UNIVERSITY OF CAPE COAST

INFORMATION AND COMMUNICATION TECHNOLOGY USE BY SENIOR HIGH SCHOOL MATHEMATICS TEACHERS AND STUDENTS IN THE CENTRAL REGION OF GHANA

DAVID ADDOTEY

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BY

DAVID ADDOTEY

Dissertation submitted to the College of Distance Education, University of Cape Coast, in partial fulfilment of the requirements for the award of Master of Education Degree in Information Technology

APRIL 2016

DECLARATION

Candidate's Declaration

I hereby declare that this dissertation is the result of my own original work and that no part of it has been presented for another degree in this university or elsewhere.

Candidate's Signature: ………………………… Date:……………………

Name: ……………………………………………………………………………..

Supervisor's Declaration

I hereby declare that the preparation and presentation of the dissertation were supervised in accordance with the guidelines on supervision of dissertation laid down by the University of Cape Coast.

Supervisor's Signature:………………………… Date:……………………

Name: ……………………………………………………………………………

ABSTRACT

The descriptive study was conducted to assess the extent to which Information and Communication Technologies (ICT) use by Ghanaian SHS mathematics teachers and students, and to uncover the factors influencing their ICT use. A cross-sectional survey design employing quantitative method for data collection was used. The population of the study comprised all mathematics teachers and students in Central region of Ghana. A stratified sampling method was used to select 40 mathematics teachers and 200 students. The findings revealed that the extent to which SHS mathematics teachers and students use ICT in teaching and learning mathematics was very low. The Independent samples t-test revealed that the male mathematics teachers use more ICT (Mean = 2.65, SD = 1.12) than the female teachers (Mean=1.51, SD=0.47) and teachers with high self-perceived efficacy use more ICT (Mean = 2.94, SD = 1.10) than those with low self- perceived efficacy (Mean = 1.63, SD = 0.51). The analysis revealed that the differences in the mean ICT use between male and female teachers and self-perceived efficacy in ICT use were statistically significance. The One-way ANOVA test also revealed that students who were above 20 years use ICT more than those below 20 years. The analysis further revealed that the differences in the mean for the use of ICT between students with different ages, school location and availability of ICT resources were statistically significant. It was recommended that the Heads of the various SHS should organise in-service training in professional development courses related to the integration of ICT in teaching and learning mathematics for their teachers.

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While I would like to believe that useful ideas came to me in a scholarly dream, I also have been strongly influenced by a number of people and institutions.

I am enormously grateful to my supervisor Dr. Paul Nyagorme for his comments, suggestions and good sense of direction that helped so much in the production of this work. He saw promise in the problem identified and guided it through the various stages of the write up.

I also appreciate the time and effort teachers and Students spent in responding to my inventories. Their concerns, expectations, and aspirations for ICT use in teaching and learning mathematics are reflected here, and they have heightened my awareness of the issues I need to address.

Finally, I register my heartfelt appreciation to my daughter Wendy and all my friends especially Aloysius and the wife Rose for their support and encouragement which enabled this work to see the light of day.

DEDICATION

To the memory of my late mother, Mary Adonu.

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CHAPTER ONE

INTRODUCTION

Background to the Study

It is an undeniable fact that Information and Communication Technologies (ICT) play a very important role in the development of every nation these days. The importance of Information and Communication Technologies cannot be over-emphasized because growth is induced by the flow of information and the realization of the importance of ICT has led most economies into knowledge based ones. Developing countries have realized this and are rigorously pursing the use of ICT as a platform for socio-economic development.

A well-known phrase in education today is ‘Information and Communication Technology integration’. The call to integrate Information and Communication Technology (ICT) in education has become a major concern to many countries all over the world. This is so because the importance of integrating Information and Communication Technology in classroom instruction cannot be overstressed. According to the Ministry of Education (MOE) and Ghana Education Service (GES, 2002), integrating Information and Communication Technology in classroom instruction ensures greater motivation, increases self-esteem and confidence, enhances good questioning skills, promotes initiative and independent learning, improves presentation of information/outputs, develops problem solving capabilities, promotes better information handling skills, increasing focus time on task, and improves social and communication skills. Ghana’s Educational Reform 2007 stated the Ministry of Education is committed to making Ghana a key player in today's digital age. To this end, the Ministry has embarked upon a programme to streamline computer studies in secondary schools. Already, a draft ICT policy has been prepared and submitted to Cabinet for approval (Modern Ghana, 2017). A curriculum has also been developed for ICT training and examination at the Senior Secondary School Certificate Examination (SSSCE) Level.

In addition, every effort is being made to provide telephone facilities to all senior secondary schools and training Colleges of Education to enable them have access to the Internet. Yelland (2001) claimed that organizations that do not incorporate the use of new technologies in schools cannot seriously claim to prepare their students for life in the twenty-first century. Hakkarainen, Ilomaki, Lipponen, Muukkonen, and Rahikainen (2000) also pointed out that ICT is a transformative tool and its full integration into the school systems is necessary to prepare students for the information society they will inherit. The World Links for Development (WorLD) programme introduced in Ghana, in 1997, was designed to use ICT to open a world of learning for teachers and students.

The programme aimed at assisting teachers and students to integrate ICT into their curricula, 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). Several studies have revealed that technology plays important role in teaching and learning mathematics. For instance, Ittigson and Zewe (2003) pointed out that technology improves the way mathematics should be taught and enhances students understanding of basic concepts. It deemphasizes algorithmic skills resulting in an increased emphasis on the development of mathematical concepts. Besides, Becta (2003) asserted that the use of technology in mathematics classroom also allow the students to focus on strategies and interpretation of answers rather than spend time on monotonous computational calculations.

Information and Communication Technologies use in mathematics instruction assists the learner in visualizing the process and concept role of symbols, which reaches great heights in calculus (Tall & Ramos, 2004). Also, Technology allows real-world applications to be more readily used in the classroom (NCTM, 2008). Furthermore, Kaino (2008) argued that Technology enhance mathematics learning by furnishing visual images of mathematical ideas, facilitating the organization and analysis of data, as well as computing efficiently and accurately. Moreover, in the six principles for improving mathematics instruction emphasized by The National Council of Teachers of Mathematics (NCTM, 2000), the sixth principle; the 3 technology principle claims that technology is essential in mathematics instruction as it influences the mathematics that is taught and enhances students' learning.

Education stakeholders in Ghana have been concerned about how teachers and students use computers in schools and how their use supports learning. At the beginning of the millennium, education authorities in Ghana embarked on a number of projects to introduce Information and Communication Technology into Ghanaian education set up at the basic and secondary school levels. For instance, 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). Therefore, in implementing policies to achieving national development in Ghana, the ICT for Accelerated Development policy (ICT4AD) emphasized the need to transform Ghana into an information-rich, knowledge-based and technology-driven high income economy and society.

The ICT4AD policy aims to achieve this mission by transforming educational system to provide requisite educational and training services and environment capable of producing the right types of skills and human resources required for developing and driving Ghana's information and knowledge-based economy and society. In view of this, the Ministry of Education (MOE) and the Ghana Education Service (GES, 2004) proposed that the use of ICT in schools must:

1) Ensure that students have ICT literacy skills before coming out of each level of education
2) Provide guidelines for integrating ICT tools at all levels of education
3) Provide means of standardizing ICT resources in all schools
4) Facilitate training of teachers and students in ICT
5) Determine type and level of ICT needed by schools for teaching and administration purposes.
6) Promote ICT as a learning tool in the school curriculum at all levels (MOE & GES, 2002, p. 32).

Integrating ICT tools such as Computers and scientific calculators in mathematics instruction have the potential to change pedagogical approaches radically and to improve individual student learning outcome by transforming the classroom social practices (Forgasz & Prince, 2004; Goos, 2005). In view of the positive impact of ICT integration in mathematics instruction, the new educational reforms in Ghana which was launched in September, 2007 placed high emphasis on the integration of ICT in all subject areas. People in the early stages were even afraid to touch the computer, but nowadays almost everybody can use the computer and its tools. Integration of ICT in mathematics is not merely using computer for typing and printing questions, browsing and delivering lessons through PowerPoint but rather using ICT in teaching various topics in mathematics. For instance, the teaching syllabus for mathematics at the Senior High School (SHS) level emphasized the need to use spreadsheet in drawing graphs and calculating means, mode, median and standard deviation (MOESS, 2010). ICT integration in mathematics instruction really has positive impact on teaching and learning mathematics (Becta, 2003; Ittigson & Zewe, 2003; Tall & Ramos, 2004; Kaino, 2008; NCTM, 2008). It is, therefore, essential for SHS mathematics teachers to use ICT in teaching and also urge students to use ICT in learning mathematics. This will enable the students to better understand the mathematics concept taught.

Statement of the Problem

The government of Ghana in collaboration with the Ministry of Education Science and Sports has made provisions to ensure that Senior High School (SHS) students get access to quality education which takes into accounts the integration of Information and Communication Technology in instruction. In view of this, stakeholders of education and policymakers in Ghana have made a remarkable step towards the introduction of ICT in Ghanaian Senior High Schools that will contribute to knowledge production, communication and information sharing among students and teachers in the school system. For instance, there has been an ICT for Accelerated Development (ICT4AD) policy which seeks to provide a framework in which information and communication technology 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 reforms in Ghana have also placed emphasis on the integration of ICT in all subject areas (MOE, 2010). Thus, the SHS mathematics syllabus promotes the use of technology to support students' learning and develop their understanding of mathematical concepts. There are many specific objectives in the SHS mathematics syllabus that encourage the use of ICT in both core and elective mathematics classrooms to investigate, draw and determine the following:

The various graphs, depreciation, quadratics and equations, relations and functions, nature, shapes, and coefficients, variables, logarithmic graphs, trigonometric functions polynomials functions, correlation regression, and scatter diagram of bivariate distributions.

Also, there has been a sudden 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). Furthermore, ICT has currently become a compulsory (core) subject for every SHS student in Ghana.

To date, however, there has been scanty research to investigate Ghanaian teachers and students' use of ICT in teaching and learning and the factors that support or inhibit their effective integration into classroom practice. Mereku, Yidana, Hodzi, Tete-Mensah, Teteh-Mensah, and Williams (2009) asserted that for Ghana, and Africa as a whole, to be able to fully integrate ICT into teaching and learning there is the need for frequent collection and analysis of data on ICT usage. A case in point is this study by Mereku, et al (2009) which found that only Core ICT teachers use ICT and employ the technology in their instructional activities; almost all teachers of other subjects do not use ICT in their instructional activities. Generally, ICT is used in typing examination questions in all institutions and in some cases educators use ICT in processing students' results.

Being a student interested in information technology and fascinated by the global trend of persistently low and in some cases no use of Information technology in the field of academic work, I have decided to probe this issue further in this research. In particular, my interest lies in the use of Information technology for mathematics purposes.

Purpose of the Study

The main purpose of this study was to find out the extent to which SHS mathematics teachers and students use computers and the Internet and also factors that influence these facilities usage. Investigating ICT use in teaching and learning SHS mathematics was pivotal because this knowledge could provide guidance for ways to enhance ICT integration it would also encourage greater use of ICT in teaching and learning mathematics and suggest effective ways of integrating ICT in mathematics instruction at the Senior High School

Research Questions

The study sought to answer the following research questions:

1. To what extent do SHS mathematics teachers use ICT in teaching?
2. To what extent do SHS students use ICT in learning mathematics?
3. What factors affect SHS mathematics teachers' ICT use in teaching?
4. What factors determine SHS students' ICT use in learning mathematics?

Significance of the Study

The study is significant because it could provide insights into teachers' and students' ICT use at the SHS level that could be sustainable and transferable to other educational institutions. The study provided empirical evidence on the factors that affect use of ICT in teaching and learning mathematics at the SHS level in Ghana. This could provide guidance for policy makers and stakeholders of education when structuring and introducing ICT integration policies in Senior High Schools. The study could also add to knowledge by providing new evidence about the existing factors that influence ICT use in mathematics classroom in

Ghana. This could serve as the basics for future studies on how to address some of the challenges to ICT integration which might lead to improving current practice in ICT integration with regards to mathematics instruction.

Delimitations

The study was delimited to only Year (Form) 1 and Year (Form) 2 students because of the fact that the Year 3 students had left at the time of administering the questionnaire, and the outcome might be different if Form 3 students were included.

Furthermore, the study was delimited to only two private SHS in Central region and the outcome might be different if private SHS representation was equal to that of public SHS.

Limitations

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

Organization of the Study

The dissertation is organized in five (5) chapters. Relevant literature review was presented in Chapter Two. The Research Methodology was described in Chapter Three. It covered issues relating to the Research Design, Population, Sample and Sampling Techniques, Instruments and Data collection procedure and the procedure for Data Analysis. Chapter Four presented the results and the discussion of the findings of the study. Chapter Five, handled the Summary, Conclusions, Recommendations and Suggestions for further research.

CHAPTER TWO

LITERATURE REVIEW

Overview

This chapter deals with the review of literature that are related to ICT use in mathematics and factors that influence it. The literature review was discussed under the following themes:

1. Theoretical framework
2. Impact of ICT in teaching and learning mathematics
3. ICT use in teaching and learning mathematics
4. Factors influencing ICT use in teaching and learning mathematics.

Theoretical Framework

In order to find out mathematics teachers and students' ICT use at the SHS level, there is the need to better understand the factors that influence it. Several studies on ICT use by mathematics teachers have identified a range of factors influencing uptake and implementation. These factors include: skill and previous experience in using ICT; access to hardware and software; knowledge of how to integrate ICT into mathematics teaching; beliefs about the role of ICT in learning; and beliefs about mathematics and how it is learned (Fine & Fleener, 1994; Simonsen & Dick, 1997; Manoucherhri, 1999; Forgasz & Prince, 2001; Walen, Williams, & Garner, 2003).

In this study, the researcher adapted Valsiner's (1997) Zone Theory as the theoretical framework to investigate mathematics teachers and students' ICT use and factors influencing their use at the SHS level. Valsiner's (1997) Zone Theory was originally designed as an explanatory structure in the field of child development to apply to interactions between teachers, students, ICT, and the teaching and learning environment.

The Zone Theory extends Vygotsky's (1978) concept of the Zone of Proximal Development (ZPD) which is often defined as the gap between a learner's present capabilities and the higher level of performance that could be achieved with appropriate assistance to incorporate the social setting and the goals and actions of participants.

In addition, Valsiner added two zones: the Zone of Free Movement (ZFM) and Zone of Promoted Action (ZPA) to Vygotsky's Zone of Proximal Development. The ZFM structures an individual's access to different areas of the environment, the availability of different objects within an accessible area, and the ways the individual is permitted or enabled to act with accessible objects in accessible areas.

The ZPA represents the efforts of a more experienced or knowledgeable person to promote the development of new skills. The ZPA describes the set of activities, objects, or areas in the environment, in which the person's actions are promoted. Goos and Bennison (2008) argued that the ZFM can be interpreted as constraints within the school environment. These include participants' characteristics, access to resources and teaching materials, and curriculum and assessment requirements. The ZPA on the other hand represents opportunities to learn from pre service teacher education, colleagues in the school setting, and professional development as indicated in Table 1.

Table 1-*Factors Affecting ICT Use*

Valsiner's Zones	Elements of the Zones
Zone of Proximal Development	Skill/experience in working with technology, Pedagogical knowledge (ICT integration). Pedagogical beliefs (ICT; mathematics)
Zone of Free Movement	Access to hardware, software, teaching materials, Support from colleagues (including technical support), Institutional culture, Curriculum & assessment requirements, Students (perceived abilities, motivation, behaviour)
Zone of Promoted Action	Pre-service education (university program), Practicum and beginning teaching experience, Professional development

Zone Theory provides a framework for analysing the relationship between mathematics teachers and students' ICT use and the factors influencing it at the SHS level. Zone Theory was adapted as a framework for this study because it enabled the researcher to analyze the relationships between individual respondents' settings, actions, and beliefs, and how these changed across school contexts. Drawing on the zone theoretical framework, the researcher investigated possible relationships between SHS mathematics teachers and students' use of ICT and factors known to affect this use:

1. Zone of Proximal Development – self-perceived efficacy in ICT use;
2. Zone of Free Movement – availability of ICT resources, age, gender, school location;
3. Zone of Promoted Action – teaching experience, number of years in school.

Impact of ICT in Teaching and Learning Mathematics

The important role that mathematics plays in the overall personal and intellectual development of the individual cannot be underestimated. Mathematics is perceived as an interrelated structure of ideas, principles and processes and in teaching; its connections among basic concepts should be established to make learning easy for students (Reys, Suydam & Smith, 1998). Mathematics teaching and learning is crucial to the future of Ghana's knowledge economy and deserves a special focus in education. Effective mathematics teaching requires understanding what students know and need to learn and then challenging and supporting them to learn it well (NCTM, 2000).

Besides, students must learn mathematics with understanding, actively building new knowledge from experience and prior knowledge. Therefore, teachers must endeavor to make mathematics easy for students to understand the various concepts taught with ease.

In the rapidly changing and technologically dependent society, students are now faced with the need for a solid understanding of mathematical skills and concepts. One of the key synergisms of mathematics is ICT, and as ICT advances it inevitably influences what happens in the mathematics classroom. Research indicates that ICT play essential role in the teaching and learning of mathematics as it influences the mathematics that is taught and enhances students' learning (NCTM, 2000).

Information and Communication Technologies influence the skills taught and enhance students' learning. ICT should, therefore, be used to support the learning of mathematics. In so doing, NCTM (2000) recommended that ICT must be embedded in the mathematics programme, rather than provided as a supplemental element.

Using ICT in mathematics classroom provide ample learning opportunities for the students. Pannen (2014) has identified five distinct ways in which ICT helps students to learn mathematics efficiently. First, the ICT enable students to learn from feedback. The computer (ICT) often provides fast and reliable feedback which is non-judgmental and impartial. Secondly, ICT enables students to produce many examples when exploring mathematical problems. Thirdly, ICT helps students to see pattern and connection. The computer enables formulae, tables of numbers and graphs to be linked readily. Fourth, the use of ICT allows students to work with dynamic images that cannot be done within traditional teaching. Students can use computers to draw graphs and manipulate diagrams dynamically. Fifth, the use of ICT enables students to work with real data which can be represented in a variety of ways. This supports interpretation and analysis that lead students to higher order mathematical thinking skills (Wahyudi, 2008).

A study conducted by Roschelle, Pea, Hoadley, Gordin and Means (2000) supported the use of ICT in teaching and learning mathematics. Their finding indicated that computer ICT can help support learning, and that it is especially useful in developing the higher-order skills of critical thinking, analysis, and scientific inquiry. The study explored the various ways computer technology can be used to improve how and what children learn in the classroom by helping students understand core concepts in mathematics. According to them computer-based mathematics builds confidences and is a great tool for remediating slower learners.

In addition, Collinson (1999) observed that with the use of ICT in the mathematics classroom, students are saved from becoming bogged down in the difficult computations. This allows them to turn their focus to understanding the concepts and how to apply them. ICT also allows open-ended assignments in which the students can learn concepts by "discovery" and are more likely to retain the concepts. The students can also experiment and view different results and methods of solutions to different problems. Without the use of ICT, students spend majority of their time and energy attempting to memorize rules and procedures while using sample exercises as models for their homework problems.

The power of ICT leads to fundamental changes in mathematics instruction. Dreyfus (1991) opined that the ability to build and run complex mathematical models, and easy exploration of "what if" questions through parametric variation has opened up new avenues for mathematics. Munirah (1996) also observed that the teaching of calculus has seen a dramatic change now that activities such as exploring data or graphical data analysis have been transformed by the computer ICT. In view of this, weaker students often are better able to succeed with the help of ICT, and thereby come to recognize that mathematics is not just for their more able classmates (Wimbish, 1992).

Moreover, Tall and Ramos (2004) were with the opinion that ICT use in mathematics instruction assist the learner in visualizing the process and concept role of symbols, which reaches great heights in calculus. ICT allows real-world applications to be more readily used in the classroom (NCTM, 2008). Besides, Kaino (2008) argued that ICT enhances mathematics learning by furnishing visual images of mathematical ideas, facilitating the organization and analysis of data, as well as computing efficiently and accurately.

Furthermore, there are several reasons for incorporating ICT into mathematics instruction. According to Ittigson and Zewe (2003) ICT are essential in teaching and learning mathematics. ICT improves the way mathematics should be taught and enhances students understanding of basic concepts. It deemphasizes algorithmic skills resulting in an increased emphasise on the development of mathematical concept. Becta (2003) however summarised the key benefits of technology in mathematics instruction as follows: firstly ICT promotes greater collaboration among students and encourages communication and the sharing of knowledge. Secondly, ICT give rapid and accurate feedback to students and this contributes towards positive motivation. Finally, the use of ICT in mathematics also allows students to focus on strategies and interpretations of answers rather than spend time on monotonous computational calculations. Becta (2003) further states, that ICT also support constructivist pedagogy, wherein students use ICT to explore and reach an understanding of mathematical concepts. This approach promotes higher order thinking and better problem solving strategies.

ICT Use in Teaching and Learning Mathematics

Mathematics teachers need to develop knowledge that is pedagogical and technological content knowledge that will enable them to use ICT in teaching mathematics. Several studies have highlighted mathematics teachers' use of ICT in the mathematics classroom Voogt (2008). ICT use in teaching and learning mathematics really has the potential to improve the way mathematics should be taught and enhances students understanding of basic concepts (Ittigson & Zewe, 2003). . For instance, Loong (2003) conducted a study to investigate mathematics teachers' use of the internet for teaching in Australia. Out of the 63 secondary mathematics teachers surveyed, the findings indicated that the teachers use the Internet for finding information such as articles about research or professional issues, or as a source of data for students to analyze in mathematics lessons. No statistically significant relationships were found between use and competency, professional development, or years of teaching experience.

Similarly, a study conducted by Mereku *et al* (2009) indicated that ICT is used in typing examination questions in all institutions and in some cases educators use ICT in processing students' examination results. Their findings further indicated that very few teachers in Ghanaian SHS use ICT in their teaching. However, no differences were observed at the pre-tertiary level in the amount of time male and female learners use ICT for academic purposes.

Though, ICT use in mathematics improve mathematics teaching and learning, the level of ICT use in mathematics fall below average. A report by the National Center for Education Statistics (2005) indicated that 44% of the American teachers used ICT for classroom instruction, 42% for computer applications, 12% for practice drills, 41% required research using the Internet, 27% had students conduct research using CD-ROMs, 27% assigned multi-media projects, 23% assigned graphical presentations of materials, 21% assigned demonstrations, 20% required students to use ICT to solve problems and analyze data, and 7% assigned students to correspond with others using the Internet.

Furthermore, Bukaliya and Mubika (2011) surveyed 320 secondary school teachers to find out their competence in ICT. Their findings revealed that only 7.5% of the teachers were knowledgeable and skilled in computer aided instruction. Their findings also revealed that 43% of the teachers used spreadsheet, 37.5% used internet and 46% used email. Thomas, et al. (2006) also conducted a study to investigate ICT use and the teaching of mathematics in the secondary classroom. Their findings revealed that only 36% of mathematics departments have the ICT policy, and while 68.4% of teachers had used computers in their lessons, 31.6% had not. However, 75% of teachers would like to use the computer more often, with availability of computers the primary obstacle, and lack of teacher training and confidence also important. This indicates that the level of ICT use among secondary school mathematics teachers is still low.

Besides, Faekah and Ariffin (2005) surveyed 554 Form Four students to find out students' attitude computer and students' skills in computing. Their findings revealed that students were not skillful in computing. Only 17.9% of the students send messages via email, 16.4% Search for information on the web and 20.6% print documents or images. Similarly, Kaino and Salani (2004) surveyed 40 students to investigate students' attitude towards the use of calculators in mathematics instruction in Botswana. Their findings indicated that majority of students used and enjoyed working with calculators. However, Boakye and Banini (2008) conducted a study to investigate the level of ICT use by Ghanaian students. Out of the 5048 students surveyed, the findings indicated that 62% use the computer for general knowledge while 13% use it for academic purposes. Their findings further revealed that 13% of the students use it for communication whereas 10% use it for research. These findings indicate that ICT use is gradually gaining grounds among Ghanaian students.

Moreover, Keong, Horani and Daniel (2005) conducted a survey to investigate the use of ICT and the barriers of integrating ICT into the teaching of mathematics. Their findings indicated that the level of ICT used by mathematics teachers in their instruction was low. Majority of the mathematics teachers use ICT for word processing (71.1%), spreadsheets (51.2%), internet activity (44.1%), search engines (44.1%), presentation software (36.9%) and databases (21.6%). Out of the 111 mathematics teachers surveyed, 39.6% of the respondents stated that they had not used ICT at all and 32.1% of them stated that they use ICT infrequently.

On the other hand, 22.6% of them responded that they had integrated ICT into specific areas of instructional units and 5.7% stated that they had fully integrated ICT into their instructional programs.

Furthermore, a study conducted by Boakye and Banini (2008) to investigate teachers' readiness for the use of ICT in Ghanaian schools indicated that, 71% of the teachers did not use ICT in classrooms, 49% of teachers use ICT to prepare lesson notes, 55% of teachers have some knowledge of web browsing, 71% use email, and 78% tried to make an effort to learn how to use the computer. These low figures imply that effective integration of ICT into Ghanaian classroom instruction has yet to be realized and utilized. Waite (2004) opined that even though teachers show great interest and motivation to learn about the potential of ICT, 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.

Besides, Thomas, et al. (2006) surveyed 32 mathematics teachers to investigate ICT use and the teaching of mathematics in the secondary classroom. Their findings revealed that while 68.4% of teachers had used computers in their lessons, 31.6% had not and 75% of teachers would like to use the computer more often. The findings further revealed that over 90% of the teachers had used calculators in their lessons and the majority of teachers (56.7%) would like to use graphic calculator (GC) more often in their teaching. Lau and Sim (2008) also in their study, gave a self-administered questionnaire which consisted of six sections to 250 secondary school mathematics and science teachers in Malaysia to explore the extent of technology adoption among them. Their findings indicated that teachers less frequently use ICT 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.

However, a study conducted by Becker (2001) to find out how teachers use computers in instruction revealed 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.

Moreover, Slaouti and Barton (2007) conducted a study to find out the opportunity for newly qualified teachers to use ICT in teaching in the secondary school. Their findings revealed that ICT most commonly used by teachers was word-processing, spreadsheets and to a limited extent, the Internet. Similarly, Koo (2008) conducted a study to investigate the factors affecting teachers' perceived readiness for online collaborative learning. Out of the 86 mathematics teachers surveyed the findings revealed that, very few of them (24%) indicated they frequently use the Internet, 47% of them indicated they hardly (never or seldom) use it and the rest (29%) indicated they occasionally use it. Besides, Chigona and Chigona (2010) interviewed 14 educators to find out the factors affecting ICT use for teaching. Their findings revealed that the integration of ICT in the curriculum delivery was generally low. The analysis revealed that low levels of ICT literacy amongst the educators, rules set by the Khanya project on who can use the ICT and what it can be used for, and insufficient technical support regarding the use of the ICT for teaching were conversion factors that led to insufficient or no integration of ICT in the Khanya schools in South Africa. In a similar situation, Abuhmaid (2011) surveyed 120 teachers to explore the extent of their ICT usage. The findings revealed that 45.2% of the teachers reported searching for additional sources on the Internet and 32.1% reported using ICT to prepare their lessons. However, ICT-based interaction in the school culture appeared to have minimal presence among teachers, as only 4.3% of the teachers reported using ICT for communication and 11.3% of them reported uploading files (e.g. lessons) to the Internet. A study conducted by Cuban (2000) to investigate the extent of ICT use in instruction revealed that very few teachers are serious users of computers in the classroom.

Also, Norris, Sullivan, Poirot and Soloway (2003) surveyed rural and urban respondents in California, Florida, Nebraska, and New York to investigate the extent of ICT use in K-12 in United States. Out of the 3,665 teachers surveyed, their findings revealed that 14% of United States K-12 teachers make no use of ICT for instructional purposes, and nearly half (45%) use it with their students less than 15 minutes per week- equivalent to just 3 minutes per day. However, only 18% of respondents reported using computers for instructional purposes more than 45 minutes per week. The analysis further indicated that only 1.4% of the respondents make extensive use of the Internet for instructional purposes, over a quarter reports making no use of the Internet, and two thirds of respondents make minimal or no use (<15 mins/week) of Internet technology with their students. Besides, Yildrim (2007) conducted a study to examine teachers' utilization of ICT in Turkey. Out of the 402 teachers surveyed, the findings revealed that teachers largely use ICT for creating handouts and tests, rather than using it to promote students critical thinking skills and to foster their higher order cognitive abilities. The findings further indicated that due to pedagogical support, teachers reported the lowest frequency for the use of ICT for teaching mathematics. Thus, teachers felt most competent on word processing whereas they felt least competent for the use of instructional software.

Factors that Influence ICT Use in Teaching and Learning Mathematics

Information and Communication Technologies use in teaching and learning mathematics has become a major concern to stakeholders and policy makers in education throughout the world. ICT use in mathematics instruction is influenced by several factors. Nor (2004) used a qualitative methodology to study conditions that facilitated the implementation of ICT integration in the Malaysian secondary school curriculum. The findings revealed that two sets of conditions: (i) essential conditions (such as availability of ICT resources and acquisition of ICT knowledge), and (ii) supporting conditions (such as accessibility of ICT resources, presence of support, desire to change among teachers, school practices, influence of external forces and teachers' commitment to the innovation) significantly influence the teachers ICT use. Besides, Norris et al. (2003) surveyed rural and urban respondents in California, Florida, Nebraska, and New York to investigate the extent of ICT use in K-12 in United States. Out of the 3,665 teachers surveyed; the analysis revealed that appropriate access to ICT infrastructure is a key factor in the effective ICT integration process. The study revealed substantive correlation between ICT access and use. Similarly, Varden (2002) used Ely's conditions as a framework to identify conditions that influence the adoption and integration of laptop computers by teachers in United States high schools. His results indicated that the conditions of "dissatisfaction with status quo," "presence of knowledge and skills," "participation," "commitment" and "leadership," were more prevalent among teachers who were early adopters than late adopters. In addition, the study found that teachers who had a higher degree of ICT integration reported greater adherence to all of Ely's conditions than those with a lower degree of ICT integration.

Research conducted by Crisan (2004) categorised variety of factors that influence ICT use in mathematics into contextual factors and the personal factors. He argued that contextual factors encompass the availability of and access to technology facilities and resources, teachers' ICT skills, teachers' ICT professional development, departmental ethos and key persons in promoting the use of ICT and the departmental policy with regard to integrating ICT into the mathematics scheme of work. Besides, Goos and Bennison (2008) surveyed 485 mathematics teachers in Australia to investigate the factors influencing ICT use in mathematics teaching. Their findings revealed that pedagogical knowledge and beliefs, access to hardware and software and participation in professional development course were factors influencing ICT use in teaching and learning mathematics. Similarly, Mereku, et al. (2009) conducted a study to investigate pedagogical integration of ICT.

Their findings revealed that availability of ICT syllabuses/manual, computers and computer laboratories that can be accessed periodically were factors that influence ICT use at the SHS level in Ghana.

In order for the school to be proactive regarding ICT in the classroom, Williams (1998) argued that the school should have an ICT plan, reviewing the curriculum to fit the ICT needs in instruction and ensuring that the staff has skills. He argued for tapping school and community resources to ensure sustainable funding mechanisms. In a similar study, Valdez (2004) pointed out that if the tremendous potential of ICT is to be optimized, educators and community members need to develop a comprehensive learning and ICT plan long before ICT equipment starts arriving. He further observes that most research studies on ICT implementation show that much of the frustration with ICT can be attributed to inadequate or nonexistent planning. Adequate planning may be especially lacking in how ICT is used to improve learning and determining how teachers receive professional development to help enhance student learning. Also, Bosley and Moon (2003) mention case study research in the UK that identified a number of factors that enable teachers to successfully engage in innovative practice. These were: previous involvement in innovations (ICT and non-ICT based), support at senior management level for implementing new practices and addressing financial implications where appropriate, involvement of several members of staff, a prevailing culture within schools of collaboration and mutual support and willingness to take risks, accepting that some ventures will succeed while others may not.

Several studies have been conducted that addressed the relationships between demographic variables such as gender, age, teaching experience and usage of ICT. Cassim and Eyono Obono (2011) surveyed 102 teachers in both rural and urban schools in South Africa to find out the factors affecting the adoption of ICT for the teaching of word problems. Their findings indicated that the following demographic factors significantly affect teachers' perceived adoption of ICT for the teaching of word problems: teaching experience ($p = 0.018$), computer access ($p = 0.000$), internet access ($p = 0.009$), and school location ($p = 0.020$). Besides, Al-Ghaith, Sanzogni, and Sandhu (2010) conducted a research to investigate factors influencing the adoption and usage of online services in Saudi Arabia. Out of the 651 participants sampled, the findings revealed that income level, age, gender, and geographic location have a significant effect on people's access to and use of the Internet and its services. On the contrary, Kumar, Rose and D'Silva (2008) conducted a research to investigate the factors influencing the effective use of ICT among Malaysian teachers. Out of the 318 teachers sampled, their findings revealed that gender ($p = 0.68$, $p>.05$), age ($F=1.303$, $p=.272$) and teaching experience ($F=9.353$, $p=.061$) did not significantly influence teachers actual usage of ICT. Besides, Norris et al. (2003) surveyed rural and urban respondents in California, Florida, Nebraska, and New York to investigate the extent of ICT use in K-12 in U.S. Out of the 3,665 teachers surveyed, the finding revealed that gender ($t=1.218$, $p=0.22$) and teaching experience (t=0.05, p=0.96) did not have significant influence on teachers ICT use.

Besides, Venkatesh and Morris (2000) conducted a research to investigate gender, social influence, and their role in ICT acceptance and usage behavior. Their findings revealed that men emphasized more on perceived usefulness in determining behavioral intention to use, while women regarded perceived ease of use as a more significant factor in determining behavioural intention to use. Similarly, Sarfo, Amartei, Adentwi and Brefo (2011) conducted a research to investigate Rural and Urban students' attitudes towards ICT in Ghana. Out of the 324 SHS students sampled, the findings revealed that the locality of the male and female students does not influence their attitudes towards ICT. Their analysis further revealed that students' attitudes towards ICT do not differ in terms of gender. However, Lee (1997) conducted a research to investigate the effects of high school restructuring and size on early gains in achievement and engagement. He found out that male teachers were more active in computer and they were also found to be more confident in handling computers than female teachers. Li and Kirkup (2007) conducted a research to investigate gender and cultural differences in Internet use. Their findings revealed that using computer is a male dominant activity and males have more positive attitudes towards the use of ICT as opposed to females. Similarly, Kahveci, (2010) conducted a research to find out students' perceptions to use ICT for learning. Out of 158 students surveyed, the findings revealed that Female students were less confident in using ICT compared to male students. He, therefore, found a significant difference F (1,158) = 6.300, p=.014 in the effect of confidence between male and female students.

Furthermore, Luan et al. (2005) conducted a study to determine if differences existed between females and males in terms of their ICT competencies in word processing, presentations, World Wide Web, electronic mail usage, spreadsheet applications, database applications, multimedia applications and virtual class applications. Their findings revealed that the mean values of female participants were statistically higher than those of males when it came to inserting (4.71 to 4.33) and editing (4.65 to 4.34) texts. Once again, the mean scores for females were higher than those of males for inserting texts (4.45 to 4.03) and deleting slides (4.41 to 3.95) in presentations. The mean values for females were higher than for males in search engine (4.57 to 4.16) and file uploads (4.47 to 4.14). However, females and males did not perceive themselves as skillful in creating their own homepages. Both genders perceived the Web as more of a search tool than as a place for them to publish their homepage. Also females scored significantly higher than males in four out of the five items related to e-mail usage. Females were significantly more skillful than males in composing (4.69 to 4.38), sending and replying (4.69 to 4.41) e-mails and sending attachments (4.67 to 4.34). No significant difference, however, was found between both genders in relation to opening attachments. The comparative analyses show that there is no significant difference between female and male competencies in terms of their competency in spreadsheet, database, multimedia and virtual class applications. Similarly, Almekhlafi, and Almeqdadi (2010) conducted a research to investigate teachers' perceptions of ICT integration in the United Arab Emirates. Out of 100 teachers sampled, the findings indicated that the means scores for female teachers on ICT used were all above 4.4, while the mean scores for male teachers ranged from 2.5 to 3.5. The One-way analysis of variance (ANOVA) statistical test further revealed that there was a significant difference in ICT use between male and female teachers. This implies that gender has influence on the teachers ICT use.

Besides, a study conducted by Martin and Lundstrom (2002) to examine the role of teachers' experience as a factor for the integration of computers in schools revealed that almost 60% of the teachers who had under 10 years of teaching experience believed computers in the classroom were essential and hence they use it extensively. However, only 25% of teachers with over 20 years of teaching experience shared this belief. In addition, Zidon and Miller (2002) conducted a research to investigate affiliations of attitudes and experience with need for learning computer skills. Their finding indicated that weak relationship existed between years of teaching and ICT usage. Conversely, Rosen and Maguire (1990) who reviewed a literature on understanding teachers' perception towards computers and computerized instruction concluded that teachers teaching experience does not eliminate computer phobias and many experienced teachers display some wariness, discomfort and/or mild anxiety in relation to computers.

Furthermore, Lau and Sim (2008) conducted a research to explore the extent of ICT adoption among secondary school teachers in Malaysia. Out of the 250 secondary school mathematics and science teachers sampled, the findings revealed that elderly respondents (aged over 45years) made more frequent use of ICT in schools (M = 3.22; S.D. = 0.57) on a five-point rating scale. On a five point rating scale, the results further revealed that young teachers aged below 35 recorded a higher mean of competency (M = 3.68; S.D. = 0.55) than 34 – 45 years and over 45years. Besides, Sia (2000) conducted a research to investigate computer anxiety and computer literacy among urban secondary school teachers in Miri, Sarawak. His findings revealed that the younger, less experienced teachers use computers in a broader, more transformational fashion. This, the study revealed, is because these teachers are probably more likely to be computer proficient, will have had more digitally focused teacher education courses, and will be less constrained by prior habits or attitudes than their older, more experienced colleagues. The findings further revealed that computer literacy levels among secondary school teachers were low, and there were significant differences in computer literacy levels between teachers of different age groups, and teachers with different years of computer experience with different software. However, Gattiker and Nelligen (1998) conducted a study to investigate computer attitude and learning performance for management education and training. Their findings revealed that age does affect teachers' perception of ICT and its usage.

Several studies have shown that participants self-efficacy in ICT use significantly influence ICT usage. Samah, Shaffril, Hassan and D'Silva (2011) conducted a research to investigate what affect perceived ease of ICT usage. A Multiple Linear Regression (stepwise method) was used to determine most significant variables that contributed towards perceived ease of ICT usage. Out of the 240 respondents sampled, the findings indicated that self-efficacy was significant contributor towards perceived ease of ICT usage. Besides, Anderson and Maninger (2007) conducted a research to investigate pre-service teachers' abilities, beliefs, and intentions regarding ICT integration. Their findings revealed that students' self-efficacy beliefs significantly influence their intentions to use software in their future classrooms. They further revealed that Students' self-efficacy and intentions were moderately correlated with each other. They however argued that the best predictors of intentions were self-efficacy beliefs, gender, and value beliefs.

Summary of the Literature Review

The study was built on the Zone Theory which considers the relationship between mathematics teachers and students’ use of ICT and the factors that influence the use of ICT by mathematics teachers and students. The theory was categorized into three branches including Zone of Proximal Development, Zone of Free Movement, and Zone of Promoted Action. The Zone of Proximal Development deals with factors related to self-perceived efficacy in the use of ICT whereas the Zone of Free Movement deals with factors such as availability of ICT resources, age, gender, and school location. The Zone of Promoted Action also deals with factors such as teaching experience, and number of years in school.

The place of mathematics in the intellectual development of the individual cannot be overemphasised. The teaching and learning of mathematics is crucial to the future of every economy and hence must be given much attention. The use of

ICT in teaching and learning mathematics has been proven to be one of the key synergisms of mathematics. The use of ICT in learning mathematics helps in developing in students a higher-order critical thinking, analytical, and scientific inquiry skills. ICT should therefore be used to support the teaching and learning of mathematics.

ICT has been proven to be very impactful in teaching and learning mathematics. For instance Ittigson and Zewe (2003) opined that ICT has the potential to improve the way mathematics should be taught and enhances students' understanding of basic concepts. Several research that have been done on the use of ICT for teaching and learning mathematics have shown that ICT has been used by teachers and students for teaching and learning over the years but the extent to which ICT has been used is very low. In most countries including the United States of America, Malaysia, Turkey, South Africa and Ghana, the use of ICT, especially the internet, for teaching mathematics has been very low. The use of ICT has been mostly done with little or no competence, professional development, knowledge and skills.

Several factors have been realized that influence the use of ICT in teaching and learning mathematics. According to researchers such as Nor (2004), Norris et al. (2003), Varden (2002), Crisan (2004) and Goos and Bennison (2008), there are some major factors that affect the use of ICT for teaching and learning mathematics. Among these factors are: teachers' knowledge, availability of ICT resources, teachers' professional development, school location, planning, and school context. Other factors that were realised to be some factors that influence the use of ICT for teaching and learning mathematics include: departmental policy with regard to integrating ICT into the teaching of mathematics; developing comprehensive learning; and demographic variables such as gender, age, and teaching experience.

CHAPTER THREE

RESEARCH METHODS

Overview

This chapter provides detailed description of the methodology that was employed in the study which included the population and setting of the study, sample and sampling procedures, research design, research instrument, data collection procedure and the method of data analysis that was used to find out how SHS mathematics teachers and students use information and communication technology.

Research Design

According to Fraenkel and Wallen (2003) research design is the overall plan for collecting data in order to answer the research questions. Also, it is the specific data analysis techniques or method that the researcher intends to use. Creswell (2012) opined that research design is a procedure in quantitative research in which investigators administer a survey to a sample or to the entire population of people to describe the attitudes, opinions, behaviours, or characteristics of the population.

The research design adopted for this study was descriptive survey which aimed at describing existing conditions during the period of the conduct of the study. Essentially, the study surveyed the extent to which SHS mathematics teachers and students use computers and the Internet, and the factors that influence the use usage of these facilities. The design therefore involved collecting data from a selected sample with the view to identifying teachers and students' usage of ICT, and the factors that determine the usage of ICT by teachers and students for teaching and learning mathematics. The descriptive survey was considered appropriate because the study sought to investigate management of an existing practice. This was to enable the researcher to explain and describe situations on the ground in relation to the variables of the study.

As Gay (1987) pointed out, descriptive survey is primarily concerned with the collection of data in order to test hypothesis or to answer questions concerning the current state of a phenomenon. According to Santosh (1993), the descriptive research design makes the researcher obtain the opinion of the representative sample of the target population. Again, it gives a picture of the variables involved in the research without necessarily subjecting the data to any vigorous statistical technique (Saunders, Lewis & Thornhill, 2007). Surveys use a standard set of questions to get a broad overview of group's opinion's, altitudes, self-reported behaviours, and demographic and background information (Onley & Barnes, 2008). In the descriptive research design, the researcher selects relevant variables for an analysis of their relationships. This method as recommended by Babbie (1990) is suitable for purposes of making generalization for a sample to a population so that inferences could be made about some opinions, or perception of the population. The descriptive survey was considered appropriate for use as it deals with questions about things as they stand currently.

What may be considered as weakness of this research design is that it is primarily concerned with the survey and analysis of an existing phenomenon, and does not attempt to introduce any intervention strategies. However, after the problem has been identified and analysed, measures can be taken to solve it. Again, the design is susceptible to errors and distortions if the researcher does not check biases that may be introduced in the measuring instruments to remove all prejudices which might have been introduced. In spite of the weaknesses, the descriptive survey was considered the most suitable for the nature and purpose of the research.

Population

The population of the study comprised of all Senior High School (SHS) mathematics teachers and students in the Central region of Ghana. Central region was chosen for this study because the researcher has been teaching in the region for the past sixteen years and is familiar with the academic environment in the region. Mathematics teachers were used in the study because the mathematics curriculum in particular emphasizes the use of ICT in the teaching and learning process.

Sampling Procedure

Stratified sampling technique was used to select 40 mathematics teachers and 200 students from the Central region. According to Mason, Lind and Marchal (1990) a stratified random sampling is when the population is first divided into subgroups, called strata. A sample is then selected from these subgroups and then the sample for the study is thus selected from the stratum. The steps in stratified sampling are as follows:

1. Divide the population into strata (e.g. Subgroups)
2. Select groups of strata to be used

3. Select individual elements or participants from the selected strata.

Stratified sampling technique was used in this study because most of the Senior High Schools in Central region are resided in both rural and urban districts. Therefore, to be able to get equal representatives of Senior High Schools from both rural and urban settings, stratified sampling technique was employed.

The researcher divided Central region into urban and rural districts. A simple random sampling technique was employed to select four (4) SHS from urban districts and four (4) SHS from the rural districts. Four mathematics teachers were then selected from each school in both rural and urban districts making a total of 40 teachers. Out of the 40 teachers, 20 were selected from rural SHS whereas 20 teachers were selected from urban SHS Twenty (20) students were also selected from each school in both rural and urban districts making a total of two hundred (200) students.

Data Collection Instruments

After a careful review of appropriate literature, questionnaire was chosen as the instrument to collect data to answer the questions set for this study. Questionnaire was chosen because it takes less time to administer them and also ensures the anonymity of respondents (Fraenkel & Wallen, 2003; Muijs, 2004). Questionnaire enabled the researcher to collect potential information about ICT use in teaching and learning SHS mathematics and the factors that influence it from teachers and students in Central region. The questionnaire consisted of both close and open-ended items. The open-ended questions enabled the researcher to probe a little deeper and explore mathematics teachers' attitudes towards ICT use in teaching mathematics.

Two forms of questionnaire were developed. One was given to the teachers and the other was given to the students. They were self-administered questionnaire. They were structured questionnaire that both consisted of close format, open-ended format and rating scale type of questions. The questionnaire were based on the ICT requirement in the SHS mathematics curriculum.

Teachers' questionnaire

The teachers' questionnaire consisted of four (4) main parts (A - D). Part (A) contained nine (9) items that elicited information on the background of the participants and the level of availability of ICT resources available for teachers. Question one to three (1 – 3) of the variables in part (A) covered respondents' gender, age and teaching experience. These data were in tune with the purpose of this research since the respondents' gender, age and teaching experience might have significant influence on participants' ICT usage. Question four to eight (4 – 8) of the variables in part (A) elicited information on the level of availability of ICT resources available for teachers. Question nine (9) elicited information on teachers participation in professional development courses related to the integration of ICT in teaching and learning mathematics. The second part (B) consisted of sixteen (16) items that elicited information on participants' self-perceived efficacy in ICT use. The third part (C) consisted of sixteen (16) items that focused on the extent to which the mathematics teachers' use ICT for general purposes and in teaching. The last part (D) consisted of both close and open ended items. The close ended part consisted of sixteen (16) items that elicited information on teachers' self-perceived efficacy in ICT use. The open ended part consisted of two (2) questions that elicited information on teachers' perceptions towards ICT use in teaching and learning SHS mathematics. Teachers' perceptions have an influence on attitudes developed toward ICT use in teaching mathematics. The teachers' questionnaire is presented in appendix A.

Students' questionnaire

The students' questionnaire also consisted of three (3) parts (A – C). The first part A contained three (3) items that elicited information on the background of the students. Students' age, gender, and form were crucial for the study since these might have influence on their ICT use in school. The second part B consisted of eight (8) items that elicited information on the level of availability and accessibility of ICT resources available for students. The last part C also consisted of seventeen (17) items that focused on the extent to which students use ICT for general purposes and in learning mathematics. The students' questionnaire is presented in appendix

Scoring of the Instrument

A Likert scale with five options (Everyday, Once a week, Once a month, Once a term, Never) was used to score frequency of mathematics teachers and students ICT use. The items on the questionnaire were scored in Table 2 as follows:

Table 2: Score of Items on Questionnaire

Response Intensity	Score
Everyday	5
Once a week	4
Once a month	3
Once a term	2
Never	1

Variable scores were obtained by computing the mean values of the responses for the related items on the variable by using Statistical Package for Social Sciences (SPSS) version 21. For the mathematics teachers and the students' frequency of ICT usage variables, the mean score ranged from 1 (Minimum) to 5 (Maximum). A mean value of 3.0 is considered to be a middle point. A mean value below 3.0 indicates a low level of ICT use and a mean value above 3.0 indicates a high level of ICT use.

The Likert scale with five options which was used to score frequency of mathematics teachers and students ICT 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. The re-coding of the five-point Likert scale into three-point Likert scale is presented in Figure 1.

Never	Rarely	Often
Never — Once a term	Once a month	Once a week — Everyday

Figure 1: Recoding of Five-Point Likert Scale into Three-Point Likert Scale

The items on the three point Likert scale were scored in Table 3 as follows:

Table 3-*Score of Three-point Likert Scale*

Response Intensity	Score
Often	2
Rarely	1
Never	0

Variable scores were obtained by computing the mean values of the responses for the related items on the variable. For the mathematics teachers and the students' frequency of ICT usage variables, the mean score ranged from 0 (Minimum) to 2 (Maximum). A mean value of 1.0 was considered to be a middle point (Rarely). A mean value below 1.0 indicated a low level of ICT use and a mean value above 1.0 indicated a high level of ICT use.

Besides, questionnaire item D which was a Likert scale with five options (Excellent, Good, Satisfactory, Learning, Poor) and questionnaire item B which was dichotomous (Yes, No) were used to score mathematics teachers self-perceived efficacy in ICT use. The items on the Likert scale questionnaire were scored in Table 4 as follows:

Table 4 - *Score of Five-point Likert Scale*

Response Intensity	Score
Excellent (Advanced)	5
Good (Proficient)	4
Satisfactory (Progressing)	3
Learning (Needs improvement)	2
Poor (Can't use it)	1

The dichotomous items on the questionnaire were also scored in Table 5 as follows:

Table 5 - *Score of Dichotomous Items on Questionnaire*

Response Intensity	Score
Yes	1
No	0

The Likert scale with five options (Excellent, Good, Satisfactory, Learning, Poor) was re-coded into a Likert scale with two options: High perceived-efficacy and Low perceived-efficacy. Poor, Learning and Satisfactory were re-coded into Low perceived efficacy, whereas Good and Excellent were re-coded into High perceived efficacy.

The items on the two-point Likert scale were scored in Table 6 as follows:

Table 6 - *Score of Two-point Likert Scale*

Response Intensity	Score
High perceived-efficacy	1
Low perceived-efficacy	0

The variable scores of questionnaire item 15 were obtained by summing the responses for the related items on the variable. The scores ranged from 1 (minimum) to 16 (maximum). A score ranging from 1 – 8 was considered as Low perceived-efficacy and a score ranging from 9 – 16 was considered as High perceived-efficacy.

The items were scored in Table 7 as follows:

Table 7 - *Score of Related Responses on Questionnaire Item 15*

Response Intensity	Score
High perceived-efficacy	1
Low perceived-efficacy	0

However, questionnaire items 15 and 17 were summed up and further re-coded into High perceived-efficacy and Low perceived-efficacy in ICT use. These two options were further scored in Table 8 as follows:

Table 8 - *Score of Summed Responses on Questionnaire Items 15 and 17*

Response Intensity	Score
High perceived-efficacy	1
Low perceived-efficacy	0

Besides, respondents were supposed to indicate either "yes" or "no" to whether they had a facility available/accessible in their various schools. These were scored in Table 9 as follows:

Table 9 - *Response to Questionnaire Items on Availability of ICT Facility*

Response Intensity	Score
Yes	1
No	0

However, availability of ICT resources for teachers was obtained by summing the responses of questionnaire items 4, 5, 6, 7, and 8 on the teachers' questionnaire. The scores ranged from 1 (minimum) to 5 (maximum). A score ranging from 1 – 3 was considered as low ICT resources available and a score ranging from 4 – 5 was considered as high ICT resources available. These were scored in Table 10 as follows:

Table 10 - *Sum of Responses on Questionnaire Items 4, 5, 6, 7 and 8*

Response Intensity	Score
High ICT resources available	1
Low ICT resources available	0

Furthermore, availability of ICT resources for students was also obtained by summing the response of questionnaire items 4, 5, 9, 10 and 11 on the students' questionnaire. The scores ranged from 1 (minimum) to 5 (maximum). A score ranging from 1 – 3 was considered as low ICT resources available and a score ranging from 4 – 5 was considered as high ICT resources available. The items were scored in Table 11 as follows:

Table 11 - *Sum of Responses on Questionnaire Items 4, 5, 9, 10 and 11*

Response Intensity	Score
High ICT resources available	1
Low ICT resources available	0

Likert scale was used to score the questionnaire because it looked interesting to respondents and both the teachers and the students enjoyed completing a scale of this type (Muijs, 2004).

Reliability and Validity

Reliability according to William (2006) referred to consistency or 'dependability' of the measurement or the extent to which an instrument measures the same way each time it is used under the same condition with the same subjects. Validity on the other hand determines whether the research truly measures that which it was intended to measure or how truthful the research results are (Joppe, 2000). To check for the validity of the instrument, the researcher allowed two (2) senior lecturers who are experts in the field of educational ICT and mathematics at both Department of Mathematics and M.Ed. Information Technology in the University of Cape Coast, 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 Testing

It is easy to overlook mistakes and ambiguities in question layout and construction when designing a questionnaire (Wilkinson & Birmingham, 2003). Besides, Awanta and Asiedu-Addo (2008) also cautioned that it is possible to design a questionnaire that is reliable because the responses are consistent, but may be invalid because it fails to measure the concept it intends to measure. In view of this, the survey instrument was pilot tested. 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). Mathematics teachers and students from the same context where the study was to be conducted were chosen because they represented the targeted respondents of the study. Twenty (20) SHS mathematics teachers and twenty one (21) students from Central region were used in the pilot study. The feedback of the respondents helped to improve the quality of the survey in terms of content coverage, content validity and reliability. Using the SPSS (Statistical package for solutions version 21), a Cronback's Alpha reliability statistics yielded a reliability coefficient of 0.682 and 0.70 for the teachers and students' respectively for the various parts of the questionnaire. Both questionnaires were highly reliable since the reliability coefficients of both questionnaires were above 0.5. The Cronback alpha was used for the Likert-type scale items because it has been judged to be appropriate for survey research in which items are not scored as wrong or right (McMillan & Schumacher, 1977).

Data Collection Procedures

The researcher collected an introductory letter from the College of Distance Education, University of Cape Coast. The introductory letter was then given to the Headmasters of the participating SHS. With consent from the Headmasters, the Heads of the mathematics department of the participating schools were informed about the study.

Ethical issues were considered in the process. Ethical issues are highly relevant and require due consideration in any research (Sarantakos, 1998). The researcher has an obligation to respect the rights, values and desires of the respondents. A possible researcher, keep data collected from respondents confidentially and record information accurately. Basing on these ethical issues, the following steps were made to reach the respondents thereby protecting their rights.

The consent of the respondents was obtained so that they could fully and voluntarily participate in the study. The purpose of the study was explained to the respondents with a covering letter attached to the questionnaire. Confidentiality was ensured since questionnaire to respondents did not require them to write their names and addresses.

The questionnaire was then administered personally to the mathematics teachers and the students. The questionnaire was administered personally to help improve the collection and response rate of the questionnaire. The questionnaire was collected as soon as it was completed by the respondents. This enabled the researcher to obtain 100% response rate.

However, some of the Headmasters of the participating schools were hesitant and urged the researcher to wait for an invitation before he could administer the questionnaire in the school. Consequently, this delayed the collection of the research data.

Data Processing and Analysis

The responses from the questionnaire items were coded and analyzed through the use of Statistical Package for Social Sciences (SPSS) version 21. The SPSS software was used for the data analysis because it was user friendly and did most of the analysis of the quantitative data for the researcher. The data entries were done by the researcher in order to check the accuracy of the data. Descriptive statistics such as percentage scores were calculated for participants' responses to frequency of ICT use in teaching and in learning mathematics. This was used to find out the extent to which SHS mathematics teachers and students use ICT in teaching and learning mathematics.

Independent samples t–test and One-way analysis of variance

The independent samples t-test compares the means between two unrelated groups on the same continuous, dependent variable (Lund & Lund, 2012). The One-way analysis of variance (ANOVA) is used to determine whether there are any significant differences between the means of three or more independent (unrelated) groups (Lund & Lund, 2012). One-Way ANOVA tests differences in a single interval dependent variable among three or more groups formed by the categories of a single categorical independent variable (Rutherford, 2000). The Independent samples t-test was employed to compare the means between the categories of gender, school location, availability of ICT resources and self-perceived efficacy in ICT use and One-Way ANOVA was employed to compare the means between the categories in mathematics teachers' age and teaching experience, and determine whether any of these means were significantly different from each other. Besides, the Independent samples t-test was also employed to compare the means between the categories of students' gender, school location and availability of ICT resources and One-way ANOVA was also employed to compare the means between the categories in students' age and number of years in school, and determine whether any of these means were significantly different from each other. Before Independent t-test and One-Way ANOVA were employed, the underlisted assumptions were tested.

Independent Samples t-test and ANOVA Assumptions

According to Lund and Lund (2012), the key Independent samples t-test and ANOVA assumptions are:

1. Dependent variable is either interval or ratio (continuous)
2. The dependent variable is approximately normally distributed for each combination of levels of the independent variables.
3. Homogeneity of variances of the groups formed by the different combinations of levels of the two independent variables.

Normality Test

Lund and Lund (2012) argued that an assessment of the normality of data is a prerequisite for many statistical tests as normal data is an underlying assumption in parametric testing. According to them, there are two main methods of assessing normality - graphically and numerically. To determine whether the dependent variables (teachers' ICT use and students' ICT use) were normally distributed for each combination of the levels of the independent variables, test of Normality was employed. The test of Normality for both teachers' ICT use is presented in Table 3.

Table 12 - *Shapiro-Wilk Test of Normality for Teachers' ICT Use*

Factor	Categories	Statistics	df	Shapiro-wilk Sig
	Female	0.77	6	0.05
Gender	Male	0.94	33	0.06*
			18	0.08*
			17	0.07*
Age	24-30	0.91		
	31-40	0.90		
	Above 40	0.88	4	0.35*
	1-5	0.90	14	0.12*
Teaching experience	5-10	0.93	13	0.32*
	Above 10	0.89	12	0.12*
School location	Rural	0.93	20	0.13*
	Urban	0.90	19	0.10*
Availability of ICT Resources	Low	0.89	6	0.32*
	High	0.91	33	0.07*
			14	0.11*
			25	0.19*
Self-perceived efficacy	Low Self-efficacy			
	High Self-efficacy	0.9 0.94		

*Normal (P>0.05). Survey data (2016)

Table 3 shows the results of the Shapiro-Wilk Test of Normality for teachers ICT use. Shapiro-Wilk Test is more appropriate for small sample sizes (< 50 samples) but can also handle sample sizes as large as 2000 (Lund & Lund, 2012). For this reason, the researcher employed the Shapiro-Wilk test as the numerical means of assessing normality. It can be observed from Table 3 that the dependent variables; teachers' ICT was normally distributed.

Table 4 shows the results of the Shapiro-Wilk Test of Normality for students' ICT use.

Table 13 - *Shapiro-Wilk Test of Normality for Students' ICT Use*

				Shapiro-Wilk
Factors	Categories	Statistics	df	Sig.
Gender	Female	099	84	0.81
	Male	0.98	110	0.07
Age	12-15	0.99	78	0.85
	16-20	0.98	109	0.10
	Above 20	0.92	8	0.44
Number of	1-5	0.93	50	0.06
years in	6-10	0.96	75	0.12
school	Above 10	0.98	69	0.52
School	Rural	0.97	99	0.41
location	Urban	0.99	95	0.09
	Low		109	
	resources		85	
Availability of	avai.			
ICT resources	High			
	resources	0.96		0.08
	avai.	0.99		0.43

*Normal (p>0.05) Source: Survey data (2016)

It can be observed from Table 4 that the dependent variables; students' ICT use was also normally distributed. If the p-value of the Shapiro-Wilk Test is greater than 0.05 then the data is normal. If it is below 0.05 then the data significantly deviate from a normal distribution (Lund & Lund, 2012). Therefore, the assumption of dependent variable being approximately normally distributed for each combination of the levels of the independent variables was met.

Test of Equality of Error Variances

To test whether the independent variables teachers' age, gender, teaching experience, school location, availability of ICT resources and teachers self-perceived efficacy in ICT use have equal variances and also students' age, gender, form, school location and availability of ICT resources have equal variance, Levene's test was employed. Levene's test is used to assess the tenability of the assumption of equal variances (homogeneity of variance). Levene's test looks at whether there are any significant differences between group variances (Field, 2005). Levene's Test of equality of error variances for both teachers and students ICT use is presented in Table 5 and Table 6 respectively.

Table 14 - *Levene's Test of Equality of Error Variances for Teachers' ICT Use*

Factor	Levene Statistics (F)	df1	df2	Sig.
Gender	3.95	1	38	0.06*
Age	1.89	2	36	0.17*
Teaching experience	0.82	2	37	0.45*
School location	5.31	1	38	0.08*
Availability of ICT resources	0.01	1	38	0.92*
Self-perceived efficacy	5.42	1	38	0.06*

Source: Survey data (2016)

The results in Table 5 show that there is homogeneity of variances of the dependent variable across groups ($p > 0.05$)

Table 15 - *Levene's Test of Equality of Error Variances for Students' ICT Use*

Factor	Levene Statistics (F)	df1	df2	Sig.
Gender	5.92	1	198	0.06*
Age	1.66	2	191	0.19*
Number of year in school	0.40	2	197	0.67*
School location	0.57	1	198	0.45*
Availability of ICT resources	0.08	1	198	0.78*

*Equal variance across group (P>0.05) Source: Survey data (2016)

The results in Table 6 show that there is homogeneity of variances of the dependent variable across groups ($p > 0.05$). If the p-value had been less than 0.05 then the researcher would have concluded that the variance across groups was significantly different (unequal) (Lund &Lund, 2012). Therefore, the assumption of homogeneity of variance was met.

Chapter Summary

The study was conducted to investigate ICT use by SHS mathematics teachers and students and the factors that influence it in the Central region of Ghana. The data collected from both teachers and students were analysed by using descriptive procedures. Independent sample t-test and One-way ANOVA were conducted to find out whether SHS mathematics teachers' ICT use in teaching was influenced by their gender, age, teaching experience, school location, availability of ICT resources and self-perceived efficacy in ICT use. Besides, Independent sample t-test and One-way ANOVA were also conducted to find out whether SHS students' ICT use in learning was also determined by their gender, age, number of years in school, school location and availability of ICT resources. The Central region was chosen as a site for the study because it is the cradle for western education where most of the high performing Senior High Schools are located. The researcher, therefore, considered the Central region appropriate to conduct this research. Moreover, the researcher has been teaching in the region for the past 16 years and knows the academic environment in the region.

CHAPTER FOUR

RESULTS AND DISCUSSION

Overview

This chapter discusses the presentation, analysis and interpretation of data obtained from the survey conducted in the eight Senior High Schools in Central Region about the use of ICT mathematics room. The data were organized and presented using descriptive statistics including frequency tables. The results are presented under the following themes:

1. Demographic information of participants
2. SHS mathematics teachers' use of technology in teaching
3. SHS students' use of technology in learning mathematics
4. Factors influencing SHS mathematics teachers' technology use in teaching
5. Factors influencing SHS students' technology use in learning mathematics

Demographic Information of Respondents

Forty (40) mathematics teachers were sampled for the study. Out of the 40 mathematics teachers sampled, 85% were male and 15% were female. It is not surprising that majority of the teachers were males because majority of females do not do mathematics at the pre-service education level. The gender distribution of the teachers is presented in Table 16.

Table 16 - *Frequency Distribution of Gender of Mathematics Teachers*

Gender	Respondents				Total	
	Rural		Urban			
	No.	%	No.	%	No.	%
Female	3	15	3	15	6	15
Male	17	85	17	85	34	85
Total	20	100	20	100	40	100

Source: Survey data (2016)

The gender distribution of teachers shows that equal number of male and female teachers was selected from both rural and urban districts. The age distribution of the teachers is presented in Table 17.

Table 17- *Frequency Distribution of Teachers' Age*

Age	Respondents				Total	
	Rural		Urban			
	No.	%	No.	%	No.	%
24-30	12	60	6	31.6	18	46.1
31-40	8	40	9	47.3	17	43.6
Above 40	0	0	4	21.1	4	10.3
Total	20	100	19	100	39	100.0

Source: Survey data (2016)

The age distribution of the teachers shows that majority of the teachers (46.15%, n = 18) were within the age range of 24-30 years followed by the range of 31 – 40 (43.59%) years. This suggests that as a whole, about 89.74% of the respondents that participated in this study were in their 20s and 30s. These teachers were selected because they were the ones trained in universities in the 2000s whereby interaction with computers was made part and parcel of their training. The other 10.26% of the respondents, who were in their 40s, probably did not have the exposure to computers as a subject matter during their preservice education. Besides, the participants teaching experience ranged from 1 to 25 years. The distribution of the teachers teaching experience is presented in Table 18.

Table 18 - *Teaching Experience of Respondents*

Teaching experience	Respondents				Total	
	Rural		Urban			
	No.	%	No.	%	No.	%
1-5	11	55.0	3	15.0	14	35.0
6-10	6	30.0	8	40.0	14	35.0
Above 10	3	15.0	9	45.0	12	30.0
Total	20	100	20	100	40	100

Source: Survey data (2016)

The results in Table 18 show that 35% (n = 14) of the teachers had teaching experience ranging from 1 –5 years and 35% also ranging 6 –10 years. These teachers were selected because the researcher wanted to find out whether these newly posted teachers use more ICT in their teaching than the older teachers. The frequency distribution of ICT resources available for teachers is presented in Table 19.

Table 19 - *Frequency Distribution of ICT Resources Available for Teachers*

Availability of ICT resources	Responses				Total	
	Rural		Urban			
	N	%	N	%	N	%
Computer lab in school	20	100.0	20	100.0	40	100.0
Lab computers connected to internet	0	0.0	10	50.0	10	25.0
Personal computers	17	85.0	19	95.0	36	90.0
Projector(s) in the computer lab	15	75.0	20	100.0	35	87.5

Source: Survey data (2016)

The frequency distribution of ICT resources available for teachers shows that none of the rural SHS had laboratory computers connected to the internet. All the mathematics teachers sampled indicated that they have computer laboratory in their school and 90% indicated that they have their personal computers. The questionnaire items 15 and 17 were summed up and re-coded into mathematics teachers' High perceived-efficacy and Low perceived efficacy in ICT as indicated in Chapter 3.

Table 20 - *Frequency Distribution of Teachers' Self-Perceived Efficacy in ICT Use*

Perceived Efficacy	No.	%
Low	14	35
High	26	65
Total	40	100

Source: Survey data (2016)

The frequency distribution of teachers' self-perceived efficacy in ICT use shows that majority of the mathematics teachers (65%) have a High-perceived efficacy in ICT use.

The gender distribution of students is presented in Table 21.

Table 21 - *Frequency Distribution of Students' Gender*

Gender	Respondents				Total	
	Rural		Urban			
	No.	%	No.	%	No.	%
Female	51	51.0	36	36	87	43.5
Male	49	49.0	64	64	113	56.5
Total	100	100	100	100	200	100

Source: Survey data (2016)

Two hundred (200) students were sampled for the study. Out of the 200 students sampled, 56.5% were male and 43.5% were female. The gender distribution of students shows that majority of female students were from the rural districts and majority of the male students were from urban districts. The age distribution of students is presented in Table 22.

Table 22 - *Frequency Distribution of Students' Age*

Age	Respondents				Total	
	Rural		Urban			
	No.	%	No.	%	No.	%
15-17	44	44.4	44	46.3	78	40.2
18-20	64	64.6	44	46.3	108	55.7
Above 20	1	1.0	7	7.4	8	4.1
Total	99	100	95	100	194	100

Source: Survey data (2016)

Ninety seven percent (97%) of the students who reported their age were within the age range of 15-24 years. The average age of the students was 18 years.

The age distribution of the students shows that majority (55.7%, n = 108) of the students were within the age range of 18 –20 years.

The frequency distribution of students' Form is presented in Table 23.

Table 23 - *Frequency distribution of students' Form*

Form	Respondents				Total	
	Rural		Urban			
	No.	%	No.	%	No.	%
Form 1	34	34	43	43	77	38.5
Form 2	66	66	57	57	123	61.5
Total	100	100	100	100	200	100

Source: Survey data (2016)

Out of the 200 students who reported their form, 25.5% were in Form (Year) 2, 38.5% were in Form (Year) 3 and 36% were in Form (Year) 4. The frequency distribution of students Form shows that majority of the students were in Form 2. None of the Form 3 students was selected because the Form 3 students had completed and left the school at the time the questionnaire was administered.

The distribution of the availability of ICT resources for students is presented in Table 24.

Table 24 - *Frequency Distribution of Availability of ICT Resources for Students*

Availability of ICT resources	Responses				Total	
	Rural		Urban			
	N	%	N	%	N	%
Computer lab	100	100	100	100	200	100
Lab computer connected to internet	0	0	50	50	50	25
Mobile phone at home	91	91	97	97	188	94
Computer at home	57	57	82	82	139	69.5
Home computer connected to internet	23	23	43	43	66	33

Source: Survey data (2016)

The frequency distribution of ICT resources available for students shows that all the schools selected have computer laboratory but none of the schools from rural districts has computers in the laboratory connected to the internet.

SHS Mathematics Teachers' Use of ICT in Teaching

The first research question raised in this study was to find out the extent to which SHS mathematics teachers use ICT in teaching. To answer this question, the mathematics teachers' general use of ICT; their use of computer in teaching mathematics; and their use of calculator in teaching mathematics; were examined. As indicated in Chapter 3, the mathematics teachers were made to respond to five-point Likert scale items on the frequency of engaging in various activities that involve ICT. For each of the ICT 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 ICT use and a mean value above 1.0 indicates a high level of ICT use.

Mathematics Teachers' General use of ICT

Table 25 shows the percentage of general usage by teachers in the various ICT applications.

Table 25 - *Proportion of Mathematics Teachers' Ratings of Their General Use of ICT*

Item	Responses						Total	
	Often		Rarely		Never			
	N	%	N	%	N	%	N	%
Finding information on internet for teaching	27	67.5	10	25	3	7.5	40	100
Communicating with colleagues and students	27	69.5	5	12.8	7	17.9	39	100
Sending email	27	67.5	11	27.5	2	5	40	100
Attaching files to email message	17	42.5	12	30	11	27.5	40	100
Preparing teaching notes/materials using MS word	15	38.5	10	25.6	14	35.9	39	100
Creating spreadsheet (MS Excel)	9	22.5	14	35	17	42.5	40	100
Making presentations (PowerPoint)	5	13.5	7	18.9	25	67.6	37	100
Creating database (MS Access)	5	12.8	9	23.1	25	64.1	39	100

Source: Survey data (2016)

The results in Table 16 show that 67.5% mathematics teachers often use ICT for finding information on the internet for teaching 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 ICT 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 ICT in general internet application, very few of them use applications involving Microsoft Word.

Mathematics Teachers' use of Computer in Teaching

Another sub-heading considered was mathematics teachers 'use of computer in teaching. Table 26 indicates mathematics teachers' use of computer in teaching.

Table 26 - *Proportion of Mathematics Teachers' Rating on Their Use of Computer in Teaching as Often, Rarely or Never*

Items	Ratings						Total	
	Often		Rarely		Never			
	N	%	N	%	N	%	N	%
Investigating the nature of graph of functions	9	23.7	12	31.6	17	44.7	38	100
Drawing graphs of grouped data	10	25	15	37.5	15	37.5	40	100
Drawing graphs of logarithmic functions	7	17.5	7	17.5	26	65	40	100
Drawing graphs of trigonometric functions and find their solutions	7	17.9	8	20.5	24	61	39	100
Drawing scatter diagram	6	15.4	8	20.5	25	64.1	39	100

for bivariate distribution

Source: Survey data (2016)

The results in Table 26 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 27 presents mathematics teachers' use of calculator in teaching.

Table 27 - *Proportion of Mathematics Teachers' Ratings of their Use of Calculator in Teaching*

Items	Ratings						Total	
	Often		Rarely		Never			
	N	%	N	%	N	%	N	%
Expressing recurring decimals as common fraction	26	65	8	20	6	15	40	100
Calculating the mean, median and standard deviation	20	50	16	40	4	10	40	100
Determining the depreciation of an item over a period of time	11	28	12	30	17	42.4	40	100

Source: Survey data (2016)

Table 27 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.

On the contrary, the open-ended question on the benefit of ICT to both teachers and students in the teachers' questionnaire revealed that majority (91%) of the teachers believe that ICT plays an important role in teaching and learning mathematics. For instance, one teacher admitted that technology helps *"students develop problem solving skill"*. Another teacher said that *"students' abstract thinking about some topics will be curbed gradually"*. Another teacher further said that ICT enables *"easy, simplification and reduction of lengthy and unnecessary steps"*. Besides, one teacher admitted that ICT *"give students access to powerful new ways to explore concept"*. Also another teacher said that *"graphs can easily be drawn hence saving time"* and lastly one teacher admitted that "ICT helps teachers to verify accuracy in calculations and diagrams. The study further revealed that very few of the mathematics teachers (19.4%) have participated in professional development course related to ICT integration in mathematics.

SHS Students' Use of ICT in Learning Mathematics

The second research question raised in this study was to find out the extent to which SHS students use technology in learning mathematics. To answer this question, the students general use of ICT; their use of computer in learning mathematics; and their use of calculator in learning mathematics; were examined. As indicated in Chapter 3, the students were made to respond to items on Likert scale.

SHS Students' General Use of ICT

The first subheading considered was SHS students' general use of ICT. Table 19 shows the percentage of usage by students in the various ICT applications.

Table 28 - *Students' General Use of ICT*

Item	Ratings						Total	
	Often		Rarely		Never			
	N	%	N	%	N	%	N	%
Communicating with friends (e.g. facebook, yahoo messenger, skype)	82	40.0	16	8.0	101	50.8	199	100
Using calculator in the mobile phone for calculator	65	34.2	58	30.5	67	35.3	190	100
Finding information on the internet to do assignment	50	25.4	21	10.0	126	64.0	197	100
Sending email	48	24.2	25	12.6	125	63.1	198	100
Creating spreadsheet	24	12.2	16	8.1	157	79.7	197	100
Preparing assignment using MS word	23	11.7	19	9.7	154	78.6	196	100
Attaching files to email message	16	8.0	19	9.5	164	82.4	199	100
Making presentation (PowerPoint)	15	1.5	9	4.6	170	87.6	194	100
Creating database (MS Access)	6	3.1	3	1.6	182	95.3	191	100

Source: Survey data (2016)

Table 28 shows that very few of the students use ICT to communicate with friends *(e.g. Facebook, Yahoo Messenger, Skype)* (40.0%), use calculator in the mobile phone for calculation (35.3%), create database (MS Access) (3.1%), make presentation (PowerPoint) (7.5%), and attach files to email message (8.0%). This indicates that SHS students' use of ICT in general computer applications is very low.

Students' Use of Computer in Learning Mathematics

The second subheading considered was SHS students' use of computer in learning mathematics. Table 29 presents students' use of computer in learning mathematics.

Table 29 - *Students' Ratings of their Use of Computer in Learning Mathematics*

Item	Ratings						Total	
	Often		Rarely		Never			
	N	%	N	%	N	%	N	%
Investigating the nature of graph of functions	6	3.0	6	3.0	186	93.9	198	100
Drawing graphs of grouped data	10	5.0	8	4.0	180	90.9	198	100
Drawing graphs of logarithmic functions	1	0.5	1	0.5	196	99.0	198	100
Drawing graphs of trigonometric functions and find their solutions	0	0.0	1	0.5	196	99.5	197	100
Drawing scatter diagram for bivariate distributions	0	0.0	0	0.0	198	100	198	100

Source: Survey data (2016)

The results in Table 29 show that majority (97.7%) of SHS students never or rarely used computer in learning mathematics. Very few students used computer to draw graphs of grouped data (5.0%) and to investigate the nature of graph of functions (3.0%). None of the students use computer to draw graphs of trigonometric functions and find their solutions and also draw scatter diagram for bivariate distributions. This indicates that the extent to which SHS students use computer in learning mathematics is very low.

Students' Use of Calculator in Learning Mathematics

The last subheading considered was SHS students' use of calculator in learning mathematics. Table 30 shows proportion of students' use of calculator in learning mathematics.

Table 30 - *Students' Ratings of Use of Calculators in Learning Mathematics*

Items	Responses						Total	
	Often		Rarely		Never			
	N	%	N	%	N	%	N	%
Expressing recurring decimals as common fractions	132	66.0	12	6.1	54	27.3	198	100
Calculating the mean, median and standard deviation	115	58.4	10	5.1	72	36.5	197	100
Determining the depreciation of an item over a periods of time	94	47.5	12	6.1	92	46.5	198	100

Source: Survey data (2016)

The results in Table 30 show that SHS students often use calculator in learning mathematics. Majority of the students indicated that they often used calculator to: express recurring decimals as common fractions (66.0%), calculate the mean, median and standard deviation (58.4%), and determine the depreciation of an item over a period of time (47.5%) when asked of their frequency of calculator use for learning mathematics. This indicates that SHS students' use of calculator in learning mathematics is high.

The open-ended items in the students' questionnaire revealed that students (98%) were not allowed to use the computer laboratory after classes and during weekends. However, they were only allowed to use the computer laboratory once every week.

Factors Influencing SHS Mathematics Teachers' ICT use in Teaching

The overall mean score of teachers' ICT use was computed from their ratings on the five-point Likert scale. This was used as the proxy score for the mathematics teachers' ICT use in teaching the subject. For each of the ICT item computed, the mean score ranged from 1(minimum) to 5 (maximum). A mean value below 3.0 indicates a low level of ICT use and a mean value above 3.0 indicates a high level of ICT use. Table 31 shows the overall mean score of teachers' ICT use in teaching.

Table 31 - *Mean score of teachers' ICT use in teaching*

	N	Minimum	Maximum	Mean	Std. deviation
ICT use in teaching mathematics	40	1	5	2.48	1.12

Source: Survey data (2016)

The results show that the mathematics teachers' overall use of ICT 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 ICT use close to zero or Never.

The third research question raised in this study was to find out which of the demographic factors (i.e. gender, age, teaching experience, school location, availability of ICT resource and self-perceived efficacy in ICT use) influence mathematics teachers' ICT use in teaching. To determine this, the mean ICT use of the categories in each of the factors was computed (see Table 23 and Table 24). To answer this question, the mean score on the mathematics teachers' ICT use were analyzed for differences in the categories for each of the six demographic factors - gender, age, teaching experience, school location, availability of ICT resources and teachers' self-perceived efficacy in ICT use.

Table 32 and Table 33 present the independent samples t-test and one-way ANOVA test results on the factors influencing teachers' ICT use in teaching mathematics respectively.

Table 32 - *Factors Influencing Teachers' ICT Use in Teaching*

Factor	Categories	N	Mean	Std. Dev.	df	t	Sig.
Gender	Female	6	1.57	0.47	38	-2.44	0.02*
	male	34	2.65	1.12			
School Location	Rural	20	2.41	0.91	38	-0.41	0.68
	urban	20	2.56	1.32			
Availability of ICT resources	Low resources	6	2.28	1.00	38	- 0. 46	0.65
	Available High resources	34	2.52	1.15			

	Available						
Self-perceived efficacy T	Low perceived High perceived	14 26	1.63 2.94	0.52 1.10	38	- 4.23	0.00**

Significant(p<0.05); * Highly Significant(p<0.001) Source: Survey data (2016)

It can be observed from Table 32 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 ICT (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' ICT use in teaching.

Table 33 - *Other Factors Influencing Teachers' ICT Use in Teaching*

Factor	Categories	N	Mean	Std. Dev.	df	f	Sig.
Age	24–30 years	18	2.73	1.09			
	31-40 years	17	2.59	1.14	36	0.94	0.40
	Above 40 years	4	2.21	103			
Teaching experience	1-5 years	14	2059	0.98			
	6-10 years	14	2.40	1.13	37	0.10	0.91
	Above 10 years	12	2.46	1.34			

Significant (p<0.05); **Highly Significant (p<0.0001) Source: Survey data (2016)

The results in Table 33 show 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 ICT (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' ICT use in teaching.

Factors Influencing SHS Students' ICT use in Learning Mathematics

The overall mean score of students' ICT use was computed from their ratings on a five-point Likert scale. This was used as the proxy score for the SHS students' ICT use in learning mathematics. Table 34 shows the overall mean score of students' ICT use in learning mathematics.

Table 34 - *Mean Score of Students' ICT Use in Learning Mathematics*

N	Minimum	Maximum	Mean	Std. deviation
200	1	5	2.07	0.53

Source: Survey data (2016)

The results show that the students' overall use of ICT in learning mathematics is low since the mean score of 2.07 is below 3.0 and the standard deviation of 0.53 meaning most of the students' rated their ICT use close to zero or Never.

The fourth research question raised in this study was to find out which of the demographic factors (i.e. gender, age, number of years in school, school location and availability of ICT resources) influence students' ICT use in learning mathematics. To determine this, the mean ICT use of the categories in each of the factors was computed (see Table 35 and Table 36). To answer this question, the mean scores of the students' ICT use were analyzed for differences in the categories for each of the five demographic factors -gender, age, number of years in school, school location and availability of ICT resources.

Table 35 and Table 36 present the Independent t-test and the One-way ANOVA test results on factors influencing students' ICT use in learning mathematics respectively.

Table 35 - *Factors Influencing Students' ICT Use in Learning Mathematics*

Factors	Categories	N	Mean	Std. deviation	df	t	Sig
Gender	Female	87	2.01	0.43	198	-144	0.152
	Male	113	2.11	0.59			
School location	Rural	100	1.94	0.54	198	-3.50	0.001**
	Urban	100	2.19	0.48			
Availability of ICT resources	Low resource available	112	1.88	0.50	198	-5.99	0.00**
	High resources available	88	2.30	0.47			

Significant ($p<0.05$); **Highly significant ($p<0.0001$) Source: Survey data (2016)

Table 36 - *Other Factors Influencing Students' ICT Use in Learning Mathematics*

Factors	Categories	N	Mean	Std. deviation	df	t	Sig
Age	15-17 years	78	2.08	0.44	191	4.69	0.01*
	18-20 years	108	2.03	0.56			
	Above 20 years	8	2.61	0.59			

Number of years in school	Year 1	123	4.19	1.04	197	0.03	0.05
	Year 2	77	2.00	0.52			

Significant ($p<0.05$); **Highly significant ($p<0.0001$) Source: Survey data (2016)

It can be observed from Table 35 and Table 36 that there are differences in the mean scores in the categories of the various factors, but the differences in the mean scores of age ($F = 4.96$, $p = 0.01$), school location ($t = -3.50$, $p= 0.001$) and availability of ICT resources ($t = -5.99$, $p = 0.00$) were found to be statistically significant.

Discussion of the Results

The study was conducted to find out the extent of ICT use among Ghanaian SHS mathematics teachers and students and the factors that determine usage. In order to achieve this, four research questions were answered were formulated.

The research question 1 investigated SHS mathematics teachers' use of ICT in teaching mathematics. The findings revealed that the mathematics teachers often use ICT 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 ICT 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 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. 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 in Western England, even though teachers show great interest and motivation to learn about the potential of technology, in practice, the use of technology is relatively low. Also, teachers' use of technology 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 ICT in mathematics instruction is yet to be realized and utilized.

It is quite surprising that the extent to which the SHS mathematics teachers use ICT in teaching is very low because majority (89.2%) of the teachers believe that ICT plays important role in teaching and learning mathematics. The mathematics teachers' low ICT use was found to be partly due to the fact that the mathematics teachers lack the skills to integrate ICT in their teaching since they have had little opportunity to participate in professional development courses related to ICT integration.

The research question 2 investigated the extent to which SHS students use ICT in learning mathematics. The findings revealed that the students often use calculator to express recurring decimals as common fractions, to calculate the mean, median and standard deviation, to determine the depreciation of an item over a period of time. This finding is consistent with the findings of Kaino and Salani (2004) who revealed that majority of students in Botswana used and enjoyed working with calculators. The finding further revealed that the students overall use of ICT in general computer applications and in learning mathematics was very low. This finding is in consonance with the findings from Boakye and Banini (2008) who concluded that SHS student use of technology for academic purposes, communication and research is very low. Faekah and Ariffin (2005) also found that students were not skillful in computing. Very few of them send messages via e-mail, search for information on the web and print documents or images.

The findings from the open-ended responses revealed that the extent to which the students use ICT in learning mathematics is very low. This was as a result of the fact that the students were not allowed to use the computer laboratory after classes and during weekends. However, the students were only allowed to use the computer laboratory once every week. Besides, the extent to which the mathematics teachers use ICT in teaching is very low and this might affect the students' use of ICT in learning mathematics. Chu (2004) argued that students' perceived usefulness of technology in learning is highly dependent of teachers' actual implementation of technology in the mathematics classrooms. He further argued that students would not be motivated to use ICT unless they have had enough hands-on experience in using some mathematics software or websites in the school.

Furthermore, the study also investigated the factors that influence SHS mathematics teachers' ICT use in teaching. The findings revealed that gender was found to statistically influence teachers' ICT 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, et al. (2010) revealed that gender significantly influence participant' 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 ICT in their teaching than the female teachers. This finding is in line 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. Also, male teachers were found to be using more ICT in their teaching than the female teachers. In Ghana this may be due largely to the fact that very few females teach mathematics at the SHS level.

The findings further revealed that self-efficacy in ICT use influence teachers' ICT use in teaching mathematics. This finding is consistent with the findings of a similar study conducted by Samah, et 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 influenced their intentions to use software in their future classrooms. The finding was in line with Valsiner (1997) Zone of Proximal Development which is a gap between a learner's present capabilities and the higher level of performance that could be achieved. If a person believes that he/she is capable of accomplishing a specific task, then that person will definitely start the task. Therefore, teachers with high perceived efficacy in ICT use will definitely use ICT in their teaching.

The investigation on factors influencing SHS students' ICT use in learning mathematics revealed that age statistically influence students ICT use in learning mathematics. This result also corroborated the research findings of Al-Ghaith, et al. (2010) who found that age has a significant influence on people's access to and use of the Internet and its services. The mean differences in the age usage revealed that SHS students who were above 20 years use more ICT than their colleagues who were below 20 years. The mean differences in their ICT use might be due to the fact that those students above 20 years were exposed to ICT earlier before their colleagues.

The findings also revealed that location of the school influences students' ICT use in learning mathematics. This confirms what Cassim and Eyono Obono (2011) said. Cassim and Eyono Obono (2011) posited that school location has the tendency of influencing technology adoption in South Africa high schools. The differences in the mean usage between rural and urban students in Ghana might be due to the fact that urban students have more access to ICT than their colleagues in the rural districts. All the students from the rural districts indicated that they have no internet in their schools while over 50% of the students from urban districts indicated that they have internet in their schools. The findings further revealed that availability of technology resources also affects students' technology use in learning mathematics. In a related study, Mereku et al. (2009) found that the availability of ICT resources such as ICT syllabuses/manual, computers and computer laboratories have a significant influence in students ICT use at the SHS level in Ghana. Similarly, Nor (2004) found that availability of ICT resources facilitate the implementation of information and communication technology integration in the Malaysian secondary school curriculum. Besides, Crisan (2004) found that the availability of technology facilities is a contextual factor that influences technology use in mathematics. The finding corroborated with the work of Valsiner's (1997) zone of Free Movement which indicated that the availability of different objects within an accessible area, and the ways the individual is permitted or enabled to act with accessible objects in accessible areas influences the person's ICT use. However, high ICT resources available in a particular school will influence the students' ICT use. The differences in the mean usage revealed that Ghanaian SHS students with high ICT resources available use more ICT than their colleagues with low ICT resources available. The reason for such a finding could be that students having high ICT resource available might definitely use more ICT than their colleagues with low ICT resources available.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Overview

This chapter presents a summary of the findings, conclusion and outlines recommendations including areas for further research.

The study explored the extent of ICT use by Ghanaian mathematics teachers and students at the SHS level. Specifically it explored the SHS mathematics teachers and students general ICT use; computer and calculator use in teaching and in learning mathematics. Mathematics teachers and students in the Central region of Ghana were used for the study. Stratified sampling technique was used to select 40 SHS mathematics teachers and 200 students for the study. Self-administered questionnaire was used as an instrument for the study. The questionnaire was based on the ICT requirement in the SHS mathematics syllabus. The data collected were analyzed quantitatively using SPSS. Descriptive statistics was used to find the extent to which SHS mathematics teachers and students use ICT in teaching and learning mathematics. Independent samples t-test and One-way analysis of variance (ANOVA) were used to find whether the demographic factors(i.e. gender, age, teaching experience, number of years in school, school location, availability of ICT resources and self-perceived efficacy in ICT use) influence mathematics teachers and students' ICT use at the SHS level. The major findings are summarized in the section that follows:

Key Findings

The key findings of the study are as follows:

It was found in this study that the extent to which SHS mathematics teachers use ICT in teaching mathematics was very low. The study revealed that majority of the mathematics teachers use ICT for general applications such as finding information on the Internet for teaching, communicating with colleagues and students, sending emails, attaching files to email messages and preparing teaching notes for teaching. But the extent to which the teachers use ICT in teaching mathematics as suggested by the SHS mathematics syllabus is very low. The study also revealed that the extent to which SHS students use ICT in learning mathematics was very low. Although majority of the students use the calculator in expressing recurring decimals as common fractions, calculating the mean, median and standard deviation and determining the depreciation of an item over a period of time very few of them use ICT in applications involving Microsoft Word and in learning mathematics. The study further revealed that gender and self-perceived efficacy in ICT use statistically influence SHS mathematics teachers' ICT use in teaching. However, teachers' age, teaching experience, school location and availability of ICT resources did not statistically influence their ICT use in teaching mathematics.

Finally, the study indicated that age, school location and availability of ICT resources influence SHS students' ICT use in learning mathematics. However, gender and number of years in school did not statistically influence students' ICT use in learning mathematics.

Conclusions

The study had revealed that the extent to which SHS mathematics teachers use ICT in teaching was very low even though majority of the teachers believe that ICT play important role in mathematics. This was found to be due in part to the fact that the mathematics teachers lack the skills to integrate ICT in their teaching. This is as a result of the little opportunity they have had to participate in professional development courses related to ICT integration. The study also revealed that the extent to which SHS students use ICT in learning mathematics was very low. This was also found to be due to the fact that majority of the students were not allowed to use the computer laboratory after classes and during weekends but only allowed to use the laboratory once every week. It was also attributed to the low ICT use in teaching by mathematics teachers which consequently affects the students' use of ICT in learning mathematics.

The extent to which the mathematics teachers and students use ICT in teaching and learning mathematics was crucial because the knowledge gained could provide insights into teachers and students ICT use at the SHS level that could be sustainable and transferable to other educational institutions. The study also provided empirical evidence on the factors that influence technology use in teaching and learning mathematics at the SHS level in Ghana. This knowledge gained could provide guidance for policy makers and stakeholders in education when structuring and introducing ICT integration policies in the Senior High Schools. It was found that SHS mathematics teachers' ICT use in teaching is influenced by gender and self-perceived efficacy in ICT use. However, age, teaching experience, school location and availability of ICT resources did not influence the mathematics teachers' technology use in teaching. The study further revealed that age, school location and availability of ICT resources influence SHS students' ICT use in learning mathematics, whereas gender and number of years in school did not influence their ICT use. In view of the findings made and conclusion drawn after analyzing the data, the following recommendations deserve consideration.

Recommendations

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

1. 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.
2. 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.
3. The Heads of the institutions should make budgetary allocations annually to maintain, replace and expand ICT facilities and resources in the schools in order to promote effective integration in the teaching and learning of mathematics.
4. The Heads of the institutions in collaboration with the Heads of Departments should emphasize the use of computer laboratory

during weekends and after classes as part of the co-curricular activities in the secondary schools. This will enable the students to get enough time to use the laboratory computers in learning mathematics.

Suggestions for Further Research

The following are recommended for further research; It is suggested that this study should be replicated to include Form three students in Central region. Similar study should be conducted in other regions in Ghana and the results compared with my research.

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APPENDICES

Appendix A

Teachers' Questionnaire

Dear Colleague

The purpose of this questionnaire is to gather data on your observations on ***Information and communication Technology use in SHS mathematics*** *classrooms in your school. Your thoughtful and truthful responses will be greatly appreciated. Please answer each question to the best of your knowledge. Your name is not required. Your responses will be kept completely confidential. Thank you for taking time to complete this questionnaire*

Instructions

Please tick [√] in the appropriate space provided below and supply answers where required.

A. Background Information

1. Gender Female ☐ Male ☐
2. Age ……………………………….. ……………………..years
3. Teaching experience ………………………………………years
4. Do you have a computer laboratory in your school?YES ☐ NO ☐

   b. If yes, how many computers are there in the laboratory? …………..

   c. If yes, how many of the computers are in good use? ……………..

5. Are any of the computers connected to internet? YES ☐ NO ☐

   b. If yes, how many ………….

6. Do you own a computer? YES ☐ NO ☐

7. Do you have projector(s) in the ICT laboratory? YES ☐ NO ☐

8. Are specialized software for teaching mathematics installed on the laboratory computers? YES ☐ NO ☐

9. Have you participated in professional development course related to the integration of ICT in teaching and learning of mathematics YES ☐ NO ☐

B. **Teachers Information and Communication Technology usage**

10. Do you use computers to do the following activities? Please tick.

	I use Computers	Yes	No
I	to find information or on internet for teaching		
Ii	to communicate with colleagues and students		
Iii	to prepare teaching notes / materials using MS word		
Iv	to create spreadsheets (MS Excel)		
V	to create database (MS Access)		
Vi	to make presentations (PowerPoint)		
Vii	to send email		
Viii	to attach files to an email message		
Ix	to investigate the nature of graphs of functions		
x	to draw graphs of grouped data		
xi	to graphs of logarithmic functions		
xii	to graphs of trigonometric functions and find their solutions		
xiii	To draw scatter diagram for bivariate distributions		
	I use Calculators		

i	to express recurring decimal as common fractions		
ii	to calculate the mean, median and standard deviation		
iii	to determine the depreciation of an item over a period of time		

A. Teachers Information and Communication Technology usage

11a how often do you use technologies in the following areas? Please, rate your frequency of use: everyday, Once a week, Once a month, Once a term or Never

	I use Computers	Everyday	Once a week	Once a month	Once a term	Never
i	to find information on internet for teaching					
ii	to communicate with colleagues and students					
iii	to prepare teaching notes/materials using MS Word					
iv	to create spreadsheets (MS Excel)					
v	to create database (MS Access)					
vi	to make presentations (PowerPoint)					
vii	to send email					
viii	to attach files to an email message					

11b. How often do you use Information and Communication technology when teaching? Please, rate your frequency of use: everyday, Once a week, Once a month, Once a term or Never

	I use Computers	Everyday	Once a week	Once a month	Once a term	Never
i.	to investigate the nature of graph of functions					
ii.	to draw graphs of grouped data					
iii.	to draw graphs of logarithmic functions					
iv.	to draw graphs of trigonometric functions and find their solutions					
v.	to draw scatter diagram for bivariate distributions					
	I use Calculators					
i	express recurring decimals as common fractions					
ii.	to calculate the mean, median and standard deviation					
iii	to determine the depreciation of an item over a period of time					

B. Ability to use Information and Communication Technology

12. How would you rate your ability in using computers?

	Rate your ability to do the following using computers	t (Advanc	Good (Proficie	Satisfact ory	Learning (Needs	Poor (Can' t

i.	Finding information or an internet for teaching					
ii.	Communicating with colleagues and students					
iii.	Preparing teaching notes/materials using Ms word.					
iv.	Creating spreadsheets(Ms Excel)					
v.	Creating database(Ms Access)					
vi.	Making presentations (PowerPoint)					
vii.	Sending email					
viii.	Attaching files to an email message					
ix.	Investigating the nature of graphs of functions					
x.	Drawing graphs of grouped data					
xi.	Drawing graphs of logarithmic functions					
xii.	Drawing graphs of trigonometric functions and finding their solutions					
xiii.	Drawing scatter diagram for bivariate distributions					
	How would you rate your ability to					

	do the following using calculators?					
i.	Expressing recurring decimals as common fractions					
ii.	Calculating the mean ,median and standard deviation					
iii.	Determining the depreciation of an item over a period of time					

13. Give two reasons why you think using information and communication technology in mathematics classroom would be beneficial to teachers.

(i) ……………………………………………………………………………

……………………………………………………………………………

(ii) ……………………………………………………………………………

……………………………………………………………………………

14. Give two reasons you think using information and communication technology in mathematics classroom would be beneficial to students.

(i) ……………………………………………………………………………

……………………………………………………………………………

(ii) ……………………………………………………………………………

……………………………………………………………………………

Appendix B

Students' Questionnaire

Dear Student

The purpose of this questionnaire is to gather data on your observations on ***Information and Communication Technology use in SHS mathematics*** *classrooms in your school. Your thoughtful and truthful responses will be greatly appreciated. Please answer each question to the best of your knowledge. Your name is not required. Your responses will be kept completely confidential. Thank you for taking time to complete this questionnaire*

Instructions

Please tick [√] in the appropriate space provided below and supply answers where required.

A. Background Information

1. Gender Female ☐ Male ☐
2. Age ………………………………….. years
3. Form …………………

B. Students Information and Communication Technology usage

4. Do you have a computer laboratory in your school? YES ☐ NO ☐

   b. If yes, how many computers are there in the laboratory? …………..

   c. If yes, how many of the computers are in good use? ……………..

5. Are any of the computers connected to internet?

   YES ☐ NO ☐

   b. If yes, how many …………

6. How often do you attend ICT classes at the computer Laboratory?

Everyday ☐ Once a week ☐ Once a month ☐ Once a term ☐

Never ☐

7. Are you allowed to use the computer laboratory after classes?

YES ☐ NO ☐

b. If yes, how many hours are you allowed to spend at the Laboratory …..

8. Are you allowed to use the computer laboratory during weekends?

YES ☐ NO ☐

b. If yes, how many hours are you allowed to spend at the Laboratory ……

9. Do you use mobile phone at home? YES ☐ NO ☐

b. If yes, how often do you use the calculator in your mobile phone for calculations? Everyday ☐ Once a week ☐ Once a month ☐ Once a term ☐ Never ☐

10. Have you have computer at home? YES ☐ NO ☐

11. Is your computer connected to internet? YES ☐ NO ☐

B. Students Information and Communication Technology usage

12a How often do you use Information and communication technology in the following areas when you are in the school? Please, rate your frequency of use: everyday, once a week, once a month, once a term or never

	I use Computers	Everyday	Once a week	Once a month	Once a term	Never
i	to find information on internet to do assignment					
ii	to communicate with friends(e.g. Facebook, yahoo messages , skype)					
iii	to prepare assignment using MS Word					
iv	to create spreadsheets (MS Excel)					
v	to create database (MS Access)					
vi	to make presentations (PowerPoint)					
vii	to send email					
viii	to attach files to an email message					

12b. How often do you use Information and communication technology when learning mathematics in school? Please, rate your frequency of use: everyday, Once a week, Once a month, Once a term or Never

	I use Computers	Everyday	Once a week	Once a month	Once a term	Never
i.	to investigate the nature of graph of functions					
ii.	to draw graphs of grouped data					
iii.	to draw graphs of logarithmic functions					
iv.	to draw graphs of trigonometric functions					

	and find their solutions					
v.	to draw scatter diagram for bivariate distributions					
	I use Calculators					
i	express recurring decimals as common fractions					
ii.	to calculate the mean, median and standard deviation					
iii	to determine the depreciation of an item over a period of time					

Appendix C

Reliability Statistics of the Teachers' Questionnaire

Reliability

Case Processing Summary

		N	%
	Valid	6	35.3
Case	Excluded[a]	11	64.7
	Total	17	100

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	No of Items
0.64	20

Appendix D

Reliability Statistics of the Students' Questionnaire

Reliability

Case Processing Summary

		N	%
	Valid	3	20
Case	Excluded[a]	12	80
	Total	15	100

a. Listwise deletion based on all variables in the procedure

Reliability Statistics

Cronbach's Alpha	No of Items
0.71	21