www.ijres.net

International Journal of Research in Education and Science (IJRES)

Contributing Factors to Pre-service Mathematics Teachers' e-readiness for ICT Integration

Wilson Osafo Apeanti
University of Education, Winneba, Ghana,
woapeanti@uew.edu.gh

To cite this article:

Apeanti, W.O. (2016). Contributing factors to pre-service mathematics teachers' e-readiness for ICT integration. *International Journal of Research in Education and Science (IJRES), 2*(1), 223-238.

International Journal of Research in Education and Science
Volume 2, Issue 1, Winter 2016 ISSN: 2148-9955

Contributing Factors to Pre-service Mathematics Teachers' e-readiness for ICT Integration

Wilson Osafo Apeanti*
University of Education, Winneba, Ghana

Abstract

This study investigated pre-service teachers' e-readiness to use ICTs for instruction. The primary data source for the study is a set of survey instrument responded by 126 pre-service mathematics teachers at the University of Education Winneba, Ghana. The survey instrument has a reliability scales (Cronbach's Alpha values) of 0.726. Multiple linear regression analysis was performed. Results revealed that, pre-service teachers' Technological Pedagogical Content Knowledge, TPACK (mean=3.76, SD=0.53), Perception of the effectiveness of ICT in teaching and learning (mean=3.85, SD=0.38), Perception of the Barriers in ICT integration (mean=3.08, SD=0.38) contributes 42.1%, 11.3% and 9.9% to the variances in the e-readiness of pre-service teachers (mean=3.63, SD=0.40). The findings could inform policy makers and teacher training institutions particularly in sub-Saharan Africa about the need to develop pre-service teachers' TPACK and address the barriers to ICT integration in order to promote the pedagogical use of ICT in mathematics instruction. Research with larger samples is hereby suggested before any major implementation of the recommendations.

Key words: Technology Pedagogical Content Knowledge; Teacher's ICTs beliefs; ICTs in mathematics education

Introduction

In today's world, the role of Information and Communication Technologies (ICTs) in the mathematics classroom has become increasingly prominent, particularly because of the current reform-oriented vision for teaching mathematics in which emphasis resides on the development of students' problem solving skills rather than rigors computational skills (Armah & Apeanti, 2012). According to the National Council of Teachers of Mathematics (NCTM), mathematics instruction must emphasis on mathematical processes such as mathematical thinking, reasoning, communication, connections and problem solving (National Council of Teachers of Mathematics, 2000). Various studies have found that ICTs promote communication and sharing of knowledge among students, gives immediate and accurate feedback to students which contribute towards students' motivation to learn mathematics (Hook, 2008, BECTA, 2003). Besides, ICTs support constructivist pedagogy where students use technologies to explore and reach an understanding of mathematical concepts by allowing them to focus on strategies and interpretations of answers rather than spend time on tedious computational calculations (Keong, Horan & Danie, 2005; Wahyudi, 2008; Armah & Apeanti, 2012). As a result, ICTs can improve the quality of teaching and learning mathematics since it can be used in variety of ways to promotes students learning (Nisse, 2006).

While the prospects of ICTs integration in mathematics instruction are inspiring, it imposes challenges to teachers and teacher training institutions (Jung, 2005). The challenge facing teacher educators is how to ensure that pre-service teachers have the repertoire of technological pedagogical content knowledge to enable them to perform this task both now and in future. As Gill and Dalgarno (2008) aptly put it:

> One of the challenges facing teacher educators is how to ensure that graduate teachers have the necessary combination of skills and pedagogical knowledge that will enable them to both effectively use today's technologies in the classroom as well as continue to develop and adapt to new technologies that will emerge in the future (p. 330).

In other words, unless there are proper models and methods of technology integration in teacher education, teachers' classroom practices may probably not be influenced by the opportunities that technology-enhanced pedagogy provides (Nolan, 2008). As teachers are the focal point in invoking the instructional opportunities afforded by ICTs (UNESCO, 2005), teacher training institutions have a pivotal role in preparing pre-service

* *Corresponding Author: Wilson Osafo Apeanti, woapeanti@uew.edu.gh*

teachers to be e-ready to integrate ICTs in their future pedagogical practices. Although different definitions are found in literature, E-readiness (electronic readiness) here is understood as the perceived readiness, preparedness or willingness of pre-service mathematics teachers to integrate ICTs in their future instructional practices.

Purpose of the Study

Studies have shown that despite the relevance of ICTs in teaching mathematics, teachers in technology rich environment do not use ICT in their instructions (Ministry of Education, 2009; Mereku et al, 2009). Studies have also indicated that the two important factors relate to technology integration in mathematics teaching and learning are: (i) knowledge and skills (Shulman, 1986; Koehler & Mishra, 2006, 2009) and (ii) mathematics teachers' attitudes, perceptions and the values they attach to ICT integration (Davis, 1989; Ajzen, 1991; Tallman & Fitzgerald, 2005). Nevertheless, they do not indicate the extent to which these factors influence teachers' e-readiness to integrate ICTs and how these factors interact among themselves. The purpose of the study was, therefore, to investigate the foregoing in a sub-Saharan African context.

Research Question

The study was guided by the research question:
To what extent do the following factors:

(1) Teacher's age
(2) Technological pedagogical content knowledge (TPACK);
(3) Perception of the effectiveness of ICT on teaching and learning;
(4) Perception of the barriers to ICT integration in mathematics instruction; relate individually and in linear combination, to pre-service mathematics teachers' perceived readiness to use ICT for instruction?

Related Literature

Technological Pedagogical Content Knowledge

Technological Pedagogical Content Knowledge (TPACK) refers to the interrelationship of the three key components of effective teaching: content, pedagogy, and technology. TPACK is a framework for understanding the specialized, multi-faceted forms of knowledge required by teachers to integrate technology in their teaching (Koehler & Mishra, 2009). The availability of a range of new, primarily digital technologies and the requirements for learning how to apply them to teaching has changed the nature of the mathematics classroom. Knowledge of technology has become an important aspect of the overall mathematics teachers' knowledge (Koehler & Mishra, 2006). The TPACK framework emphasises that the knowledge and skills of the 21st century teacher must intersect three fundamental domains: content knowledge, pedagogical knowledge and technological knowledge. The implication of TPACK is that properly prepared teachers can take advantage of the exclusive features of technology to teach content in ways that promote quality learning experience for students (Garofalo, Harper, So, Schirack, & Stohl, 2001).

TPACK is the basis of effective teaching with technology, requiring an understanding of the representation of concepts using technologies. First of all, it is a pedagogical technique that uses technologies within the constructivist perspective to teach content (Koehler & Mishra, 2006, 2009). When mathematics teachers teach by simultaneously integrating knowledge of technology, pedagogy and content they bring TPACK into play (Koehler & Mishra, 2009). Secondly, TPACK provides knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face. Finally, TPACK framework explains how knowledge of technologies can be used to build on existing knowledge to develop new epistemologies or strengthen old ones (Koehler & Mishra, 2006, 2009).

Koehler and Mishra (2009) argue that instead of examining each of the aforementioned domains in isolation, there is also a need to examine them in pairs: pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), and all three taken together as technological pedagogical content knowledge (TPACK). Thus, mathematics teachers must not only develop fluency and cognitive flexibility in each of the key domains (i.e content, pedagogy, and technology) of the TPACK framework, but also in the manner in which these domains and contextual parameters interrelate so as to develop effective solutions to students' mathematical problems (Vacirca, 2008; Shin, et al., 2009; Koehler and Mishra, 2009). Other authors (e.g Keating & Evans, 2001; Zhao, 2003; Neiss, 2005; Hughes, 2005) have argued that knowledge about technology cannot be treated as context-free and that good teaching requires an understanding of how technology relates to the pedagogy and content. Consequently, pre-service mathematics teachers must be able to blend the knowledge that they have acquired in technology, pedagogy and mathematical content in order to effectively integrate technology in their future mathematics instruction. Thus, TPACK represents a class of knowledge that is central to the mathematics teachers' work with technology.

Pre-service Teachers' Perception of the Effectiveness of ICT on Teaching and Learning

Even though adequate knowledge in the pedagogical use of ICTs is imperative in determining the e-readiness of pre-service teachers for pedagogical integration of ICTs, studies have identified other factors than can influence teachers actual use of ICTs in the instructional process These factors includes pre-service teachers' perception about the usefulness of ICTs in the instructional process and their perception about the barriers in ICTs integration (Granger, Morbey, Owston & Wideman, 2002). The success of ICTs in mathematics classrooms depends largely on the perception of teachers about it usefulness in helping students to succeed in mathematics (Can & Cagiltay, 2006). Studies have revealed that, teachers tend to use technology in ways shaped by their own personal perspectives on the curriculum and on their pedagogical practices (So, 2006, Lai, Pratt, & Trewern, 2001, Lua & Sim, 2008). Many authors have revealed that, the lack of ICT integration in the mathematics classroom is due to teacher anxiety (Saye, 1998; Preston, Ox, & Cox, 2000; Tella, et al., 2007; Lua & Sim, 2008), teachers' perception (Can & Cagiltay, 2006; Lua & Sim, 2008) and pedagogical belief systems (Jones, 2004; Zevenbergen, 2004). Even though there are computer technology resources available in many schools in developing countries particularly sub-Saharan Africa, teachers are not willing to adopt them in the teaching and learning process as expected. As a result, questions have been raised about the influence of teachers' perception on the use of ICT in the instructional process.

Barriers to Pedagogical Integration of ICT in Mathematics Instruction

Many studies have evaluated the benefits of pedagogical integration of ICT in mathematics (e.g. Forgasz & Prince, 2004; Kumar, 2008; Gill & Dalgarno, 2008). However, there are many barriers that hinder effective pedagogical integration of ICT in mathematics instruction. A study by Norton, McRobbie, and Cooper (2000) which studied mathematics staff in a technology-rich secondary school revealed that teachers' resistance was related to their beliefs about mathematics teaching and learning and their existing pedagogies. This result suggests that, knowledge and beliefs may be the actual barriers. Conceivably, these teachers are either uncomfortable with technology, are unsure how to incorporate technology into their curricula, or have not witnessed examples of its effective use. Recently, literature emerging on the use and adoption of ICTs in classrooms has identified teacher knowledge in ICT to be an important factor determining whether or not teachers use ICTs in their classrooms and the ways in which they use the ICTs to support learning (Zevenbergen, 2004). Lack of knowledge in ICTs has significant impact on teachers' beliefs and attitude toward ICT integration in the instructional process (Koehler & Mishra, 2006, 2009).

Jones (2004) found that seven barriers existed while integrating ICTs into mathematics lessons. These barriers were (i) lack of confidence among teachers during integration (21.2% responses), (ii) lack of access to resources (20.8%), (iii) lack of time for the integration (16.4%), (iv) lack of effective training (15.0%), (v) facing technical problems while the software is in use (13.3%), (vi) lack of personal access during lesson preparation (4.9%) and (vii) the age of the teachers (1.8%). These findings are consistent with a similar study by Keong, Horani, and Daniel (2005) that identified six major barriers faced by the one hundred and eleven (111) teachers in the implementation of ICT into their mathematics classroom. They included lack of time in the school schedule for projects involving ICT (54.6%), inadequate teacher training opportunities for ICT projects (40.8%), lack of adequate technical support for ICT projects (39.2%), lack of knowledge about ways to integrate ICT to enhance the curriculum (38.8%), integrating and using different ICT tools in a single lesson (36.8%) and the absence of access to the necessary technology at the homes of students (33.0%). Similarly, Saye (1998) categorized the barriers in integrating ICT in mathematics instruction into three; teacher anxiety, lack of knowledge and skills, and pedagogical belief systems. Shelley et al. (2006) also listed the following as barriers to integration of ICT: lack of teacher training, lack of administration support, limited time for teacher planning, computer placement in remote locations making access difficult, budget constraints, and basic resistance to change by many educators.

Despite enormous challenges to the pedagogical integration of ICT in mathematics instruction in sub-Saharan African, there appears to be some gains. For instance, Malcolm and Godwyll (2008) study about diffusion of ICTs in Ghana found that, regardless of being under-paid, over-worked or struggling in poor resourced environments, some mathematics teachers often defied the resistance to changes in classroom practice from fellow teachers, school administrators and parents and managed to find the extra time and energy required to integrate ICTs in schools. These teachers are probably, highly self-motivated and confident with ICT tools and may be attributed to the teacher training programme experience as well (Redmond, Albion, & Maroulis, 2006).

Methodology

Methodological Consideration and Research Design

Every research must have bases for its enquiry; it has to be situated within particular philosophical or theoretical convictions to guide the study. These convictions, understood as 'research paradigms', are the set of beliefs, values and world views that researchers have in common regarding what is knowledge (ontology), how it can be ascertained (epistemology), and the procedures for studying it (methodology) (Johnson & Onwuegbuzie, 2004). The study used quantitative research approach underpinned by the post positivism paradigm. Positivism acknowledges that people have subjective views and interpretations of the world due to their personal experiences but it is these that lead to "partial and biased understanding" of the world (Duffy, & Jonassen 1992, p. 3). To ameliorate these partiality and biasness, the researcher's goal is to strive for absolute truth and accurate understanding or meaning. In quantitative research, knowledge is obtained through deductive testing of hypothesis to examine the relationship among dependent and independent variables**.** Cross-sectional survey method of data collection was adopted. This involves collecting information at just one point in time from a sample that has been drawn from a predetermined population by administering questionnaire or ability test to individuals to find out specific characteristics of the group (Fraenkel & Wallem, 2000).

Participants and Setting

The population for this study was pre-service teachers' pursuing a 4-year degree programme in Mathematics leading to the award of Bachelor of Education (B.Ed.) from the University of Education, Winneba (UEW), and Ghana. Specifically, the target population was students from the Department of Mathematics Education.

Sample and Sampling Technique

Purposive sampling technique was used to sample one hundred and twenty-six (126) third year mathematics education students in the UEW, Ghana. Because the study seeks to investigate the factors the influence the e-readiness of pre-service mathematics teachers, it was imperative to select sample that is related to the central issue being studied. As a result, the choice of the third year students as the sample for the study was based on the fact that the third year pre-service mathematics teachers would have studied enough content in the cognate ICT courses as at the time of administering the instrument.

Instrument

Teaching with Technology Instrument (TTI) which was adapted and modified from Lambert (2004) and Yidana (2007) was the questionnaire used for this study. The instrument provided data on participants' Technology Pedagogical Content knowledge, Perceptions of the effectiveness of ICT on teaching and learning, Perceptions of Barriers and Challenges of ICT integration in mathematics instruction and their E-readiness to Use ICT for Instruction. The reliability scales (Cronbach's Alpha values) for the survey instrument was .726 which indicates a high degree of reliability of the items in the instrument (Fraenkel & Wallem, 2000).

Multiple Linear Regression Analysis

Multiple linear regression analysis was employed in this study to find out how pre-service mathematics teachers' age, technological pedagogical content knowledge, perception about the effectiveness of ICT integration and perception about the barriers in ICT integration relates to their e-readiness to use ICT for instruction.

Multiple Linear Regression Assumptions

The major assumptions of multiple linear regression are sample size, variable type, non-zero variance, no perfect multicollinearity, homoscedasticity, normally distributed residuals, Independence, linearity, outliers and influential cases. All these assumptions were checked using various methods and suggestions from literature as discussed below.

Sample Size

Sample size is fundamental to the generalization of a multiple regression model and hence it is important to collect enough data to obtain a reliable regression model. The rule of thumb suggests that there should be a minimum of 10 or 15 cases of data per predictor (Field, 2005). However, Green (1991) gave two rules of thumb for the minimum acceptable sample size. First if you want to test the overall fit of your regression model (i.e. test the R^2), he recommended minimum sample size of 50 + 8*K* and second if you want to test the individual predicators within the model (i.e. test b-values of the model) he suggested a minimum sample size of 104 + *K*, where *K* is the number of predictors (independent variables). He concluded that if you are interested in both the overall fit and the contribution of individual predictors which is the case of this study, the minimum sample sizes should be calculated for both cases and the largest value should be used as the minimum sample size for the regression model.

From the rule of thumb which indicate a minimum of 15 cases of data per predictor (Field, 2005), a sample size of 126 and 4 predictors (Factors 1-4) gives a ratio of 126: 4 (i.e. 31 cases per a predictor) which meets this requirement. Additionally, using the recommendation of Green (1991), 4 predictors will give a minimum sample size of 82 (i.e. 50 + 8(4)) to test for the overall fit of the regression model and a minimum sample size of 108 (i.e. 104 + 4) to test for the individual predictors. The study used a sample size of 126 which meets these requirements.

Variable Type

All predictor variables must be quantitative or categorical and the outcome variables must be quantitative in order to be used in a multiple regression model (Field, 2005). The outcome variable (E-readiness) and predictor variables (Factor 1- 4) used in the regression model were all quantitative data with their respective means (see Table 2).

Non- zero Variance

The predictors in the multiple regression model should have some variation in value (that is they do not have a variance of zero). All the predictor variables used in this study had non-zero variance. The value of the variance for the predictor variables are Factor 1(32.564), Factor 2 (.281), Factor 3 (.145) and Factor 4 (.141) (see Table 1).

No-perfect Multicollinearity

Multicollinearity refers to the relationship among predictor variables. Multicollinearity exists when there is a strong correlation between two or more predictors. However, in a multiple regression model, there should be no perfect linear relationship between two or more of the predictors and so, the predictor variables should not correlate too highly. Field (2005) indicated that multicollinearity poses a threat to the validity of multiple regression analysis because:

i. It limits the size of *R* (multiple correlation coefficient) because of shared variance among overlapping predictors
ii. It makes it difficult to assess the individual importance of a predictor

iii. It increases the variance of the regression coefficients resulting in unstable predictor equation from sample to sample.

Multicollinearity was check using a correlation matrix of all the factors, collinearity diagnostic output from SPSS which is the Variance Inflation Factor (VIF) and Tolerance statistic (1/VIF) as suggested by literature (e.g. Bowerman & O'Connell, 1990; Field, 2005). According to Bowerman and O'Connell (1990) if the VIF is greater than 10 then multicollinearity may be biasing the regression model and a Tolerance statistic below 0.1 indicate serious problems with the regression model. From the bivariate correlation of regression factor (see Table 3) , predictor variables (Factors 1- 4) correlated weakly among each other with a correlation coefficients ranging from -0.143 to 0.239 ($-0.143 \leq r \leq 0.239$). Additionally, from Table 1, the Tolerance ranges from 0.908 to 0.957 which are all substantially greater than 0.1 and the VIF values which range from 1.045 to 1.102 are significantly less than 10. Therefore, since the predictor factors correlated weekly, VIF values are less than 10 and Tolerance values are all greater than 0.1 there is no perfect multicollinearity among the predictor factors and hence there is no violation of the no perfect multicollinearity assumption.

Table 1. Collinearity statistics for predictor factors

	Tolerance	**VIF**
Factor 1 (Age)	.937	1.068
Factor 2 (TPACK)	.957	1.045
Factor 3 (Perception of effectiveness)	.911	1.098
Factor 4 (Perception of barriers)	.908	1.102

a. Dependent Variable: E-readiness

Homoscedasticity

This assumption indicates that at each level of the predictor variable, the variance of the residual terms should be constant. Residuals are differences between the obtained and predicted factor (E-readiness) score. This assumption was checked using the scatter plot of the standardized residuals (see Figure 1). The scatter plot has most of the scores concentrated in the center with no obvious pattern. This scatter plot distribution indicates that the assumption of homoscedasticity was not violated.

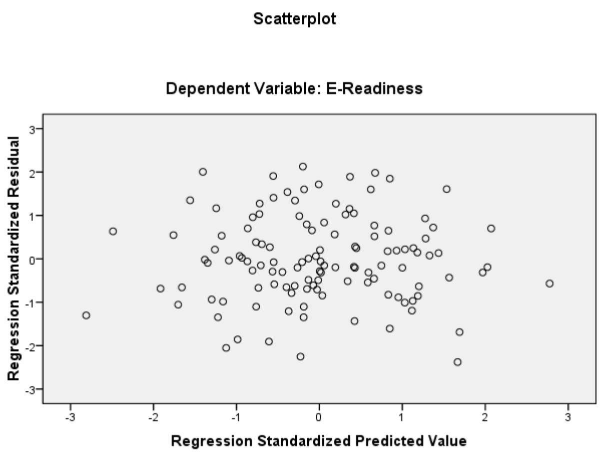

Figure 1. Scatter plot of the standardized residuals

Normally Distributed Residuals

It is assumed that the residuals in the model are random normally distributed variables with a mean of zero (0) and a standard deviation of one (1). This means that the difference between the value predicted by the model and the observed data are most frequently zero or very close to zero and the difference much greater than zero only happens occasionally. The histogram in Figure 2 indicates that the residual are almost normally distributed (mean = -8.68E-15 and standard deviation = 0.983). This indicates that the normally distributed residuals assumption was met.

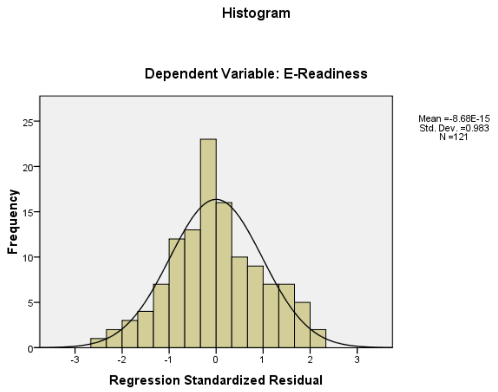

Figure 2. Histogram of regression standardized residuals

Independence

It is assumed that all of the values of the outcome variables are independent, that is the value of the outcome variables comes from a separate entity. To ensure that this assumption is not violated, the participants were encouraged to complete the questionnaire independently. Additionally, the data were screened to find out whether there were cases which have similar identical responses. None of these cases were found. The week correlation (-0.143≤ r ≤0.239) among the predictor factors in Table 3 indicates that these factor were independent of each other and as a result the assumption of independence was not violated.

Linearity

It is assumed that the mean values of the outcome variable for each increment of the predictors lie along a straight line. In other words, the regression model should be linear. This assumption was checked using the Normal P-P Plot (Figure 3). The Normal P-P Plot shows that the increment in the predictors lies along a straight line. This shows that the linearity assumption was met.

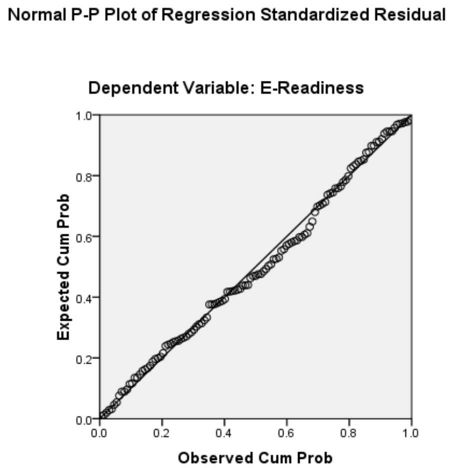

Figure 3. Normal P-P plot

Outliers and Influential Cases

An outlier is a case that differs substantially from the main trend of data. Outliers can cause a regression model to be biased because they affect the values of the estimated regression coefficients. Field (2005) indicated that standardized residuals more than 3.29 or less than -3.29 are a cause for concern because in an average sample a value that high is unlikely to happen by chance. From the scatter plot (see Figure 1) all the standardized residuals lies within the range of -3 to 3 which signifies that there is no serious concern for the presence of outliers.

Influential cases on the other hand are cases that exert undue influence over the parameters such that if these cases are deleted would lead to different regression coefficient. There are several statistics that can be used to assess the influence of a particular case. Cook's distance statistic is a measure of the overall influence of a case on the model and a cook's distance value greater than 1 may be a cause for concern. A second measure of influence is Leverage or Hat Value which gauges the influence of the observed value of the outcome variable over the predicted values. The average Leverage value is defined as $(K + 1)/n$ in which K is the number of predictors in the model and n is the number of participants. Leverage value can lie between 0 (indicating that the case has no influence whatsoever) and 1 (indicating that the case has complete influence over prediction). If no cases exert undue influence over the model, then the Leverage value should be close to the average value ($(K + 1)/n$). Stevens (1992) recommends using three times the average ($3(K + 1)/n$) as a cut-off point for identifying cases having undue influence. Related to the leverage values are the Mahalanobis distance which measure the distance of cases from the means of the predictor variables.

To check the effect of influential cases, SPSS output of the summary of the residual statistics was examined for extreme cases. None of the cook's distance was found to be greater than 1 which shows that no case has undue influence on the model. The average Leverage value was calculated as 0.04 (i.e. $(K + 1)/n = 5/126$) and so the value three times as large (0.12) will be a cut-off point for identifying cases having undue influence on the model (Stephens, 1992). All the cases were within this boundary of three times the average Leverage value except for case 75 which had a Leverage value of 0.19. Therefore, case 75 needed further scrutiny. Looking back through the data, it was found that case 75 had the highest age (55 years) score and since the age was not set to a certain limit case 75 was retained. With the Mahalanobis distance value, for a sample of 100 with three (3) predictors, values greater than 15 indicates a problematic case (Field, 2005). This study uses a sample of 126 with four (4) predictors therefore 15 was set as a cut-off point yet none of the Mahalanobis distance value for the cases came close to exceeding this criterion. The evidence suggests that there were no influential cases which were serious in this study.

From the results of all the tests of assumptions of multiple linear regression discussed above, it was accurate to conclude that no violation of these assumptions occurred in this study and therefore the use of multiple regression was justified.

Findings

Descriptive Statistics for the Factors

The dependent variable (DV) used in the multiple regression was: Pre-service mathematics teachers' e-readiness to use ICT for instruction while the independent variables (IV) were:

Factor 1: Age
Factor 2: Technological Pedagogical Content Knowledge (TPACK)
Factor 3: Perception of the effectiveness of ICT on teaching and learning
Factor 4: Perception of the barriers of ICT integration in mathematics instruction

For Factors 2-4, Likert's five-point scale items were administered. A score or level of agreement between 3 and 5 is considered as a high score or a high level of agreement. The aggregate score for the factors (both the DV and IV) were used in the multiple regression analysis. Table 2shows the descriptive statistics of the factors used in the multiple regression.

Table 2. Descriptive statistics of factors

	N	Minimum	Maximum	Mean	Std. Deviation	Variance
Factor 1 (Age)	121	20	55	28.57	5.71	32.56
Factor 2 (TPACK)	126	2.44	4.85	3.76	.53	.281
Factor 3 (Perception of effectiveness)	126	2.87	4.73	3.85	.38	.145
Factor 4 (Perception of barriers)	126	2.00	4.20	3.08	.38	.141
E-readiness	126	2.39	4.54	3.63	.40	.160

The mean age of the participants (Factor 1) was 28.57 (SD = 5.706) and Factor 2 had an average of 3.76 (SD = 0.5304) which indicate that participants of the study had a considerably high Technological Pedagogical

Content Knowledge (TPACK) score. Factor 3 had an average of 3.85(SD = 0.380) which shows that the participants of the study have a positive perception towards the effectiveness of ICT integration in mathematics instruction. This finding is consistent with the findings of Lua and Sim (2008) which revealed that in general, teachers broadly agree that the use of ICTs makes them more effective in their teaching, more organized in their work and better able to meet the varying needs of students. However, an average score of 3.08 (SD = 0.375) for factor 4 indicates a high score on the perception of barriers to ICT integration in the Ghanaian setting. The E-readiness had an average score of 4.54 (SD = 0.399) which indicates that the participants perceived to have high level of readiness to use ICT for instruction.

The bivariate correlations among the factors are shown in Table 3. Factor 2 (TPACK) had a very strong positive correlation (r = .745) with the dependent factor (E-readiness) followed by factor 3 (Perception of effectiveness) with r =.516 and factor 4 (Perception of barriers) with r = 0.471. However, age (factor 1) was negatively correlated (r=-.119) with E-readiness.

Table 3. Bivariate correlation of regression factors

	e-readiness	Factor 1 (Age)	Factor 2 (TPACK)	Factor 3 (Perception of effectiveness)	Factor 4 (Perception of barriers)
e-readiness	1.00				
Factor 1 (Age)	-.119	1.00			
Factor 2 (TPACK)	.740	-.143	1.00		
Factor 3 (Perception of effectiveness)	.516	.087	.131	1.00	.
Factor 4 (Perception of barriers)	.476	-.162	.099	.239	1.00

These findings indicate that, Technological Pedagogical Content Knowledge (TPACK) have a considerable high positive influence (r =.74) on the participants perceived readiness to use ICT in their future instructional practice as literature have indicated (e.g. Koehler & Mishra, 2006; Niess, 2006; Vacirca, 2008). Additionally, the moderately positive correlation of participants' perception of the effectiveness of ICT integration in mathematics instruction (Factor 3) (r = 0.516) and their perception of the barriers in ICT integration (Factor 4) (r = 0.471) with their perceived readiness to use instructional technology (E-readiness) substantiate the findings of Granger, et al. (2002) which indicated that pre-service teachers' perceptions about ICT integration have significant influence on their actual use of ICT tool in the instructional process. However, Factor 1 (Age) correlated weakly and negatively (r = - 0.119) with the dependent factor (E-readiness). This negative correlation shows that, younger participants had a slightly high e-readiness score than older participants which is consistent with the findings of Hernes, Hestman and Haeland (2000).

Hypotheses Testing

To answer the research question, multiple linear regression was conducted to test the following research hypothesis:

(a) $H_{\mathbf{01}}$: $\underline{R} = 0$, that is the linear combination of independent factors does not significantly relate to the E-readiness of pre-service mathematics teachers.

H_{A1}: $\underline{R} \neq 0$, that is the linear combination of independent factors does significantly relate to the E-readiness of pre-service mathematics teachers.

(b) H_{02}: $\beta_i = 0$, that is Factor i does not significantly relate to the E-readiness of pre-service mathematics teachers, i = 1, 2, 3, 4.

H_{02}: $\beta_i \neq 0$, that is Factor i significantly relates to the E-readiness of pre-service mathematics teachers, i = 1, 2, 3, 4.

(c) H_{03}: $\underline{R} = 0$, there is not any other significant combination of factors better than the full-model.

H_{A3}: $\underline{R} \neq 0$, there is a significant combination of a reduced model better than the full model.

Hypothesis (a) was used to test the significance of the combined factors of the regression model, hypothesis (b) was used to test for the significance of individual factors and hypothesis (c) was used for the test of significance of the reduced model.

Test of the Significance of Combined Factors

Standard regression analysis was conducted to determine the relationship of a linear combination of predictor variables (Factors 1- 4) with the E-readiness of pre-service mathematics teachers using the research hypothesis:

(a) H_{01}: $\underline{R} = 0$, that is the linear combination of independent factors does not significantly relate to the E-readiness of pre-service mathematics teachers.

H_{A1}: $\underline{R} \neq 0$, that is the linear combination of independent factors significantly relate to the E-readiness of pre-service mathematics teachers.

Table 4 shows the standard regression model summary and Table 5 indicates the Analysis of Variance (ANOVA) test of statistical significance of regression model. From the ANOVA (Table 5), F = 138.63 and p = .000(< .05) which indicates that the test was statistically significant. Therefore, the null hypothesis (H_{01}) was rejected which means that the linear combination of independent factors significantly relates to the E-readiness of pre-service mathematics teachers (H_{A1}).

Table 4. Standard regression model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.909[a]	.827	.821	.16892	.827	138.634	4	116	.000	1.977

a. Predictors: (Constant), Factor 4 (Perception of barriers), Factor 2 (TPACK), Factor 1 (Age), Factor 3 (Perception of effectiveness)

b. Dependent Variable: e-readiness

The standard regression model summary (Table 4) indicates that the value of the regression coefficient (R = .909). This show how well all independent factors combined related with the dependent factor (e-readiness). Additionally, the Adjusted R^2 = .821 which shows that all the factors combine contributed 82.1% of the variances in the dependent factor E- readiness.

Table 5. ANOVA of regression significance

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	15.824	4	3.956	138.634	.000[a]
	Residual	3.310	116	.029		
	Total	19.134	120			

a. Predictors: (Constant), Factor 4 (Perception of barriers), Factor 2 (TPACK), Factor 1 (Age), Factor 3 (Perception of effectiveness)

b. Dependent Variable: e-readiness

Test of the Significance of Individual Factors

The significance of the individual regression coefficient (Beta weights) illustrated in Table 6 was used to test the hypothesis:

(b) H_{02}: $\beta_i = 0$, that is Factor i does not significantly relate to the E-readiness of pre-service mathematics teachers, i = 1, 2, 3, 4.

H_{02}: $\beta_i \neq 0$, that is Factor i significantly relates to the E-readiness of pre-service mathematics teachers, i = 1, 2, 3, 4.

From Table 6, Factor 1 (Age) was not statistically significant (B = -.002, t = -.041; p = .967 > .05) and we fail to reject the null hypothesis (H_{02}) that Factor 1 (Age) does not significantly relate to the E-readiness of pre-service teachers. For Factor 2 (TPACK) the test was statistically significant (B = .662, t = 16.763; p = .000 (< .05)) and we reject the null hypothesis (H_{02}) that Factor 2 (TPACK) does not significantly relate to the E-readiness of pre-service teacher. Factor 3 (Perception of effectiveness) was statistically significant (B = .351, t = 8.683; p = .000

< .05) and we reject the null hypothesis (H_{02}) that Factor 3 (Perception of effectiveness) does not significantly relate to the E-readiness of pre-service. For Factor 4 (Perception of barriers) the test is statistically significant (B = .327, t = 8.056; p = .000 < .05) and we reject the null hypothesis (H_{02}) that Factor 4 (Perception of barriers) does not significantly relate to the E-readiness of pre-service teacher.

Table 6. Regression coefficient of the standard regression model

Model 1	Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95% Confidence Interval for B Lower Bound	95% Confidence Interval for B Upper Bound
(Constant)	-.719	.221		-3.250	.002*	-1.157	-.281
Factor 1 (Age)	.000	.003	-.002	-.041	.967	-.006	.005
Factor 2 (TPACK)	.498	.030	.662	16.763	.000	.439	.557
Factor 3 (Perception of effectiveness)	.370	.043	.351	8.683	.000	.286	.455
Factor 4 (Perception of barriers)	.343	.043	.327	8.056	.000	.259	.427

Test of Significance of the Reduced Model

Factor 1 (Age) did not contribute significantly to the regression model, therefore the multiple regression was run again without Factor 1 (Age) to test the hypothesis:

(c) H_{03}: $\underline{R} = 0$, there is not any other significant combination of factors better than the full-model.

H_{A3}: $\underline{R} \neq 0$, there is a significant combination of a reduced model better than the full model

To test this hypothesis, the stepwise method was used in the regression model to select the best possible model. The factors were entered in the following order Factor 2, Factor 3 and Factor 4. This was based on the preliminary standard regression results. The stepwise method generated three (3) regression models (see Table 7).

Table 7. Summary of standard regression for three models

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics: R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.747[a]	.558	.554	.26674	.558	156.389	1	124	.000	
2	.856[b]	.733	.728	.20825	.175	80.440	1	123	.000	
3	.912[c]	.832	.828	.16587	.099	71.888	1	122	.000	1.924

a. Predictors: (Constant), Factor 2 (TPACK)

b. Predictors: (Constant), Factor 2 (TPACK), Factor 3 (Perception of effectiveness)

c. Predictors: (Constant), Factor 2 (TPACK), Factor 3 (Perception of effectiveness), Factor 4 (Perception of barriers)

d. Dependent Variable: E-readiness

Table 8 shows the ANOVA of regression significance of the three models. The statistics for the models are: Model 1 (F = 156.387, p = .000 (<.05)), Model 2 (F = 168.509, p = .000 (<.05)) and Model 3 (F = 201.046, p = .000 <.05). This indicates that the linear combination of independent factors in all the three models significantly relate to the E-readiness of pre-service mathematics teachers. However, the summary of the standard regression of the three models (Table 7) have the following statistic: Model 1 (R^2 = .588, Adjusted R^2 = .554), Model 2 (R^2 = .733, Adjusted R^2 = .728) and Model 3 (R^2 = .832, Adjusted R^2 = .828). Since the multiple correlations of the full model (Model 3) is the highest (R^2 = .832) of the three models we fail to reject the null hypothesis (H_{03}) that there is not any other significant combination of factors better than the full-model.

Table 8. ANOVA regression significance of three models

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	11.127	1	11.127	156.389	.000[a]
	Residual	8.822	124	.071		
	Total	19.949	125			
2	Regression	14.615	2	7.308	168.509	.000[b]
	Residual	5.334	123	.043		
	Total	19.949	125			
3	Regression	16.593	3	5.531	201.046	.000[c]
	Residual	3.356	122	.028		
	Total	19.949	125			

a. Predictors: (Constant), Factor 2 (TPACK)

b. Predictors: (Constant), Factor 2 (TPACK), Factor 3 (Perception of effectiveness)

c. Predictors: (Constant), Factor 2 (TPACK), Factor 3 (Perception of effectiveness), Factor 4 (Perception of barriers)

d. Dependent Variable: E-readiness

Table 9 shows the regression coefficient Model 1, Model 2 and Model 3. Since there is not any other significant combination of factors better than the full-model, Model 3 was used. Therefore, the final regression equation for the unstandardized B- coefficients was:
e-readiness = 0.496*Factor 2 (TPACK) + 0.368*Factor 3 (Perception of effectiveness) + 0.346*Factor 4 (Perception of barriers) – 0.717

Also, the final regression equation for the reduced model involving significant factors was:
Predicted Z (E-readiness) = .659*Factor 2 (TPACK) + .350*Factor3 (Perception of effectiveness) + .250*Factor4 (Perception of barriers)

Table 9. Regression coefficient of three standard regression models

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	95% Confidence Interval for B Lower Bound	95% Confidence Interval for B Upper Bound
1	(Constant)	1.514	.171		8.862	.000	1.176	1.852
	Factor 2 (TPACK)	.562	.045	.747	12.506	.000	.473	.652
2	(Constant)	-.003	.215		-.014	.989	-.429	.423
	Factor 2 (TPACK)	.511	.036	.678	14.349	.000	.440	.581
	Factor 3 (Perception of effectiveness)	.445	.050	.424	8.969	.000	.347	.543
3	(Constant)	-.717	.191		-3.753	.000	-1.095	-.339
	Factor 2 (TPACK)	.496	.028	.659	17.471	.000	.440	.552
	Factor 3 (Perception of effectiveness)	.368	.041	.350	9.074	.000	.288	.448
	Factor 4 (Perception of barriers)	.346	.041	.325	8.479	.000	.265	.426

a. Dependent Variable: E-readiness

Comparative Importance of the Factors

Table 10 shows the comparative Beta weights of the factors from factor 1 to factor 4. Technological Pedagogical Content Knowledge (TPACK) (Factor 2) made the most significant (Beta = .662, p = .000(< .05)) unique contribution to the perceive readiness (E-readiness) of pre-service mathematics teachers in the study. The second most significant factor was pre-service mathematics teachers perception of the effectiveness of ICT integration in mathematics instruction (Factor 3) with Beta = .352 and p = .000(< .05) followed by pre-service mathematics teachers perception of the barriers in ICT integration (Beta = .327, p = .000(< .05)). However, Age (Factor 1) did not make any statistically significant contribution to the perceived readiness (E-readiness) of pre-service mathematics teachers (Beta = -.002, p = .967(> .05)).

Table 10. Beta values- comparative importance of factors

Factors	Beta	t- statistic	Sig.
Factor 1 (Age)	-.002	-.041	.967*
Factor 2 (TPACK)	.662	16.763	.000
Factor 3 (Perception of effectiveness)	.351	8.683	.000
Factor 4 (Perception of barriers)	.327	8.056	.000

a. Dependent Variable: E-readiness * $p < .05$

Table 11 shows the parts and partial correlation of significant factors. Zero-order correlation is the correlation coefficients of the individual factors with the dependent factor (E-readiness). The Part-squared values indicate the contribution of individual factors the total R^2 (overall fit of the regression model). Technological Pedagogical Content Knowledge (Factor 2) is the most important factor for determining the E-readiness of pre-service mathematics teachers which contributed 42.1% (Part-Square = .421) to the value of R^2. This was followed by pre-service teachers' perceptions about the effectiveness of ICT integration in mathematics instruction (Factor 3) which contributed 11.3% (Part-Square = .113) to the value of R^2. Pre-service mathematics teachers' perception about the barriers in ICT integration (Factor 4) contributed 9.9% (Part-Square = .099) to the value of R^2 (Figure 1).

Table 11. Parts and partial correlation of significant factors

	Correlations			
Factors	Zero-order	Partial	Part	Part- Square
Factor 2 (TPACK)	.747	.845	.649	.421
Factor 3 (Perception of effectiveness)	.534	.635	.337	.113
Factor 4 (Perception of barriers)	.471	.609	.315	.099

a. Dependent Variable: E-readiness

Figure 4 illustrates the summary of the comparative importance of significant factors in the regression model.

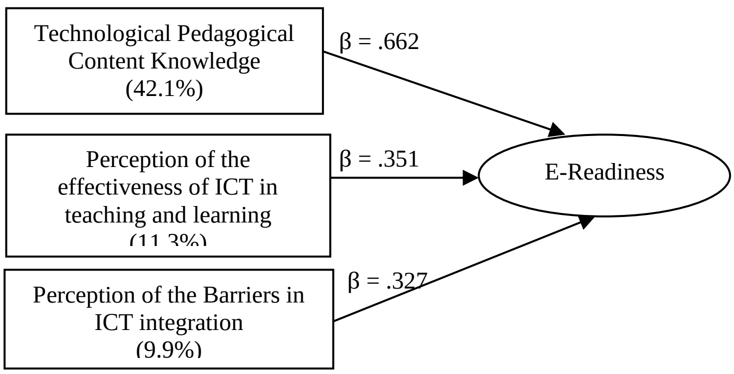

Figure 4. Comparative importance of significant factors in the regression model

Discussion

The findings in the regression model revealed that Technological Pedagogical Content Knowledge is the most important factor for determining the e-readiness of pre-service mathematics teachers and it contributes 42.1% to the total variance in pre-service mathematics teachers' perceived readiness. These finding confirms Koehler and Mishra (2006, 2009) theory of Technological Pedagogical Content Knowledge (TPACK) which indicates that TPACK is the basis of effective teaching with technology, requiring an understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face.

Also, it was found that pre-service mathematics teachers' perceptions about the effectiveness of ICT integration in mathematics instruction contribute 11.3% to the total variance in their perceived readiness to use ICT for instruction. This finding confirms the Technology Acceptance Model (TAM) by Davis (1989). TAM signifies that teachers Perceived Usefulness (PU) of ICT in the teaching and learning process influence their Attitude (A) towards the use of ICT and their Behavioural Intention (BI) to use ICT which then influence their actual use of ICT for instruction.

It was also found in the multiple linear regression that pre-service mathematics teachers' perception about the barriers in ICT integration influenced their perceived readiness to integrate ICT in mathematics instruction and it contributes 9.9% to the total variance in their perceived readiness. This finding is in consonance with the Theory of Planed Behaviour (TPB) by Adjzen (1991). The TPB indicates that Perceived Behaviour Control (PBC) which is the individual's perception of his or her control over the barriers in the performance of a particular the behaviour (in this case ICT integration) influence his Intention (I) to perform that behavior which then influence the actual behaviour .This signifies that since the pre-service teachers' perception of the barriers and challenges to ICT integration in mathematics instruction influence their perceived readiness, there in a need provide the necessary support and encouragement that will address some of these challenges.

Conclusion and Recommendation

The main purpose of the study was to investigate the factors that influence the e-readiness of pre-service mathematics teachers. It was revealed that, pre-service mathematics teachers from the UEW have reasonable Technological Pedagogical Content Knowledge. This might be as the result of the cognate ICT courses in the Mathematics Education programme. Technological Pedagogical Content Knowledge is an imperative factor that has influence on whether teachers use ICT for teaching or not. Therefore, other teacher Education Departments should emulate the effort by the Department of Mathematics Education to include cognate ICT courses in their curriculum in order to train pre-service teachers in ICT integration. The study also revealed that pre-service mathematics teachers from the UEW have positive perception about the pedagogical usefulness of ICT in mathematics teaching and learning. This indicates that pre-service teachers generally view ICT integration as an effective way of delivering instruction and if the necessary contextual conditions are providing, they are more likely to integrate ICT in their instruction.

This study has also shown that, the e-readiness of pre-service teachers is significantly influenced by Their Technology Pedagogical Content Knowledge, Perception of the effectiveness of ICT in teaching and learning and Perception of the Barriers in ICT integration. Therefore, teacher education institutions in sub-Saharan regions in Africa particularly the University of Education, Winneba, should put in place a scheme that will address the technology related professional needs of pre-service mathematics teachers in ICT integration. Numerous studies (e.g. Can & Cagiltay, 2006; Lua & Sim, 2008) support the idea that effective technology training is the major factor that can help teachers develop positive attitudes and perception toward technology integrating in curriculum. However, the technology training for pre-service teachers should not simply focus on basic computing skills but it should be focused on the possible ways of helping pre-service teachers to achieve deeper connections among content, pedagogical, and technological knowledge.

Limitations

Since the study aimed at investigating the e-readiness of prospective mathematics teacher, it covered one teacher training university (i.e. UEW) in Ghana. This is because UEW is the largest teacher training university in Ghana and has a specific Mathematics Education course unlike the Colleges of Education which train teachers in all subject areas taught at the basic education level. In the UEW, the study was delimited to only the third year B.Ed. Mathematics student because of the fact that third year student would have studied enough content in the cognate ICT courses as at the time of administering the instrument. Therefore, the results of the study would be strictly applicable to prospective mathematics teachers from UEW and similar sub-Saharan teacher education institutions in Africa. A broader survey that covers more than on institution is recommended in future studies to clarify to a large extent the e-readiness of prospective mathematics teachers.

References

Ajzen I. (1991). The theory of planned behaviour. *Organizational Behaviour and Human Decision Processes, 50*, 179-211.

Armah, P. H. & Apeanti, W. O. (2012). The effect of graphing software on students' conceptual understanding of quadratic functions. *African journal of educational studies in mathematics and science, 10* (1) 9-22

BECTA. (2003). *What the Research Says about Using ICT in Maths*. UK: Becta ICT Research.

Bowerman, B. L. & O'Connel, R. T. (1990). Linear statistical models: an applied approach (2nd edition). Belmont, CA: Duxbery.

Can, G., & Cagiltay, K. (2006). Turkish Prospective Teachers' Perceptions Regarding the Use of Computer Games with Educational Features. *Educational Technology & Society, 9* (1), 308-321.

Davis, F.D. (1989) Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly, 13*, 319-340.

Duffy, T.M. & Jonassen, D.H. (1992) *Constructivism and the Technology of Instruction: A Conversation*, Lawrence Erlbaum Associates.

Field, A. (2005). *Discovering statistics using SPSS (2nd edition).* London: SAGE Publication Ltd.

Forgasz, H., & Prince, N. (2004). *Computers for secondary mathematics: Who uses them and how?* Retrieved March 2, 2012, from http://aare.edu.au/01pap/for01109.htm

Fraenkel, J.R., & Wallen, N.E. (2000). *How to design and evaluate research in education*, (5th ed.). New York: McGraw-Hill Publishing Co.

Garofalo, J., Harper, S.R., So, T. Schirack, S.O., & Stohl, H.D. (2001). Learning mathematics and developing pedagogy with technology: A reply to Browning and Klepsis. *Contemporary Issues in Technology and Teacher Education, 1*(3). Retrieved March 12, 2012 From http://www.citejournal.org/vol1/iss3/currentissues/mathematics/article1.htm.

Gill, L., & Dalgarno, B. (2008). *Influences on pre-service teachers' preparedness to use ICTs in the classroom*. Retrieved May 2, 2012, from http://www.aare.edu.au/03pap/war03165.pdf

Granger, C., Morbey, H., Owston, R. & Wideman, H. (2002). Factors contributing to teachers' successful implementation of IT. *Journal of Computer Assisted Learning*. *18*, 480-488.

Green, S. B. (1991). How many subjects does it take to do a regression analysis? *Multivariate Behavioural Research, 26*, 499-510

Hernes, F., Hestman, M., & Haaland, E. (2000). *Knowledge and competence in ICT among teachers in Norway.* Retrieved December 20, 2012 from http://www.ifip.or.at/con2000/iceut2000/iceut09-04.pdf

Hook, C. H. (2008). A Practical Framework for Technology Integration in Mathematics Education. *In Proceedings of the 2008 International Conference on Science and Mathematics Education*. Penang, Malaysia: SEAMEO RECSAM, 1 – 11

Hughes, J. (2005). The role of teacher knowledge and learning experience in forming technology integrated pedagogy. *Journal of Technology and Teacher Education, 13*, 277-302

Johnson, R. & Onwuegbuzie, J. (2004). Mixed Methods Research: A Research paradigm whose time has come. *American Educational Research Association. 33* (7).14-26.

Jones, A. (2004). *A review of the research literature on barriers to the uptake of ICT by teachers.* London: BECTA

Jung, I. (2005). ICT-Pedagogy Integration in Teacher Training: Application Cases Worldwide. *Educational Technology & Society, 8* (2), 94-101.

Keating, T., & Evans, E. (2001). *Three computers in the back of the classroom: Pre-service teachers' conceptions of technology integration.* Paper presented at the annual meeting of the American Educational Research Association, Seattle, WA

Keong, C. C., Horan, I. S., & Danie, l. J. (2005).A study on the use of ICT in mathematics teaching. *Malaysian Online Journal of Instructional Technology (MOJIT)2* (3), 43-51

Koehler, M. J. & Mishra, P. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record, 108* (6), 1017–1054. Columbia: Columbia University.

Koehler, M. J., & Mishra, P. (2009). What is technological pedagogical content knowledge? *Contemporary Issues in Technology and Teacher Education, 9*(1), 60-70.

Kumar, R. (2008). Convergence of ICT and Education. *Proceedings of world academy of science, engineering and technology* (pp. 556-559). Ghaziabad,India: WASET.ORG

Lai K. W., Pratt K., & Trewern, A. (2001). *Learning with technology: evaluation of the Otago secondary schools' technology project.* Dunedin: The Community Trust of Otago

Lambert, J. L. (2004). *Technology intergration expertise in meddle school social studies teachers: a study of multiplicity in thinking and practice*. Retrieved June 24, 2009, from http://www.lib.ncsu.edu/theses/available/etd3232004203313/unrestricted/etd.pdf

Lau, B. T & Sim, C. H. (2008). *Exploring the extent of ICT adoption among secondary school teachers in Malaysia*. Retreived 23 October, 2009 from http://www.ijcir.org/volume2 number2/article3%2019-36.pdf.
Malcolm, E. & Godwyll, F. (2008). *Diffusion of Information Communication Technology in Selected Ghanaian Schools.* Retrieved September 25, 2009, from http://www.iconnectonline.org/News/Diffusion_ICT_GhanaianSchools_Malcolm_Godwyll.pdf/download
Mereku, D. K., Yidana, I., Hodzi, W., Tete-Mensah, I., Tete-Mensah, W., & Williams, J. B. (2009). *Pan-African research agenda on the pedagogical integration of ICT:Phase 1 Ghana report. University of Education, Winneba,* Canada: International Development Research Center(IDRC)
Ministry of Education. (2009). *Report on e-readiness assessment of second cycle institutions in Ghana.* Accra: ICT in Education Programmes Unit, Ministry of Education.
National Council of Teachers of Mathematics. (2000). *Principles and standards for school mathematics*. Reston, VA: NCTM
Neiss, M. L. (2005). Preparing teachers to teach science and mathematics with technology: Developing a technology pedagogical content knowledge. *Teaching and Teacher Education*, *21*(5), 509–523.
Nolan, K. (2008). In Teacher Education, *The Future Is Now*: The Importance of Modelling Effective Technology Integration in Mathematics Education Classes. Retrieved July 25, 2012, from http://education.uregina.ca/iteachered/downloads/Nolan- FutureIsNow.pdf.
Norton, S., McRobbier, C. J., & Cooper, T. J. (2000). Exploring secondary mathematics teachers’ reasons for not using computers in their teaching: Five case studies. *Journal of Research on Computing in Education, 33*(1)
Preston, C., Ox, M., & Cox, K.(2000). *Teachers as Innovators in learning: what motivates teachers to use ICT*. Retrieved April 30, 2009 from http://www.mirandanet.ac.uk/pubs/tes_art.htm
Redmond, P., Albion, P. R., & Maroulis, J. (2006). *Intentions v Reality: Pre-service teachers’ ICT Integration during Professional Experience*. Retrieved September 14, 2009, from http://eprints.usq.edu.au/603/1/02_site05.pdf
Saye, J. (1998). Technology in the classroom: The role of dispositions in teacher gate keeping. *Journal of Curriculum and Supervision, 13*(3), 210-234
Shelly, G. B., Cashman, T. J., Gunter, G. A. and Gunter, R. E. (2006). Integrating Technology and Digital Media in the classroom, 4thed, Boston: Thompson Course Technology.
Shin, T. S., Koehler, M. J., Mishra, P., Schmidt, D. A., Bara, E., & Thompson, A. D. (2009). *Changing Technological Pedagogical Content Knowledge (TPACK) through course experiences*. Retrieved June 24, 2012, from http://punya.educ.msu.edu/publications/Shin_et_al_SITE2009.pdf
Shulman, L. (1986). Those who understand: Knowledge growth in Teaching. *Education Research, 15(2),* 4-14.
So, H. J. (2006). *Conflicts in pedagogical and technical knowledge: pre-service teachers’ understanding and misconception of Integrating technology into PBL lessons*. Retrieved June 24, 2012, from http://lsl.nie.edu.sg/events/ICLS2006_Proceeding_DrSo.pdf
Tallman, J., & Fitzgerald, M. A. (2005). Blending online and classroom learning environments: Reflections on experiences and points to consider. *Knowledge Quest, 34*(1), 25-28.
Tella, A., Tella, A., Toyobo, O.M., Adika, L.O., & Adeyinka, A.A.2007. An Assessment of Secondary School Teachers Uses of ICTs: Implications for Further Development of ICT's Use in Nigerian Secondary Schools. *The Turkish Online Journal of Educational Technology, 6*(3), 12.
UNESCO. (2005). *Regional guidelines on teacher development for pedagogical integration [Working draft]*. Bangkok, Thailand.
Vacirca, E. (2008). *How do teachers develop their technological pedagogical content knowledge in the context of system-wide pedagogical and curriculum reform?* Retrieved June 24, 2009, from AARE Conference Brisbane 2008: http://www.formatex.org/micte2009/book/13891393.pdf
Wahyudi, M. (2008). *What does research say on the use of ICT to improve the teaching and learning of mathematics?* Retrieved May 23, 2009, from http://fadjarp3g.files.wordpress.com/2008/06/9-makalah-wahyudi-recsam-riset-ict.pdf
Yidana, I. (2007). *Faculty perceptions of technology integration in the teacher education curriculum: a survey of two Ghanaian universities.* Ohio: College of Education of Ohio University. Retrieved May 23, 2009, from: https://etd.ohiolink.edu/ap:0:0:APPLICATION_PROCESS=DOWNLOAD_ETD_SUB_DOC_ACCNUM:::F1501_ID:ohiou1178570000,attachment
Zevenbergen, R. (2004). *Using ICTs to support numeracy learning: The way of the future? Whose future?* Retrieved June 24, 2009, from http://www.merga.net.au/documents/symp42004.pdf
Zhao, Y. (Ed.). (2003). *What teachers should know about technology: Perspectives and practices*. Greenwich, CT: Information Age.