Implementing and Analyzing the Impact Assessment Algorithm for Adoption of Information and Communication Technology in Basic Education

Alo O. O., Olabiyisi S. O., Omidiora E. O., Ganiyu R. A.

Abstract — In this paper, an impact assessment algorithm for evaluating the adoption of Information and Communication Technology (ICT) in basic education through Cross-impact method was implemented and analyzed. The implementation of the algorithm was carried out using C# programming language while its qualitative evaluation was explored through analysis of variance, regression analysis and sensitivity testing. The result of analysis of variance confirmed that Government Policy (GP), Teacher Competency (TC), Availability of ICT infrastructure (IF), Integration of ICT in school curriculum by Ministry of Education (MC), Student preparedness in adopting ICT in learning process (SC) and Perception of schools' management in adoption of ICT in schools (MI), which are the six major events considered, were significantly important in adoption of ICT in basic education. The regression analysis yielded correlation coefficients of 91%, 85%, 87%, 92%, 95% and 95% with respect to GP, TC, IF, MC, SC and MI. The results of sensitivity testing showed that increase in Initial Probability (InitProb) of each event had positive influence on other alternative events. For increase in InitProb of GP and IF, the TC experienced the highest significant changes of 52% and 63%, respectively. For increase in InitProb of TC, MC and SC, the MI experienced the highest significant changes of 34%, 29% and 42%, respectively. For increase in InitProb of MI, the SC experienced the highest significant change of 33%. The developed algorithm serves as an improvement on existing user perspective method of analysing the use of ICT in education. It could be adopted by policy makers at Federal and States levels to forecast the impact of ICT in basic education.

Index Terms—Impact assessment algorithm, Basic education, Event, Adoption of ICT, Instruction

— — — — — — — — ◆ — — — — — — — —

1 INTRODUCTION

Information and communications technology usually called ICT is an umbrella term that includes any communication device or application, encompassing: radio, television, cellular phones, computer and network hardware and software, satellite systems and so on, as well as the various services and applications associated with them, such as videoconferencing and distance learning. The expression was first used in 1997 in a report by Dennis Stevenson to the UK government and promoted by the new National Curriculum documents for the UK in 2000. ICT is often used in the context of "ICT roadmap" to indicate the path that an organization will take with their ICT needs [8]. The term ICT is now also used to refer to the merging (convergence) of audio-visual and telephone networks with computer networks through a single cabling or link system. There are large economic incentives (huge cost savings due to elimination of the telephone network) to merge the audio-visual, building management and telephone network with the computer network system using a single unified system of cabling, signal distribution and management [9].

In ensuring effective use of ICT in education system, [10] identified a number of frameworks setting for education programmes. These include: policy and vision of ICT use in schools, technology and infrastructure, curriculum, pedagogy and content development. However, with a population of over 148 million, and among the next 'eleven' group of potentially endowed nation, Nigeria has set for herself a wide array of ambitious goals of several global and national frameworks that seek to promote the fundamental right of her citizens to quality education. Despite this, at a meeting held in Indonesia in April 2008, it was revealed that Nigeria is one of the only two countries that were at the risk of not meeting the targets of EFA, because the quality of teaching and learning in schools remain a significant challenge [11]. Various studies conducted in Nigeria have also shown clearly that there are low academic achievements among pupils in such basic skills as literacy, numeracy and life skills [12].

Studies have established the roles of ICT in achieving quality education at all levels of the school system. ICT is seen as a key tool in acquiring, processing and disseminating knowledge [1]. It offers increasing possibilities for codification of knowledge about teaching activities anywhere, anytime [2]. Other researchers have also argued that ICT has the potential to transform learning environments and improve the quality of teaching [3], providing access to richer environment [4], increasing opportunities for active learning, inter connectivity and feedback [5], enhancing motivation to learn [6], and having a positive effect on students' achievement in different subject areas [7]. As a signatory to a number of pacts and treaties to the world declarations on education (that is, Education For All and the Millennium Development Goals), which also spurred her to develop a number of policies in this regard, Nigeria also committed herself to the promotion of quality education through ICT [13]. The same is also emphasized in

- *Alo O. O. E-mail: ooalo@lautech.edu.ng*
- *Olabiyisi S. O. E-mail: soolabiyisi@lautech.edu.ng*
- *Omidiora E. O. E-mail: eoomidiora@lautech.edu.ng*
- *Ganiyu R. A. E-mail: raganiyu@lautech.edu.ng*
- *Department of Computer Science and Engineering, Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria.*

the Universal Basic Education policy that talks about an opportunity for Nigeria to confront head-on the challenges of and to take full advantage of the possibilities offered by new information and communication technologies for improving the quality education. Thus, in addition to the benefits associated with the practical application of ICT in the achievement of 'Education For All' (EFA) goals and especially in the context of Nigeria's UBE, it is equally important to develop an algorithm that could assist in assessing the effect of integrating ICT in Education. As a result, by cross-impact method, [14] developed an impact assessment algorithm for evaluating the adoption of ICT in basic education using selected South-Western states of Nigeria (Oyo, Lagos and Ekiti) as a case study. This paper extends [14] by implementing and analyzing the impact assessment algorithm for evaluating the adoption of Information and Communication Technology in basic education.

2 RESEARCH METHODOLOGY

2.1 The Impact Assessment Algorithm
The Cross-impact method was based on the analysis of experts' opinions considered. The list of the 6 (six) events were considered relevant to the adoption of ICT in Basic Education. The events and their interpretations were as enumerated below:

The event1 represents Government policy
The event2 represents Teacher Competency
The event3 represents Availability of ICT infrastructure
The event4 represents Integration of ICT in school curriculum by Ministry of Education
The event5 represents Student preparedness in adopting ICT in learning process
The event6 represents Perception of schools' management in adoption of ICT in schools

The impact assessment algorithm developed by [14] entails the following steps:

STEP 1: Start {by identifying the events [n] relevant to adoption of ICT in basic education}
STEP 2: Input n;
STEP 3: Input initProb[n];
STEP 4:
   i. Input Matrix M1=Matrix[n,n];
   ii. Input Matrix M2=Matrix[n,n];
STEP 5: Input i=0,j=0; initialise i and j to 0
STEP 6: Repeat {Compute odd ratio}
   i. ComputeOddRatio1[i,j]=M1[i,j]/(1-M1[i,j]);
   ii. Compute OddRatio2[i,j]=M2[i,j]/(1-M2[i,j]);
   iii. Increment j;
   iv. Until j=n;
   v. Repeat
   vi. Increment i;
   vii. Goto i
   viii. Until i=n;
STEP 7: Input i=0,j=0,; initialise i and j to 0
STEP 8: Repeat {Test for Occurence}
   i. SET isCross=false; test for occurrence of i and j
   ii. If i=j then

   iii. SET isCross=true;
   iv. If isCross=true   then
   v. Compute OccurenceoddRatio[i,j]=null
   vi. Compute NonOccurenceoddRatio[i,j]=null
      else goto vii
   vii. Compute OccurenceoddRatio[i,j]=M1[i,j]/([j,i])
   viii. Compute NonOccoddRatio[i,j]=M2[i,j]/(1-M2[i,j])
   ix. Increment j;
   x. Until j=n;
   xi. Repeat
   xii. Increment i;
   xiii. GOTO i.
   xiv. Until i=n;
STEP 9: Select an event probability such that:
   i. If rand> event
   ii. Set IsOccur=false else
   iii. Set IsOccur=true
STEP 10: Select
   i. If IsOccur =true
   ii. Compute J1= initprob[n]* M1[i,j]   Else
      Compute J2= initprob[n]* M2[i,j]
STEP 11: Repeat STEPS 3 to 10
      Until Event[n]=tested
STEP 12: Repeat STEP 3 through 11
STEP 13: Compute freq=TotalNoOccurence/TotalNoRun
STEP 14: Set SelectedEvent=Event[n];
STEP 15: Input NewInitialProb=x
STEP 16: Repeat STEPS 9 to 15
STEP 17: Display NewMatrix[n,]
STEP 18: Stop

2.2 Implementation of the Impact Assessment Algorithm
The algorithm was implemented on the Microsoft.NET framework using Visual Studio.NET (C#). Implementation was done on a computer system with hardware requirements as follows: AMD Dual-Core (C50), 2.00 GHz processor, RAM 1GB, Hard Disk Spaces of 20 GB.The developed algorithms were all written in Microsoft C# within the Microsoft Visual studio development environment. During the implementation, initial probabilities, probabilities of events when it's occurred and when it did not occurred were the input into the software. New set of prsssobabilities for the events emerged as simulated consistency matrix.

2.3 Performance Evaluation of the Impact Assessment Algorithm
At this stage, the Cross-impact matrix is ready for sensitivity testing. Sensitivity testing was used to evaluate the Cross-impact method and highlight the key events in the model [15]. An event is selected (an initial probability estimate), this event was changed from its original value and the matrix was run. If significant differences occur between this run and the original run, the event that was changed is apparently an important event. Thus, if no significant differences appear, that particular event probably is a relatively unimportant part of the analysis. For further evaluation, Stata statistical software version 11 was used to carry out Regression analysis and analysis of variance (ANOVA) on the data col-

lected from the survey.

3 RESULTS AND DISCUSSION

3.1 Assessment of Changes in the Events

Fig. 1 compared the changes that occurred as a result of occurrence of the six events under consideration. The occurrence of government policy (GP), availability of ICT infrastructures (IF), teacher competency (TC), integration of ICT in school curriculum by ministry of education (MC), and perception of school's management in adopting ICT (MI) were all having positive changes (positive impact) on all other alternative events. But occurrence of student preparedness in adopting ICT in learning process (SC) have positively, negatively and undecidedly impact on all other alternative events. This shows that student preparedness in adopting ICT in learning process depend on all other alternative events before it could be effective.
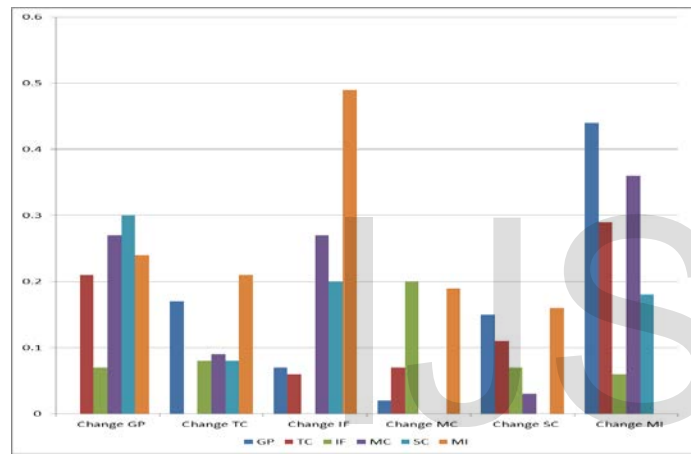

Fig. 1. Changes in Test of Occurrence of the Events

3.2 Evaluation of the Developed Algorithm

The generated Cross-impact probability matrix was evaluated by performing sensitivity testing. There were significant differences that occurred as changes were made to each event considered. The change that was made on government policy (GP) and availability of ICT infrastructures from their original value to 100% resulted in positive significant difference on other alternative events respectively. When teacher competency was changed to be 100%, there were positive significant change on government policy, availability of ICT infrastructures, student preparedness in adopting ICT in learning process, school's management perception in adopting ICT and integration of ICT in school curriculum by ministry of education. Therefore, interpretation of changes in sensitivity testing of the events is presented in Fig. 2.
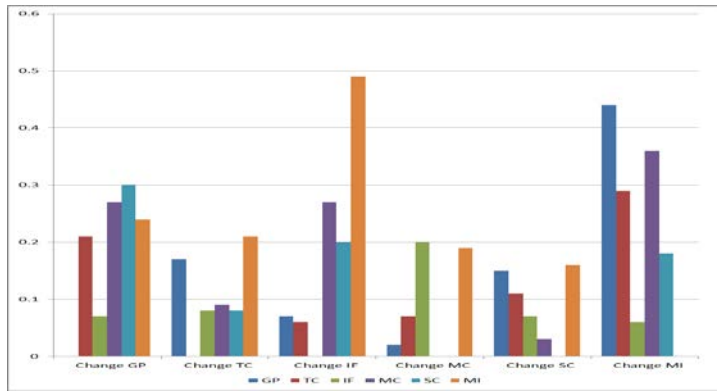

Fig. 2. Changes in Sensitivity Testing of the Events

It was discovered that government policy(GP) gave a positive significant difference on all alternative events, the teacher competency(TC) have highest significant change of 52% while the integration of ICT in school curriculum by ministry of education (MC) have the least of 8%. For the teacher competency (TC), perception of school's management in adopting ICT (MI) had the highest positive significant change of 34% while availability of ICT infrastructures (IF) had least positive significant change difference 8%. Considering the availability of ICT infrastructure, the highest significant difference of 63% was obtained from teacher competency (TC) while the least of 9% goes to student preparedness in adopting ICT in learning process (SC). Likewise, for integration of ICT in school curriculum by ministry of education (MC), highest positive significant difference of 29% goes to perception of school's management in adopting ICT (MI) while undecided significant difference of 0% goes to availability of ICT infrastructure (IF). The student preparedness in adopting ICT in learning process (SC) had its highest positive significant difference of 42% to be accorded to perception of school's management in adopting ICT (MI) while it's least positive significant difference goes to availability of ICT infrastructure (IF) of 10%. Lastly, for perception of school's management in adopting ICT (MI), highest positive significant difference of 33% was accorded to student preparedness in adopting ICT in learning process (SC), while the least significant difference of 12% goes to the integration of ICT in school curriculum by ministry of education (MC).

The result of regression analysis shows the R2 of the events: Government policy (GP), Teacher Competency (TC), Availability of ICT infrastructure (IF), Integration of ICT in school curriculum by Ministry of Education (MC), student preparedness in adopting ICT in learning process (SC) and Perception of schools' management in adoption of ICT in schools (MI) which were 0.905, 0.848, 0.873, 0.923, 0.944 and 0.953 respectively, as it is shown in Table 1.

TABLE 1
REGRESSION ANALYSIS ON THREE MODELS CONSIDERED

Variable	Model1		Model2		Model3	
	Coef	t-value	Coef	t-value	Coef	t-value
Government Policy	-	-	.16680964	2.27**	.14932765	1.80 *
Teacher's competence	.18903871	2.27**	-	-	.0195603	0.22
Infrastructure	.13469955	1.80*	.0155694	0.22	-	-
Ministry of Education adopting ICT	.37104493	5.28**	.02716654	0.38	.25782419	3.32**
Student Competence	-.00435865	-0.05	.17500519	2.28**	.11267212	1.30
School Management	.06052215	0.78	.25667821	3.67**	.12142662	1.50
Constant	.79929966	2.91**	.88427163	3.46**	.5083513	1.73*
R_square (R^2)	0.3828		0.3149		0.3022	
F	19.59902		14.52378		13.68664	

*10% Significant level, ** 5% Significant level.

This can be interpreted as follows: 91% of variation in GP is explained by Teacher Competency (TC), Availability of ICT infrastructure (IF), Integration of ICT in school curriculum by Ministry of Education (MC), student preparedness in adopting ICT in learning process (SC) and Perception of schools' management in adoption of ICT in schools (MI); 85% of variation in TC is explained by Government policy (GP), availability of ICT infrastructure (IF), integration of ICT in school curriculum by Ministry of Education (MC), student preparedness in adopting ICT in learning process (SC) and perception of schools' management in adoption of ICT in schools(MI); 87% of variation in availability of ICT infrastructure (IF), is explained by Government policy (GP), Teacher Competency (TC), Integration of ICT in school curriculum by Ministry of Education (MC), Student preparedness in adopting ICT in learning process (SC) and Perception of schools' management in adoption of ICT in schools (MI); 92% of variation in integration of ICT in school curriculum by Ministry of Education MC is explained by Government policy (GP), Teacher Competency (TC), Availability of ICT infrastructure (IF), Student preparedness in adopting ICT in learning process (SC) and Perception of schools' management in adoption of ICT in schools (MI); 95% of variation in Student preparedness in adopting ICT in learning process (SC) is explained by Government policy (GP), Teacher Competency (TC), Availability of ICT infrastructure (IF), Integration of ICT in school curriculum by Ministry of Education (MC), and Perception of schools' management in adoption of ICT in schools (MI) and 95% of variation in perception of schools' management in adoption of ICT in schools (MI) is explained by Government policy (GP), Teacher Competency (TC), Availability of ICT infrastructure (IF), Integration of ICT in school curriculum by Ministry of Education (MC), Student preparedness in adopting ICT in learning process (SC). These demonstrated that all the events were determinant factors responsible for adoption of ICT in basic education. Also it was an indication that all data used for the analysis were reliable (Richard, 1999). Therefore the data used have a good predictive ability for prediction of ICT in basic education in Nigeria.

The Analysis of variance (ANOVA) result for the events is presented in Table 2.

TABLE 2
THE ANALYSIS OF VARIANCE (ANOVA) RESULT

Source	Model 1	Residual	Model2	Residual	Model3	Residual
SS	12.1468783	5.35312168	.061574654	.314358677	.235427503	.048655824
Df	4	1	4	1	4	1
MS	3.03671958	5.35312168	.015393663	.314358677	.058856876	.048655824
$F_{(tab)}$	0.57		0.05		1.21	

$F_{(critical)} = 225$

For the Government policy (GP), Teacher Competency (TC), Availability of ICT infrastructure (IF), Integration of ICT in school curriculum by Ministry of Education (MC), Student preparedness in adopting ICT in learning process (SC) and Perception of schools' management in adoption of ICT in schools (MI) their F(calculated) were 307.90, 179.95, 214.72, 384.06, 589.55 and 648.11 respectively while all the events have their F (critical) to be 2.21. Since the F(calculated) of the events were greater than F (critical) , for all the events at the 5% significant level, then the null hypotheses are rejected at that level. Hence, the value of test statistics F is significant at 5% level of significance and concluded with 95% confidence that the events: Government policy (GP), Teacher Competency (TC), Availability of ICT infrastructure (IF), Integration of ICT in school curriculum by Ministry of Education (MC), Student preparedness in adopting ICT in learning process (SC) and Perception of schools' management in adoption of ICT in schools (MI) were significantly important in adoption of ICT in education.

4 CONCLUSION

In this paper, we have been able to implement and analyze the developed algorithm by [14]. Precisely, [14] developed an impact assessment algorithm which is characterized by six major events that are responsible for the adoption of Information and Communication Technology in basic education in South-West Nigeria. The events under consideration include Government Policy (GP), Teacher Competency (TC), Availability of ICT Infrastructures (IF), Integration of ICT in school curriculum by ministry of education (MC), Student preparedness in adopting ICT in learning process (SC) and Perception of school's management in adopting ICT (MI). The analysis of the aforementioned algorithm shows that the occurrence of GP, IF, MI, TC and MC yielded positive impacts on all other alternative events while the SC assumed combination of positive and undecided impact on all other alternative events. This implies that GP, TC, IF, MC and MI are all important influential events on adoption of ICT in Nigeria basic education, which means without them ICT adoption in basic education cannot be completely realized. Obviously, SC is less important influential event because without the other events being put in place, it can't be realized. Conclusively, the sensitivity testing carried out gives the results that change in GP, IF and TC produced an effect which is highly positive on alternative events. Regression analysis revealed that data used were reliable for all the events and analysis of variance on the data used revealed that GP, TC, IF, MC, SC and MI have positive coefficient which were statistically significant at 5% significant lev-

el. This signified that GP, IF, TC and other alternative events must be put in place before adoption of ICT in Nigeria basic education could be fully achieved.

REFERENCES

[1] Adedoyin, A., Akinnuwesi B. and Adegoke, M. (2008): "A Framework of information and communication technology (ICT) policy for education in Nigeria", In J.B. Babalola, L.

[2] Larsen, K. and S. Vincent-Lancrin (2005): "The impact of ICT on tertiary education: advances and promises", Presented at OECD/NSF/U. Michigan conference, 10-11th January, 2005, Available from http://www.advancingknowledge.com/drafts/larsen.

[3] Siemens, G. (2005): "Connectivism: A learning theory for the digital age", International journal of instructional technology and distance learning, available from http://www.idtl.org/journal/jam_05/article01.htm ; accessed 5th June, 2005.

[4] Caplan, D. (2005): "The development of online courses", In T. Anderson and F. Elloumi (Eds.), Theory and practice of online learning, Creative commons: Athabasca University, pp. 175.

[5] Launllard, D. (2002): "Rethinking university teaching: A conversational framework for the effective use of teaching technologies", 2nd ed., London, New York, pp188-192.

[6] Abrami, P. C. (2001): "Understanding and promoting complex learning using technology", Educational research and evaluation, Vol. 7, No. 2, pp 113-136.

[7] Chambers, E. A. (2003): "Efficacy of educational technology in elementary and secondary classrooms": A meta-analysis of the research literature from 1992-2002, Ph.D dissertation, Southern Illinois University at Carbondale, ProQuest digital dissertations database publication, No. AAT 3065343.

[8] Castells, M. (1997): "The rise of the network society", Blackwell, Oxford, pp.56.

[9] Spencer, D. (Ed.). (1994): "Webster's new world dictionary of computer terms", 5th ed., NY: Macmillan general reference, New York, pp.421.

[10] UNESCO (2004): "Integrating ICT into education", ICT lessons learned series, Bangkok.

[11] Goldman Sachs (2007): "The N-11: More than an acronym", Global economics paper, No. 153 [http://www.chicagobooth.edu/alumni/clubs/Pakistan/docs/next11 dream-march%20'07-goldmansachs.pdf].

[12] Lawal, R. A. (1995): "An analysis of reading habits of Nigerians secondary school students: A case-study of form four student in Oyo", Unpublished M.Ed. dissertation, Faculty of education, University of Ibadan.

[13] Federal Government of Nigeria (2003): "Universal basic education Act", NERDC, Lagos, Nigeria.

[14] Alo, O. O., Olabiyisi, S. O., Omidiora, E. O. and Ganiyu, R. A. (2015): Development of an Impact Assessment Algorithm for the Adoption of Information and Communication Technology in Basic Education using Cross-Impact Method, International Journal of Advanced Research in Computer Science and Software Engineering, India, 5(1): 171–177, ISSN 2277-128X (www.ijarcsse.com).

[15] Alarcon, F., and Ashley, B (1998),"Project management decision making using Cross-impact analysis", Elsevier Science Ltd and IPMA, vol 16, No 3, pp 145-152.