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Assessment of Mathematics Tutors' ICT Integration into Teaching and Learning of Mathematics in Colleges of Education of Ghana

John Mensah
Mathematics/ICT Department, Foso College of Education, Assin Foso, Ghana

ABSTRACT

The study explored the extent of ICT integration in teaching and learning of mathematics among Colleges of Education (CoE) mathematics tutors in Ghana. The study which included forty-four (44) CoE mathematics tutors from Central, Greater Accra, Ashanti and Western region utilized a descriptive survey as its research design and made use of both quantitative and qualitative data. This study used convenience and purposive sampling techniques to select the sample of forty-four (44) mathematics tutors of the CoE in Ghana. Data for this study were gathered using questionnaire. The questionnaire was made up of closed and opened end questions. The questionnaire was put into two (2) main parts (A-B). The A part elicited information on the demographic profiles and the B part elicited information on the integration of ICT into mathematics teaching and learning. The findings of this study revealed that mathematics tutors to a large extent used ICT for general applications, however, mathematics tutors' ICT integration and computer-based technology use in mathematics teaching and learning in CoE in Ghana is low. It is recommended that, the CoE principals should collaborate with the mathematics departments to develop the skills and ability to integrate ICT into mathematics teaching and learning process in the CoE to the maximum level.

Keywords : ICT Integration, Mathematics Tutors, Teaching and Learning, Colleges of Education, Mathematics

I. INTRODUCTION

Colleges of Education (CoE) of Ghana mathematics courses require tutors to integrate information and communication technology (ICT) in their instruction. ICT integration is the process of incorporating technology to the educational system to improve teaching and learning. That is, one of the units in the methods of teaching Junior High School (J.H.S) mathematics stipulated that tutors should explore the use of computer system to teach mathematics (Institute of Education, University of Cape Coast, 2009). According to United Nations Educational, Scientific, and Cultural Organisation (UNESCO) (2007), information and communication technology (ICT) refers to the form of technology that is used to transmit, process, store, create, display, share or exchange information by electronic means. This definition includes technologies such as radio, television, video, DVD, telephone (both fixed line and mobile phones), satellite systems and computer network hardware and software as well as the equipment and services associated with these technologies such as video conferencing, e-mail and blogs.

It is well known that the quality of human capital of any nation depends upon the quality of education it offers to her citizens, and the quality of education given is determined by the quality of teachers. It is, therefore, necessary that the standard of teachers be kept abreast of current expansion in knowledge due to rapid technological advancement

going on around the world (MOEYS, 2004). The developed individual, then, is a vital resource needed to accelerate developmental efforts of a country in all sectors of the economy. Asare (2010) stated that the education enterprise makes this development possible. Central to education enterprise is the teacher. In this regard, today's teacher needs to be trained and retrained to be able to effectively use ICT to support and aid teaching and learning. In addition, today everyone needs to be abreast with technology use in order to operate meaningfully in a competitive world. Teacher educators are challenged with the task of preparing teachers to utilize technology (ICT integration) as an essential tool in developing a deep understanding of mathematics for themselves and for their students and to emphasise the importance of learning with technology rather than learning about technology (Assuah, 2010).

Considering the impact of ICT in teaching and learning process, the Ghana ICT for Accelerated Development (ICT4AD) policy has the objective to facilitate the deployment, utilization, and exploitation of ICT within the educational system to improve on educational access and delivery and support teaching and learning from primary schools upwards (MOESS, 2003). Thus, the CoE are to implement the policy of integrating ICT into teaching and learning of mathematics. Forgasz (2006) and Asare (2010) pointed out that ICT integration (computers) do assist students' mathematical understanding. Some of the reasons provided included the speed at which computers deal with calculations that would be tedious to do manually, the accuracy of the output and the visual output of the medium. Also, computers have the potential to re-enforce learning rather than facilitate it. In addition, technology use (ICT integration) is seen as essential in teaching and learning of mathematics and it influences mathematics that is taught and enhances students learning. A large number of studies have also revealed that integrating ICT in mathematics has the potential to make learning effective and improving students learning outcomes by providing opportunities for students to develop the skills and knowledge that will empower them in this modern society (Forgasz & Prince, 2004; Fitzallen, 2007; Kumar, 2008; Gill & Dalgarno, 2008).

It was stated that, the rapid development in ICT has made tremendous changes in the twenty-first century as well as affected the demands of modern societies. Recognizing the impact of new technologies on the workplaces and everyday life, today's educational institutions try to restructure their educational programmes and classroom facilities in order to minimize the gap between developed and the developing countries use of technologies into teaching and learning process. This restructuring process requires effective diffusion of technologies into existing context in order to provide learners with knowledge of specific subject areas to promote meaningful learning and to enhance professional productivity (Tomei, 2005).

Yidana and Asiedu-Addo (2001) pointed out that, the proliferation of ICT laboratories at all levels of the school system testifies to the potency of the of ICT integration in delivery of education. Again, Ghana cannot join the new information revolution without a well-developed technological infrastructure (Darkwa, 2010). According to Darkwa (2010), adequate ICT infrastructure to support the expansion and high level connectivity is needed for the rapid emergency implantation of ICT in the nation. In this regard, the CoE have ICT laboratories with computers connected to the internet and other ICT facilities to be used for ICT integration into teaching and learning of mathematics. But, with all these efforts teachers including mathematics tutors are said not embracing the use of technology in their teaching (Kafyulilo, Fisser, Pieters & Voogt, 2015).

Again, it is stated that technology (ICT integration) implementation has not been entirely successful at the

school level, even globally, for a variety of reasons (Leng, 2006). Also, teachers including mathematics tutors have been cautious of technology (ICT integration) and are relatively slow to adopt the innovative methods in the teaching-learning process. In general, teachers have the reputation of being inherently and universally 'stubborn' when facing change (Nawawi, Ayub, Ali, Yunus & Tarmizi, 2005). Then, are the mathematics tutors in CoE of Ghana integrating ICT into teaching and learning process? To answer this question, there is the need for this study to investigate the extent of mathematics tutors' ICT integration into teaching and learning of mathematics with regard to availability of ICT facilities and curriculum of the CoE in Ghana. This study sort to explore the extent of mathematics tutors' ICT integration in teaching and learning of mathematics of the CoE in Ghana. That is, this study examined the extent mathematics tutors use ICT, computer-based technology and computer in their teaching and learning process in the CoE of Ghana.

The generalization that could be made on the findings of this study has limitation. That is, the study findings should not be generalized to all CoE in Ghana since those involved were mathematics tutors from CoE in Central, Greater Accra, Western and Ashanti regions. Also, the population of this study was selected by considering easy accessibility due to time and financial constraints.

II. METHODOLOGY

Research Design

This study used descriptive survey as its research design and made use of both quantitative and qualitative data. According to Cozby (2001), survey research employs questionnaire to ask people to provide information about themselves, facts such as peoples' attitude, perceptions and beliefs, demographics like age, gender, work experience and so on and other facts about the past or intended future behaviour.

Sample and Sampling Technique

This study used purposive sampling techniques to select the CoE in the four regions namely Central, Greater Accra, Ashanti and Western. The CoE in the four regions were chosen because the CoE use the same mathematics curriculum developed by Institute of Education, University of Cape Coast and implement the same government educational policy which have emphasis on ICT integration into educational instructions. In all, the four regions had fifteen (15) CoE with eighty-five (85) mathematics tutors.

The sample size for this study was forty-four (44) mathematics tutors. Although the study is about mathematics tutors in the colleges, not all the tutors were selected for this study. The forty-four (44) mathematics tutors who completed or returned their questionnaire were used for this study giving a response rate of 59.46%. The rest of the mathematics tutors (40.54%) were either absent or did not make their questionnaire available on the days that the researcher went round for data collection and therefore they were not considered for this study. The respondents consisted of ten (10) females representing 27.7% and thirty-four (34) males representing 77.3%. Forty-four (44) mathematics tutors who reported their age were within the age range of 21–60 years and their age ranged from 41 to 50 years. The private colleges of education in the four regions were not considered because the study concentrated on the government established CoE.

Research Instrument

Questionnaire was the instrument used to collect data for this study. The questionnaire was made up of close and open ended type items. Since the study is about mathematics tutors ICT integration, questionnaire is considered most appropriate and it is probably the

most used data collection instrument in educational research which is more familiar to respondents (Muijs, 2004). The questionnaire was made up of two (2) main parts (A and B). Part A elicited information on the demographic profiles which includes the gender and age and the part B elicited information on the integration of ICT into mathematics teaching and learning. Part B has items 7-10 which were concerned with the integration of ICT into mathematics teaching and learning. Except for questions 8 which was open ended item, the rest were likert scale type items.

Item 7 elicited information on whether or not mathematics tutors' use ICT or computer based technology in their teaching and item 8 obtained explanation for using or not using ICT in their teaching in class. Items 9a-9j elicited information on whether or not mathematics tutors' use stated computer-based technology in teaching of mathematics in CoE. Questionnaire items 10a-10c dealt with how often the participants integrate ICT in class. The purpose of these items was to establish what the participants exactly use ICT for in class and how often they use them.

Scoring of the Instrument

The yes and no statements were coded into Statistical Package for Social Sciences (SPSS) programme with Yes (1), No (0) and the Used (1) and Not used (0). Frequencies for the items 7 and 9 were computed and converted into percentages. The open-ended question 8 was scanned through carefully, the commonly provided responses were also carefully summarized and put under themes.

The likert-type scale items were coded into the SPSS programme and the positive statements scored as: Often (3), Rarely (2) and Not used at all (1). The statement with the options Yes, No and Unsure were coded with Yes (2), No (1) and Unsure (0). The responses provided by the participants for these items were again computed into frequencies and converted into percentages. The questionnaire items 9 and 10 were recoded into variables in order to help in the analysis.

Data Collection Procedure

After obtaining the permission from the Head of Mathematics Education Department in UEW, preliminary contacts were made to Mathematics Head of Department (HODs) of the selected colleges and their consent was sought. Also, colleagues and other senior mathematics tutors in the selected colleges were informed about the exercise and their consent was sought by the researcher. The researcher administered majority of the questionnaire personally to the mathematics tutors and some mathematics HODs and colleague tutors assisted in administering the instruments to the mathematics tutors. Some of the questionnaires were collected by the researcher as soon they were completed from the respondents. The questionnaire was administered and collected by the researcher to enhance response rate of the questionnaire.

With the ethical principles of research, the researcher sought permission from the supervisor, the Head of Mathematics Education Department in UEW and the Mathematics Head of Department in the colleges before the questionnaire was administered. Also, respondents were assured of confidentiality which means that no name was required on the questionnaire or used during the write up of the study.

III. RESULTS AND DISCUSSION

Analysis of Results

The results are organised and analysed under ICT integration into mathematics teaching and learning.

Integrating ICT into Mathematics Teaching and Learning

In order to answer the question that explored extent of mathematics tutors' ICT integration into teaching and learning in the CoE of Ghana, the data were obtained by examined mathematics tutors use of ICT into teaching and learning of mathematics, mathematics tutors computer-based technology use into mathematics teaching and learning and mathematics tutors general use of ICT into teaching and learning.

CoE Mathematics Tutors' Use of Computer-Based Technology in Teaching and learning

CoE mathematics tutors' use of computer-based technology in teaching and learning was presented in Mathematics tutors usage of ICT in teaching as shown in Table 1.

Table 1: Mathematics Tutors' Use of ICT

Use of ICT	Frequency	Valid Percent	Cumulative Percent
No	21	47.7	47.7
Yes	23	52.3	100
Total	44	100	

Table 1 indicates that majority of the mathematics tutors (n=23, 52.3%) stated yes they use ICT in teaching in class and a small number of them (n=21, 47.7%) stated no they do not use ICT in teaching mathematics in class in CoE.

However, to answer the opened end type item on reasons why mathematics tutors use ICT in teaching the results revealed that majority of the mathematics tutors use ICT in teaching because it makes cumbersome calculations easier or quicker to solve, gives accurate predictions, computers and calculators allow them to carry out problems quicker and more real life calculations can be changed quickly. For instance, one of the tutors mentioned that the learner see the effect of their changes. Also, results showed that some software save time and help verify understanding of concepts.

In addition, the opened end type item on reasons why mathematics tutors do not integrate ICT in mathematics teaching was examined. The results pointed out that, majority of the mathematics tutors lack the knowledge and skills to handle ICT tools in teaching. The results also showed lack of pre-service and in-service training makes it difficult to integrate ICT in their teaching and they think teaching is done equally successfully without the use of computer or other ICT tools and software.

The distribution of computer-based technology used in teaching mathematics by the tutors ranged from calculator to SPSS. The distribution of mathematics tutors computer-based technology used in teaching mathematics is shown in Table 2.

Table 2 : Computer-Based Technology Used in Teaching Mathematics

Computer-based technology used	Used N(%)	Not used N(%)
Calculator	23(52.3)	0(0)
Computer	10(22.7)	8(18.2)
Mobile phone	8(18.2)	10(22.7)
Printer	4(9.1)	11(25.0)
Projector	5(11.4)	10(22.7)
Power point	8(18.2)	8(18.2)
Microsoft word	5(11.4)	12(27.3)
Excel	5(11.4)	11(25.0)
Internet	11(25.0)	7(15.9)
Access/SPSS	1(2.3)	0(0)

Out of the twenty-three mathematics tutors who responded 'yes' they integrate ICT in teaching and learning process, it can be seen from Table 2 that majority of the tutors (n=23, 52.3%) use calculator in

teaching in class. That is, the number one ICT tool used by the tutors in terms of ranking by all. Calculator is followed by the internet (25.0%) and computer (43.5%) as the first three computer-based technology used in teaching mathematics in CoE in Ghana. However, very few of the mathematics tutors (2.3%) use access/SPSS in teaching mathematics in class.

The mathematics tutors' responses to the extent of their computer-based technology use were aggregated with a score of 1-5 indicating low computer-based technology use in teaching and a score of 6-10 indicating high computer-based technology use in teaching. Figure 1 presents categories of computer-based technology use in CoE and some respondents were not using computer-based technology in teaching.

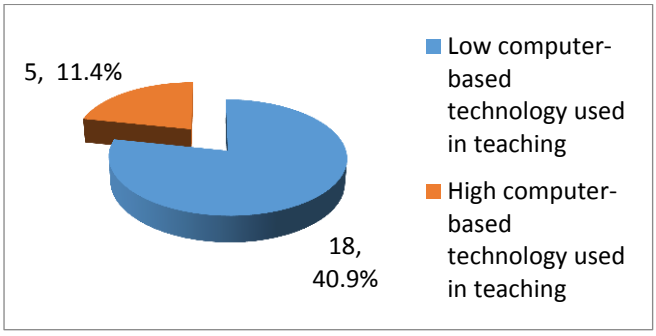

Figure 1 : Categories of Computer-Based Technology Used in Teaching

Figure 1 indicates that, majority of the mathematics tutors (n=18, 40.9%) computer-based technology use in teaching is low and very few of them (11.4%) computer-based technology use in teaching is high. This shows that although large proportion of the mathematics tutors use computer-based technology in teaching is low but there are few mathematics tutors whose computer-based technology use in teaching is high.

CoE Mathematics Tutors' General Use of ICT in Teaching and learning

This study further investigated how often mathematics tutors generally use ICT in class. The Table 3 presents mathematics tutors general use of ICT in teaching and learning of mathematics with the missing responses.

Table 3 : Mathematics Tutors' General Use of ICT in Teaching

General use of ICT in teaching	Often	Rarely	Not used at all
	N(%)	N(%)	N(%)
In the preparation of lessons	12(27.3)	5(11.4)	3(6.8)
In the preparation of students' tasks	14(31.8)	5(11.4)	2(4.5)
In processing students results	17(38.6)	3(6.8)	1(2.3)
In lesson presentation in class	9(20.5)	9(20.5)	3(6.8)
To communicate with students by e-mail	1(2.3)	5(11.4)	11(25.0)

The results revealed that majority (n=17, 38.6%) of the mathematics tutors often use ICT in processing students' results and it is followed by 31.8% of them often use ICT in the preparation of students' task. The results also indicated that 27.3% of the mathematics tutors often use ICT in the preparation of lessons and majority (25.0%) of them do not at all use ICT to communicate to students by e-mail (see Table 3). This result indicates that mathematics tutors extent of using ICT for general application in teaching and learning is large.

CoE Mathematics Tutors' Use of Computer in Teaching and Learning

Another area considered was mathematics tutors' use of computer in teaching. Table 4 presents mathematics tutors' use of computer in teaching.

Table 4 : Mathematics Tutors' Computer Use in Teaching

Computer use in teaching	Often	Rarely	Not used at all
	N(%)	N(%)	N(%)
i. to investigate the nature of graphs of functions	7(15.9)	6(13.6)	10(22.7)
ii. to draw graphs of grouped data	5(11.4)	4(9.1)	14(31.8)
iii. to draw graphs of linear equations and equalities and determine their solution set	4(9.1)	11(25.0)	8(18.2)
iv. to draw scatter diagram for bivariate distributions	3(6.8)	11(25.0)	9(20.5)
v. to draw graphs of trigonometric functions and find their solutions	8(18.2)	5(11.4)	10(22.7)
vi. to draw graph of curve(s) and lines and use it to find the area between the curve(s) and the lines	2(4.5)	7(15.9)	14(31.8)

The results in Table 4 indicated that, majority of the mathematics tutors either rarely or not at all use computer in teaching in class. That is, majority (n=14, 31.8%) of the tutors do not use computer at all to draw graph of grouped data and to draw graph of curve(s) and lines and use it to find the area between the curve(s) and the lines. However, very few of the tutors (n=8, 18.2%) often use computer to draw graphs of trigonometric functions and find their solutions, 15.9% (n=7) of them often use computer to investigate the nature of graphs of functions and very little proportion (11.4%) of them often use computer to draw graphs of grouped data. This result shows that mathematics tutors extent of using computer in mathematics teaching process is little.

CoE Mathematics Tutors' ICT Integration Categories in Teaching and Learning

The researcher tried to put mathematics tutors' ICT integration in teaching and learning into low and high categories to determine the level of ICT integration in CoE in Ghana. The three likert scale type questions were scored with the minimum as 1 and the maximum as 3. The mean score of the data is 2. The mean value below 2 indicates low use of ICT and mean value above 2 indicates high use of ICT in teaching and learning of mathematics by the mathematics tutors. The Table 9 indicates mathematics tutors' categories of ICT integration in teaching.

Table 5 : Categories of Integration of ICT in Teaching

Categories	Frequency	Valid Percent	Cumulative Percent
Low general use of ICT in teaching	6	26.1	26.1
High general use of ICT in teaching	17	73.9	100
Low use of computer in teaching	21	91.3	91.3
High use of	2	8.7	100

computer in teaching

Table 5 showed that, majority of the mathematics tutors' (n=17, 73.9%) general use of ICT in teaching is high whiles very few (n=2, 8.7%) of the mathematics tutors' use of computer in teaching is high. This indicates that mathematics tutors extent of integrating ICT generally in teaching and learning of mathematics is large. But, mathematics tutors extent of use of computer in teaching and learning of mathematics in CoE in Ghana is low.

Discussion

The findings for the extent of mathematics tutors ICT integration into mathematics teaching and learning of the CoE in Ghana revealed that simple majority of the mathematics tutors integrate ICT in mathematics teaching and a large proportion of the mathematics tutors computer-based technology used in teaching is low. This finding is supported by Waite (2004) research that, even though teachers show great interest and motivation to learn about the potential of ICTs, in practice, the use of ICT is relatively low and it is focused on a narrow range of applications, with word processing being the predominant use. In addition, the findings revealed that the calculator, internet and computer are the most popular computer-based technology used by the mathematics tutors in teaching mathematics.

Moreover, the findings showed that mathematics tutors extent of often use ICT for general applications in teaching mathematics is large, but mathematics tutors extent of use of computer often in mathematics teaching process is little. That is, to little extent mathematics tutors often use computer to draw graph of trigonometric functions and find their solutions, investigate the nature of graphs of functions and draw graphs of grouped data. Also, to large extent mathematics tutors generally use ICT often to process students' results, in the preparation of students' tasks and in the preparation of their lessons. In line with other studies, Earle (2002) research on the integration of instructional technology into public education, promises and challenges pointed out that simple combination of hardware and software will not make ICT integration naturally follows. Though there is no one formula for determining the optimal level of ICT integration in the educational system, creative teachers at all levels of education have always found ways to incorporate innovative teaching aids and strategies in their classes and therefore teachers need to plan thoughtfully before they start ICT integration into a curriculum. Hence, this study considered frequent use of computer-based technology and computer in teaching and learning to measure mathematics tutors' extent of ICT integration. Since mathematics tutors' computer-based technology use is low and the extent of ICT integration in mathematics teaching is little then, in a whole mathematics tutors extent of ICT integration in mathematics teaching and learning in CoE of Ghana is little. The finding is in consistent with Mereku, Yidana, Hodzi, Tete-Mensah, Tete-Mensah, & Williams (2009) who found that technology (ICT) is used in typing examination questions in all institutions and in some cases educators use technology in processing students' examination results but very few teachers use technology in their teaching in Ghana. Also, a study done by Cuban (2000) to investigate the extent of technology use in instruction revealed that very few teachers are serious users of computers in the classroom. Similar studies by Zhao & Cziko (2001) suggested that ICT as a tool to promote learning is not generally well embedded in teachers practice and Van Belle and Soetaert (2001) pointed out that information technology in the classroom is used in an ineffective way and it has proven difficult to integrate within traditional curriculum settings.

IV. CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The main purpose of this study was to explore mathematics tutors' ICT integration in teaching and learning of mathematics in the CoE in Ghana. Based on the findings made in this study, it can be concluded that:

a) Mathematics tutors' ICT integration into teaching and learning of mathematics in the CoE of Ghana is minimal.
b) Mathematics tutors computer-based technology used in mathematics teaching is low.
c) Mathematics tutors use of computer often in mathematics teaching process is low.
d) Mathematics tutors largely use ICT for general applications in teaching mathematics.
e) Mathematics tutors use the calculator, internet and computer as the computer-based technologies in their teaching and learning of mathematics.
f) Mathematics tutors often use ICT in general applications. That is, when processing students' results, preparing students tasks and in the preparation of lessons.

Recommendations

From the findings of this study, it is recommended that:

i. The CoE principals should collaborate with the mathematics departments to develop the skills and ability to integrate ICT into mathematics teaching and learning process in the CoE to the maximum level.
ii. The CoE administrators should motivate the mathematics departments to organize in-service training for the mathematics tutors on how to integrate ICT tools and software in their teaching and learning instructions.
iii. The CoE administrators should assist colleges mathematics tutors acquire relevant ICT tools to enable them integrate ICT effectively into teaching and learning in the colleges.
iv. The curriculum developers should help colleges' mathematics tutors to identify at least one ICT tool and software to teach any of the mathematics courses in the CoE.
v. The CoE principals should assist mathematics departments with budgetary allocation to have ICT laboratory for mathematics teaching and learning.
vi. The principals of CoE should provide computers, derive 5 or 6, sketch pad, projectors and internet to enable mathematics tutors to enhance effective integration of ICT into teaching and learning process.

Educational Implication of the Study for Mathematics Teaching and Learning

It was found in this study that mathematics tutors in CoE extent of ICT integration in mathematics teaching and learning in Ghana is low and this has some negative implications towards teaching and learning of mathematics. That is, most of the mathematics tutors will be teaching without integrating ICT as expected in the 21st century educational instructions. Also, the pre-service teachers taught by the mathematics tutors will not be motivated to harness the potentials of ICT integration into teaching and learning in both on-campus and off-campus teaching practices.

Suggestion for Further Research

It is suggested that in future, researchers could explore the mathematics tutors' ICT integration in mathematics teaching and learning of the CoE in the other regions in Ghana. This could provide a basis for generalization for conclusions to be arrived at about

mathematics tutors ICT integration in mathematics teaching and learning in the CoE of Ghana.

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