

## **Technology use among Ghanaian Senior High School mathematics teachers and the factors that influence it**

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### **Abstract**

The study sought to investigate technology use among Ghanaian Senior High School mathematics teachers and to also uncover the factors influencing their technology use. A cross-sectional survey design with mixed quantitative and qualitative data was gathered for the study. The population of the study comprised of all mathematics teachers in Ashanti region. A stratified sampling technique was used to select 80 mathematics teachers from both rural and urban districts in Ashanti region. The findings revealed that the extent to which SHS mathematics teachers use technology in teaching was very low. The Independent samples t-test revealed that the male mathematics teachers use more technology (Mean = 2.65, SD = 1.12) than the female teachers (Mean = 1.51, SD = 0.47) and teachers with high perceived efficacy use more technology (Mean = 2.94, SD = 1.10) than those with low perceived efficacy (Mean = 1.63, SD = 0.51). The analysis revealed that the differences in the mean technology use between male and female teachers and self-perceived efficacy in technology use were statistically significant ( $t = -2.44$ ,  $p = 0.02$ ) and ( $t = -4.23$ ,  $p = 0.00$ ) respectively.

Keywords           perceived efficacy; teachers' technology use; technology integration in teaching mathematics

### **Introduction**

A catch phrase in education today is technology integration. The call to integrate Information and Communication Technology (ICT) in education has become a major concern to Education stakeholders and policymakers across the world. From the early 1990s, education stakeholders in Ghana have been concerned about how teachers and students use computers in schools and how their use supports learning (Boakye & Banini, 2008). In the middle of the 1990s, educational providers realized that Ghanaian professionals could not compete on the global market for jobs, because they were limited in skill, especially in the area of Information Technology (Nyarko, 2007). In view of this, the World Links for Development (WorLD) programme was introduced in Ghana, in 1997. This programme was designed to use technology to open a world of learning for teachers and students. The programme aims to assist teachers and students to integrate technology into their curricula, to facilitate collaborative projects and distance learning among teachers and students, to assist students in using computers and the internet as communication and research tools, and to develop local educational content on the internet (Kwei, 2001).

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Several studies have highlighted teachers' use of technology in mathematics instruction and the factors that influence their use. Keong, Horani and Daniel (2005) claim that the level of technology used by mathematics teachers in their instruction is low. Besides, Lau and Sim (2008) reveal that mathematics and science teachers in Malaysia less frequently use technology for communication with peers (26%), and for personal development (12%), but frequently use internet for browsing (53%). Their findings further revealed that teachers' computer competency is possibly related to their frequent use of word processing (71%), presentation tools (50%) and courseware (63%) in preparing teaching materials and presenting lessons. Similar study conducted by Yildirim (2007) reveals that teachers largely use technology for creating handouts and tests, rather than using it to promote students critical thinking skills and to foster their higher order cognitive abilities. Moreover, Becker (2001) claim that teachers generally used computer technology to support their existing practices (providing practice drills, demonstration) and communication (such as the use of email) rather than to engage students in learning that involves higher order thinking. Besides, Cuban (2000) asserts that very few teachers are serious users of computers in the classroom. Waite (2004) opines that even though teachers show great interest and motivation to learn about the potential of technology, in practice, the use of technology is relatively low and it is focused on a narrow range of applications, with word processing being the predominant use. Similarly, Boakye and Banini (2008) claim that majority of the teachers in SHS level in Ghana do not use technology in classrooms but often use technology to prepare lesson notes, browse the web and send emails. Mereku et al (2009) also assert that technology 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.

Besides, several studies have highlighted the factors that influence mathematics teachers' technology use in teaching. A study conducted by Mereku, *et al* (2009) revealed that availability of ICT syllabuses/manual, computers and computer laboratories that can be accessed periodically were factors that influence teachers technology use in teaching. Cassim and Eyono Obono (2011) claim that teaching experience, computer access, internet access and school location significantly affect teachers' perceived adoption of technology for the teaching of word problems. Besides, Lee (1997) found that male teachers were more active in computer and they were also found to be more confident in handling computers than female teachers. A study conducted by Li and Kirkup (2007) revealed that using computer is a male dominant activity and males have more positive attitudes towards the use of technology as opposed to females. Furthermore, Samah et al (2011) claim that self-efficacy was significant contributor towards teachers' perceived ease of ICT usage.

At the beginning of the millennium, education authorities in Ghana embarked on a number of projects to introduce Information and Communication Technologies into Ghanaian education set up at the basic and secondary school levels. For instance, there has been an ICT for Accelerated Development (ICT4AD) policy which seeks to provide a framework in which information and communication technologies will be used to transform the educational sector, allowing all Ghanaians to pursue quality life-long learning opportunities regardless of their geographical location (Republic of Ghana, 2003). Besides, the new educational reform in Ghana which was launched in September, 2007 has

alsoplaced high emphasis on the integration of ICT in all subject areas (MOESS, 2007). At least eleven (11) specific objectives in both Core and Elective SHS mathematics syllabus emphasized the need to use spreadsheet in drawing graphs and calculating means, mode, median and standard deviation (MOESS, 2010). Furthermore, there has been an increase of computer laboratories at all levels of the school system and this testify to the potency of the use of computer technology in education delivery (Yidana & Asiedu-Addo 2001).Also, ICT has currently become a compulsory (core) subject for every SHS student in Ghana.

Due to the above mentioned efforts put up by education stakeholders and policymakers in Ghana to ensure the use of technology in instruction, it is believed that the mathematics teachers will lay the foundation for technology integration in instruction. This is so, because the mathematics curriculum in particular emphasizes the integration of technology in instruction. It is in the light of this that the researcher conducted the study to investigate the extent to which Ghanaian SHS mathematics teachers use technology in teaching and also uncovered the factors that influence it.

### **Research Questions**

The study sought to answer the following research questions:

- i. To what extent do SHS mathematics teachers use technology in teaching?
- ii. Which factors (gender, age, teaching experience, school location, availability of technology resources, self-perceived efficacy in technology use) influence SHS mathematics teachers' technology use in teaching?

### **Methodology**

The population of the study comprised of all public Senior High School (SHS) mathematics teachers in the Ashanti region of Ghana. Mathematics teachers were used in the study because the mathematics curriculum in particular emphasizes the use of technology in the teaching and learning process. Stratified sampling technique was used to select 80 mathematics teachers from the Ashanti region. The researcher divided Ashanti region into urban and rural districts. A simple random sampling technique was employed to select five (5) SHS from urban districts and five (5) SHS from the rural districts. Eight (8) mathematics teachers were then selected from each school in both rural and urban districts making a total of 80 teachers.

### **Instrument**

After a careful review of appropriate literature, questionnaire was chosen as the instrument to collect data to answer the questions set for this study. It was self-administered questionnaire. It was structured questionnaire that consisted of close format, open-ended format and rating scale type of questions. The questionnaire was based on the technology requirement in the SHS mathematic curriculum. To check for the validity of the instrument, the researcher allowed two (2) senior lecturers who were experts in the field of educational technology and mathematics at the Department of Mathematics Education in the University of Education, Winneba (UEW) to evaluate the questionnaire for content and construct as well as face validity. After the panel's feedback was received, the necessary changes to the content of the questionnaire were made. Later, the improved questionnaire was pilot-tested

to establish not only its reliability but also to identify defective items, and ensured that the instrument was clearly understood by respondents.

### **Pilot Test**

A pilot test of a survey questionnaire is a procedure in which a researcher makes changes in an instrument based on feedback from a small number of individuals who complete and evaluate the instrument (Creswell, 2012). The questionnaire was then administered personally to the mathematics teachers. The questionnaire was administered personally to help improve the collection and response rate of the questionnaire. The responses from the questionnaire items were coded and analyzed through the use of Statistical Package for Social Science (SPSS) software version 16.0. The data entries were done by the researcher in order to check the accuracy of the data. Data were cleaned before running any analysis. Descriptive statistics such as percentage scores were calculated for participants' responses to frequency of technology use in teaching. Independent samples t-test and One-way ANOVA were used to test the null hypothesis that "there is no significant difference between the categories for each of the demographic factors on the teachers' technology use.

### **Results**

#### *SHS Mathematics Teachers' Use of Technology in Teaching*

The study was conducted to find out the extents to which SHS mathematics teachers use technology in teaching. To answer this question, the mathematics teachers' general use of technology; their use of computer in teaching mathematics; and their use of calculator in teaching mathematics; were examined. The mathematics teachers were made to respond to five-point likert scale items (Everyday, Once a week, Once a month, Once a term, Never) on the frequency of engaging in various activities that involve technology.

The Likert scale with five options which was used to score frequency of mathematics teachers' technology usage was further re-coded into a Likert scale with three options (Often, Rarely, Never). Never and Once a term were re-coded into Never, Once a month was re-coded into Rarely and Once a week and Everyday were re-coded into Often. For each of the technology items computed, the mean score ranged from 0 (minimum) to 2 (maximum). A mean score of 0 indicated Never, 1 indicated Rarely and 2 indicated Often: a mean value of 1.0 is considered to be a middle point; a mean value below 1.0 indicates a low level of technology use and a mean value above 1.0 indicates a high level of technology use.

#### *Mathematics teachers' general use of technology*

Table 1 presents the percentage of general usage by teachers in the various ICT applications.

**Table 1** Proportion of mathematics teachers' ratings of their general use of technology as often (2), rarely (1) or never (0)

Item	Teachers' ratings of their general use of technology					
	Often		Rarely		Never	
	N	%	N	%	N	%
1. Finding information on internet for teaching	54	67.5	20	25.0	6	7.5
2. Communicating with colleagues and students	55	69.2	10	12.8	15	17.9
3. Sending email	54	67.5	22	27.5	4	5.0
4. Attaching files to email message	34	42.5	24	30.0	22	27.5
5. Preparing teaching notes/materials using MS word	31	38.5	20	25.6	29	35.9
6. Creating spreadsheet (MS Excel)	18	22.5	28	35.0	34	42.5
7. Making presentations (PowerPoint)	11	13.5	15	18.9	54	67.6
8. Creating database (MS Access)	10	12.8	19	23.1	51	64.1

The results in Table 1 show that majority of the mathematics teachers often use technology for finding information on the internet for teaching (67.5%), communicating with colleagues and students (69.2%), sending email (67.5%) and attaching files to email message (42.5%). However very few of these teachers use technology to create spreadsheet (MS excel) (22.5%), create database (MS Access) (12.8%) and make presentations (PowerPoint) (13.5%). This indicates that although majority of SHS mathematics teachers' often use technology in general internet application, very few of them use applications involving Microsoft Word.

#### *Mathematics teachers' use of computer in teaching*

Another subheading considered was mathematics teachers' use of computer in teaching. The mathematics teachers' use of computer in teaching is presented in Table 2.

**Table 2** Proportion of mathematics teachers' ratings on their use of computer in teaching as often, rarely or never

Item	Teachers' ratings of their use of computer in teaching					
	Often		Rarely		Never	
	N	%	N	%	N	%
1. Investigating the nature of graph of functions	19	23.7	25	31.6	36	44.7
2. Drawing graphs of grouped data	20	25.0	30	37.5	30	37.5
3. Drawing graphs of logarithmic functions	14	17.5	14	17.5	52	65.0
4. Drawing graphs of trigonometric functions and find their solutions	14	17.9	17	20.5	49	61.5
5. Drawing scatter diagram for bivariate distributions	12	15.4	17	20.5	51	64.1

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The results in Table 2 show that majority of the mathematics teachers do not use computer in teaching mathematics. Only 23.7% of the teachers used computer to investigate the nature of graph of a function and 25.0% indicated that they used computer to draw graphs of grouped data. However, very few of these teachers used computer to draw: graphs of logarithmic functions (17.5%), graph of trigonometric functions (17.9%) and scatter diagrams for bivariate distributions (15.4%). This implies that SHS mathematics teachers' use of computer in teaching mathematics is very low.

*Mathematics teachers' use of calculator in teaching*

The third subheading considered was mathematics teachers' use of calculator in teaching. Table 3 presents mathematics teachers' use of calculator in teaching.

**Table 3** Proportion of Mathematics Teachers' Ratings of their Use of Calculator in Teaching As Often, Rarely or Never

Item	Teachers' ratings of their use of calculator in teaching					
	Often		Rarely		Never	
	N	%	N	%	N	%
1. Expressing recurring decimals as common fractions	52	65.0	16	20.0	12	15.0
2. Calculating the mean, median and standard deviation	40	50.0	32	40.0	8	10.0
3. Determining the depreciation of an item over a period of time	22	27.5	24	30.0	34	42.4

Table 3 shows that majority of the mathematics teachers often use calculator to express recurring decimals as common fractions (65.0%) and to calculate the mean, median and standard deviation (50%). However, only (27.5%) of the teachers use calculator to determine the depreciation of an item over a period of time. This means that mathematics teachers rarely use calculator in teaching mathematics.

**Factors that Influence SHS Mathematics Teachers' Technology Use in Teaching**

The overall mean scores of teachers' technology use were computed from their ratings on the five-point Likert scale. This was used as the proxy score for the SHS mathematics teachers' technology use in teaching. For each of the technology items computed, the mean score ranged from 1 (minimum) to 5 (maximum). A mean value below 3.0 indicates a low level of technology use and a mean value above 3.0 indicates a high level of technology use. The overall mean score of teachers' technology use in teaching is presented in Table 4.

**Table 4** Mean Score of teachers' technology use in teaching

	N	Minimum	Maximum	Mean	Std. Deviation
Technology use in teaching mathematics	80	1	5	2.48	1.12

The results show that the mathematics teachers' overall use of technology in teaching mathematics is low since the mean score of 2.48 is below 3.0 and the large standard deviation of 1.12 meaning most of the teachers rated their technology use close to zero or Never.

The second question raised in this study was to find out which of the demographic factors (i.e. gender, age, teaching experience, school location, availability of technology resource and self-perceived efficacy in technology use) influence mathematics teachers' technology use in teaching. To determine this, the mean technology use of the categories in each of the factors was computed (see Table 5 and Table 6).

**Table 5** Results of the independent samples t-test Factors Influencing Teachers' Technology Use in Teaching

Factor	Categories	N	Mean	Std. Dev.	df	t	Sig.
Gender	Female	12	1.51	0.47	38	-2.44	0.02*
	Male	68	2.65	1.12			
School Location	Rural	40	2.41	0.91	38	-0.41	0.68
	Urban	40	2.56	1.32			
Availability of Technology Resources	Low Resources Available	12	2.28	1.00	38	-0.46	0.65
	High Resources Available	68	2.52	1.15			
Self-perceived Efficacy	Low Perceived Efficacy	28	1.63	0.52	38	-4.23	0.00**
	High Perceived Efficacy	52	2.94	1.10			

\*Significant ( $p < 0.05$ ); \*\*Highly Significant ( $p < 0.001$ )

To answer this question, the mean score on the mathematics teachers' technology use were analyzed for differences in the categories for each of the six demographic factors - gender, age, teaching experience, school location, availability of technology resources and teachers' self-perceived efficacy in technology use. Independent samples t-test and One-way analysis of variance (ANOVA) were used to test the null hypothesis that "there is no significant difference between the categories for each of the six demographic factors on the teachers' technology use". Table 5 and Table 6 present the Independent samples t-test and One-way ANOVA test results on factors influencing teachers' technology use in teaching mathematics respectively.

**Table 6** Factors Influencing Teachers' Technology Use in Teaching

Factor	Categories	N	Mean	Std. Dev.	df	F	Sig
Age	24 – 30 years	37	2.73	1.09	36	0.94	0.40
	31 – 40 years	35	2.59	1.14			
	Above 40 years	8	2.21	1.03			
Teaching Experience	1 – 5 years	28	2.59	0.98	37	0.10	0.91
	6 – 10 years	28	2.40	1.13			
	Above 10 years	24	2.46	1.34			

\*Significant ( $p < 0.05$ ); \*\*Highly Significant ( $p < 0.001$ )

It can be observed from Table 4.17 and Table 4.18 that there are differences in the mean scores in the categories of the various factors, but the differences in the mean scores of gender ( $t = -2.44$ ,  $p = 0.02$ ) and self-perceived efficacy in technology use ( $t = -4.23$ ,  $p = 0.00$ ) were found to be statistically significant. This indicates that gender and self-perceived efficacy statistically influence SHS mathematics teachers' technology use in teaching. Therefore, the null hypotheses that there are no significant differences between the SHS mathematics teachers (i) who are males and females as well as (ii) those with high and low perceived efficacy in their technology use were rejected. Hence, we accept the alternated hypotheses that there are significant differences in technology use between male and female SHS mathematics teachers as well as SHS mathematics teachers with high and low self-perceived efficacy. In other words, gender and self-perceived efficacy in technology use statistically influence SHS mathematics teachers' technology use in teaching.

## Discussion

The study was conducted to investigate the extent to which Ghanaian SHS mathematics teachers use technology in teaching and to also uncover the factors that influence it. The findings revealed that the mathematics teachers often use technology for general computer applications such as finding information on the internet for teaching, communicating with colleagues and students, sending emails, attaching files to email messages and preparing notes for teaching. However, the extent to which these teachers use technology in teaching mathematics was very low. This finding is consistent with the findings of Boakye and Banini (2008) who concluded that majority of the teachers at SHS level in Ghana do not use technology in classrooms but often use technology to prepare lesson notes, browse the web and send emails. The finding is in consonance with Mereku et al (2009) who found that technology 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.

The finding is also consistent with similar studies carried out in different countries. For instance, Waite (2004) found that even though teachers show great interest and motivation to learn about the potential of technology, in practice, the use of technology is relatively low and it is focused on a narrow range of applications, with word processing being the



predominant use. Besides, a study conducted 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. Moreover, Becker (2001) concluded that teachers generally use computer technology to support their existing practices (providing practice drills, demonstration) and communication (such as the use of email) rather than to engage students in learning that involves higher order thinking. This indicates that the use of technology in mathematics instruction is yet to be realized and utilized.

It is quite surprising that the extent to which the SHS mathematics teachers use technology in teaching is very low because majority of the teachers believe that technology plays important role in teaching and learning mathematics. The mathematics teachers' low technology use was found to be partly due to the fact that the mathematics teachers lack the skills to integrate technology in their teaching since they have had little opportunity to participate in professional development courses related to technology integration.

Furthermore, the study also investigated the factors that influence SHS mathematics teachers' technology use in teaching. The findings revealed that gender was found to statistically influence teachers' technology use in teaching mathematics. The finding is consistent with the findings of Almekhlafi, and Almeqdadi (2010) who found that gender has influence on teachers in United Arab Emirates technology use. Besides, similar study conducted by Al-Ghaith, Sanzogni, and Sandhu (2010) revealed that gender significantly influence participants Adoption and Usage of Online Services in Saudi Arabia.

The differences in the mean usage between the SHS mathematics teachers revealed that the male teachers use more technology in their teaching than the female teachers. This finding is in consonance with the findings of Lee, (1997) who found that the male teachers in United States were more active in computer use and were also more confident in handling computers than their female counterparts. Li and Kirkup (2007) also found that using computer is a male dominant activity and males have more positive attitudes towards the use of technology as opposed to females. It is not surprising that the male teachers use more technology in their teaching than the female teachers. In Ghana this may due largely to the fact that very few females teach mathematics at the SHS level.

The findings further revealed that self-perceived efficacy in technology use statistically influence teachers' technology use in teaching mathematics. This finding is consistent with the findings of a similar study conducted by Samahet al (2011) who found that self-efficacy was significant contributor towards perceived ease of ICT usage. Anderson and Maninger (2007) also found that pre-service teachers' self-efficacy beliefs significantly influence their intentions to use software in their future classrooms. This indicates that Ghanaian SHS mathematics teachers having high perceived efficacy in technology use will sure use technology in teaching.

## **Conclusion**

The study had revealed that the extent to which SHS mathematics teachers use technology in teaching was very low even though majority of the teachers believe that technology plays important role in mathematics. This was found to be due in part to the fact that the mathematics teachers lack the skills to integrate technology in their teaching since they have had little opportunity to participate in professional development courses related to

technology integration. Besides, this was also found to be due in part to the fact that the mathematics curriculum and the existing syllabus do not explicitly state what ICT tools must be used and how it should be used in the teaching and learning process. It was found that SHS mathematics teachers' technology use in teaching is statistically influenced by gender and self-perceived efficacy in technology use. However, age, teaching experience, school location and availability of technology resources did not statistically influence the mathematics teachers' technology use in teaching.

### **Recommendations**

From the summary of the major findings of this study, it is recommended that: the Heads of the various SHS should organize in-service training in professional development courses related to the integration of ICT in teaching and learning mathematics for their teachers.

The Curriculum Research Development Division (CRDD) of the Ghana Education Service in collaboration with the related agencies in the Ministry of Education should carry out research to review critically the mathematics curriculum and revise the existing syllabus to explicitly state what ICT tools must be used and how it should be used in the teaching and learning process.

The teaching institutions should endeavor to make the necessary provisions for more females to pursue mathematics in their pre-service education and also train them to develop the skills in ICT in order to integrate it in their teaching.

### **Limitation**

The findings of this study should not be generalized to all SHS mathematics teachers in Ghana, as the respondents involved were mathematics teachers in Ashanti region of Ghana. This population was selected because of ease of accessibility due to time constraint and limited financial resources. Thus, this places a limitation on the generalization that could be made on the findings of this study.

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