

Innovative use of Technology in Teacher Education Pedagogical Practices: The Effects of ICT-BASED Inquiry Approach on Pre-service Teachers' Achievement in the Inquiry Learning Process.

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Abstract

This is an intervention study that examines the effect of ICT-BASED inquiry pedagogy on pre-service teachers' achievement in technology, pedagogy and content knowledge; ICT literacy and competence; interest towards the use of ICT; and, achievement in the inquiry learning process. However, this article only reports the findings of the effect of the intervention (ICT integration) on pre-service teachers' achievement in the inquiry learning process. The study is a one factor three level quasi-experimental research with three different interventions (ICT integration) involving 192 pre-service teachers' (males and females) from four colleges of education in Nigeria. The participants were randomly assigned into three equal groups for the intervention. Both quantitative and qualitative data were collected for the study; the quantitative data were collected before and after the intervention. Analysis of covariance (ANCOVA) was used for the analysis; while for the qualitative data, content analysis was used. Findings from the study indicated significant differences between the groups [$F(2,188)=11.960$, $P=.000$, partial $\eta^2=.113$]; and the marginal means plot shows that intervention 2 and 3 were more effective than intervention 1 compared with a mean score value of 44.524 and 44.400 (for groups 2 and 3) compared to 42.951 (for group 1). Analysis of the qualitative data in the study has shown that, innovative use of technology in inquiry-based teaching-learning approach improves pre-service teachers' understanding of inquiry learning process and improves their skills of inquiry, critical thinking and problem-solving skills associated with '21st Century Skills'.

Key Words: *ICT; Inquiry Approach; Teacher Education; and Pre-service Teachers'.*

Introduction

The teacher is a crucial factor in any educational system whose competence and efficiency has far reaching implications in the attainment of educational objectives and goals (Pelgrum 2001). Thus, the level of ICT literacy and competence of the teacher is crucial in determining the success of ICT integration in schools (Rosnaini & Mohd. Arif 2010). However, teachers' competence toward the use and application of ICT in their educational practices is dependent on teacher education and training on one hand; and, teacher educators on the other hand. Workshops and standalone courses on technology integration for in-service teachers may not be enough in ensuring effective use of technology in pedagogical practices (Mishra & Koehler 2006).

Preparing teachers to integrate ICT in their pedagogical practices need to be rooted deeply and effectively in the teacher education programme from the onset (Teo 2008); and teacher educators need to integrate and model the use of ICT in their pedagogical practices as well (Borlick, et. al. 2003). However, ensuring effective technology integration in teacher education would require a careful planning and transformational changes in curriculum content and pedagogical practices (Hammond & Munfra 2009) in addition to having access to ICT facilities. Even though technology integration in educational practices is much appreciated and considered a welcome development by most teacher educators (Baron & Goldman 1994; Ong 1999); it is yet to be fully integrated in teacher education curriculum and pedagogical practices in Nigeria (Onasanya, et. al. 2010). Most often, lack of theoretical and conceptual framework for technology integration in education and pedagogy has always been advanced as a reason for the low level of technology integration in teacher education and pedagogy (Misrah & Koehler 2006).

In this study, a framework for ICT integration in social studies teacher education curriculum and pedagogical practices was developed in line with the Technology, Pedagogy and Content Knowledge (TPACK *hereafter*) theory. The framework provide a guide for curriculum based technology integration for social studies teacher education; and, the integration of web-based technology resources, smart board and power point in the use of inquiry approach for citizenship instructions in social studies teacher education (ICT based inquiry approach for classroom instruction), in line with the Giving, Prompting and Making (GPM *hereafter*) model. The study tests the effectiveness of three different ICT intervention designs on the pre-service teachers' basic knowledge of the inquiry approach in social studies education.

Review of Literature

The need for ICT Integration in Teacher Education

Human involvement with computers and internet has made ICT an integral part of the human society. Preparing young citizens towards effective use of these technologies in society as future adult has been the concern of most educational system around the world (Greenhow, Robelia, & Hughes 2009). However, the success of every goal oriented innovation and transformational changes in the education industry for ICT integration in schools lies heavily on the school teachers' (Hammond et al. 2009). Therefore, preparing teachers to use technology in education has been the major challenge of educational administration in most countries. On the other hand, preparing new breed teachers to use ICT in their teaching has been the focus of teacher education training (Chai, Koh & Tsai 2010). Meeting up with these challenges

in the teacher education industry would require meaningful and well-directed ICT integration in teacher education curriculum and pedagogy for all disciplines (Gao, et al. 2009).

However, even though the need for ICT integration in teacher training and education is well established in literature (Chai, Koh & Tsai 2010); the present curriculum structure and pedagogical practices in teacher education and training does not adequately prepare the pre-service teachers for ICT integration (Kay 2006; Swain 2006). The pre-service teachers are not properly exposed to pedagogical use of ICT by the teacher educators (Brown & Warschauer 2006; Lim et al. 2010). Therefore, much is still needed in the development and application of frameworks, course designs and instructional models for subject disciplines in pre-service training (Haydn & Barton 2007; Lawless & Pellegrino 2007; Mishra, Koehler & Kerekuik 2009).

Pre-service teachers' are only exposed to one or two stand-alone ICT courses in most teacher education programme (Hsu & Sharma 2006) as the case is with Nigeria. The courses are basically taught for the development of ICT skills without being linked to any pedagogical design and subject content (Mishra, Koehler & Kerekuik 2009). This curricular arrangement and practice do not exposed the pre-service teachers to any adequate training on relating the ICT skills acquired to pedagogical designs and specific subject content (Lawless & Pellegrino 2007; Mishra, Koehler & Kerekuik 2009). The pre-service teachers are therefore left to wonder on their own regarding the syntheses of the three knowledge components for classroom application. This situation presents a reasonable research gap in teacher education curriculum and pedagogy (Angeli & Valanides 2005). Thus, studies are needed to bridge this gap in teacher education. New course designs, frameworks and instructional models for subject disciplines in teacher education need to be developed and tested on pre-service teachers' achievement and interest (Lisowski, Lisowski & Nicolai 2006). Such studies would provide lead ways for the needed changes in teacher education curriculum and practice that provide room for adequate training in the syntheses and application of these components in classroom teaching (Jonassen, et al. 2008; Mishra & Koehler 2006).

Most of the existing studies related to TPACK focuses on ICT course designs for teachers' professional development of ICT skills; and the effects of ICT skills on pre and serving teachers' (Chai, Koh & Tsai 2010). Such studies are built on the ground that proficiency in ICT skills is needed for teachers to effectively integrate ICT in their teaching (Littrell, Zangunmi & Zangunmi 2005). This is because teachers with high confidence level in their ICT skills tend to use ICT more in their instructional practices (Zhao, Pugh, Sheldon & Byers 2002). This notwithstanding, because practical application of ICT in classroom instructions requires a balance syntheses of utilising relevant ICT tools in teaching particular subject content using the appropriate pedagogy. This would in turn involve some changes in teacher education curriculum, pedagogical practices, and instructional designs for subject disciplines that need to be guided by theoretical frameworks, course designs and instructional models. Researches are therefore needed to guide the development of such frameworks, course designs and models; and, to test the effectiveness of such frameworks and models for ICT integration in teacher education for respective subject disciplines.

Methodology

This is a quasi-experimental study that investigates the effects of three intervention designs for ICT Integration in the use of inquiry approach for instructions in social studies teacher education. One hundred and ninety two (192) social studies pre-service teachers' were randomly selected to participate in the study. The sample population was made up of 101 males (52.6%) and 91 females (47.4%); 138 (71.9%) are within the age bracket of 18-24 years of age, 45 (23.4%) within the age group of 25-29 years of age while 9 participants (4.7%) are within the ages of 30 years and above.

Instrumentation

Both qualitative and quantitative instruments were used for data collection in this study; a questionnaire was adapted and used as instrument for the collection of quantitative data while observation rubrics was used for the qualitative data collected. The instrument (questionnaire) adapted from literature is titled 'Self-rated Knowledge of the inquiry approach in Social Studies Education (SRKIASSES)' has nine (9) items measuring one construct—knowledge of the inquiry approach. Table 1 below display the source where the items of the construct of the scale were sourced, selected and adapted for this study from literature.

Table 1

Sources of the Self-rated Basic ICT literacy and Competence Instrument

SBKIASSE				
The Construct	The scales		The theoretical base	Supporting literature
Knowledge of the Inquiry Approach	Social Studies Inquiry-based Instruction Survey Scale;	C.o.I Survey	CLT; Vygotsky Theory	Okam (1998); Okam & Bozimo (2000); Okam (2004); Albough, et. al., (2008); Swan et. al., (2008); Oliver (2007); Hsin-kai Wu & Chou-En Hsieh (2006); Spronken-Smith & Walker (2010).

Note:

CLT = Constructivist Learning Theory.

The construct and items that makes up the instrument were selected and adapted from the 'Social Studies Inquiry-based Instruction Survey'; the instrument was widely used for official and academic purposes by academics, the National educational Resource Centre and Social Studies Association of Nigeria (SOSAN) within the context of the Nigerian Society. The scale was developed on the basis of the constructivist learning approaches and theory (the philosophical base of Nigerian National Policy on Education Okam, 2002). Some of the literatures establishing the reliability of the scale are identified in table 1 above. Before adapting the nine items of the constructs, all the items earlier selected and considered for adapting were validated by experts for face and content validity; factor analysis was also performed to ensure that, all the items selected has meet up with the accepted eigenvalues benchmark. Nine items were

finally adapted to measure the construct based on experts' recommendations in the validation report and the result of the factor analysis. The reliability of the internal consistency of the nine items adapted was tested in the pilot study.

The instrument has only one construct with nine items. Thus, mean inter-item correlation coefficient reliability analysis was performed to test the internal consistency reliability of the instrument. Finding from the analysis indicated a Cronbach's Alpha value of .779 and .785 (based on standardised items); suggesting that, the scale is reliable. The inter-item correlation value of the nine (9) items indicated in the inter-item correlation table ranges from .227 (item 3) to .491 (item 8). The corrected item total correlation value of the nine (9) items ranges from .354 (item 1) to .562 (item 5); indicating no item with a value that falls short of .3, therefore suggesting that all the nine items are measuring the same underlying construct. Based on this result and what was reported earlier in the literature identified in table 4.5 (B section), the internal consistency of the scale was considered reliable.

Observation rubrics was design for the inquiry facilitators (the teacher educators involved in this study) to assess the pre-service teachers' performance and skills in the inquiry learning process. The rubrics measure nine (factors) intrinsic in the inquiry-based teaching-learning process. Factor 1-8 has four rating scale represented by score that ranges from 46 to 100 while factor 9 has five (5) rating scale represented with scores ranging from 40 to 100. The nine factors assessed by the facilitators using the rubrics are shown in table 2 below.

Table 2

The Factors Measured by the Assessment Rubrics

S/No	Factors	Rating Scale	Grading
1	Understanding of the Inquiry-based Learning	1-4 (46-100 marks)	D-A
2	Skills of raising Research Questions and building the Inquiry Framework	1-4 (46-100 marks)	D-A
3	Skills of Literature Review	1-4 (46-100 marks)	D-A
4	Critical Thinking and Reasoning Skills	1-4 (46-100 marks)	D-A
5	Skills of Data Collection	1-4 (46-100 marks)	D-A
6	Skills of Data Analysis	1-4 (46-100 marks)	D-A
7	Collaboration and Participation	1-4 (46-100 marks)	D-A
8	Contribution to Group	1-4 (46-100 marks)	D-A
9	Final work done and presented	1-5 (40-100 marks)	E-A

The rubric was adapted based on Mullinix (2003) General Rubrics Grading Criteria and the work of Marzano, Debra Pickering and McTighe (1993) on 'Assessing Students' Outcome'.

The Quasi-experimental (Factorial) Design

This study is a one factor three level quasi-experiment that utilises the approaches of the pre-test—post-test design only as is presented in table 3 below.

Table 3

The Pre-test Post-test (Factorial) Design

The Factor	Levels	Sample size	The Dependent Variables
ICT Integration	X1	64	Y1
	X2	64	
	X3	64	

As shown in the table above, the focus of the study is on one factor that is ICT integration in teacher education curriculum and pedagogical practices. This factor in focus has three levels depicted as X1, X2, and X3 in the above table; the 3Xs means ICT Integration Treatment One, Treatment Two and Treatment Three respectively. Each treatment was meant to be applied to only one group; implying that, the factorial design has three treatment groups. On the other hand, the dependent variables is coded Y1 (Basic Knowledge of Inquiry). The effect of the three different treatments on the dependent variable was designed to be compared. By adopting the pre-test post-test design, it means that, the dependent variable is to be measured before and after the administration of the intervention.

The Intervention

In the design of this study, three sets of technology were used for classroom instruction using the inquiry approach as the treatment (the intervention) administered to the three research groups in four colleges of education. The first set of technology used is what Mishrah and Koehler (2006) described as ‘standard technology’ that is White Board, recorded audio tapes/cassette, and printed materials. The second set consist of Power Point, and web-based technology resources (search engines and free access web data base); while the third set is made up of Power Point, Smart Board and web-based technology resources.

These technologies were integrated into Social Studies Teacher Education teaching-learning process using the GPM instructional model that was developed in line with TPACK framework. The inquiry based teaching-learning process and the integration of the technologies identified in the teaching-learning process is guided by the principles underlying the application of the GPM model in social studies classroom instructions.

In treatment one, only the White Board, recorded audio tapes/cassettes and printed materials were used in the inquiry process using the GPM instructional model. The recorded audio tapes/cassettes and printed materials were integrated into the inquiry based teaching and learning process using the GPM model in teaching and learning Citizenship Education. Treatment two was the integration of Power Point and web-based technology resources in the inquiry-based teaching and learning process within the context of social studies teacher education. The third treatment was the integration

of Power Point, Smart Board and web-based technology resources in the teaching and learning of the integrated social studies teacher education curriculum using the inquiry-based approach. What differentiates the third treatment from the second treatment was the use application of Smart Board in the teaching learning process using the inquiry-based approach. Summary of the three treatments is shown in table 4 below.

Table 4
Summary of the Treatments

The Groups	Group 1	Group 2	Group 3
The Treatments	<p>a. The integration of the White Board, recorded audio tapes/cassettes and Printed Materials;</p> <p>b. The teaching and learning of Citizenship Education; Methodology; and technology as separate curriculum components.</p>	<p>a. The integration of Power Point and web-based technology resources;</p> <p>b. The teaching and learning of the integrated social studies teacher education curriculum.</p>	<p>a) The integration of Power Point, Smart Board, and web-based technology resources;</p> <p>b) The teaching and learning of the integrated social studies teacher education curriculum.</p>

As shown in the summary table, the integration of recorded audio tapes/cassettes, White Board and printed materials is in treatment one (X1); while the integration of Power Point and web-based technology resources is for the second treatment (X2). The integration of Smart Board in addition to Power Point and web-based technology resources is for the third treatment (X3).

Analysis and Findings

One-way between-groups analysis of covariance (ANCOVA) was used. Preliminary investigation was conducted to ensure that the assumptions for ANCOVA were not violated. The scatter plot was inspected to check for the assumption of linearity, straight lines suggesting linear relationship were indicated in the plot showing that the assumption for linearity was not violated; the assumption of homogeneity of regression slopes was checked statistically. The output generated indicates a sig. value of .713 (above .05—not significant) for the interaction level between the independent variable (the intervention—groups) and the covariate (the pre-test scores); suggesting that, the interaction level was statistically not significant. This result implies that the assumption of homogeneity of regression slopes was not violated. The Levene's Test of Equality of Error Variance indicates a sig. value of .087 (greater than .05—not

significant). Thus, suggesting that the assumption of equality of error variances was not violated. The result of the analysis of covariate (ANCOVA) performed is presented in table 4—the test of between subjects effects.

Table 4

The Test of Between Subjects Effects of the Overall Self-rated Basic Knowledge of the Inquiry Approach in Social Studies Education

Tests of Between-Subjects Effects

Dependent Variable: Post-test Overall Self-rated Basic Knowledge of Inquiry Approach in Social Studies Education 'b'

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	99.720 ^a	3	33.240	8.116	.000	.115
Intercept	6689.190	1	6689.190	1633.318	.000	.897
OKIA 'a'	1.772	1	1.772	.433	.511	.002
Groups	97.964	2	48.982	11.960	.000	.113
Error	769.947	188	4.095			
Total	371878.000	192				
Corrected Total	869.667	191				

a. R Squared = .115 (Adjusted R Squared = .101)

The result of the one-way between-groups analysis of covariance (ANCOVA) presented above was conducted to test the effectiveness of three different interventions (ICT integration) on the overall self-rated knowledge of the inquiry approach in social studies education test. The independent variable was the three different types of interventions (ICT integration) given to groups 1; 2; and, 3 respectively, and the dependent variable was the post-test scores for overall self-rated knowledge of the inquiry approach in social studies education test administered after the intervention was completed. The pre-test scores of the participants were used as the covariate in this analysis. Preliminary checks were conducted to ensure that there was no violation of the assumptions for normality, linearity, homogeneity of variances, homogeneity of regression slopes, and reliable measurement of the covariate. After adjusting for pre-intervention (pre-test) scores, there was significant difference in the post-test scores between the three intervention groups on the overall self-rated knowledge of the inquiry approach in social studies education test [$F(2,188)=11.960, p=.000$, partial eta squared=.113].

The estimated marginal means table presented in table 5.22 show that, group 2 has the highest mean score value of 44.524 followed by group 3 with a mean score value of 44.400, while group 1 has the lowest mean score value of 42.951 in the post-test scores on overall self-rated knowledge of the inquiry approach in social studies education test, after removing the effect of the covariate (the pre-test scores). The

differences in the estimated marginal means between the groups implies that, intervention 2 and 3 were more effective than intervention 1 (compared).

The facilitators of the inquiry process (teacher educators) handling the groups involved in the study in all the four colleges of education where the study was conducted provide an assessment of the pre-services teachers' performance, acquisition and application of some skills related to inquiry-based learning during the intervention period. The assessment was based on individual pre-service teacher but the group as a whole. Each facilitator therefore assesses the group he/she facilitates during the study based on the assessment rubrics described in the method section.

The facilitators rating of the pre-service teachers' understanding of the inquiry-based teaching-learning approach in groups 1 ranges from 61 marks being the lowest (college 2) to 68 marks (college 4). All the four score values awarded are within the 'B—Grade'. Meaning that, the pre-service teachers in that group shows an average understanding of the inquiry-based learning process. The scores awarded to groups 2 on the other hand ranges from 73 (college 2) to 77 marks (college 3) while the scores awarded to groups 3 ranges from 74 (college 2) to 78 marks (college 3). The two set of scores for the two groups (2 and 3) in all the colleges falls within the 'A—Grade'. Meaning that, the shows a good understanding of the inquiry-based learning process; and in the acquisition of related that includes: skills and competence of raising research questions and building inquiry frameworks; ability and competence in accessing, interpreting, evaluating and utilising information in establishing facts relevant to the issues under inquiry'; ability, skills and competence in identifying the importance and challenges of the inquiry in question; ability to translate and apply content knowledge into real life situation; skills of data exploration and collection in the inquiry process; skills of data analysis;

The facilitators rated the final work of groups 1 as 'C—Grade' with scores ranging from 51 (college 4) to 56 marks (college 2); groups 2 were rated with 'B—Grade' with scores that ranges from 62 (college 4) to 67 marks (college 1); groups 3 too were rated 'B—Grade' with scores ranging from 65 (college 3) to 68 marks (college 1). Indicating that 'work done and presented (by groups 1) was partially complete and has partially meets the expectations but not to the acceptable standard; the work shows inconsistency in demonstrating an understanding of the issues under inquiry and the inquiry learning process in general; average analysis; inconsistent use citation and from mixed quality sources; not much of technology was used'. However, the 'B—Grade' for groups 2 and 3 respectively implies that, 'work done and presented is complete and up to the expected standard; shows good understanding of the issues under inquiry and the inquiry learning in general; good analysis and presentation; relevant citations of facts for proves and evidence; and good use of technology'.

Discussion

Findings from this study has shown that, pre-service teachers' in groups 2 and 3 that were exposed to curriculum-based ICT integrated social studies teacher education curriculum using digital technology in the inquiry process, have higher self-rated knowledge of inquiry approach; compared to groups 1 that were exposed to learning technology, pedagogy and social studies education as separate curriculum domains using standard technology. Meaning that, curriculum-based ICT integration in social studies teacher education; and the integration of digital technology in social studies

teacher education pedagogical practices have a significant positive effect on pre-service teachers' knowledge of inquiry approach in social studies education. However, in addition to this, analysis of the teacher educators' assessment rubrics used in this study has shown that groups 2 and 3 have higher achievement in acquiring some skills intrinsic in social studies inquiry process than those in groups 1.

Based on this findings, it is evident that, curriculum-based ICT integration in social studies teacher education on one hand; and the integration of Power Point, Smart Board, web-based technological tools and data base resources in the use of inquiry approach for instructions in social studies teacher education can help pre-service teachers' to:

- a. Have better understanding of inquiry-based teaching-learning approach for instructions in social studies education;
- b. Acquire the skills and competence of raising inquiry research questions and building of inquiry frameworks;
- c. Acquire the skills of data exploration and literature review;
- d. Acquire the skills of critical thinking, problem-solving and decision-making which form part of life-long learning and 21st century skills.

Meaning that, ICT integration in social studies teacher education as designed in this study provides an effective approach that can facilitates the preparation of pre-service towards acquiring the knowledge, skills and competence needed to practice the use of inquiry approach and ICT in their pedagogical practices as teachers. These findings are similar to was reported as effects or benefits of ICT integration by other studies in Nigeria. Anyaogu (2012), similarly reported that the integration of ICT in pedagogical practices help to provide access to more wider sources of data, information (in form of video, audio and text) for data collection building knowledge through inquiry process compared to use of printed resources. It enhances inquiry attitudes and skills among learners as well as the inquiry process itself (Ezekola & Okoli, 2012; Obasi, 2008). It exposes learners to learning the process and skills of data collection, review and analysis (Obilor, Iheonunekwu & Ugbuta, 2012).

Recommendations and Conclusion

Based on the findings of this study, it is believed that the following recommendations would be useful in helping to prepare pre-service teachers' to integrate ICT in their pedagogical practices when in service.

1. Teacher educators need to improve on their pedagogical practices; model the use of ICT they teach in their pedagogical practices; and, shift away from lecture to activity oriented teaching-learning approach;
2. Pedagogical practices need to be re-directed toward the development of skills in addition to content knowledge;
2. In addition to teaching ICT as course (stand-alone) in teacher education, it should as well be embedded into the curriculum framework of respective disciplines.
3. Use of inquiry approach integrated with digital technology in teacher education pedagogy need to be emphasised so as to help learners acquire 21st century skills. This would assist pre-service teachers in acquiring the knowledge and skills needed to direct their pedagogical practices towards the development of 21st century skills using ICT and related pedagogical approaches.

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