionnaire was distributed to the teachers, permission was sought from all heads of the participating institutions. Assistant headteachers for academic of the participating institutions were chosen by their heads as contact persons. The questionnaires were delivered personally to each school to be distributed to the participants. This method was chosen to increase the return rate (Chen, 2010). Also the involvement of teachers in the study was strictly voluntary. They were also assured of confidentiality of any information given. The instrument was distributed to 273 teachers in different departments. One week was given to the teachers to complete the questionnaire except teachers in a particular school who were given two weeks to complete since they were busily invigilating end of term examinations. Follow-up phone calls were made to the Assistant Headteacher for academic in each school to remind the teachers to complete the questionnaire. The questionnaires were collected in person from Assistant Heads after completion. In all a total of 241 questionnaires were collected from the participants indicating an 88.3% return rate. Of 241 questionnaires received, 10 were not used for data analysis since they were incomplete. Thus 231 valid questionnaires were used for data analysis indicating 84.6% of the total questionnaires.

Analyses

Data were analyzed using descriptive statistics, multivariate analyzes of variances (MANOVAs) and independent samples t-tests and multiple regression. Descriptive statistics was used to describe and summarize the properties of the mass of data collected from the respondents (Gay & Airasian, 2000). The demographics of the respondents and teachers frequency of use of ICT were analyzed using descriptive statistics.

MANOVAs were used to find the mean differences and statistical significance of differences among two or more groups (Tabachnick & Fidell, 2012, p.245). The independent samples t-tests were used only in situations where the independent variable had two levels, for example when comparing means of two groups of participants in the study (Meyers, Gamst & Guarino, 2006, p. 282). MANOVAs and t-tests were used to analyze research questions 2 and 3. Multiple regression analysis was used to assess the relationship between one dependent variable and several independent variables (Tabachnick & Fidell, 2012, p. 117). Multiple regression analysis was used to analyze research question 4.

RESULTS

This section reports the results for each analysis individually.

Sample description

Two hundred and thirty-one teachers participated in this study. Table 1 shows the demographic information of the respondents with respect to gender, age, teaching experience, computer experience and school type. As can be seen from Table 1, 33.8% of teachers were females and 66.2% were males, 17% of the teachers surveyed were more than 50 years old and 35% of them had more than 20 years teaching experience.

***Table 1**: Demographic information of respondents*

Variable	Category	Frequency	Percentage
Gender	Male Female	153 78	66.2 33.8
Age	20-29 30-39 40-49 50-59 60 and above	26 85 79 39 2	11.3 36.8 34.2 16.9 .9
Years of teaching experience	1-5 6-10 11-15 16-20 Over 20	48 43 59 46 35	20.8 18.6 25.5 19.9 15.2
Years of computer experience	Not at all Less than 1 1-3 4-6 7-10 Over 10	11 22 51 76 44 27	4.8 9.5 22.1 32.9 19.0 11.7
School type	Urban Semi-urban Rural	92 88 51	39.8 38.1 22.1

Research question 1:

What is the frequency of teachers' innovative use of ICT in classroom?

Table 2 shows the distribution of teachers' responses on their frequency of innovative use of ICT in classroom. Cronbach's alpha value of 0.92 for teachers' responses to these six items showed a high internal consistency. This is in consistent with Kline (2005), that alpha value of .90 is considered excellent, .80 very good and .70 acceptable.

More than half of the teachers surveyed reported "never" using computers for organizational, communicative and supportive purposes. 47.2% of the teachers survey reported using computers occasionally or frequently for instructional purposes. The result is in agreement with Usluel and Askar (2002) findings that teachers intensely use computer technologies for managerial purposes and that their computer use for instructional purposes have been insufficient. Also 45.1% of the teachers reported using computers occasionally or frequently for evaluative purposes.

***Table 2**: Teacher responses for innovative uses of ICT*

Innovative use	Never (%)	Occasionally (%)	Frequently (%)	Almost Alawys (%)	Mean	Std deviation
instructional	51.1	34.6	12.6	1.7	1.65	.77
Communicative	56.3	32.0	9.5	2.2	1.58	.75
Organizational	58.0	26.8	9.5	5.6	1.63	.88
Evaluative	51.5	32.5	12.6	3.5	1.68	.82
Supportive	52.8	33.8	10.8	2.6	1.63	.78

cronbach α = 0.92, std deviation = standard deviation

Research question 2:

Are there any significant differences in teachers' innovative uses of ICT by gender, school type, teaching experience and computer experience?

MANOVAs were used to find the mean differences in the use of ICT by gender, school type, teaching experience and computer experience. This was followed, if the MANOVA was significant ($p < .05$), by univariate analyses of variance (*F*-tests). Tables 3, 4 and 5 show the mean values, standard deviation values and *p*-values of the categories. Analyses of variance (ANOVA) were used to test for difference both between and within groups.

The multivariate result was not significant for gender, Wilks' Lambda = .96, $F = 1.74$, $df = (6, 224)$, $p = .11$, indicating no difference in the use of ICT between male and female teachers. However, when the results for the dependent variables were considered separately, the only difference to reach statistical significance was evaluative use: $F (1, 229) = 4.885$, $p = .028$ as shown in table 3. An inspection of the mean scores indicated that female teachers (mean = 1.73, Std = .787) reported using ICT for evaluative purpose significantly more than male teachers (mean = 1.58, Std = .689). The study is in agreement with Adams (2002) that female teachers applied ICT more than the male teachers.

***Table 3**: Multivariate Analyses of Differences between Male and Female teachers on innovative uses of ICT**

Innovative use of ICT	Gender	Mean	Std	*F*	*p*
Instructional	Male Female	1.64 1.67	.749 .800	.060	.807
Communicative	Male Female	1.58 1.56	.758 .749	.028	.867
Organizational	Male Female	1.61 1.65	.889 .850	.105	.746
Evaluative	Male Female	1.59 1.85	.798 .854	4.885	.028
Supportive	Male Female	1.58 1.73	.689 .787	1.897	.170

*Males (N = 153), Females (N = 78), *df* = 1, *df* (Error) = 229, cronbach α = 0.92, std = standard deviation

Further, table 4 shows the mean differences of innovative use of ICT by the teachers' school type (Urban, semi-urban and rural schools). The multivariate result was significant for school type by frequency of teacher use of ICT, Wilks' Lambda = .910, F = 1.804, df = (12, 446), p = .045, indicating a multivariate effect. Univariate ANOVAs were conducted on each dependent measure separately to determine the locus of the statistically significant multivariate effect. As seen from table 4, school type significantly affected instructional use, F = 3.047, df = (2, 228), p = .049, and "organizational use, F = 3.232, df = (2, 228), p = .041.

Independent samples t tests were then conducted to compare the means between pairs of school types for instructional and organizational uses of ICT. The results revealed that teachers in urban schools use ICT more than teachers in rural schools for organizational purposes, t (178) = 2.542, p = .012. Also urban teachers use ICT for instructional purposes" more than rural teachers, t (141) = 2.338, p = .021. Further, it was revealed that teachers in semi-urban schools use ICT for instructional purposes (mean = 1.59) more than teachers in rural schools (mean = 1.49). However, semi-urban teachers and rural teachers were not significantly different in their use of ICT with regards to instructional purposes, t (137) = .789, p = .455. On the other hand teachers in rural schools use ICT for organizational purposes (mean = 1.61) more than teachers in semi-urban schools. But, rural teachers and semi-urban teachers were not significantly different in their use of ICT with regards to "organizational purposes", t (137) = -.973, p = .332.

***Table 4**: Multivariate Analyses of Differences among Urban, Semi-urban and Rural schools on innovative uses of ICT**

Innovative use of ICT	Type of school	Mean	Std	*F*	*p*
Instructional	Urban	1.79	.749	3.047	.049
	Semi-urban	1.59	.783		
	Rural	1.49	.731		
Communicative	Urban	1.65	.844	1.070	.345
	Semi-urban	1.49	.695		
	Rural	1.59	.669		
Organizational	Urban	1.79	.920	3.232	.041
	Semi-urban	1.47	802		
	Rural	1.61	.874		
Evaluative	Urban	1.77	.891	1.949	.145
	Semi-urban	1.69	.793		
	Rural	1.49	.731		
Supportive	Urban	1.72	.789	.986	.375
	Semi-urban	1.56	.741		
	Rural	1.61	.827		

*Urban (N = 92), Semi-urban (N = 88), Rural (N = 51), *df* = 2, *df* (Error) = 228

Finally, table 5 shows the mean differences of innovative use of ICT by the teachers' years of teaching experience. The multivariate result was not significant for years of teaching experience by frequency of teacher use of ICT, Wilks' Lambda = .867, *F* = 1.342, *df* = (24, 772.187), *p* = .127, indicating no multivariate effect. However, ANOVA results revealed that teachers with 6-10 years teaching experience use ICT for evaluative purposes (mean = 1.81, *p* = .029) significantly more than teachers in other categories of years of teaching experience. Also teachers with 11-15 years teaching experience use ICT for instructional purposes (mean = 1.81, p = .014) and supportive purposes (mean = 1.86, p = .007) significantly more than teachers in other categories of years of teaching experience.

These results indicate that teachers with more years of teaching experience seem to use ICT more frequently to transform their teaching. The result is in agreement with Russell, Bebell, O'Dwyer, & O'Connor, (2003) who found that new teachers who were highly skilled with technology more than older teachers did not incorporate ICT in their teaching. The researchers cited two reasons: new teachers focus could be on how to use ICT instead of how to incorporate ICT in their teaching. Secondly, new teachers could experience some challenges in their first few years of teaching and spend most of their time in familiarizing themselves with school's curriculum and classroom management.

***Table 5**: Multivariate analyses of teachers' teaching experiences on innovative uses of ICT*

Innovative uses of ICT	Teaching Experience	Mean	Std	*F*	*p*
Instructional	1-5 6-10 11-15 16-20 Over 20	1.60 1.79 1.81 1.63 1.29	.736 .709 .861 .799 .519	3.190	.014
Communicative	1-5 6-10 11-15 16-20 Over 20	1.52 1.79 1.63 1.59 1.29	.714 .861 .828 .686 .519	2.364	.054
Organizational	1-5 6-10 11-15 16-20 Over 20	1.58 1.88 1.66 1.61 1.34	.895 .905 .940 .906 .539	1.938	.105
Evaluative	1-5 6-10 11-15 16-20 Over 20	1.65 1.81 1.75 1.74 1.37	.838 .732 .939 .801 .690	.150	.029
Supportive	1-5 6-10 11-15 16-20 Over 20	1.56 1.74 1.86 1.57 1.29	.769 .759 .899 .720 .519	3.597	.007

df = 4, *df* (Error) = 226, Std = standard deviation

Research question 3:

Are there significant differences in computer skills, computer experience and computer access between male and female teachers?

A MONOVA was used to find the differences in computer skills, experience and access as shown in table 6. The multivariate result was significant, Wilks' Lambda = .946, *F* = 4.349, *df* = (3, 227),

p = .005, indicating a multivariate effect. A one-way ANOVA results revealed that there was a significant difference between male and female teachers regarding their access to computers, F = 9.25, df = (1, 229), p = .003.

Independent samples t tests were then conducted to compare the means between male and female teachers regarding their access to computers. The results revealed that male teachers have access to computers more than the female teachers, t (229) = 3.042, p = .003.

Table 6*: Multivariate analyses of gender differences in computer skills, experience and access*

Variables	**Gender**	**Mean**	**Std**	***F***	***p***
Computer experience	Male Female	3.90 3.81	1.30 1.29	.273	.602
Computer access	Male Female	3.77 3.21	1.36 1.28	9.25	.003
Computer skills	Male Female	2.72 2.64	.861 .807	.405	.525

Research question 4:

What is the relative importance of factors such as computer experience and computer access in explaining teachers' computer skills in ICT?

To address this question, a relationship between the dependent variable (computer skills) and the independent variables (computer experience and computer access) was initially found. Pallant (2007, p.132) conventions adopted to determine the strength of correlation, suggests that a coefficient between 0.50 and 1.00 indicates a high correlation, between 0.30 and 0.49 shows medium correlation and between 0.10 and 0.29 shows a small correlation. Pearson product-moment correlation (Tabachnick & Fidell, 2012, p. 56) was used to find the relationship between the dependent variable and the independent variables.

As table 7 illustrates, there was a high positive correlation between teachers' computer skills and computer experience (r = .59, p < .001). Also, there was a high positive correlation between teachers' computer skills and computer access (r = .65, p < .001). Furthermore, computer access was positively related to computer experience. All the relationships were statistically significant at the .01 level of significance. This explains that, as teachers have more access to computers, there is likelihood to use the computers, thus improving teachers' computer experience and computer skills.

***Table 7**: Summary of Correlation matrix of computer skills, experience and access*

Variable	Computer skills	Computer experience	Computer access
Computer skills	1.00		
Computer experience	.59**	1.00	
Computer access	.65**	.56**	1.00

**. Correlation is significant at the 0.01 level (2-tailed)

To determine the relative importance of independent variables and also the amount of variance, multiple regression analysis was conducted. According to Gay & Airasian (2000), the independent variables that individually correlated with dependent variable were used to perform the analysis. The independent variables were computer experience and access. The results of the multiple regression analysis are shown in tables 8 and 9.

As shown in table 8, the results of multiple regression analysis indicated that the two variables influence teachers' computer skills at the .05 level of significance. These are computer experience (β = .39, t = 6.8, p = .000) and computer access (β = .42, t = 7.4, p = .000). The result revealed that the largest predictor of teachers' computer skills was computer access.

***Table 8**: Multiple regression on dependent variable (computer skill)*

Variable	Unstandardized B	Standardized Beta	t	*p*
Computer experience	.25	.39	6.8	.000
Computer access	.26	.42	7.4	.000

As shown in table 9, the results of multiple regression analysis indicated that 51.4% of the variance in teachers' computer skills was explained by the independent variables. The test statistic was significant at the .05 level of significance ($F_{(2, 230)} = 20.55$, $p = .000$).

Table 9: *Analysis of Variance*

Sources	Sum of Squares	Df	Mean Square	F Value	R Square	Adjusted R Square	*p*
Model	83.82	2	41.91	20.55	.514	.509	.000
Error	79.35	228	.35				
Total	163.17	230					

CONCLUSION

This study investigated secondary school teachers' use of computer technologies in classrooms. The aim of the study was to explore the differences in secondary school teachers' innovative uses of ICT and frequency of use in classroom. The study has provided data on teachers' use of ICT in teaching and learning, related to their gender, years of teaching experience and school type.

The results of this study found that male teachers have access to computers more than the female teachers. However, the study revealed that there was on difference in the innovative use of ICT between female teachers and male teachers. This finding contradicts the claims that teachers' gender and ICT use have cited female teachers' low levels of computer use due to their limited technology access, skill, and interest (Volman & van Eck, 2001) and also male teachers are more competent in the use of ICT than female teachers (Makrakis &Sawada, 1996; Cooper, 2006).

Further, the analysis revealed significant differences in the use of ICT in teaching among urban, semi-urban and rural teachers. The study found that teachers in urban schools used ICT for instructional and "organizational purposes more significantly than teachers in semi-urban and rural schools. But, there was no significant difference between teachers in semi-urban and rural schools in using ICT for instructional and "organizational purposes

Also, there was no significant difference between years of teaching experience and teachers' ICT use, but experience did influence teachers' use of ICT. These results indicate that teachers with more years of teaching experience seem to use ICT more frequently to transform their teaching. The result is in agreement with Russell, Bebell, O'Dwyer, & O'Connor, (2003) who found that new teachers who were highly skilled with technology more than older teachers did not incorporate ICT in their teaching. The researchers cited two reasons: new teachers focus could be on how to use ICT instead of how to incorporate ICT in their teaching. Secondly, new teachers could experience some challenges in their first few years of teaching and spend most of their time in familiarizing themselves with school's curriculum and classroom management.

Moreover, analysis found that there was a high positive correlation between teachers' computer skills and computer experience ($r = .59$, $p < .001$). Also, there was a high positive correlation between teachers' computer skills and computer access ($r = .65$, $p < .001$). Furthermore, the study revealed that computer access was positively related to computer experience. All the relationships were statistically significant at the .01 level of significance. This explains that, as teachers have more access to computers, there is likelihood to use the computers, thus improving teachers' computer experience and computer skills.

Finally, when the relative importance of factors influencing teachers' computer skills was investigated, it was found that computer access ($\beta = .42$) was the strongest determinant. The least determinant was computer experience ($\beta = .39$). The results of multiple regression analysis indicated that 51.4% of the variance in computer skills was explained by the independent variables (computer access and computer experience).

The results of this investigation involving 231 secondary school teachers strongly support Rozell and Gardner (1999) that teachers' computer experience relates positively to their computer attitudes. The more experience teachers have with computers, the more likely that they will show positive attitudes towards computers. Further, the teacher's inability to integrate ICT into teaching to transform students' learning processes is obvious among teachers. This insufficient use of computers to transform teaching activities buttresses the claim that computers are basically used for teacher-centred learning rather than student-centred learning (Cuban, Kirkpatrick & Peck,

2001). This is clear evidence that for the government to achieve the aim of implementing ICT in secondary schools to transform education, factors that discourage teachers from using ICT to transform teaching need to be investigated.

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