UNIVERSITY OF EDUCATION WINNEBA

THE PERCEPTION OF GHANAIAN SENIOR HIGH SCHOOL TEACHERS AND STUDENTS ON THE INTEGRATION OF INFORMATION AND COMMUNICATION TECHNOLOGY INTO MATHEMATICS TEACHING AND LEARNING

BELINDA OWUSU MINTAH

JUNE, 2015

UNIVERSITY OF EDUCATION WINNEBA

THE PERCEPTION OF GHANAIAN SENIOR HIGH SCHOOL TEACHERS AND STUDENTS ON THE INTEGRATION OF INFORMATION AND COMMUNICATION TECHNOLOGY INTO MATHEMATICS TEACHING AND LEARNING

BELINDA OWUSU MINTAH

(8130110005)

A DISSERTATION IN THE DEPARTMENT OF MATHEMATICS EDUCATION, FACULTY OF SCIENCE EDUCATION, SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES, UNIVERSITY OF EDUCATION, WINNEBA, IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF PHILOSOPHY IN MATHEMATICS EDUCATION

JUNE, 2015

DECLARATION

STUDENT'S DECLARATION

I hereby declare that this thesis, with the exception of quotations and references contained in published works which have all been identified and duly acknowledged, is entirely my own original work, and it has not been submitted, either in part or whole, for another degree elsewhere.

NAME OF STUDENT: BELINDA OWUSU MINTAH

SIGNATURE…… **DATE**…….....

SUPERVISORS' DECLARATION

I hereby declare that the preparation and presentation of the thesis was supervised in accordance with the guidelines on the supervision of thesis as laid down by the University of Education, Winneba.

NAME OF SUPERVISOR: DR. P.O. COFIE

SIGNATURE…… **DATE**…….....

DEDICATION

This dissertation is dedicated to the Almighty God for his numerous love, mercies and strength bestowed on me to go through this study. The work is also dedicated to my Spiritual father Apostle Stephen Waye Oyina for being a source of inspiration and for his spiritual support. My father Mr. Benson Owusu and my husband Mr. Clement Amankwah. To my dearest children Keziah and Keren Amankwah.

ACKNOWLEDGEMENT

I wish to express my profound gratitude to my supervisor Dr P. O. Cofie for his encouragement and support throughout this study. May the Almighty God bless you and grant you the desires of your heart. I also want to thank all the lecturers at the Department of Mathematics UEW, especially: Prof. C. Okpoti, Prof. Aseidu-Addo, Dr. J.N. Nyala, Dr. Nabie, Dr. Assuah, and Dr. Issifu Yidana whose tuition and great thoughts have contributed in no small measure in conducting this research.

TABLE OF CONTENTS

CONTENT

Page

CHAPTER TWO

LITERATURE REVIEW

REFERENCES

APPENDICES

LIST OF TABLES

Table

Page

ABSTRACT

The purpose of the study was to find teachers and students perceptions on the integration of ICT into Mathematics teaching and learning in the Ghanaian Senior High Schools and discover the potential barriers hindering effective ICT integration. The population comprised all teachers and students in the Greater Accra Region. A simple random sampling was used to select the teachers and the students. Two public mixed and one private mixed school from the Ga South Municipality were purposefully selected. A total of twenty five (25) teachers and sixty (60) students were selected from the three schools. The research design for the study was mixed method

research design. Questionnaires were administered personally to both the teacher and the students as well interview. SPSS version 16 was used in generating the various outputs for analysis. The findings revealed that 95.8% of the teachers have not been using computers in their classroom instruction even though they have access to computers in their schools. It was also discovered that 83.3% of the schools do not have specialized software for teaching Mathematics installed on the computers in their laboratories. However, it was found out that most of the students had good perception concerning the use of computers and graphic calculators and were convinced that are good tools for learning Mathematics. It is therefore recommended that specialized software for teaching and learning Mathematics be installed on the computers in the various Senior High Schools laboratories to enable the Mathematics teachers in the SHS have access to them and use them in their teaching.

CHAPTER ONE

INTRODUCTION

1.0 Overview

This chapter is the introductory section of the study, it is on the general background of the study, statement of the problem, purpose of the study, objectives of the study, research questions, significance of the study, limitation, delimitations of the study and the organizational plan of the study.

1.1 Background of the Study

The International Society for Technology in Education (ISTE, 2007) and the National Council of the Accreditation of Teacher Education (NCATE, 2002), advocate the use of technology in education. They suggested that students should be provided opportunities to engage in technology-supported activities that enhance their learning experiences. Other organizations have also encouraged the use of technology for every aspect of teaching and learning of mathematics and, in some cases all grade levels beginning in kindergarten (Conference Board of Mathematical Sciences, 2001; National Council of Teachers of Mathematics (NCTM; 2000), Mathematics Association of America, 1991; Mathematics Sciences Education Board, 1991).

Researchers have found that Information and Communication Technology (ICT) can support learning when appropriately integrated with teaching techniques, curriculum, and assessments (Means & Haertel, 2004). The use of technology has a long history in mathematics education. ―Technology is essential in teaching and learning of mathematics; it influences the mathematics that is being taught in schools and enhances students' learning" (NCTM, 2000, p.11). Teachers who learn about technology while using it to explore mathematics topics are more likely to see its potential benefits. The use computer for example provides access to different methods, techniques, numerical computation, graphics representations, acquisition and processing of experimental data and the set of methods for production of documents. It is a tool for documentary research (online and offline resources, encyclopedias, CD-ROMs and cultural services, etc.); Self-learning (with screening assessment, response analysis, control corresponding to a real training analysis) and self-assessment: production of documents, e-mail exchanges, production of websites. It allows classes in a profound transformation of the pedagogical relationship (educational contract) teacher-student. For example, the projection of a document for

the whole class makes possible a collective effort through appropriate software (word processing, spread sheet, etc…) and can mediate the dual teacher-student relationship.

The use ICT in and for education is rapidly expanding in many countries and is now seen worldwide as both a necessity and an opportunity for improving and enhancing the education offered to citizens across the globe. (United Nations Educational Scientific and Cultural Organisation (UNESCO, 2006). Information and Communication Technology is, in fact, now regarded as ―one of the building blocks of modern society" (UNESCO, 2002) and is now considered as one of the indices that should be used to assess a society's development. Many countries globally now regard the acquisition of ICT skills as part of their ―core education, alongside reading, writing and numeracy" (UNESCO, 2002).

In relation to the learning of mathematics, The National Council of Teachers of Mathematics (NCTM 2008; NCTM 2011) emphasized technology as an essential tool and important components of a high-quality mathematics education, which can provide access to mathematics for all students. This tool supports both the visualisation and the interactive part, helping students to extend mathematical reasoning and sense making by using it for computation, construction, and representation as they explore problems. Mathematics is closely related to visualisation, and better learning can be achieved by using different representations of mathematical objects and procedures, in order to foster students' understanding of the subject. Even better is when students can interact with these visualisations and can explore on their own new features of the mathematical content.

The fundamental meaning of the term visualization is to form a mental image. According to Zimmermann and Cunningham (1991), transformation of the symbolic

into the geometric. _Visualization is the ability, the process and the product of creation, interpretation, use of and reflection upon pictures, images, diagrams, in our minds, on paper or with technological tools, with the purpose of depicting and communicating information, thinking about and developing previously unknown ideas and advancing understanding‘(Zimmermann & Cunningham, 1991, p. 3)

Computer-based technologies are now commonplace in classrooms, and the integration of these media into the teaching and learning of mathematics is supported by government policy in most developed countries. However, many questions about the impact of computer-based technologies on classroom mathematics learning remain unanswered, and debates about when and how they ought to be used continue.

For a country to compete effectively in the digital world, beginning teachers need to play an important role in integrating computer technology into the curriculum (Magliaro, 2007). The role of ICT in the school classroom is becoming increasingly prominent, both because of the need for children to develop skills that will empower them in modern society and because of the potential value of such technologies as tools for learning. One of the challenges facing teacher educators is how to ensure that graduate teachers have the necessary combination of skills and pedagogical knowledge that will enable them to both effectively use today‘s technologies in the classroom as well as continue to develop and adapt to new technologies.

ICT integration in education has its merits. Its use not only changes the traditional ways of teaching, but also requires teachers to be more creative in adapting and customizing their own teaching materials and strategies (Reid 2002). Among all the teaching methods and strategies, collaborative learning, problem-based learning, and the constructivist approach are the most widely used teaching strategies to deal with

the challenges of ICT use (Abbott & Faris 2000; Whelan 2008).The use of technology has become a standard, and with it mathematics has become a much more interesting science. In addition, just like students and teachers, business people are also utilizing modern technologies in their business routines, determining best decisions, performing statistical analysis, and assessing economic situations. This way, the use of technology is crucial in mathematical calculations in today‘s world.

To successfully initiate and implement educational technology in the school program depends strongly on teachers‘ support and attitudes. It is believed that if teachers perceived technology programs as neither fulfilling their own needs nor their students‘ needs, it is likely that they will not integrate the technology into teaching and learning. Evidence suggests that teachers‘ attitudes and beliefs influence successful integration of ICT into teaching (Hew & Brush, 2007; Keengwe & Onchwari, 2008). If teachers‘ attitudes are positive toward the use of educational technology, then they can easily provide useful insight about the adoption and integration of ICT into the teaching and learning processes.

Drent and Meelissen (2008), identify three objectives for the integration of ICT in education. These are: the use of ICT as a _discipline or profession‘; ICT as a _teaching or learning medium‘ and the use of ICT as an _object of study‘ (Drent & Meelissen, 2008, p.187). It can be gleaned from these objectives that integration involves aiding the teaching and learning process (apart from the third objective which is a discipline in itself).

Successful integration of ICT in education can lead to a number of benefits. That emerge in the future (Gill & Dalgarno, 2008)

Ittigson and Zewe (2003) stated that technology is essential in teaching and learning mathematics. ICT improves the way mathematics should be taught and enhances student understanding of basic concepts. Many researchers have carried out studies to evaluate the benefits of using ICT in mathematics.

Becta (2003) summarised the key benefits – firstly ICT promotes greater collaboration among students and encourages communication and the sharing of knowledge. Secondly, ICT gives rapid and accurate feedbacks to students and this contributes towards positive motivation. Finally, the use of ICT in mathematics classroom also allows students to focus on strategies and interpretations of answers rather than spend time on tedious computational calculations.

Furthermore, it is claimed that ICT supports constructivist pedagogy, wherein students use technology to explore and reach an understanding of mathematical concepts. This approach promotes higher order thinking and better problem solving strategies which are in line with the recommendations forwarded by the National Council of Teachers of Mathematics (NCTM); students would then use technology to concentrate on problem- solving processes rather than on calculations related to the problems (Ittigson & Zewe, 2003). Technology keeps changing so dramatically that people who do not regularly update their knowledge and skills become outdated in its usage (Daggert & Pedinott, 2005).

Daggert and Pedinott (2005), contend that many people initially welcome the introduction of technology and use of computers with skepticism, but soon realize that without them, life would be unproductive. If people become acquainted with the basics of computers and technology, they would possess the technological skills to easily transfer to other advanced technologies (Daggert & Pedinott, 2005).

Furthermore, students who have grown up in the age of information technology have a great advantage over older generations in terms of the learning curve (Daggert & Pedinott, 2005). For students to obtain a real-world rigorous and relevant education, they need to explore and master the concepts behind the up-and-coming technologies (Daggert & Pedinott, 2005).

The NCTM Principles and Standards for School Mathematics, emphasize the use of technology as an essential tool for teaching and learning mathematics effectively. Technology extends the mathematics that is taught and enhances students‟ learning by using the constructivist approach (NCTM, 2002). Constructivism allows students to construct their own understanding of mathematical concepts, so that the primary role of teaching is not to lecture, explain, or to transfer mathematical knowledge, but to create situations for students to make the necessary mental constructions (Anderson, Reder, & Simon, 2000).

Researchers (Rochelle et al., 2001; diSessa, 2001; Bransford, Brown & Cocking, 1999). Have found that when technology makes abstract ideas tangible, teachers can more easily

- Build upon students‘ prior knowledge and skills.
- Emphasize the connections among mathematical concepts.
- Connect abstractions to real-world settings.
- Address common misunderstandings.
- Introduce more advanced ideas.

The integration of ICT into Education may result in the creation of new possibilities for learners and teachers to engage in new ways of information acquisition and

analysis, and this may enhance access to and improve the quality of education delivery on equitable basis (Ministry of Education and Sports, 2010) in Ghana.

According to the Ministry of Education, Youth and Sports (MOEYS) and Ghana Education Service (GES) (2002), integrating technology in classroom instruction ensures greater motivation, increase self- esteem and confidence, enhance good questioning skills, promotes initiative and independent learning, improves presentation of information, output, develops problem solving abilities, promotes better information handling skills and improves social and communication skills.

Integration of ICT into the teaching and learning of Mathematics is not merely using it for typing and printing questions, browsing but rather using ICT in teaching various topics in Mathematics. For instance, the syllabus for Mathematics at Senior High School (SHS) level emphasized the need to use Spread sheets in drawing graphs and calculating means, mode, median and standard deviation. (MOESS, 2010).

According to the compilation made by Anamuah-Mensah, Mereku, and Ghartey-Ampiah (2009) on TIMSS (2007) report on Ghanaian Students' Overall Achievement, Ghana's mathematics score of 309, was one of the lowest, and is statistically significantly lower than the TIMSS scale average of 500**.**

Institutions and the fact that in most subjects, teachers do not use ICT in their instructional activities, the managers, educators and learners involved could not say much about the impact of ICT applications on work in the various institutions. That is, very little evidence was available to conclude on improvements in administration, classroom practice and students' academic outcomes due to the use of ICT. The Curriculum Research and Development Division (Teaching Syllabus for Information

and Communications Technology (Core) (CRDD 2007a, CRDD 2007b & CRDD 2007c) of the Ministry of Education Science and Sports.

The specific objectives in the SHS mathematics syllabus so as to encourage the use of technology in the core mathematics classroom:

- Specific objective 1.10.3 under statistics I urges teachers to encourage students to use computer to draw pie chart, bar chart and histogram.
- Specific objective 2.4.2 under percentages II encourages the use of calculator and computer to determine the depreciation of an item over a period of time.
- Specific objective 2.6.4 under statistics II encourages students to use spread sheet or computers to draw graphs and calculate mean, mode, median and standard deviation and compare with their own results.
- Specific objective 2.8.5 under quadratic functions and equations encourages the use of computers to investigate the shapes of quadratic graphs as the values of the constants change.
- In addition to the above, the following specific objectives in the elective mathematics syllabus also encourage the use of technology in the elective mathematics classroom:
- Specific objective 1.4.1 under relations and functions urges teachers to introduce the use of graphic calculators and computers to investigate nature of graphs of functions.
- Specific objective 1.5.1 under polynomial functions encourages the use of graphic calculators and computers to investigate the shapes of graphs as coefficients of the variables and the constants change.

- Specific objective 1.5.6 under polynomial functions encourages the use of graphic calculator or computer to investigate the graph of cubic functions.
- Specific objective 2.4.4 under logarithmic functions urges teachers to introduce the use of graphic calculators and computer in drawing logarithmic graphs.
- Specific objective 2.7.1 under trigonometric functions encourages students to use the calculators and computers to investigate the nature of graphs of trigonometric functions
- Specific objective 2.7.2 under the same trigonometric functions encourages students to use the calculator and computer to draw graphs of trigonometric functions and find their solutions (graphical approach).
- Specific objective 3.4.1 under correlation and regression urges teachers to assist students to use graphic calculators and computers to draw scatter diagram for bivariate distribution. (CRDD, 2010)

The government of Ghana and other institutions have invested huge sums of money in procurements of computers and establishment of computer laboratory in most SHS's, but it is still unclear whether these computers are being used effectively by teachers in their instructions. The researcher's school Ngleshie Amanfro Senior High School in the Greater Accra Region of Ghana was formally having twenty (20) desktop computers which was being used by the teachers and students. Three to four students were to use one desktop computer during ICT practical lessons. But recently the school have received forty five (45) laptops from the government and also expanded the ICT laboratory to enable the implementation of its ICT policy and hence the research.

1.2 Statement of the Problem

According to Rogers (1999), not all teachers have embraced computer technology as the basic tool for teaching and learning in the classroom. The Chief Executives Officers Forum (2001) School Technology Readiness Report states that only 32% of the teachers who had received training in both basic computer skills and curriculum integration, used computer technology to a –moderate extend" in their teaching and only 8% reported using technology to a –great extent."

One major requirement of the 2007 Educational Reform was to ensure that all students in pre-tertiary institutions in Ghana acquire basic ICT literacy skills (including internet use) and apply these not only in their studies but also in a variety of ways in their everyday life activities (CRDD, 2007a, 2007b & 2007c). Computer technology use for teaching and learning is gaining acceptance in education globally but in Ghana efforts to use ICT in education began to receive governments' attention only recently. Ghana's recent participation in an international survey which was used to rate the ICT Development Indices (IDI) of the participating countries revealed that the country ranked between 100th and 140th position out of 154 countries surveyed (ITU, 2009).

The new curriculum in Mathematics at Senior High School (SHS) places emphasis on skills acquisition, creativity and the arts of enquiry and problem solving. As part of the reforms the curriculum places a lot of emphasis on Information and Communication Technology (ICT) as a tool for teaching Mathematics, Ministry of Education, Science and Sports in Ghana (MOESS, 2007). The findings of the research conducted by Agyei and Voogt (2011a, 2011 b) showed that mathematics teachers did not integrate technology in their instruction in spite of government efforts in the procurement of computers and recent establishment of computer laboratory in most Senior High Schools.

In order for Mathematics teaching and learning situation to be more meaningful and authentic, there is the need to come up with a conducive learning environments that support learner-centered approach and discourage rote learning. It is the teachers' responsibility to understand what learners needs to know and should also have an immense knowledge in mathematics and the appropriate instructional strategies to meet the different learning styles of the learners.

Difficulty in understanding Mathematics has become a major concern to all educators in Ghanaian Schools. This has driven them to finding how best to improve the academic performance of the students and motivate them in understanding the concepts with the use of new methods in teaching of mathematics. To address these issues, the researcher intends integrate the new technology as a new tool in teaching mathematics.

1.3 Purpose of the Study

The purpose of the study is to investigate teachers' and students' perceptions on the integration of ICT into Mathematics teaching and learning in Ghanaian Senior High Schools. The study will also investigate into the potential barriers hindering SHS Mathematics teachers and students effective use of technology and suggest ways of integrating technology into Mathematics instruction at the SHS level in Ghana.

1.4 Objectives of the Study

The researcher would like to achieve the following objectives at the end of the research

- To find if SHS Mathematics teachers and students use Technology in teaching and learning.

- To find the perception of Mathematics teachers and students in relation to the integration of ICT in mathematics teaching and learning..
- To identify potential barriers hindering the effective integration of ICT in the Mathematics classroom for both the teachers and students.

1.5 Research Questions

The following research questions were used to guide the conduct of the study:

1. To what extent do SHS Mathematics teachers and students use Technology in teaching and learning?
2. What perception do Mathematics teachers and students have in relation to the integration of ICT into mathematics teaching and learning?
3. What are the potential barriers hindering the effective integration of ICT in the Mathematics classroom for both the teachers and students?

1.5.1 Hypothesis

Ho: There is no significant relationship between teachers and students Perception on the integration of ICT into mathematics teaching and learning.

H_a: There is significant relationship between teachers and students perception on the integration of ICT into mathematics teaching and learning.

1.6 Significance of the Study

The findings of this study will shed light on how widely computer technology can be integrated in the classroom. The study findings will also provide policy makers, administrators, school board members, parent and other members of the school community to make the right decisions that would lead to wide integration of computers in the schools so as to improve students‘ performance in the learning of

mathematics. Finally the study could serve as the bases for future studies on how to address some setbacks on ICT integration in teaching mathematics at the SHS.

1.7 Limitations of the Study

The limited time available may prove to be a challenge to conducting an in-depth and thorough analysis of the data**.** The fact that only three schools were investigated is in itself a limitation as the findings cannot be generalized, but will give a deeper understanding of the concerned schools.

1.8 Delimitation of the Study

It would have been appropriate to cover the entire SHS in Ghana but due to constraints such as finance and time, the research is restricted to only three (3) schools, two (2) public schools and one (1) private school all in Greater Accra Region in the Ga South Municipality.

1.9 Organization of the Study

The study is structured in 5 chapters: Chapter One is on the Introduction and problem definition as well as its purpose and research questions. Relevant literature review is presented in Chapter Two. The literature review is based on the subheadings related to the study. The research design and methodology is described in Chapter Three. Results and discussion of data will be presented in Chapter Four. The summary of findings, discussions, recommendations and suggestions for further studies into the problem, based on the findings of this study will also be discussed in Chapter Five.

CHAPTER TWO

LITERATURE REVIEW

2.0 Overview

The literature review in this Chapter Two focuses on the theoretical framework of the study and discusses the literatures that are related to teachers and students perceptions on technology integration in Mathematics Education. The literature review is therefore structured under the following:

- Theoretical Framework.
- Technology use in Mathematics Teaching and Learning
- The Perceptions of Mathematics Teachers in Relation to the Integration of ICT in their Classroom Instructions.
- The Perceptions of Students on the use of ICT in Learning Mathematics.
- Potential Factors Hindering the Effective Integration of ICT in the Mathematics Classroom for Both the Teachers and Students.

2.1 Theoretical Framework

Research has it that the use of computers became popular in the 1980‘s when personal computers became available to consumers. According to Pelgrum and Law (2003) history has it that towards the end of the 1980‘s, the term _information technology‘ began to replace the word _omputer‘. The term information technology therefore referred to computer‘s processing ability, indicating a shift from computing technology to the capacity to store and retrieve information. Pelgrum and Law (2003) again posited that the term ICT emerged, signaling the introduction of e – mail and 2q electronic messaging with computer technology. We have seen a tremendous increase

in the integration of theory and methods with tools and technologies supporting cognitive processing in individuals and in teams.

The theoretical frame of the research is based on Technology and Cognition that are related by the principle of cognitive technologies, as described by Pea (1987), who suggests that technology should be used as cognitive tools for learning purposes. Ten years ago, Google (founded November 1998) did not exist. Now it processes 200 million queries a day. In 1998, there was no Wifi, no fiber, no DSL7, no power line network, no Bluetooth, no Wimax, no GPRS. Today half of the population in Western Europe has high bandwidth access to the Internet, and Wi-Fi network is becoming ubiquitous. The possession of mobile phones grew sharply (in France, from 8.5% in 1997 to 84% in 2007), and Internet access too (for French households it was multiplied by 100).

There are 800 million Bluetooth devices worldwide (the system was launched in 1998). E-bay (founded 1995) has 200 million users and over 7 billion dollars turnover. Wikipedia (founded 2001) has 10 million articles, and 200 million visits per month, in more than 250 languages. A flash memory card of 2 Gigabytes costs less than 10 Euros. Today‘s standard PC would have been in the world‘s top 500 ten years ago.

Cognitive technologies have transformed how mathematics can be done and how mathematics education can be accomplished. Each of these technologies makes mathematical activities accessible to students. A cognitive technology can be an amplifier, extending the existing curriculum or it can be a reorganizer, changing the fundamental nature and arrangement of the curriculum (Pea, 1987).

A purpose function of cognitive technologies is knowledge for action – a condition to promote mathematical thinking. These tools provide functional environments in order to see applications immediately (interactive model). They help students and motivate them to think mathematically by providing activities which purposes go beyond ―learning mathematics". Pea (1987), mentioned three process functions. These are:

1. Developing conceptual fluency – helping students become more fluent in performing routine mathematical tasks.
2. Mathematical exploration – the computational discovery learning environment provides a rich context that helps students broaden their intuition. Students can make conjectures about different mathematical objects (medians, angles, bisectors). They can explore the properties of triangles and discover theorems on their own.
3. Integrating different mathematical representations – linking different representations of mathematical concepts, relationships and processes. It help students to understand the relationship between different ways of representing mathematical problems, for example, change the value of a variable in an equation and observe the changes in the graph. Rapid interactivity and representational tools create a new kind of learning experience.

We are in need of a ―cognitive technology' (Pea, 1987) as ―any medium that helps transcend the limitations of the mind: in thinking, learning, and problem solving activities" (p.91). Such ―technologies' might develop visual means to better ―see' mathematical concepts and ideas.

Cognitive technology refers to technologies that carry out cognitive operations. Thus, rather than a Cognitive technology has developed so much in recent years, it now

does not only enable to offload or to distribute cognition, but also can take over cognitive capacity that was once the sole domain of humans. In some cases, the technology can even replace the human who is no longer needed. For example, Global Positioning System (GPS) and satellite navigation technology has in many cases taken over what humans have done in the past.

Cognitive technologies can be characterised as those systematic means created by humans and used by them for the achievement of cognitive aims, including either cognitive states or cognitive processes that lead to such states or help significantly to reach them. As these technologies are used in our cognitive processes, as they cognize with us and for us, they influence and impact the very way we think and affect the very nature of cognition. As cognitive technologies advance, they shift from being mere tools that aid cognition to having constitutive roles in shaping cognitive processes themselves. Through them, our mind becomes ―bio-technological" and ―hybrid", and our brains ―plastic" — in the suggestive terminology of Andy Clark (2003, 2004).

The aim of Cognitive Technology is to facilitate the realization for both science and society benefit. In particular, critical to meeting the needs of a more complex workplace, an aging population, and a society increasingly sophisticated in their use of information technology, it improved interaction between the practice of science and the application of scientific findings.

2.1.2 Cognitive Technologies and Mathematics

The entry of cognitive technologies into the mathematics education brings principal changes which approach the education near the student and fight against so-called ―math phobia" (this term was established by Seymour Papert, 1993). Most of the

cognitive technologies support the graphics presentation of solving problems which increase clearness and comprehension.

Cognitive technologies present the basic movement from mechanical and uncritical fact downloading (teaching) to the process of cognition and discovering of new facts and skills (learning). Student does not receive new knowledge directly from his/her teacher but he/she looks for information himself/herself and constructs them. The teacher loses the role of the source of information. More and more the teacher becomes the handmaid or helpmate and guide**.** The cognitive technologies offer immediate feedback and enable an individual approach which support the education and oriented towards a student. The student can verify what happen if he/she changes any parameters of a problem without solving the problem again from the beginning. Cognitive technology can increase human mental capacity by enabling to ―offload" cognitive operations onto technology. Such offloading reduces cognitive load and thus frees up cognitive resources. For example, using calculators offloads simple mathematical operations to technology. By using calculators humans do not need to spend cognitive resources to do the mathematical operations and cognitive resources are available to do other tasks.

2.2. The Use of Technology in Mathematics Teaching and Learning

Technology is the making, modification, usage, and knowledge of tools, machines, techniques, crafts, systems, methods of organization, in order to solve a problem, improve a pre-existing solution to a problem, achieve a goal or perform a specific function. It can also refer to the collection of such tools, machinery, modifications, arrangements and procedures. (Teaching with Technology, 2006)

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) from the Internet.

Becker‘s (2000) nationwide survey of teachers in the United States revealed that, while ICT use enabled a minority of teachers to put into practice a pedagogy that is more constructivist and more in tune with their teaching philosophy, it has not transformed the teaching practices of a majority of teachers, particularly teachers of secondary academic subjects. However, the teachers did acknowledge that under the right conditions computers are becoming a valuable instructional tool and is having an impact not only on students performance in the classroom but on their academic efforts outside the classroom as well.

Similarly, in a survey of 170 secondary school teachers in New Zealand, Lai and Pratt (2004) found that 82% of the teachers considered ICT to be beneficial to their teaching but not in the area of methods of delivery and classroom practice. Significantly, the most obvious effect identified by the teachers was not a change of philosophy or pedagogy but improved efficiency in the administration and management of teaching, including lesson preparation and presentation.

Balanskat et al., (2006) reported similar findings, in their review of the ICT impact studies conducted in Europe. They found that ICT use enabled teachers to save time and to increase productivity in such activities as preparing and updating daily lessons

and maintaining records. In addition, ICT use has fostered greater collaboration between teachers with increased sharing of resources and ideas.

Boakye and Banini (2008), conducted a research to investigate teachers‘ readiness for the use of technology in Ghanaian schools and indicated that, 71% of the teachers did not use technology in classrooms, 49% of teachers use technology 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 technology into Ghanaian classroom instruction is not yet to be realized and utilized.

A study conducted by the National Center for Education Statistics revealed that only 23 percent of the teachers surveyed felt well prepared to integrate technology into their instruction (NCES, 2000). In another study, more than half of the teachers surveyed did not believe that their pre-service programs prepared them well in either technology or 21st century skills (Walden University, 2010).

According to Rowand (2000), a survey based on a National Center for Education Statistics (NCES, 2000), found that 39% of teachers indicated that they used computers or the Internet to create instructional materials, 34% for administrative record keeping, less than 10% reported to access model lesson plans or to access research and best practices. Novice teachers were more likely to use computers or the Internet. Similarly and according to a report released by the US Department of Education, NCES (2000), novice teachers were more likely to use computers or the Internet to accomplish various teaching objectives.

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.

A survey carried out by Forgasz and Prince (2002) found that 61% of the respondents (teachers) used spreadsheets, 45% used word processing and 30% used Internet browsers. In the same survey, it was found that 19% used Geometer‘s sketchpads, 19% used CD-ROMs that accompanied mathematics textbooks, 18% used Graphmatica, 14% used Maths Blaster and 8% used other mathematics-specific software. Knowledge of the use of software on the part of the teachers is not the only criterion for integrating ICT into mathematics lessons; a sound pedagogical knowledge on how to integrate it is another critical success factor.

Ball and Stacey (2005), who studied the trial of a new senior secondary mathematics subject for which CAS use was permitted in all assessment, describe an example of a teacher who believed that students learn best if they first use by-hand (pen and paper) skills for new procedures and then later move to using technology as the procedures increase in difficulty.

Tella, Tella, Toyobo, Adika and Adeyinka (2007) examined Nigerian Secondary School teachers uses of ICTs and implications for further development of ICT use in schools using a census of 700 teachers. The findings showed that most teachers perceived ICT as very useful and as making teaching and learning easier. It was recommended that professional development policies should support ICT-related

teaching models, in particular those that encourage both students and teachers to play an active role in teaching activities.

In a study by Bergqvist (1999), students were encouraged to use investigations on a graphing calculator in order to better understand the factor theorem by graphing a quadratic function together with the two linear functions of its factorisation. Some evidence was found that students could benefit from investigations on a graphing calculator when trying to understand factorisation and the factor theorem. Another result was that students could get a better understanding for the connection between graphical and algebraic representations of functions.

The use of technology to actively engage K-12 student learners was supported by National Education Technology Plan (United States Department of Education, 2010). This publication outlined a plan that consisted of five goals for transforming the United States (US) education system; the first of these goals provided students with learning experiences that were engaging and empowering.

Technology can be useful to the extent when it focuses student thinking in ways that are germane, not extraneous. In primary school, it is important to learn to do arithmetic fluently. Using technology to do this thinking for the student would be inappropriate. In secondary school, however, students have mastered arithmetic and should be focused on more advanced skills and concepts. Computational support can be very important.

The use of technology when studying mathematics is not a new issue, since humankind always has been looking for solutions to avoid time consuming routine work. The use of technology has a long history in mathematics education. Starting from magic slate, book, magic lantern, Blackboard, radio, Slide rule video tape,

Television, Calculator, computer, Interactive Board, Apple I pad all come under technology. Paper money and coins, beans, bears, buttons, and other small items are helpful for counting and computation skills. Straws, grouped by tens, are great for teaching Mathematics.

Lars-Erik Björk and Hans Brolin (1995) in Edinburgh initiated a long term research project, the ADM- project (Analys av Datorns konsekvenser för Matematikundervisningen), where tool-kit computer programmes was used to enhance the conceptual understanding of functions. The time the students practiced routine skills was reduced, and the students were instead given the opportunity to use computer software, ―Matematikverkstad" (_the mathematics tool kit').

The programme made it possible for the students to work with functions, numerical solutions of equations, calculation of integrals, and problem solving on different levels. At the end of the project, a test was used to evaluate the students' progress. Compared to a reference group of students, the test classes had significantly better results on tasks concerning conceptual understanding and on problem solving tasks, while no difference could be found concerning routine skills.

Bennett (2002) utilizes interactive geometry software to find such indirect measures using lengths that are easy to measure and proportions in similar triangles. Specifically, the worksheet directs the learner to create line segments to represent the tree's height and the learner's height in the application; then learners construct parallel lines to simulate the rays of the sun. Finding the tree's height is a matter of calculating the unknown length (tree's height) in the proportion of ratios of object height to shadow length.

Boakye and Banini (2008) conducted a study to investigate the level of technology 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 technology use is gradually gaining grounds among Ghanaian students.

Doppen (2004) investigated student self-efficacy about the use of technology. He reported that a computer- assisted social study instruction helped high school students develop more interactions among themselves and that it grasped students‘ interest during the course.

A review conducted by Schacter (1999) shows that on the average, students who used computer instruction scored in the 64th percentile on tests on achievement, compared to students in the controlled conditions without computers who scored in the 50th percentile.

It is seemingly impossible for education institutions to implement new technological advances as fast as they become available. Gone are the days of isolated classrooms where educational television programs and a chalkboard are the most exciting supplementary teaching and learning devices available. Enter today‘s classroom and one will see a plethora of innovative technological tools and methods are available to students and teachers (United States Department of Education, Office of Educational Technology, 2013).

Ultimately, modern technologies have become inseparable parts of learning, teaching, and practicing mathematics. Professors and students use various electronic devices to broaden the range of material covered in classes. With the help of calculators and

computers with specific applications they also delve deeper into separate subjects of mathematics. Technology has also changed the way physically challenged students learn mathematics.

Generally, the use of technology has become a standard, and with it mathematics has become a much more interesting science.

In addition, just like students and teachers, business people are also utilizing modern technologies in their business routines, determining best decisions, performing statistical analysis, and assessing economic situations. This way, the use of technology is crucial in mathematical calculations in today‘s world.

Some examples of ICT use in mathematics include: portables, graphic calculators and computerized graphing, specialised software, programmable toys or floor robots, spread sheets and databases. Studies have shown that a range of portable devices exists which allow pupils to collect data, and manipulate it using spread sheets and databases for work in numeracy. Some portable equipment also enables the study of maths to move out of the classroom and to incorporate fieldwork investigations (Moseley & Higgins 1999).

According to Liang and Su (2000) computer programs showed how students are attracted to the interactive computer programs designed for business statistics course, and were motivated to attend classes when computer programs are applied to teaching. In addition, students were able to understand confusing topics, and felt that teaching them to use computer facilities really improves their own abilities to apply similar programs in analyzing real-world problems.

Blackett and Tall (1991) employed a computer program that draws the desired right triangles to facilitate students‘ exploration of the relationship between numerical and geometric data. The results of the study show that computer representation enabled students to make this exploration in an interactive manner. They were encouraged to make dynamic links between visual and numerical data, which is less apparent in a traditional approach. The authors conclude that even the least able became adept at using the computer and, though they had some difficulty writing down their results, they had few difficulties with visualization.

According to Wilson (2000) appropriate uses of ICT tools can enhance Mathematics teaching and learning and support how conceptual development of Mathematics is taught and learnt. Kerrigan (2002) cited in Mistretta (2005) also found the benefits of using Mathematics software to include the following:

- Promoting learners‘ higher order thinking skills – Mathematical games and simulations help learners to apply mathematical ideas to problem situations.
- Developing and maintaining learners‘ computation and communication skills – Calculators and graphic calculators accelerate the speed of learners when solving mathematical problems results in more accurate results and improved learners confidence in Mathematics ;
- Introducing learners to collection and analysis of data- Databases and spread sheets give the learners the confidence of analysing large amount of data accurately;
- Facilitating learners algebraic and geometric thinking – Geometric software and algebraic systems offer learners a bridge from the abstract world of Mathematics to the concrete world wherein learners are able to create and

observe numerical representation, symbolic representation and geometric representation; and

- Showing the learners the role of Mathematics in an interdisciplinary setting – Integrated Mathematics packages allow learners the opportunities to explore problem- based
- Learning.

Lagrange (1999) paper attempted to analyze the integration of graphing calculators (TI-92) in 4 high school pre-calculus classes. The purpose of Lagrange's research was not to prove that teaching was better with graphing calculators, but to reflect on the changes that graphing calculators may bring to the teaching and learning of mathematics. There were classroom observations and interviews of 25 teachers. The interviews also involved questioning nearly 500 students. The analysis was done on a compilation of mathematical activities and provided interesting insights on how technology may support the learning of mathematics. The findings from Lagrange's research suggested that understanding mathematics with the help of a computer algebra system was not a view students generally considered. Students enjoyed the new classroom situations, but did not recognize that the situations could bring better comprehension of mathematical content. The findings also included teachers considering using the calculators as a break from teaching algorithmic skills and set techniques.

Kaino and Salani (2004) research revealed that majority of students in Botswana used and enjoyed working with calculators. The finding further revealed that the students overall use of technology in general computer applications and in learning mathematics was very low.

Merrienboer and Kirschner (2007) indicate that showing a learner what to do through worked-out examples, and modeling example, in addition to practice, are important dimensions for successful learning. The activation principle emphasizes that learning is promoted when relevant prior knowledge is activated. Stimulating prior knowledge of the learners and making it active for use in working memory, as a foundation for new information, is the key to productive and successful learning.

2.2.1 The Roles Play by the Integration of ICT in the Teaching and Learning of Mathematics

Teachers and students have access to valuable resources via the Internet that include software, simulations, spread sheet, and graphing calculators (Roblyer & Edwards, 2000). Students can learn mathematics using comprehensive mathematics tutorials. Drill and practice programs offer instant feedback for skill building. Higher learning skills can be acquired through geometric exploration programs where learners create shapes, experiment with mathematical formulas and visualize data in graphic formats

The use of ICT has been found to play several roles in the teaching and learning of Mathematics. Some of these roles are:

- Assist students in accessing digital information efficiently and effectively:

  As Brush, Glazewski and Hew (2008) stated, ICT is used as a tool for students to discover learning topics, solve problems, and provide solutions to the problems in the learning process. ICT makes knowledge acquisition more accessible, and concepts in learning areas are understood while engaging students in the application of ICT.

- Support student-centered and self-directed learning:

  Students are now more frequently engaged in the meaningful use of computers (Castro Sánchez & Alemán 2011). They build new knowledge through accessing, selecting, organizing, and interpreting information and data. Based on learning through ICT, students are more capable of using information and data from various sources, this enable them to critically assess the quality of the learning materials.

- Produce a creative learning environment:

  ICT develops students‘ new understanding in their areas of learning (Chai, Koh and Tsai 2010). And provides more creative solutions to different types of learning inquiries. For example, in a reading class, e-books are commonly used in reading aloud activities.

  Learners can access all types of texts from beginning to advanced levels with ease through computers, laptops, personal digital assistants (PDAs), or iPads. More specifically, these e-books may come with some reading applications, which offer a reading-aloud interface, relevant vocabulary-building activities, games related to reading skills and vocabulary acquisition, and more. Therefore, ICT involves purpose- designed applications that provide innovative ways to meet a variety of learning needs.

- Promote collaborative learning in a distance-learning environment:

  Koc (2005) mentioned that using ICT enables students to communicate, share, and work collaboratively anywhere, any time. For instance, a teleconferencing classroom could invite students around the world to gather together

simultaneously for a topic discussion. They may have the opportunity to analyze problems and explore ideas as well as to develop concepts. They may further evaluate ICT learning solutions. Students not only acquire knowledge together, but also share diverse learning experiences from one another in order to express themselves and reflect on their learning.

- Offer more opportunities to develop critical (higher-order) thinking skills:

Based on a constructive learning approach, ICT helps students focus on higher-level concepts rather than less meaningful tasks (Levin & Wadmany 2006). Mcmahon (2009) in a Western Australian secondary school study showed that there were statistically significant correlations between studying with ICT and the acquisition of critical thinking skills. A longer exposure in the ICT environment can foster students' higher critical thinking skills. Thus, schools are strongly advised to integrate technology across all of the learning areas and among all learning levels. Where this is done, students are able to apply technology to the attainment of higher levels of cognition within specific learning.

Devices like simple and scientific calculators, personal computers, handhelds, and many other have revolutionized the practice, teaching, and learning of mathematics. These instruments help people to collect, record, organize, and analyze numerical mathematical data. Moreover, nowadays there are many special computer software applications that provide very fast and accurate computations, and even draw corresponding graphs and tables.

Computer software offers quick and easy transformation of data to graphics to learn transformational geometry such as tessellations. It can interface with devices like

probe ware systems to capture data. Students can conduct experiments and concept demonstrations using these devices.

Spread sheet programs, such as Excel, offer graphics, algebraic functions, equation editors, calculator, and word processor to support complex calculations and writing research papers. Spread sheet program can be used by the student to allocate a budget and compare alternative options with _'what if'' activities. Variables can be changed easily so students can quickly learn the dynamic aspect of budgeting. Spread sheets are also used to search for patterns, construct algebraic expressions, simulate probabilistic situations, justify conjectures, generalize concepts and graph chart data. For long, the role of Mathematics was limited to purely academic domain. Now, the role of Mathematics is not restricted to purely academic domain. It has entered the domain of Technology and Industry. New fields in Mathematics such as Operation Research, Control theory, Signal Processing and cryptography have been generated which need technology. Technology can reduce the effort devoted to tedious computations and increase students' focus on more important mathematics.

Having such powerful tools at hand, scholars and students can significantly increase the extent of their mathematical research, learn new concepts with a new interactive approach, and perform much more mathematical calculations and solve more mathematical problems. Teachers of Mathematics can frequently use computer to perform mathematical tasks thereby leading to professional development and higher-order thinking in academic achievement contexts.

In developing countries, particularly in Ghana, the metaphor of the information age has generated a whole set of speculations about the need for educational reforms that will accommodate the new tool, –omputer", as indicated by Pelgrim (2001).

Government and educational planners in Ghana have responded to the challenge by creating national programmes to integrate new technologies (e.g., computers, internet, and intranet) at all educational levels.

Jonassen (2000) also suggests that students will understand trigonometric functions better and more conceptually if they are able to inter-relate numerical and symbolic representations with their graphical output. With respect to the way trigonometry is taught, Blackett and Tall (1991) point out the advantages of the computer approach comparing to the traditional approach, stating that it can allow students to manipulate the picture and relate its dynamically changing state to the corresponding numerical concepts, having the potential to improve understanding. They call this ability to use the computer to carry out certain arduous constructions whilst the student can focus on specific relationships _the principle of selective construction', considering it as one of the most powerful educational principles for the use of new technology.

The use of graphic calculators and computerized graphing in mathematics speeds up the graphing process, freeing people to analyse and reflect on the relationships between data (Hennessy 2000; Clements 2000; Hennessy et al. 2001).

Computer technology is attracting a large proportion of the country's limited budget for education. Education is no longer about memorizing facts and pictures, but rather, it is about learning where to find this information, and more importantly, it is about how and where the information which has been acquired can be used. Learners must actively construct their own understandings rather than simply absorb what others tell them (Bransford et. al, 2000).

A number of previous studies have shown that an appropriate use of ICT can raise educational quality and connect learning to real-life situations (Lowther, et al., 2008;

Weert & Tatnall 2005). As Weert and Tatnall (2005) have pointed out, learning is an ongoing lifelong activity where learners change their expectations by seeking knowledge, which departs from traditional approaches. As time goes by, they will have to expect and be willing to seek out new sources of knowledge. Skills in using ICT will be an indispensable prerequisite for these learners.

The Ministry of Education have recently started implementing projects with the aim of equipping every school with computers and internet connection in Ghana. Also, there are plans intended to meet the necessary conditions for the integration of technology in the teaching and learning of different subjects, as the reformulation of the curriculum content based on ICT use, and the training of the teachers to use ICT during the teaching process.

Kent and Facer (2004) indicated that school is an important environment in which students participate in a wide range of computer activities, while the home serves as a complementary site for regular engagement in a narrower set of computer activities. Increasingly, ICT is being applied successfully in instruction, learning, and assessment. ICT is considered a powerful tool for educational change and reform.

For technology to be relevant, constant investment has to be made in that technology, its replacement and updating. Technology can be used to enhance critical thinking and critical literacy skills, evaluating the legitimacy and accuracy of online content is the central part of 21st century education. Technology has played a vital role in educating and connecting students to learning opportunities. With frequent flow of information, including instruction, available on the Internet, and new technologies making computers increasingly portable, high school students are presented with many new opportunities for enhancing and supplementing their learning.

Geo boards are useful for introducing geometric concepts. Clinometers are useful for teaching and learning of Trigonometry. An abacus allows children to conceptualize math formulas by working with tangible objects.

Smartphones help students study more effectively and even more often. Interactive whiteboards connect classrooms to the world and replace the chalkboards of the past. Ipads, laptops, and desktop computers are usually in modern classrooms. Once the hardware is in the hands of students, then teachers could direct them to social learning tools such as wikis, blogs, discussion boards, live chats, or webinars. Among a few of the technology tools that can make lessons effective and interesting are Skype, Animoto, Twitter, Dropbox, Google Earth, and YouTube just to name a few.

Specialists software such as Computer Algebra Systems (CAS), Dynamic Geometry Systems (DGS) and Mathematics curriculum software improve pupils‘ skills and understanding in algebra, allow pupils to manipulate and measure shapes leading to higher level of learning among them (Hennessy et al., 2001; Clements 2000). Programmable toys or floor robots controlled by instructions in programming languages (usually Logo) were one of the earliest applications of ICT tools to mathematics and where used were the cause of significant changes in mathematics teaching (Becta 2003). Logo encourages pupils to develop problem-solving skills, leads them to develop higher levels of mathematical thinking as well as learn geometric concepts (Clements, 2000).

The use of technologies such as virtual learning environments allows students to participate in classrooms and opportunities far from the reach of their school walls, and interact with students from across the country. In many countries and districts, technology has allowed students from impoverished backgrounds to experience a

world-class education and participate in advanced placement courses. Through the use of online curricula, social media outlets, virtual learning academies and assistive technology devices there is greater access for all students to enhance their learning.

The use of technology in education can enhance meaningful learning better than the traditional classroom instructions. ―They can engage a wider range of intelligence, connecting school with real world, supporting interaction, offering dynamic displays, multiple and linked representations, interactive models and simulations and the storage and retrieval of multiply categorized information" (Ashburn & Floden, 2006, p.28). In this way, by integrating technology into the teaching and learning process, educators aim to increase students' abilities to understand complex ideas and learn challenging content.

Samuelsson (2003) addressed the role of the computer as an agent of change and focused on the following issues:

1. What new methods will be used by the teachers because of the technology?

According to Samuelsson (2003);

a. When teachers use technology to introduce the concept of the equation of a straight line (y = kx + m), the teaching will be different compared to an ordinary introduction. The students will be able to easily investigate how different values for the parameters ‗k and m' will affect the graph of the function.
b. The students learn more mathematics through visualization and models in the computer.

c. The students will learn effective procedures that help them to solve problems more efficiently, mainly due to the element of game and competition offered by the computer.

2. What in the everyday technology-enriched teaching of mathematics supports the overall visions that exist for school mathematics?

He went on further to say;

a. The student‘s views of mathematics may be affected in a positive way if the teaching is pursued with technology

b. Learning oriented teaching with utility programs seems to support the vision that the teacher should focus more on conceptual learning and less on the learning of skills and procedures.

3. What in the everyday technology-enriched teaching of mathematics interfere with the overall visions that exist for school mathematics?

Finally to the above question he says;

a. To work with drill and practice software supports an old form of teaching mathematics, which the modern school is leaving behind. The technology could thus be assimilated into old traditions.

b. The students‘ possibilities to reflect over the content in the problems are reduced by the element of game and competition offered by the computer.

c. Technology offers a variety of different distractions, which results in students doing other things than mathematics in the classroom, surfing on the web, checking e-mail, and so forth. Technology becomes amusement (Samuelsson, 2003, p. 221-222).

Derive 6 is a powerful system for doing symbolic and numeric mathematics on your personal computer. Derive 6 makes an excellent tool for learning, teaching and doing mathematics in the following areas:

- Making plots of mathematical expressions in two and three dimensions using various coordinate systems
- Equipping students with algebraic processing skills (polynomials and surds)
- Drawing of graph of equations and inequalities (linear, simultaneous – both linear/ one quadratic, linear and quadratic inequalities)
- Investigating graphs of Functions (notation, composite, inverse, modulus function, odd/even functions, transformation of functions)
- Coordinate geometry (distance between points, gradient, equation of a straight line)
- Indices (rules of indices, fractional, negative, zero, exponential function, natural logarithm function)
- Sequences and series (sequences, series - including Σ notation, arithmetic and geometric series)
- Trigonometry (radian measure, basic trig, graphs, sin/cos/tan of any angle, transformations of trig functions)
- Differentiation (gradient function, differentiation of n x , exponential and logarithmic differentiation, increasing/decreasing functions, turning points, using differentiation to solve practical problems

Integration (inverse of differentiation, boundary conditions, definite integrals, finding areas using integration) Numerical methods (absolute and relative errors, calculating with approximations, finding the roots of f(x) =0)

Researchers are designing new interactive multi-touch 'smart' desk classrooms which have been found to boost pupils' mathematical skills. Using multi-user desks in the "classroom of the future" the children were able to work together in new ways to solve questions and problems using inventive solutions. A three-year project with 400 eight to 10-year olds in India found that using interactive "smart" desks can have benefits over doing maths on paper, and that pupils are able to improve their fluency and flexibility in maths by working together. Burd's team found that 45 % percent of pupils who used a maths programme on the smart desk system increased the number of unique mathematical expressions they created, compared with 16 % percent of those doing it on paper. "We found our tables encouraged students to collaborate more effectively," said Burd. "Such collaboration just did not happen when students used paper-based approaches." (Source; Times of India dated 24/11/2012).

Devices like simple and scientific calculators, personal computers, handhelds, and many other have revolutionized the practice, teaching, and learning of mathematics. These instruments help people to collect, record, organize, and analyze numerical mathematical data. Moreover, nowadays there are many special computer applications that provide very fast and accurate computations, and even draw corresponding graphs and tables. Having such powerful tools at hand, scholars and students can significantly increase the extent of their mathematical research, learn new concepts with a new interactive approach, and perform much more mathematical calculations and solve more mathematical problems.

Businesses too benefit much from the use of technology in their various mathematical calculations. Operations and production management, statistical and probability analysis, economic reports, - all these and many more have become more efficient and accurate with the help of calculators and special software applications. Programs like

Excel, Mathematica, Maple, MatLab assist millions of businesspeople all over the world to perform statistical inferences, determine probability of events, make important business decisions under uncertainty, assess financial health of companies, and much more (CT4ME 2005). All of these operations are directly linked with mathematics

2.3 The Perceptions of Mathematics Teachers in Relation to the integration of ICT in their Classroom Instructions.

Some researchers studied the relationship between teachers‘ perceptions of the use of ICT and their actual integration of ICT into teaching and learning processes.

Eugene (2006) explored the effect of teachers‘ beliefs and attitudes towards the use of ICT in classrooms. An observation method was used to collect data on teachers‘ beliefs and attitudes. The study revealed that there was inconsistency between teachers‘ beliefs and their actual use of technology in the classroom. Teachers‘ beliefs and teaching practices were found not to match. Similarly, Simonson (2004) used a quantitative study to explore the beliefs of primary school teachers on the use of ICT in teaching. The result revealed that teachers‘ beliefs and attitudes were related to their use of technology.

Anderson and Maninger (2007) conducted a study to investigate pre-service teachers' abilities, beliefs, and intentions regarding technology 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.

A study (Agyei and Voogt, 2010) conducted in Ghana among pre-service and in-service mathematics teachers explored the influence of computer attitudes, competencies and access of the teachers on their levels of ICT integration using the will, skill and tool concept. The study reported low levels of ICT integration as a result of low competencies and access levels of teachers knowledge on the use ICT in teaching and learning. Furthermore, the study showed fairly high levels of positive computer attitudes and indicated among others to be a necessary condition to prepare teachers for new teaching methods which are flexible and involve appropriate use of ICT. Of equal importance to ICT integration is teacher preparation programmes.

Drent and Meelissen (2008) conducted a study about factors which influence the innovative use of ICT by teacher educators in the Netherlands. A sample of 210 teachers was used for the study. Their study revealed that student–oriented pedagogical approach, positive attitude towards computers, computer experience, and personal entrepreneurship of the teacher educator have a direct positive influence on the innovative use of ICT by the teacher.

However, with respect to pedagogical practice teachers continued to use a more traditional approach to teaching simply by viewing ICT as a tool to support their didactic approach. As such, they concluded that –teachers do not exploit the creative potential of ICT and engage students more actively in the production of knowledge. Several researchers have argued that teacher beliefs about teaching and how students acquire knowledge play a critical role in determining not only the degree to which technology is used in the classroom but how technology is used to support teaching and learning.

Teachers often view the technology integration as an additional imposition on their already demanding time schedule when they simply want to get on with the business of teaching. In addition to the fact they do not believe that they have the technical competence to effectively use technology in the classroom, they fail to see its utility or relevance for their subject. Research has shown that teachers' perceived usefulness of an innovation play a pivotal role in determining the extent to which that innovation will be adopted for use in the classroom (Hall & Hord, 2001).

Almekhlafi and Almeqdadi (2010) conducted a study to investigate teachers' perceptions of technology integration in the United Arab Emirates. Out of 100 teachers sampled, the findings indicated that the means scores for female teachers on technologies used were all above 4.4, while the mean scores for male teachers ranged from 2.5 to 3.5. The One-way ANOVA statistical test further revealed that there was a significant difference in technology use between male and female teachers. This implies that gender has influence on the teachers technology use.

Palak and Walls (2009) also conducted a mixed study to investigate whether teachers who frequently integrate technology and work at technology-rich schools shift their beliefs and practices toward a student-centered paradigm. The results showed that their practices did not change; neither student-centered nor teacher-centered beliefs are powerful predictors of practices. However, teachers' attitudes toward technology significantly predict teacher and student technology use, as well as the use of a variety of instructional strategies. Sang et al., (2010) focused on the impact of Chinese student teachers' gender, constructivist teaching beliefs, teaching self-efficacy, computer self-efficacy, and computer attitudes on their prospective ICT use. The findings confirmed the results of the study by Palak & Walls (2009) that the strongest predictor of future ICT use were teachers' attitudes toward it.

In addition to the influence of teacher attitudes, Sang et al., (2010) further indicated that pre- service teachers with highly constructivist teaching beliefs have stronger intentions to integrate technology into their future teaching practices. Furthermore, more confident pre-service teachers were more capable of and interested in using computers in real classrooms. Thus, although teachers‘ attitudes towards ICT use were found to be the strongest predictor of technology integration, the impact of their beliefs and confidence in using ICT should not be undermined.

Zhao and Frank (2003) noted that change in teacher beliefs regarding the value of computers was more likely to occur when teachers were socialized by their peers to think differently about technology use. An innovation is less likely to be adopted if it deviates too greatly from prevailing values, pedagogical beliefs, and practices of teachers and administrators in the school. Teacher practice is more likely to change in professional communities that support technology integration.

Koo (2008) conducted a study in Malaysia 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.

Hennessy, Ruthven and Brindley (2005) conclude that teacher commitment to integrating technology relates to ―recognising the educational value and believing in the transformative potential of the technology" (p. 185), the teachers in their study were concerned to use technology only where they believed it enhanced learning compared with other approaches.

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.

Liu (2010) examined the relationship between the pedagogical beliefs of teachers and technology integration in the classroom in a study involving 1139 elementary schools teachers in Taiwan. He argued that technology integration involves perceptions and practices associated with technology use and as such teachers' beliefs about technology can and will influence the teaching methods they employ in the classroom. Studies have shown that teachers beliefs were critical indictors of classroom technology use and that teachers with strong constructivist pedagogical beliefs were more likely to use technology in the classroom (Becker, 2000; Ertmer & Ottenbreit-Leftwich, 2009). However, Liu (2010) found that while teachers held learner-centered beliefs they did not integrate constructivist teaching with technology use thus revealing clear inconsistencies between teacher pedagogical beliefs and teaching activities disregarded either.

Buabeng-Andoh (2012) exploring teachers' skills, perceptions, and practices about ICT in the second cycle institutions in Ghana found that 68% of the 231 teachers used some type of software in their lesson delivery.

Abbott and Faris (2000) examined pre-service teachers' attitudes toward the use of computers before and after a semester-long technology literacy course. The results showed that positive attitudes toward computers increased after the course because of the instructional approaches, meaningful assignments requiring technology, and

supportive faculty. Thus, the authors claimed that teacher education programs should teach pre- service teachers not only how to use hardware and software, but also how to incorporate computers into their teaching strategies and activities. The authors also noted that small groups and collaborative learning are the most appropriate when introducing new hardware and software because more advanced and experienced teachers can assist those who need more technology learning support.

Doering, Hughes and Huffman (2003), analyzed the pre-service teachers‘ perspectives regarding ICT in their future classrooms before and after participation in a teacher preparation program, prior to taking the preparation courses, teachers were doubtful about the utility of ICT in the classroom, implying that they would closely examine and consider technology integration, rather than blindly incorporate it into their teaching practices. After completing the courses, their doubt had transformed into more positive sentiments.

The teachers had a better understanding about ICT use in the classroom. Although the teachers were confronted with other issues such as technology availability, accessibility, professional support, and classroom management, their perceptions about technology‘s role had changed. They were more likely to believe that technology can assist in learning and to recognize its importance.

Teo (2008) conducted a survey on pre-service teachers‘ attitudes towards computer use in Singapore. A sample of 139 pre-service teachers was assessed for their computer attitudes using questionnaire with four factors: affect (liking), perceived usefulness, perceived control, and behavioural intention to use the computer. He found that teachers were more positive about their attitude towards computers and

intention to use computer than their perceptions of the usefulness of the computer and their control of the computer.

Sugar et al. (2005) report that the teachers believed that their principal, school, parents and students were keen for them to use technology. These perceived subjective norms acted as enablers, encouraging teachers to have a positive intention towards incorporating various new technologies into their teaching.

Lai and Pratt between 2001 and 2004 conducted a three-year study of New Zealands e-learning initiative. The study aimed at investigating teachers‘ perceptions of the teaching and learning effects of ICT use in 26 secondary schools. For the purpose of the study both quantitative and qualitative data were collected. Lai and Pratt (2007) concluded that the integration of ICT in educational practice had a number of positive social and motivational effects on the learners including increased interest and engagement and that the social and motivational effects were more frequently observed than cognitive and learning effects. Teachers reported an improvement in the presentation of work, an increased sharing of resources, greater collaboration between students and an increased motivation for learning as student engagement was greater. However, the study also revealed a number of negative consequences such as increased plagiarism and a higher level of distraction.

Sorgo, Verckovnik and Kocijancic (2010) who found high correlation between frequency of use of ICT, perceived value and teachers‘ competence in use of ICT among science teachers. They concluded that teachers‘ competence and confidence were predictors of using ICT in teaching. The data analysis also showed positive relationship between computer experience and ICT use.

Tobin, Routitsky and Jones (1999), investigated teachers‘ perceptions of the use of graphics calculators in secondary schools. Overall, most of these teachers believed that the graphics calculator would improve students‘ mathematical understanding and make a positive contribution to student learning. Such positive attitudes act as enablers for change. On the other hand, in their research on teaching algebra, Cedillo and Kieran (2003) reported that their most experienced teachers, with strong mathematics backgrounds, were initially half-hearted about teaching with technology. Their negative attitude seemed to stem from a belief that using technology would not enhance student learning. Their views and practices changed markedly over time as they observed positive impact on their students‘ learning.

Thomas, Tyrrell and Bullock (1996) also found that once teachers started using computers in their mathematics classrooms, there was a positive shift in their perception of the value of using computers. These initial negative attitudes would have acted as initial barriers to individual teachers‘ intention to change, but their attitudes slowly changed as a result of their experience.

Coffland and Strickland (2004) found that teachers perceived that teaching with technology required more time both in preparation and in class than their traditional teaching. The perceived effort involved in learning technology, and changing practice was highlighted by the teachers who commented that the ―technology required more time to learn and implement than they had available or were willing to give” (p. 358). This included a perception that if they used technology, they would not have time to finish the course.

Teo et al. (2008) investigated a quantitative study examining the possible relationship between Singaporean pre-service teachers‘ beliefs about teaching and technology use.

Constructivist teaching beliefs were significantly and positively correlated with both constructivist and traditional technology use.

In a survey of teachers' perceptions of the effects of technology on students' performance, the respondents indicated strong agreement that technology had a positive effect on the students' performance (Hurley &Mundy, 1997).

Serhan (2009) and Chai, Koh and Tsai (2010) also investigated pre -service teachers' beliefs about the use of computer technology and the effectiveness of ICT courses. The results of both studies indicate that after participating in courses, pre-service teachers recognized the importance of technology integration into their curricula and believed that ICT use would enhance student learning. They felt that such courses prepared them to apply ICT in the future, and their abilities to select, evaluate, and use a variety of technological resources improved. Chai, Koh and Tsai (2010) found that ICT courses with direct instruction on the use of technological tools through the technology enhanced lesson (TEL) approach helped teachers learn how to use technologies as supporting tools in order to enhance their teaching and student learning. Consequently, the pre-service teachers viewed the preparation course favourably.

Research done in Canada showed that in-service and pre-service mathematics teachers believe that they are not adequately trained and often are not given appropriate tools to implement educational technology in their classrooms (Hardy, 2003)

2.4 The Perceptions of Students on the Use of ICT in Learning Mathematics

Students constitute a significant group within this social system, and their perspectives play an important part in framing the activity that takes place in school settings. Indeed, it has been argued that young people should be seen as active

participants in shaping social and educational processes rather than viewed as passive recipients of them (Pollard & Tann, 1993). Students' attitudes affect the impact of technology, especially students' perceptions of their abilities to solve mathematical problems and attitudes to using technology to learn mathematics (Moos & Azevedo, 2009).

As stated by Galbraith and Haines (1998) it is a crucial step in understanding how the learning environment for mathematics is affected by the introduction of computers and other technology gaining insights into students' attitudes and beliefs.

According to Lord and Harland (2000), pupils' perspectives in the UK has been linked either to the development of school-based strategies based on consultation with pupils on effective classroom practice, or to aspects of curricular evaluation. Few studies have however focused specifically on secondary pupils' views on their current classroom use of ICT in teaching and learning. Where students' perspectives have provided the focus for such inquiry in other educational settings (for example the Canadian technology-enhanced Secondary Science instruction (TESSI) project), pupils' enhanced participation in learning activities and their development of successful learning strategies were attributed to the combined influences of – and interactions between – the technologies employed and the pedagogical and social milieu of the classroom (Pedretti et al., 1998).

Adentwi and Brefo (2011) conducted a study to investigate rural and urban students' attitudes towards information and communication technology 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 technology. Their analysis further revealed that students' attitudes towards technology do not differ in terms of gender.

Interestingly, the most important impact of the integration of technology in the classroom was that students enjoyed the learning experiences which resulted to a more responsible for their own learning.

Ellington (2003, 2006) indicated that teaching mathematics at K-12, using calculators in testing and instructions resulted in students developing the necessary operational skills in understanding mathematical concepts. In addition, installation of computers into a secondary school showed that there is a relation between use of computers in the classrooms and the students‘ positive attitudes towards learning (i.e. enjoying the subject, having motivation to learn more) (Wishart & Blease, 1999).

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 technology unless they have had enough hands-on experience in using some mathematics software or websites in the Merrill (2002, 2006) indicates that the real intrinsic motivation for learners is learning. Learners have integrated instruction into their life when they are able to demonstrate improvement in skills and modify their new knowledge for use in their everyday lives school.

Other studies (Holloway and Valentine, 1999; Becta, 2001; Facer et al., 2001; Wellington, 2001) have begun to examine the nature and extent of young people‘s use of ICT outside school and the influence that it may have upon their learning with ICT in school. Whilst results indicate that some children (often those who use computers extensively at home) are capable of integrating their use of ICT in balanced and sophisticated ways (Furlong et al 2000), the indications are that this further accentuates inequities between such young people and their peers who lack similar

access to these technologies. Findings also show that whilst boundaries between home knowledge and school knowledge are being eroded, learners‘ experience of ICT takes on a different character depending upon the context of its use. Furlong et al (2000) found that at home, young people tend to control their own time, how they use technology and the content of what they do.

In school, however, the locus of control lies elsewhere; emphasis is on learning activities managed by the teacher, metered by timetable constraints, designed to meet curriculum criteria and attainment targets and incorporate the mandatory use of ICTs. Similarly, Saye and Brush (2004) noted that technology- assisted learning environments –can support more disciplined inquiry into ill-structured problems” (p. 352), which implies that the use of technology fosters students‘ interactions among them and with the curriculum material. Kulik (1994) implemented approved instructional software for 18 elementary schools and analyzed 950 students' achievement during an eight-year experience. This study concluded that there is a direct link between students' test scores and their participation in computer education course, and all students' test scores rose because of this BS/CE program. The results also showed that the more access students had to computers, the more positive students and teachers attitudes were toward computers and technology in order to make inquiry happen.

Kahveci, (2010) conducted a study in Turkey to find out students‘ perceptions to use technology for learning. Out of 158 students surveyed, the findings revealed that Female students were less confident in using technology compared to male students. He therefore found a significant difference in the effect of Confidence between male and female students.

Manzo‘s (2001) study found that many of the students who are drawn to Electronic Arts Class were struggling in most of their other classes. Once they saw what they could do with technology, they began to appreciate the importance of doing well in all subjects

Gao (2005) also found that perceived usefulness of computer is positively correlated with students‘ attitudes toward it. The study unearthed that the learners who perceived computer education to be irrelevant were not positively predisposed toward the subject.

Anderson and Maninger (2007) investigated the changes in and factors related to students' technology-related abilities, beliefs, and intentions. Statistically significant changes were found in students' perceived abilities, self-efficacy beliefs, value beliefs, and intentions to use software in their future classrooms. Students' self-efficacy, value beliefs, and intentions were moderately correlated with each other. Abilities were correlated with self-efficacy and computer access. The best predictors were self-efficacy beliefs, gender, and value beliefs.

Vale and Leder (2004) report that female secondary students were less positive than male secondary students about computer-based mathematics. The female students were more likely to be concerned about successful results in computer-based mathematics, while male students were more concerned about the relevance of the mathematics and their personal pleasure in using computers in mathematics classes. In contrast, Pierce, Stacey and Bartaksas‘ (2007) administration of the Mathematics and Technology Attitude Scale for middle secondary school students found female students were less confident than males about using technology but that this did not

significantly affect the students‘ beliefs about the value of technology for learning mathematics.

Underwood and Brown (1997) examined the calculus instructors' perceptions about the impacts of using computers and calculators on specific topics of calculus, student motivation and student learning. The results identified that using computers increases students‘ self-efficacy, develops their positive attitude toward learning and makes learning more relevant, meaningful, and enjoyable; therefore, it causes declining in academic frustration.

2.5 Potential Barriers Hindering the Effective Integration of ICT in the Mathematics Classroom for both the Teachers and Students.

Many studies have shown several obstacles that teachers experience in the integration of ICT in their classrooms. Jones (2004) found a number of barriers for the integration of ICT into lessons: (1) lack of confidence among teachers during integration, (2) lack of access to resources, (3) lack of time for the integration, (4) lack of effective training, (5) facing technical problems while the software is in use, (6) lack of personal access during lesson preparation and (7) the age of the teachers.

Other factors have been pointed out in literature as barriers to ICT integration in teaching and learning. These barriers include but are not limited to, lack of appropriate software, lack of time for training and the use of ICTs, Lack of technical support, lack of competence to use ICT, lack of follow up for new skills, lack of differentiated training programmes, technical faults with ICT equipment. Literature indicates that teachers are already burdened people and when they are confronted with factors such as these, they tend to avoid integration all together so that they are not burdened further (Hew & Brush, 2007).

Students, adapted to teacher-dependent educational system rather than self-directed and motivated, are more comfortable with a teacher-controlled learning as 75 percent of participants preferred the traditional modes of teaching over their new experience.

The study can be supported by the idea of Akerlind and Trevitt (Akerlind &Trevitt , 1995) who argue that resistance to change is likely to be greatest when it conflicts with the students‘ past learning experiences, particularly when it also involves using the technology to foster a more active, self-directed style of learning.

Snoeyink and Ertmer (2002) have identified these or similar variations as widespread barriers: lack of computers, lack of quality software, lack of time, technical problems, teacher attitudes towards computers, poor funding, lack of teacher confidence, resistance to change, poor administrative support, lack of computer skill, poor fit with curriculum, scheduling difficulties, poor training opportunities, and lack of vision as to how to integrate ICT in instruction.

Frederick, Schweitzer and Lowe (2006) showed that student mobility, special needs, and anxiety over standardized test results are the main challenges associated with ICT use. These challenges can be solved by providing more authentic group- and problem-based learning activities, and adequate learning support (Whelan 2008).

Whelan (2008) also identified more barriers from the student perspective, including: subpar technical skills that reduce access to ICT in classroom; an insufficient number of academic advisors; lack of timely feedback from instructors; and reduced interaction with peers and instructors. Therefore, the author recommends the following strategies to facilitate the learning process: more induction, orientation, and training for students; an increased emphasis on the importance of instructor access

and effective administration; and the expansion of podcasting and online conferencing tools.

In general, capacity building, curriculum development, infrastructure, policy, and government support are required in order to lower student barriers and improve the effectiveness of ICT use in the classroom. In addition, Castro Sánchez and Alemán (2011) encourage students to acquire specific technical skills to facilitate learning in ICT environments.

Research have shown that such programmes have not adequately modelled the use of technology in their method courses (Adamy & Boulmetis 2006) or incorporated effective approaches to technology integration into a single technology courses (Brown &Warschauer 2006).

Language plays an important role in influencing the Internet usage. Since the Internet is dominated by English language content, English speaking countries have a strategic advantage in popularizing the use of the Internet (Xiaoming & Seet Kay, 2004). On the other hand, non-English speaking countries such as Iran face enormous difficulty in tapping the potential of the Internet as an information source. More than 60 percent of student stated insufficient native language content over the web as the main reason they can‘t use the internet as a reliable source to broaden their learning experience.

In a study with 111 teachers in Malaysia, Keong, Horani and Daniel (2005) identified six major barriers faced by the teachers to implement ICT into their mathematics classroom. These were lack of time in the school schedule for projects involving ICT (54.6%), inadequate teacher training opportunities for ICT projects (40.8%), lack of adequate technical support for ICT projects (39.2%), lack of knowledge about ways to integrate ICT to enhance the curriculum (38.8%), integrating and using different ICT

tools in a single lesson (36.8%) and the absence of access to the necessary technology at the homes of students (33.0%).

Research reports continue to reveal that instructional technology is not reaching its potential in classrooms. Teachers are reluctant to use technology for a variety of reasons. Some do not believe it is useful for teaching and learning mathematics (Hazzan, 2000), some lack familiarity with the technological tools (Manoucheri, 1999), and some lack knowledge related to the use of technology as part of classroom instruction (National Center for Education Statistics, 2000).

Research reveals several obstacles that teachers face in the course of implementing ICT integration. Chief among the obstacles are the teachers themselves. Although the majority of teachers believe that ICTs have the ability to improve class- room learning, an almost equal number of them still find it difficult to understand ICTs‘ specific benefits or how it can be used so as to achieve maximum results (Old- field, 2010).

Studies by Korte and Husing (2007), Blankskat et al., (2006) and Becta (2008) have tried to bring to the fore these contrasting perceptions of teachers and even revealed that despite the continuous hype of the advantages of ICTs in teaching and learning, there is still a small group of teachers who do not see any considerable benefit to learners while using ICTs.

A study published in 2004 shows that, in Italy, 37% of high-school teachers regularly use a PC to prepare their lessons and 20% use a PC for classroom presentations. Most teachers use the Web mainly to acquire further knowledge in their subject matter (62%), to visit websites dealing with school and education (26%), to download material for classroom use (20%) as assessment tests, tools for school activity

management, lists of subject links, etc., and to access to encyclopaedias and databases (19%). The results which emerged from this study show that one of the major factors preventing teachers from using computers in the classroom is the lack of PCs and data projectors (67%), the lack of educational software and learning materials at school (55%). As a matter of fact, in Italian schools computers are available mainly in labs (78%).

There is a huge gap in the contrast between young people‘s use of ICT in their personal lives and their experiences of ICT in education. Today‘s learners are having new practical experiences and engaging with new forms of practical learning on a daily basis. This tide of practical learning, because much of it is happening beyond the school walls in bedrooms and on the streets, is difficult to quantify and assess. Students are more stressful because they are not aware of other students and they also believe that they are not familiar with team work which would be the vital way to reduce their stress. This finding is supported by other studies (Hunt et al., 2002), as much of the current interest in on-line learning has been driven by its potential to harvest the benefits of collaborative learning through the establishment of learning communities.

The lack of incentives and support for teachers are other factors hindering their use of ICT. The SRI-World Links evaluation (Kozma et al., 2004) shows that teachers enthusiastically engage in collaborative projects and often portray constructivist pedagogy. However, school administrators offer very little structural support and few incentives to use the technology effectively in the classroom. Too often the curriculum in developing countries is rigid and overloaded, leaving little time for innovative classroom practices.

National policies need to make more commitment to helping teachers effectively integrate computers and internet technologies into the classroom by aligning curricula, exams, and incentives with the educational outcomes that they hope to gain. In the end, computers by themselves bring very little to the learning process – they are only tools for teaching and learning.

As Mishra and Koehler (2007) point out teachers often have inadequate experience with using digital technologies for teaching and learning and as such do not consider themselves sufficiently prepared to do so.

The incorporation of technology into mathematics generates a list of objections and concerns identified by Heid (1997), as;

1. Finance and equity – this concern is related to the possibilities of the institution to afford the financial support for technology: the resource materials and the maintenance for the hardware and the software
2. The nature of technology use – it is a concern related to the integration of technology in mathematics education and which revolves around how students will use technology, if they will overuse it or use it for inappropriate topics. They can develop a false security, not being aware of the computer limitations or calculators results. Also students can shift attention from the mathematical activity to the tool.
3. Students‘ Learning – a third set of concerns points toward what students would not learn if technology is incorporated into the teaching of mathematics. Computers and tools can become a crutch, replacing students‘ mathematical thinking, reasoning, mental computational abilities and basic skills.

4. Curriculum balance and implementation – two major areas of concern arise with respect to curriculum: what is the proper balance of computer use with other practices, and what is required from the students to do and to know? When students are presented with rich problems and powerful technology, they are likely to take a variety of directions in approaching the problems this is because teachers and students begin with problems instead of topics, making them focus on many different topics at the same time (Romagnano, 1994). Many of the technology intensive curricula require more time both in and out of the classroom (Schmidt & Callahan, 1992; Solow, 1991).
5. Teacher preparation - One of the most pervasive concerns about the integration of technology into the teaching of mathematics is a concern about the adequacy of teacher preparation, if they will be appropriately prepared to engage their students in using the technology as an aid in their mathematics learning.
6. Public perception – this is a concern about how the changes brought on by technology should be communicated to the public (the parents, school board members), so as to understand the promise of technology in education.

Several internal factors also influence technology integration outcomes (Sang et al., 2011). Internal factors related to teachers include: understanding of ICT use; beliefs, which may conflict with the application of ICT; attitudes toward technology integration; perceptions, including intention or motivation to use ICT; self-confidence and knowledge; technology skills; readiness to use ICT; and technology self-efficacy (Al-Ruz & Khasawneh 2011; Chen 2008; Lin, Wang & Lin 2012 ; Sang et al., 2011 ; Tezci 2011a).

Chen (2008) discovered two common issues associated with internal factors;

First, teachers may implement policies based on limited or improper theoretical interpretations and comprehension of ICT use. Second, teachers may be under pressure to cover all content and be unwilling or hesitant to let students spend more time exploring content on their own with technology due to their other conflicting beliefs. These issues imply that teacher beliefs may not resonate in their practices. A school culture emphasizing competition and a high stakes assessment system can discourage teachers from integrating technology into their classrooms. Thus, teacher beliefs influence ICT use in the classroom (Chen 2008).

Another barrier to effective integration of technology in the K-12 classroom often lies with the teacher. According to Gorder (2008), while many teachers are at ease teaching technology skills, they are not comfortable using technology to promote active learning and to meet the individual needs of students. Prensky (2010) stated, ―And these teachers are right to be concerned, since depending on how it is used, technology can either help or hinder the educational process" (p.3). Presnky maintained that technology deepens and enhances the learning process when students use technology in meaningful ways - not when teachers simply use it themselves.

According to Bingimlas (2009) teacher competence refers primarily to the ability to integrate ICT into pedagogical practice. Lack of knowledge/competence is regarded as a significant teacher related barrier to ICT integration.

According to a report by Becta (2004), many teachers who are unskilled in ICT are not prepared to use them in the classroom or in front of students who might probably know more than them. This lack of confidence is further deepened with the expectation of students on the competence of the teacher in the use of ICTs. This is so

because students are of the view that their teachers know more than them and with this at the back of the mind of the teacher if he/she is even having a fair knowledge about ICTs will not be willing to go and disgrace him/her before the students.

Bauer and Kenton (2005) found that teachers, who were highly educated and skilled with technology, were innovative and adept at overcoming obstacles, but they did not integrate technology on a consistent basis both as a teaching and learning tool. Results suggest that schools have not yet achieved true technology integration.

Gulbahar (2007) concluded that teachers and administrative staff felt themselves competent in using ICT available at the school; they reported a lack of guidelines that would lead them to successful integration.

Earle (2002) pointed out some barriers to the integration of technology in the classroom including both restraining forces that are extrinsic to teachers such as access, time, support, resources, and training and forces that are intrinsic such as attitudes, beliefs, practices, and resistance. Brinkerhof (2006) pointed out that barriers are grouped into four main categories: resources, institutional and administrative support, training and experience, and attitudinal or personality factors.

According to Rodden (2010) the training of teachers in the integration of ICT in the learning and teaching process as is a difficult one. This is so because it involves a number of complex factors in order to render the training effective. These complex factors include finding the time for training, training in pedagogy, skills training and the use of ICT in the teacher‘s initial training (Bingimlas 2009)

Mauza (2002) again reported a number of factors for successful integration. He claimed that as teachers acquires skills in ICT; they find it easy to incorporate

strategies to integrate ICT into the curriculum, taking into consideration, access to equipment and creativity in the curriculum design. He recommends that teachers would need to recognise the benefits of ICT in the teaching and learning process before they will be willing to implement it in the classrooms.

Forgasz (2006) who surveyed grades 7 to 10 teachers' views on the use of computers for teaching mathematics. She identified teachers' lack of access, confidence, computer skills and time as factors which create barriers to teachers' use of computers in mathematics, while easy access, teacher's confidence, along with student motivation and enjoyment, were encouraging factors.

Lundell and Howell (2000) noted some factors that prevent schools from using computers for teaching and learning. Among these factors were: insufficient funds, insufficient numbers of computers, lack of computer literacy among teachers, lack of subject teachers trained to integrate computers into learning areas; the absence of properly developed curricula; lack of resources for teaching computer skills.

Research has shown that minimal or lack of incentives for the teachers who sacrifice their time to integrate technology in their classes contributes significantly to teachers unwillingness to use technology. In a survey conducted at Hollins University in 2000 on obstacles to technology integration, "70% [of respondents reported] that there were no outside incentives provided to initiate these changes" (Spodark, 2003, p. 20).

In an observation, Bitner and Bitner (2002) added that barriers to ICT can be centered on the support networks that are available to the school. These include internet connectivity, support from the teachers, the administration, technical service and students as well. This is to say that whereas the role of the teacher is crucial in the success of integrating ICT, the support system is a factor on which the success of the

programme highly depends. This brings to the fore that the technical and curriculum areas need to be provided with support that is both on site and ongoing.

The study of Nigerian secondary school teachers by Tella et al (2007), a lack of technical support in the schools, and teachers‟ lack of expertise in using ICT, were the prominent factors hindering teachers‟ readiness and confidence in using ICT.

Research by Gomes (2005) also concluded that lack of training in digital literacy, lack of pedagogic and didactic training in how to use ICT in the classroom and lack of training concerning the use of technologies in specific subject areas, were obstacles to the use of new technologies in classroom practice.

The effective integration of ICT into education and specially teaching mathematics resists against the integration of these new technologies (Askar & Usluel, 2002; Kilicman & al; 2010). The reasons for this resistance are many: lack of knowledge or skills in the use of these new technologies, difficulty to accept news working methods and sometimes even asserting the ineffectiveness of these technologies.

CHAPTER THREE

METHODOLOGY

3.0 Overview

This chapter Three provide detailed description of the methodology that is 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 would be used to explore the integration of computer technology into the teaching and learning of Mathematics at the Senior High Schools.

3.1 Population and Setting

The population of the study comprised of both private and public Senior High Schools Mathematics teachers and students in the Greater Accra Region of Ghana. Greater Accra Region was chosen for the study because the researcher has been teaching in the region for the past six years. Mathematics teachers were used because the curriculum for Mathematics is emphatic on the use of technology in the teaching and learning process.

3.2 Sampling and Sampling Technique

A simple random sampling and purposive sampling techniques was used to select three (3) Senior High Schools made up of two (2) public mixed schools and one (1) private mixed school from Ga South Municipality. Ten (10) mathematics teachers each were purposively and randomly selected from the two public mixed schools and five (5) from the one private school because the private school might not have enough Mathematics teachers who have actually undergone training on how to use the

computer to teach mathematics making a total of twenty five (25) teachers. Twenty (20) students were randomly selected from each school making a total of sixty (60) students. The male teachers were twenty one (21) and the female teachers were three (3). Also the male students were thirty four (34) whiles the females were twenty six (26).

3.3 Research Design

The research design for the study was mixed method research design. Johnson and Onwuegbuzie (2004) define mixed methods research as ~~t~~he class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study"(p.17).

Tashakkori and Teddlie (2003) argue that multiple methods are useful if they provide better opportunities for a researcher to answer research questions and where the methods allow a researcher to better evaluate the extent to which the research findings can be trusted and inferences to be made from them. Not only is it perfectly possible to combine quantitative and qualitative within the same piece of research, but it is often advantageous to do so (Saunders, Lewis & Thornhill, 2007).

Quantitative methods will enable the researcher to ensure high levels of reliability of gathered data and Qualitative research on the other hand allowed the researcher to obtain more in-depth information about the extent of technology use among SHS mathematics teachers and students in Ghana. The purpose of gathering different types of data is to understand more fully, to generate deeper and broader insight, to develop important knowledge claims about the extent of technology use among Ghanaian SHS mathematics teachers and students and the factors that hinder their use. Quantitative methods will enable the researcher to gather numerical data on SHS mathematics teachers' and students' use of technology in teaching and learning and also investigate

potential difficulties that influence their effective use. Qualitative methods on the other hand will enable the researcher to collect non-numerical data on mathematics teachers' perceptions about technology use in SHS mathematics. Each approach has its particular strengths and, when used together, could provide a thorough picture of the study (Onley & Barnes, 2008).

3.4 Research Instrument

Research instrument for the study was questionnaire. Questionnaire was used because it takes less time to administer them and also ensures the anonymity of respondents (Fraenkel & Wallen, 2000; Muijs, 2004). Questionnaire enabled the researcher to collect potential information about technology integration into the teaching and learning SHS mathematics. The questionnaires consist of both close and open ended items. The open-ended questions enable the researcher to probe a little deeper and explore mathematics teachers' perceptions towards technology use in teaching mathematics. Two forms of questionnaires were developed. One was given to the teachers and the other given to the students.

3.5 Pilot – Testing of Instrument

In order to get the validity, reliability and appropriateness of the questionnaire instrument, a pilot-test of the instrument was conducted at Ngleshie Amanfro Senior High School in the Greater Accra Region. As indicated Sudman and Bradburn (1982) who emphasized the need for pilot testing because –every questionnaire (survey) must be tested and refined under real-world conditions" (p. 282). The pilot-testing revealed poorly worded questions, some repeated questions, and ambiguities and helped to bring out items that the respondents have difficulties understanding. A pilot-test of a questionnaire is a procedure in which a researcher makes changes in an instrument

based on feedback from a small number of individuals who complete and evaluate the instrument (Creswell, 2012). The validity was improved by consulting experts in the field. The final version of the questionnaire was sent to teachers and students. The researcher was the main instrument for data collection.

3.6 Data Collection Procedure

The researcher collected a letter of introduction from the Department of Mathematics Education, University of Education, Winneba. Copies were made and given to the heads of the various schools sampled for the study before embarking on the data collection exercise. After sampling the students and teachers were given questionnaires personally by the researcher. The questionnaires were collected back as soon as it was completed.

3.7 Method of Data Analysis

The qualitative approach was used to analyze a wide variety of data, including feedback of students and teachers in order to define their perceptions and to make a qualitative analysis of their work. The responses from the questionnaire items was coded and analyzed through the use of Statistical Package for Social Science (SPSS) software version 16.0 and Microsoft Excel 2007. The SPSS software was used for the data analysis because it is easy to use and did most of the analysis of the quantitative data for the researcher. Data was analyzed using the following steps: Each copy of the questionnaire was given a serial number and a code for easy identification before scoring the respondents. The variables were coded and tabulated. Descriptive and inferential statistics were used, thus providing the opportunity to make precise statement and gives good representation of data.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS AND DISCUSSION

4.0 Overview

This chapter Four presents the analysis of the data that was collected during the study and discusses the results. In all eighty five (85) questionnaires were administered. Sixty (60) questionnaires were for the students and Twenty five (25) for the teachers. A total of eighty four (84) questionnaires were retrieved and this represents a total of 98.8%. One (1) teacher did not take part in the study. The results are presented according to the sequence of the research as follows:

1) To what extent do SHS Mathematics teachers and students use Technology in teaching and learning?
2) What perceptions do Mathematics teachers and students have in relation to the integration of ICT into mathematics teaching and learning?
3) What are the potential barriers hindering the effective integration of ICT in the Mathematics classroom for both the teachers and students?

4.1 Demographic Information on Respondents

Table 4.1 Frequency of Response from Participating Schools

Name of School	Teachers frequency	%	Students frequency	%
Ngleshie Amanfro SHS	10	41.7	20	33.3
Christian Methodist SHS	5	20.8	20	33.3
Darius SHS	9	37.5	20	33.4
Total	**24**	**100**	**60**	**100**

The Table 4.1 and shows the frequency of response of the names of the schools used in the study reports that 10 teachers (41.7%) and 20 students (33.3%) of the respondents were from Ngleshie Amanfro Senior High School. 5 teachers (20.8%) and 20 students (33.3%) of the respondents were from Christian Methodist Senior High School. 9 teachers (37.5%) and 20 students (33.4%) of the remaining respondents were from Darius Senior High School

Table 4.2 Gender of Respondents

Response	Teachers frequency	%	Students frequency	%
Male	21	87.5	34	56.7
Female	3	12.5	26	43.3
Total	**24**	**100**	**60**	**100**

From the Table 4.2 it can be seen that as many as 21teachers (87.5%) and 34 students (56.7%) of the respondents were males whiles 3 teachers (12.5%) and 26 students (43.3%) were females. This shows that majority of the teachers and students used in the study were males.

Table 4.3 Teaching Experience

No of years	frequency	%
0 -1	1	4.2
2-5	9	37.5
6-10	5	20.8
11-15	5	20.8
15and above	4	16.7
Total	**24**	**100**

The Table 4.3 of the teachers teaching experience indicated that one (4.2%) and nine (37.5%) have spent one (1) year and 2-5years respectively in teaching. Five (20.8%)

of the respondents have respectively 6-10 years and 11-15years teaching. Four (16.7%) have been teaching for over fifteen years (15). This show that majority of the respondents have spent between 2-5 years of teaching.

Table 4.4 Ages of the Respondents

Respondents	Ages	Frequency	%
Teachers (24)	20 - 29	5	20.8
	30 - 39	12	50
	40 - 49	4	16.7
	50 - 59	2	8.3
	60 & above	1	4.2
Students (60)	16 – 17	26	43.4
	18 - 19	29	48.3
	20 - 21	5	8.3

Table 4.4 shows that the age distribution of the respondent indicated 5(20.8%) of the teachers fell between 20 - 29 and the majority of the teachers constituting 12(50%) fell between the ages 30 - 39, also 4(16.7%) of the teachers fell between the ages 40 - 49 while only 1(4.2%) was of the ages of 60 & above. Looking at the ages of the students from table 4.4 26(43.4%) of them were between the ages 16 - 17 years. Majority of them however were between the ages 18 -19 constituting 29(48.3%). The remaining of the students were between the ages 20 - 21 with 5(8.3%).In drawing up conclusion the researcher realized that most of the teachers were in the age group (30-39) whiles the students were in the age group 16-19 years.

4.2 Research Question 1: To What Extent do SHS mathematics teachers and students use Technology in Teaching and Learning?

In order to answer the research question above, the respondents were asked whether they have been using computer during teaching and learning of Mathematics and their response is presented in the table 4.5 below:

Table 4.5 Teachers Response on the Use of Computer in Their teaching

Response	Frequency	%
Yes	7	29.2
No	17	70.8
Total	**24**	**100**

Table 4.5 answers the question do you use computers in your teaching? on the teachers questionnaire and it indicates that 7 (29.2%) have been using computer in their teaching whiles as many as 17 (70.8%) have not been using computers in their teaching.

Table 4.6 Teachers Response on their Access to Computers in the School

Response	Frequency	%
Yes	23	95.8
No	1	4.2
Total	**24**	**100**

It can be seen from Table 4.6 which answers the question do you have access to computers in the school? On the teachers questionnaire indicated that 23 (95.8%) of the respondents have access to computers in their schools .Only1 representing (4.2%) of the teachers do not have access to computers in their school. A deduction can be

made from the table that majority of the respondents have access to computers in their schools.

Table 4.7 Respondents View on Specialized Software for Teaching Mathematics Installed on the Laboratory Computers

Response	Frequency	%
Yes	4	16.7
No	20	83.3
Total	**24**	**100**

In answering the question Is specialized software for teaching mathematics installed on the lab computers? On the teachers questionnaire, Table 4.7 shows that as many as 20 (83.3%) of the respondents claimed they do not have specialized software installed on their laboratory computers for mathematics teaching and learning. Four (16.7%) responded in the positive manner. The above findings showed that a vast majority of the respondents do not have specialized software for teaching mathematics installed on their laboratory computers.

Table 4.8 Students' Response on Difficulties in Using Computers

Response	Frequency	%
Strongly agree	18	30
Agree	17	28.3
Not sure	10	16.7
Disagree	11	18.3
Strongly disagree	4	6.7
Total	**60**	**100**

Table 4.8 which answers when I have difficulties using computers I know I can handle them on the students questionnaire indicate that 18(30%) and 17(28.3%) of the respondents respectively said they strongly agreed and agreed to the statement. 10(16.7%) are not sure. Eleven (18.3%) and 4(6.7%) of the respondents disagreed and

strongly disagreed to the fact that when they have difficulties using the computer, they know they cannot handle them. A deduction can be made from the above that most of the students believe that when they have difficulties using the computer they know they can handle them.

Table 4.9 I enjoy trying new things on a computer

Response	Frequency	%
Strongly agree	36	60
Agree	18	30
Not sure	2	3.3
Disagree	2	3.3
Strongly disagree	2	3.4
Total	**60**	**100**

Table 4.9 above indicating students response on I enjoy trying new things on the computer on the students questionnaire shows that 36(60%) and 18(30%) of the respondents strongly agreed and agreed to the assertion above respectively. Two (3.3%) of the students favoured not sure, disagreed and strongly disagreed respectively to the fact that they enjoy trying new things on a computer. It can be deduced that majority of the mathematics teachers do not integrate technology into their teaching indicating a low level of technology use by both teachers and students at the Senior High Schools.

4.3 Research Question 2: What perceptions do Mathematics teachers and students have in relation to the integration of ICT into mathematics teaching and learning?

Table 4.10 I am encouraged to make use of computers in my teaching *(Teachers)*

Response	Frequency	%
Strongly disagree	4	16.7
Disagree	5	20.8
Indecisive	3	12.5
Agree	5	20.5
Strongly agree	7	29.2
Total	**24**	**100**

According to teachers response on I am encouraged to make use of computer in my teaching the above Table 4.10, indicate that 4(16.7%) and 5(20.8%) of the respondents respectively strongly disagreed and disagreed to the fact that they are encouraged to make use of computers in their teaching. Three (12.5%) were indecisive and 5(20.8%) agreed. The rest 7(29.2%) strongly agreed.

Table 4.11 I enjoy using new tools for my instructions

Response	Frequency	%
Strongly disagree	1	4.2
Disagree	3	12.5
Indecisive	2	8.3
Agree	8	33.3
Strongly agree	10	41.7
Total	**24**	**100**

From the teachers response, Table 4.11 indicates that 1(4.2%) and 3(12.5%) of the respondents respectively favoured strongly disagreed and disagreed that they enjoy

using new tools for instruction. Two (8.3%) were indecisive and 8(33.3%) and 10(41.7%) of the teachers agreed that they strongly agreed that they enjoy using new tools for their classroom instructions. It can be seen that majority of the teachers will enjoy using new tools to teach.

Table 4.12 I f there is a computer in my future classroom; it will help me to be a better teacher

Response	Frequency	%
Strongly disagree	3	12.5
Disagree	2	8.3
Indecisive	4	16.7
Agree	6	25
Strongly agree	9	37.5
Total	**24**	**100**

From Table 4.12 above on the teachers response it can be seen that 3(12.5%) strongly disagreed and 2(8.3%) disagreed that if there is a computer in their future classroom it will help them be better teachers. Four (16.7%) of the respondents were indecisive. Six (25%) agreed to the statement. Nine (37.5%) of the teachers strongly agreed that they will be better teachers if they have computers in their future classroom.

Table 4.13 There are enough professional development/training opportunities in ICT.

Response	Frequency	%
True	2	8.3
False	22	91.7
Total	**24**	**100**

According to the teachers response, Table 4.13 shows that 2(8.3%) of the respondents responded that there are enough training opportunities in ICT. As many as 22(91.7%) of the respondents indicated that the professional development/training opportunities

in ICT is not enough. The outcome of the response shows that teachers are not integrating ICT into mathematics teaching because they have not undergone enough training on how to do so.

Table 4.14 There is good quality software available to me.

Response	Frequency	%
True	5	20.8
False	19	79.2
Total	**24**	**100**

Table 4.14 shows that 5(20.8%) of the respondents indicated that there is good quality software available to me to teach. The remaining 19(79.2%) held their views as there is no quality software available to them to use in their classroom instructions. In answering Research question two, it can be deduced that Mathematics teachers have not been specially trained on how to use Mathematics software as well as not making available to them quality software to use in their teaching.

Table 4.15 Computing power makes it easier to explore Mathematics ideas

(Students)

Response	Frequency	%
Strongly agree	30	50
Agree	18	30
Not sure	7	11.7
Disagree	5	8.3
Strongly disagree	0	0
Total	**60**	**100**

From the students response, Table 4.15 above shows that 30 (50%) and 18 (30%) of the respondents respectively strongly agreed and agreed to the assertion that

computing power makes it easier to explore mathematical ideas. Seven (11.7%) were not sure and 5(8.3%) disagreed to the statement whiles none strongly disagreed. It can be concluded that majority of the students were convinced that the integration of ICT into mathematics teaching and learning will make it easier for them to explore mathematical ideas.

Table 4.16 I think using technology waste too much time in the learning of Mathematics

Response	Frequency	%
Strongly agree	5	8.3
Agree	12	20
Not sure	6	10
Disagree	13	21.7
Strongly disagree	24	40
Total	**60**	**100**

From the students response, Table 16 indicates that 5(8.3%) and 12(20%) of the respondents respectively strongly agreed and agreed to the above statement that using technology in learning Mathematics waste too much. Six (10%) were not sure.13 (21.7%) and 24(40%) disagreed and strongly disagreed to the above statement. A deduction can be made from the above responses that using technology in learning Mathematics does not waste too much time.

Table 4.17 Computer and graphic calculators are good tools for calculation but Not for my learning of Mathematics

Response	Frequency	%
Strongly agree	4	6.7
Agree	9	15
Not sure	3	5
Disagree	18	30
Strongly disagree	26	43.3
Total	**60**	**100**

Table 4.17 indicates that 4(6.7%) strongly agreed and 9(15%) of the respondents agreed to the fact computer and graphic calculators are good tools but not for learning of mathematics. Three (5%) were not sure to the statement. 18(30%) and 26(43.3%) disagreed and strongly disagreed to the above assertion. It can be concluded that most of the students think that computers and graphics calculators are good tools for learning Mathematics.

Table 4.18 I know computers are important but I don't feel I need to use them to learn Mathematics

Response	Frequency	%
Strongly agree	11	18.3
Agree	16	26.7
Not sure	4	6.7
Disagree	10	16.7
Strongly disagree	19	31.7
Total	**60**	**100**

According to the students response, Table 4.17 above shows 11(18.3%) of the respondents strongly agreed and 16(26.7%) agreed to the statement above. Four (6.7%) were not sure. 10(16%) and 19(31.7%) of the respondents respectively

disagreed and strongly disagreed to the assertion that computers are important but they do not feel the need to use them to learn mathematics. .

4.4 Research Question 3: What are the Potential Barriers Hindering the Effective Integration of ICT in the Mathematics Classroom for Both the Teachers and Students?

The results of teacher's response to potential barriers hindering effective integration of ICT Into mathematics teaching and learning is as shown in Table 19.

Table 4.19 Response on potential barrier hindering effective integration of ICT into mathematics teaching and learning

Response	Frequency	%
Lack of knowledge about computers	6	4.6
Computers not accessible	8	6.2
Lack of training	8	6.2
Little previous knowledge	7	5.4
Not sure how useful computers are	3	2.3
Lack of confidence	2	1.5
Computers equipment's not reliable	8	6.2
Teachers do not have sufficient time to integrate ICT	15	11.5
Schools are unsure as to how to effectively integrate ICT	10	7.7
Lack of technical support regarding ICT integration	14	10.8
Lack of sufficient ICT training	13	10
Lack of ICT infrastructure	15	11.5
Lack of time to use computers	21	16.1
Total	**130**	**100**

It can be deduced from Table 4.19 that 21(16.2%) responses went in favour of lack of time to use computer as a factor hindering the respondents from integrating ICT into their teaching and learning. 15(11.5%) and 14(10.8%) of the response also went in for

lack of ICT infrastructure and lack of technical support regarding ICT integration respectively as a factor also preventing the respondents from using ICT to teach.13(10%) of the response went in favour of lack of sufficient ICT training as a factor preventing effective integration of ICT.

Based on the data 8(6.2%) responses also went to computer equipment not reliable, lack of training and computers not accessible as the inhibiting factors. Seven (5.4%) and 6(4.6%) responses went in favour little previous knowledge and lack of knowledge about computers respectively as factors. 3(2.3%) and 2(1.5%) of the response also favoured not sure how useful computers are and lack of confidence as factors also hindering effective integration of ICT.

A conclusion can drawn from the above table that, there are four (4) major potential factors hindering the effective integration of ICT in the SHS Mathematics classroom. These are: lack of time to use computers, lack of infrastructure, lack of technical support regarding ICT integration and lack of sufficient ICT training. On the contrary two (2) factors that the respondents went in favour of that does not hinder them from effective integration of ICT in the classroom are lack of confidence and not sure how useful computers are.

4.6 Discussion of the Results

This study aims at discovering the perceptions of teachers and students on the integration of ICT into Mathematics teaching and learning in the Ghanaian Senior High School. To enable the researcher to achieve this, three (3) research questions were answered.

Research question one was to find the extent to which SHS Mathematics teachers and students use Technology in teaching and learning. On the teachers‘ use of Computer in their teaching, the findings revealed that 70.8% of mathematics teachers do not use computers in their teaching even though 95.8% of the teachers have access to computers in their schools indicating a minimal extent. It was also discovered that 83.3% of the teachers reported that the computers in the schools do not have specialised mathematics software installed on them This is consistent with Boakye and Banini (2008), on a research conducted to investigate teachers‘ readiness for the use of technology in Ghanaian schools their finding showed that, 71% of the teachers did not use technology in classrooms, 49% of teachers use technology 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 technology into Ghanaian classroom instruction has yet to be realized and utilized. This confirms a study by Snoeyink and Ertmer (2002) that identified lack of quality software among others as one of the reasons why mathematics teachers are not integrating ICT into their teaching.

The findings on the part of the students use of computer in learning Mathematics also revealed that 60% of the students enjoy trying new things on a computer and 30% of them believe that the use of computers comes with some difficulties they know they can handle them. This is line with Boakye and Banini (2008) on a study conducted to investigate the level of technology use by Ghanaian students. Out of the 5048 students surveyed, their 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 technology use is gradually gaining grounds among Ghanaian students.

Research question two investigated the mathematics teachers' and students' perception in relation to the integration of ICT into mathematics teaching and learning. The findings revealed that 91.7% of the teachers believed that the professional development/training opportunities in ICT were not enough to enable them integrate ICT into mathematics teaching. On the part of the students the findings indicated 43.3% of the students were convinced that the integration of ICT into mathematics teaching and learning will make it easier for them to explore mathematical ideas. This supports Schacter (1999) findings that, ICT is used as a tool for students to discover learning topics, solve problems, and provide solutions to the problems in the learning process. Secondly, ICT makes knowledge acquisition more accessible, and concepts in learning areas are understood while engaging students in the application of ICT.

Table 4.20: Teachers Perception on ICT Integration into Mathematics Teaching

	N	Minimum	Maximum	Mean	Std. Deviation
I am encouraged to use computers in my teaching	24	1	5	3.25	1.511
I enjoy using new ICT tools for instruction	24	1	5	3.96	1.197
If there is a computer in my future classroom it will help me be a better teacher	24	1	5	3.67	1.404
Valid N (listwise)	24				

It was found that the teachers had positive perceptions toward the use of ICT in the teaching and learning of Mathematics. Specifically, as shown in Table 4.20, teachers

indicated that they were encouraged to make use of computers in teaching (M = 3.25, SD = 1.511). Similarly, teachers enjoyed using new ICT tools for instruction (M = 3.96, SD = 1.197). Also, teachers noted that if there is a computer in their classroom it will help to be a better teacher (M = 3.67, SD = 1.404). This confirms a research by Doering, Hughes & Huffman (2003), who analyzed the pre-service teachers' perspectives regarding ICT in their future classrooms before and after participation in a teacher preparation program, prior to taking the preparation courses, teachers were doubtful about the utility of ICT in the classroom, implying that they would closely examine and consider technology integration, rather than blindly incorporate it into their teaching practices. After completing the courses, their doubt had transformed into more positive sentiments.

4.6.1 Research Hypothesis

Ho: There is no significant relationship between teachers and students perception on the Integration of ICT into mathematics teaching and learning.

H_a: There is significant relationship between teachers and students perception on the Integration of ICT into mathematics teaching and learning.

The aim of this hypothesis is to assess if there exist any relationship between teachers and students perception on the integration of ICT into mathematics teaching and learning. In order to find answer to the above hypothesis Pearson correlation analysis was performed on the two variables-teachers' perception and students' perceptions.

The results are shown in Table 4.21 and Table 4.22 below:

Table 4.21: Students' rating on their perceptions on ICT use in learning mathematics

ITEMS	SA		A		NS		D		SD	
	N	%	N	%	N	%	N	%	N	%
(1) I am encouraged to make of Computers in my learning	30	50	18	30	7	11.7	5	8.3	0	0
(2) I enjoy using new tools for my learning of Mathematics	4	4.6	9	15	3	5	18	30	26	43.3
(3) If there is a computer in my classroom it will help me to be a better student.	11	18.3	16	26.7	4	6.7	10	16.7	19	31.7

SA= STRONGLY AGREE, A= AGREE NS = NOT SURE D= DISAGREE SD = STRONGLY DISAGREE

From Table 4.21 thirty of the students representing 50% agreed to being encouraged to use the computer, while 26 students representing 43.3% strongly disagreed the use of the computer in learning mathematics. This is in line with Chu (20004) assertion that students' perceived usefulness of technology in learning is highly dependent of teachers' actual implementation of technology and that students would not be motivated to use technology unless they have had enough hands-on experience in using it.

Table4.22: Teachers' perceptions on ICT integration into mathematics teaching.

	SD		D		NS		A		SA	
ITEMS	N	%	N	%	N	%	N	%	N	%
(1) I am encouraged to make use of computers in my teaching	4	16.7	5	20.8	3	12.5	5	20.5	7	29.2
(2) I enjoy using new tools for my Instructions	1	4.2	3	12.5	2	8.3	8	33.3	10	41.7
(3) If there is a computer in my future Classroom; it will help me to be a better teacher	3	12.5	2	8.3	4	16.7	6	25	9	37.5

SA= STRONGLY AGREE, A= AGREE NS = NOT SURE D= DISAGREE SD = STRONGLY DISAGREE

From Table 4.22 ten of the teachers representing 41.7% strongly agreed to enjoy the use of the computer in teaching while 4 representing 16.7 % strongly disagreed to being encouraged to use the computer. This is in line with the findings of Chai, Koh and Tsai (2010), that technology helps as a supporting tool which enhance teachers delivery of the lesson.

Table 4. 23 Correlation matrix for Teachers and students perceptions

	I am encouraged to use computers in my teaching	I enjoy using new tools for my teaching	If there is a computer in my classroom it will help me be a better math teacher
I am encouraged to use computers in my learning.	.813		
I enjoy using new tools for my learning.		-.578	
If there is a computer in my classroom it will help me be a good math student			.000

$* p < 0.05$ (2-tailed)

The null hypothesis that there is no significant relationship between teachers and students perceptions on the integration of ICT into Mathematics teaching and learning was statistically tested using Pearson's correlational method. As shown in Table 4.23 the test revealed that there was no statistically significant correlation between teachers and students perception on the encouragement of the use of ICT in teaching/learning ($r = 0.813; n = 5; p > 0.05$). Similarly, there was no statistically significant correlation between teachers and students perception on the issue of enjoying the use of new ICT tools for teaching/learning ($r = -0.578; n = 5; p > 0.05$). Also, there was no statistically significant correlation between teachers and students perception on the issue that if there is a computer in the classroom it will help to be a better mathematics teacher/student($r = 0.000; n = 5; p > 0.05$). These results are consistent with the null hypothesis by suggesting that there is no significant relationship between teachers and students perceptions on the integration of ICT into Mathematics teaching and learning.

Research question 3 investigated into the potential barriers hindering the effective integration of ICT in the mathematics classroom for both teachers and students. The findings of the study revealed four (4) major potential barriers hindering the effective integration of ICT in the SHS Mathematics classroom. These are lack of time to use computers (16.1%), lack of infrastructure (11.5%), lack of technical support regarding ICT integration (10.8%) and lack of sufficient ICT training (10%). On the contrary two (2) factors that the respondents went in favour of that does not hinder them from effective integration of ICT in the classroom were lack of confidence (1.5%) and not sure how useful computers are (2.3%). The literature has pointed out several factors as barriers to ICT integration in Mathematics teaching and learning. But the above report coincide with that of Hew and Brush (2007) who identified lack of time for

training and the use of ICTs, Lack of technical support and lack of differentiated training programmes among others as some of the barriers to effective integration of ICT into teaching and learning.

On this issue, a study with 111 teachers, Keong, Horani and Daniel (2005) identified six major barriers faced by the teachers to implement ICT into their mathematics classroom and among others were lack of time in the school schedule for projects involving ICT (54.6%), inadequate teacher training opportunities for ICT projects (40.8%), lack of adequate technical support for ICT projects (39.2%) and lack of knowledge about ways to integrate ICT to enhance the curriculum.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.0 Overview

This chapter presents a summary of the study, conclusions from the study, recommendations and suggestion on areas appropriate for further study.

5.1 Summary

The main Purpose of the study was to find the perception Mathematics teachers and students at the Senior High School in the Ga South Municipality on the integration of ICT into Mathematics teaching and learning. The following research questions guided the study:

(1) To what extent do SHS Mathematics teachers and students use Technology in teaching and learning?

(2) What perception do Mathematics teachers and students have in relation to the integration of ICT into mathematics teaching and learning?

(3) What are the potential barriers hindering the effective integration of ICT in the Mathematics classroom for both the teachers and students?

Data were collected from eighty four (85) respondents comprising of sixty (60) students and twenty four (25) teachers were selected randomly and purposely from three schools. Two public mixed school and one private mixed school. Tools used for the data collection was a questionnaire. The questionnaire was structured for both teachers and students. The questionnaire consisted of both open and closed-ended items. It was designed to find responses from the respondents based on the research questions. It was administered personally by the researcher. The instrument was pilot-

tested at Ngleshie Amanfro SHS using different respondents to find out the validity and reliability of the instrument. In all, a total of three SHS Schools were involved. Eighty five (85) questionnaires were made for both the teachers and students respectively but eighty four (84) were retrieved. The retrieval rate was 96% for 24 teachers out of 25 and 100% for 60 students out of 60. The data were analyzed using both descriptive and inferential statistical method.

5.2 Summary of the Findings

Research Question 1: To what extent do SHS Mathematics teachers and students use Technology in teaching and learning?

It was discovered from the study that the extent to which Mathematics teachers at the SHS technology use in teaching Mathematics was minimal since majority of the teachers constituting 70.8% claimed that they have not been using computers in their teaching. It was also discovered that 95.8% of the teachers have access to computers in their schools, they do not have any specialized software for teaching Mathematics installed on their laboratory computers.

Furthermore, the study indicated that the extent to which students at SHS use technology in learning Mathematics was moderate. Thirty percent (30%) of the students claimed that they can handle any difficulties encountered when using the computer to learn Mathematics as well as enjoy trying new things on the computers.

Research Question 2: What perception do Mathematics teachers and students have in relation to the integration of ICT into mathematics teaching?

This question was to investigate into teachers perceptions in relation to the integration of ICT into Mathematics teaching. The teachers 41.7% indicated that they are

encouraged to make use of computers in their teaching and enjoyed using new tools for their classroom instruction. It was also discovered that 37.5% of the teachers claimed they believe to be better teachers if their future classroom will have computers. In addition to that it was found out that 91.7% of the teachers indicated that professional development/training opportunities in ICT was not enough or inadequate. With regards to the students' perception on the use of ICT in learning Mathematics, fifty percent (50%) of the students were convinced that the integration of ICT into Mathematics teaching and learning will make it easier for them to explore Mathematical ideas. Also 40% of the students think that computers and graphic calculators are good tools for learning Mathematics and using such tools does waste too much time in Mathematics learning.

Research Question 3: What are the Potential Barriers Hindering the Effective Integration of ICT in the Mathematics Classroom for Both the Teachers and Students?

In relation to the potential barriers hindering the effective integration of ICT in the Mathematics classroom, numerous factors were identified but majority of the respondents agreed to these as the major factors found to hinder their effective integration of ICT into Mathematics teaching and learning. They are as follows: Lack of time to use computers, Lack of infrastructure, Lack of technical support regarding ICT integration and Lack of sufficient ICT training .The minor factors identified were: Lack of confidence and Not sure how useful computers are.

5.3 Conclusions

The following conclusions were drawn from the research questions that were set. Concerning the extent to which Mathematics teachers and students use technology in teaching and learning, majority of the teachers responses indicated that they have not

been using computers in their classroom instruction even though most of them the claimed that they have access to computers in their schools. It was discovered that most of the schools do not have specialized software for teaching Mathematics installed on the computers in their laboratories. On extent of the students‘ use of technology in learning Mathematics it was revealed that Majority of the students claimed that they can handle any difficulties encountered when using the computer to learn Mathematics as well as enjoy trying new things on the computers.

Also it can be concluded that majority of the teachers indicated that they encouraged making use of computers in their teaching and enjoying using new tools for their classroom instruction concerning their perceptions in relation to the integration of ICT into Mathematics teaching.

Furthermore, the students had good perception concerning the use of computers and graphic calculators and were convinced that are good tools for learning Mathematics. Also majority of the students have accepted the fact that the integration of ICT into Mathematics teaching and learning will make it easier for them to explore Mathematical ideas.

Lastly, with respect the potential factors hindering effective integration of ICT in the Mathematics classroom, it was found out that although there were numerous factors, the four (4) major factors identified were: Lack of time to use computers, Lack of infrastructure, Lack of technical support regarding ICT integration and Lack of sufficient ICT training.

5.4 Recommendations

I would to make the following recommendations based on the findings of the research work done.

- Specialized software for teaching and learning Mathematics should be installed on the computers in the various Senior High Schools laboratories to enable the Mathematics teachers in the SHS have access to them and use it in their teaching.
- Adequate ICT infrastructure should be provided to the Senior High Schools to accommodate enough students at a time looking at their population size. This would enable the teachers and students to increase the number of days and hours spent using the ICT facilities.
- Teachers and students should use ICT in giving and receiving assignments.
- Professional developments and training programmes should be frequently organised for teachers especially those who teaches Mathematics to enable them become conversant with the necessary tools to use and also enhance teachers‘ technology integration abilities and skills for effective technology integration.
- Teachers should be provided with some release time so that they can plan effectively for technology integration in teaching and learning.

5.5 Suggestion for Further Research

For a more precise generalization on the conclusions made on the teachers and students perceptions on the integration of ICT into mathematics teaching and learning in the Senior High Schools, there is the need to further study in other district in the Greater Accra Region of Ghana.

REFERENCES

Abbott, J. A. and Faris, S. E.,(2000). *Integrating technology into pre-service literacy instruction*: A survey of elementary education students' attitudes toward computers, Journal of Research on Computing in Education, vol. 33, pp.149-161.

Abuhmaid, A. (2011). *ICT training courses for teacher professional development in Jordan*. The Turkish Online Journal of Educational Technology – October 2011, vol.10(4) 210 Retrieved on 17th February, 2012 from http://www.tojet.net/results.asp?volume=10&issue=4&year=2011

Adamy, P., & Boulmetis, J.(2006). *The impact of modelling technology integration on Pre-service teachers' technology confidence.* Journal of computing in higher Education 17 (2), 100-120.

Agyei, D. D. & Voogt, J. (2011a). ICT use in the teaching of mathematics: Implications for professional development of pre-service teachers in Ghana. *Education and Information Technologies,* 16(4), 423-439. http://dx.doi.org/10.1007/s10639-010-9141-9

Agyei, D. D. & Voogt, J. (2011b). Exploring the potential of the will, skill, and tool model in Ghana: Predicting prospective and practicing teachers' use of technology. *Computers & Education,* 56(1), 91-100. http://dx.doi.org/10.1016/j.compedu.2010.08.017

Agyei, D. D., & Voogt, J. (2010). Developing pre-service teacher's competencies to use Activity- based learning with technology in mathematics education. Technology Pedagogy and Education.

Akerlind, G. and Trevitt, C. (1995): Enhancing learning through technology: when students resist the change.

Al-ruz, J. A. and Khasawneh, S.,(2011). Jordanian pre-service teachers' and technology integration: *A human resource development approach, Educational Technology and Society*, vol. 14, pp.77-87

Almekhlafi, A. G., and Almeqdadi, F. A. (2010). *Teachers' perceptions of technology integration in the United Arab Emirates school classrooms*. Educational Technology & Society, 13 (1), 165–175

Anderson, J. R., Reder, L.M., & Simon, H.A. (2000). *Applications and misapplications of cognitive psychology to mathematics education*. Texas Educational Review.

Anderson, S., & Maninger, R, (2007). Pre-*service teachers' abilities, beliefs, and intentions regarding technology integration. Journal of Educational Computing Research*, 37 (2), 151-172.

Anamuah-Mensah J (2002) National Education Review Committee Report (2002). *Report President'S committee on Review of Education Reforms in Ghana*. Accra: Ministry of Education.

Anamuah-Mensah, J., Mereku, D. K. & Ghartey-Ampiah J. (2009), TIMSS *report on Ghana's achievement* in TIMSS 2007.

Askar, P., & Usluel, Y. K. (2002). Perceptions of teachers about the characteristics of computers in the diffusion process of technology. H. U. Journal of Education, 22, 14–20.

Ashburn, E. A., & Floden, R. E. (2006). *Meaningful learning using technology: What educators need to know and do*. New York: Teachers College Press

Ball, L., & Stacey, K. (2005). *Teaching strategies for developing judicious technology use*. In W. J. Masalski, & P. C. Elliott (Eds.), Technology-supported mathematics learning environments (2005 National Council of Teachers of Mathematics Yearbook) (pp. 3–15). Reston: NCTM.

Balanskat, A., Blamire, R. & Kefala, S. (2006). The ICT Impact report: A Review of Studies of ICT impact on schools in Europe. European Schoolnet.

Bauer, J., & Kenton, J. (2005). *Toward technology integration in the schools*: Why it isn't happening. Journal of Technology and Teacher Education, 13 (4), 519-546.

Becta (2004). *A Review of the research literature on barriers to the uptake of ICT by teachers* BectaTeachers[Online],available:http://partners.becta.org.uk/page_documents/research/barriers.pdf [accessed 19 Dec 2009].

Becta (2001). *Impact2: Emerging Findings from the Evaluation of the Impact of Information and Communications Technologies on Pupil Attainment,* London, DfES.

Becta (2003) Harnessing technology: Schools survey 2008. Retrieved 20 October 2011 from http://emergingtechnologies.becta.org.uk/uploaddir/downloads/page_documents/re earch/ht_schools_survey08_analysis.pdf. [Accessed 20th October 2011]

Becta (2008) Harnessing technology: Schools survey 2008. Retrieved 20 October 2011 from http://emergingtechnologies.becta.org.uk/uploaddir/downloads/page_documents/re earch/ht_schools_survey08_analysis.pdf. [Accessed 20th October 2011]

Becker, H. (2000). *Findings from the Teaching, Learning, and Computing Survey. Education Policy Archives*, 8, 51. Retrieved January 10th, 2011 from http://epaa.asu.edu/ojs/article/view/442/565.

Bennett, D. (2002). *Exploring geometry with Geometer's Sketchpad*. Emeryville, CA: Key Curriculum Press.

Bergqvist, T. (1999). *Gymnasieelever undersöker ett matematiskt begrepp med grafräknare*. Nordic Studies in Mathematics Education, 7, 35-60

Bitner, N. & Bitner, J. (2002). *Integrating technology into the classroom: Eight keys to success*. Journal of Technology and Teacher Education, 10 (1), 95 -100.

Bingimlas, K. (2009) _*Barriers to the Successful Integration of ICT in Teaching and Learning Environments*: A Review of the Literature', Eurasia Journal of Mathematics, Science and Technology Education, 5(3), 235-245.

Blackett, N., & Tall, D. O. (1991). *Gender and the versatile learning of trigonometry using computer software*. In F. Furinghetti (Ed.), Proceedings of the 15th conference of the International Group for the Psychology of Mathematics Education, 1, 144-151. Assisi, Italy.

Boakye, K.B., & Banini, D.A. (2008). *Teacher technology readiness in Ghana*. In K. Toure, T.M.S. Tchombe, & T. Karsenti (Eds.), technology and Changing Mindsets in Education. Bamenda, Cameroon: Langaa; Bamako, Mali: ERNWACA / ROCARE.

Bransford, J.D., Brown, A. L., & Cocking, R.R. (1999). *How people learn: Brain, mind, experience and school.* Washington, DC: National Academy Press.

Bransford, J. D., Brown, A. L., Cocking, R. R., Donovan, M. S., & Pellegrino, J. W. (Eds.). (2000). How people learn: Brain, mind, experience, and school (Expanded ed.). Washington, DC:National Academy Press. Retrieved from: http://books.nap.edu/openbook.php?record_id=9853&page.

Brinkerhof, J. (2006). *Effects of a long-duration, professional development academy on technological skills, computer self- efficacy, and technology integration beliefs and practices*. Journal of Research on Technology in Education, 39 (1), 22-44.

Brown, D., & Warschauer, M. (2006). From the university to the elementary classroom: students' experiences in learning to integrate technology in instruction. Journal of Technology and Teacher Education, 14(3), 599–621.

Brush, T., Glazewski, K. D. and Hew, K. F., (2008). *Development of an instrument to measure preservice teachers' technology skills, technology beliefs, and technology barriers*. Computers in the Schools, vol. 25, pp.112-125.

Björk, L-E. & Brolin, H. (1995). *Using new technology as a tool to increase student understanding of calculus. Proceedings of the International Conference on Technology in Mathematics* Teaching, Edinburg

Buabeng-Andoh, C. (2012). An Exploration of Teachers' skills, Perceptions and practices of ICT in Teaching and Learning in the Ghanaian Second-cycle Schools. *Contemporary Educational Technology,* 3(1), 36-49.

Castro Sánchez, J. J. and Alemán, E. C., 2011. *Teachers' opinion survey on the use of ICT tools to support attendance-based teaching. Journal Computers and Education*, vol. 56, pp.911-915.

Cedillo, T., & Kieran, C. (2003). *Initiating students into algebra with symbol-manipulating calculators*. In J. T. Fey, A. Cuoco, C. Kieran, L. McMullin, & R. M. Zbiek (Eds.), Computer algebra systems in secondary school mathematics education (pp. 219–240). Reston: NCTM

Chief Executives Officers Forum. (2001). Key building blocks for student achievement in the 21st Century. *The CEO Forum School Technology and Readiness Report*. Retrieved November 27, 2009 from http://www.ceoforum.org/reports.html

Chai, C. S., Koh, J. H. L. and Tsai, C.-C., (2010). *Facilitating preservice teachers' development of technological, pedagogical, and content knowledge (TPACK). Educational Technology and Society*, vol. 13, pp.63-73.

Chen, C. H., 2008. *Why do teachers not practice what they believe regarding technology integration? Journal of Educational Research,* vol. 102, pp.65-75.

Chu, S., B. (2004). *Factors affecting the perceived usefulness of information technology in mathematics learning and teaching*. Retrieved on 6th April 2012 from http://hub.hku.hk/bitstream/10722/31911/1/FullText.pdf

Clark, A. (2003). Natural-Born Cyborgs: *Minds, Technologies, and the Future of Human Intel- ligence*. Oxford: Oxford University Press.

Clark, A. (2004). *–Towards a science of the bio-technological mind*". In Gorayska and Mey (eds), 25–36.

Clements, D. H. (2000). *From exercise and tasks to problems and projects- unique contributions of computers to innovative mathematics education*. The Journal of Mathematics Behavior, 19(1), 9–47.

Coffland, D., & Strickland, A. (2004). *Factors related to teacher use of technology in secondary geometry instruction*. Journal of Computers in Mathematics and Science Teaching, 2(4), 347–365.

Conference Board of Mathematical Sciences. (2001). *The mathematics education of teachers*. Washington, DC: American Mathematical Society & Mathematics Association of America.

Creswell, J., W. (2012). *Educational Research: Planning, Conducting and Evaluating Quantitative and Qualitative Research, (4th edn). Boston*: Pearson Education, Inc.

Daggert, W., & Pedinott, J. (2005). *International center for leadership in education. School Leadership and Management*, 10 (1), 115-126.

Dahland, G. & Lingefjärd, T. (1996). *Graphing calculators and students´ inter-pretations of results.* A study in four upper secondary classes in Sweden. Nordic Studies in Mathematics Education, 4(2/3), 31-50

DiSessa, A. A. (2001). *Changing minds: computer, learning, and literacy*. Cambridge (Mass.): The MIT Press

Doering, A., Hughes, J. and Huffman, D., (2003). Pre-service teachers: Are we thinking with technology? Journal of Research on Technology in Education, vol. 35, pp.342-361.

Doppen, F. H. (2004). *Beginning social studies teachers' integration of technology in the history classroom*. Theory and Research in Social Education, 32(2), 248-279.

Drent, M. & Meelissen, M. (2008) .*Which factors obstruct or stimulate teacher educators to use ICT innovatively*? Computers & Education, 51(1), 187-199.

Earle, R. S. (2002). *The Integration of instructional technology into public education*: promises and challenges. Educational Technology, 42 (1), 5-13.

Ellington, J. (2003). *A meta-analysis of the effects of calculators on students' achievement and attitude levels in precollege mathematical classes*. Journal for Research in Mathematics, 34(5), 433-463.

Ellington, J. (2006). *The effects of non-cas graphing calculators on student achievement and attitude levels in mathematics: A meta-analysis*. School Science and Mathematics, 106(1), 16-25.

Ertmer, P.A. & Ottenbreit-Leftwich, A. (2009). *Teacher Technology Change: How knowledge, beliefs and culture intersect*. Retrieved April, 2011 from

Eugene, J. (2006). *How teachers integrate technology and their beliefs about learning*: Is there a connection? Journal of Technology and Teacher Education, 14(3), 581-597.

Forgasz, H. (2006). *Factors that encourage or inhibit computer use for secondary mathematics teaching*. Journal of Computers in Mathematics and Science Teaching, 25(1), 77–93.

Forgasz, H.J. & Prince, N. (2002). *Software used for mathematics learning – reporting on a survey*. Vinculum, 39(1), 18-19.

Fraenkel, J.R., & Wallen, N.E. (2000). *How to design and evaluate research in education, (5th ed.)*. New York: McGraw-Hill Publishing Co.

Frederick, G. R., Schweizer, H. and Lowe, R., 2006. *After the in-service course: Challenges of technology integration, Computers in the Schools*, vol. 23, pp.73-84.

Furlong, J., Furlong, R., Facer, K. & Sutherland, R. (2000). *'The National Grid for Learning: a curriculum without walls*?', *Cambridge Journal of Education*, 30, 1, 91-110.

Galbraith, P., & Haines, C. (1998). Disentangling the nexus*: Attitudes to Mathematics and technology in a computer learning environment*. Educational Studies in Mathematics, 36(3), 275-290.

Gao, Y. (2005). Applying the Technology Acceptance Model to Educational Hypermedia: A field study. Journal of Educational Multimedia and Hypermedia, 14 (3), 237 – 247.

Gill L, Dalgarno B (2008). Influences on pre-service teachers' preparedness to use ICTs in the classroom. Retrieved May 2, 2009, from http:// www.aare. edu.au

/03pap/war03165.pdf

Gorder, L. (2008*). A study of teacher perception of instructional technology integration in the classroom.* Delta Pi Epsilon Journal, L(2), 63-76.

Gulbahar, Y. (2007). *Technology planning: A Roadmap to successful technology integration in schools*. Computers and Education, 49 (4), 943-956.

Hardy, M. D. (2003). ―It should have been stressed in all education classes"; preparing mathematics teachers to teach with technology. ERIC-ED.478379.

Hall, G.E. & Hord, S.M. (2001). *Implementing Change: Patterns, Principles and Potholes*. Boston: Allyn & Bacon.

Hazzan, O. (2000). *Attitudes of prospective high school mathematics teachers toward.technology integrating information technologies into their future teaching*. (ERIC Document Reproduction Services No. ED444539)

Heid, M. K. (1997). *The technological revolution and the reform of school mathematics*. American Journal of Education 106(1), 5-61

Hennessy, S. (2000). *Graphing investigations using portable (palmtop) technology*. Journal of Computer Assisted Learning, 16, 243–258.

Hennessy, S., Ruthven, K., & Brindley, S. (2001). *Teacher perspectives on integrating ICT into subject teaching: commitment, constraints, caution and change*. Journal of Curriculum Studies, 37(2), 155–192. doi:10.1080/0022027032000276961

Hew K. F., Brush T. (2007). *Integrating technology into K-12 teaching and learning*: Current knowledge gaps and recommendations for future research. Education Tech Research Dev 55:223-252.

Holloway, S. & Valentine, G. (1999). *The Cyberkids report,* Loughborough, Loughborough University.

Hurley, N. & Mundy, P. (1997). *Technology innovation*: Teacher preparation, adaptability and effectiveness. Washington: US Department of Educational Resources Information Center.

Hunt, L. M. and Thomas, M. J. W. and Eagle, L (2002): *Student Resistance to ICT in Education. In IEEE Proceedings of the International Conference on Computers in Education* (ICCE'02)

International Society for Technology in Education. (2007). *National educational technology standards for student* (2nd ed.). Eugene, OR: Author

International Society for Technology in Education. (2002*). National educational technology standards for teachers.* Eugene, OR: Author.

Ittigson, R.J. & Zewe, J.G. (2003). *Technology in the mathematics classroom*. In Tomei, L.A. (Ed.). Challenges of Teaching with Technology Across the Curriculum: Issues *and* Solutions .114-133

Johnson, R. B. & Onwuegbuzie, A. J. (2004). Mixed methods research: *A research paradigm whose time has come.* Educational Researcher 33(7), 14-26

Jonassen, D. H. (2000). *Computers as mind tools for schools: Engaging critical thinking*. Upper Saddle River, NJ: Prentice Hall, Inc.

Jones, A. (2004). *A Review of the research literature on barriers to the uptake of ICT* b y t e a c h e r s . UK: Becta .

Kahveci, M. (2010). *Students' perceptions to use technology for learning: measurement integrity of the modified fennema-sherman attitudes scales*. The Turkish Online Journal of Educational Technology volume 9, 185 – 201. Retrieved on 15th November,2011from http://comu.academia.edu/MuratKahveci/Papers/511335/studentsperceptions_to_use_technology_for_learning_measurement_integrity_of_the_modified_fennemasherman_attitudes_

Kaino, L., M. and Salani, E., B. (2004). *Students' gender attitudes towards the use of calculators in mathematics instruction*. Proceedings of the 28th Conference of the International Group for the Psychology of Mathematics Education, 2004 Vol. 3 113–120

Keengwe, J. & Onchwari, G. (2008). *Computer technology integration and student learning*: Barriers and promise, Journal of Science Education and Technology, 17, 560–565.

Keong, C. C., Horani, S & Daniel, J. (2005). *A Study on the use of ICT in mathematics teaching.* Malaysian Online Journal of Instructional Technology (M O J I T). 2, (3).

Kent, N. and Facer, K. 2004., *Different worlds? A comparison of young people's home and school ICT use*. Journal of Computer Assisted Learning, vol. 20, pp.440-455

Kilicman, A., Hassan, M.A., & Husain Said, S.K. (2010). Teaching and learning using mathematics software—The New Challenge". Proc. Social and Behavioral Sc 8: 613-619.

Koc, M. 2005., *Implications of learning theories for effective technology integration an pre-service teacher training*: A critical literature review, Journal of Turkish Science Education, vol. 2, pp.2-18.

Korte,W.B., Oldfield A. (2010, November 26). iTEC. Retrieved January 15, 2013, from Futurelab: http://itec.eun.org

Koo, A. C. (2008). *Factors affecting teachers' perceived readiness for online collaborative learning*: A case study in Malaysia. Educational Technology & Society, 11 (1), 266-278

Kozma, R., McGhee, R., Quellmalz, E., & Zalles, D. (2004). *Closing the digital divide: evaluation of the World Links Program.* International Journal of Educational Development, 25(4), 361-381.

Kulik J.A.(1994) , *"Meta-analytic Studies of Findings on Computer Based Instruction," in technology assessment in education and training*, E.Baker and H. O'Neil, Eds. Hillsdale, NJ: Erlbaum, 1994, pp. 9-33

Lagrange, J. (1999). *Complex calculators in the classroom: Theoretical and practical reflections on teaching pre-calculus*.International Journal of Computers for Mathematical Learning 4(1), 51-81.

Lai, K. & Pratt, K. (2004). *Positive to a Degree: The Effects of ICT Use in New Zealand Schools*. Computers in Schools, Vol 24(3/4), 95-109

Levin, T. and Wadmany, R., 2006. *Teachers' beliefs and practices in technology-based classrooms: A developmental view*, Journal of Research on Technology in Education, vol. 39, pp.417-441.

Liang, C.-L. & Su, Y.-T. (2000). *Using multivariate rank sum tests to evaluate effectiveness of computer applications in teaching business statistics*. 27 (3), 337-345.

Lin, M.-C., Wang, P.-Y. and Lin, I.-C., 2012. Pedagogy technology: *A two-dimensional model for teachers' ICT integration*, British Journal of Educational Technology, vol. 43,pp.97-108.

Liu, S-H. (2010). Factors Related to Pedagogical Beliefs of Teachers and Technology Integration. Computers & Education (56), 1012-1022

Lord, P. & Harland, J. (2000). *Pupils' Experiences and Perspectives of the National Curriculum: Research Review*, QCA

Loong, E. (2003). *Australian secondary school teachers' use of the Internet for mathematics*. In L. Bragg, C. Campbell, G. Herbert, & J. Mousley (Eds.) Mathematics education research: Innovation, networking, opportunity (Proceedings of the 26th annual conference of the Mathematics Education Research Group of Australasia, pp. 484-491). Sydney: MERGA

Lowther, D. L., Inan, F. A., Strahl, J. D. and Ross, S. M., 2008. *Does technology integration work when key barriers are removed?*. Educational Media International, vol. 45, pp.195-213

Lundell, P. & Howell, C. (2000). *Computers in schools. A national survey of information and communication technology in South African Schools*. Cape Town: Education Policy Unit (EPU), University of the Western Cape.

Magliaro, J. (2007). *Mathematics teachers' preparedness to integrate computer technology into the curriculum*. Canadian Journal of Learning Technology Vol.33 (3).

Mathematics Association of America. (1991). A call for change: *Recommendation for the preparation of teachers of* mathematics. Washington, DC: Author

Mangesi, K. (2007). ICT education in Ghana. *Survey of ICT and education in Africa*: Ghana Country Report. Research Centre (IDRC)

Manoucheri, A. (1999). Computers and school mathematics reform: *Implications for mathematics teacher education***.** Journal of Computers in Mathematics and Science Teaching, 18(1), 31-48

Manzo, K. K. (2001). *Academic record. Education Week*, 20(35), 22-35. Washington.

Mauza, S. (2002). *Learning to teach with new technology: Implications for professional development*. Journal of Research on Technology in Education, 35 (2), 272-28

Mcmahon, G., 2009. Critical *thinking and ICT integration in a Western Australian secondary school.* Educational Technology and Society, vol. 12, pp.269–281.

Means, B., & Haertel, G. (2004). *Using technology evaluation to enhance student learning.* New York: Teachers College Press

Merrill, M.D. (2002). *First principles of instruction, Educational technology Research and Development*, Vol. 50(3), 43-59.

Merrill, M.D. (2006). *Hypothesised performance on complex tasks as a function of scaled instructional strategies*. In J. Elen,& R. E. Clark (Eds.), Handling complexity in learning environments; theory and practice Amsterdam: Elsevier, 265-281.

Mistretta,R.M.(2005).*Integrating Technology into Mathematics Classroom; The role of the the teacher preparation program*. The Mathematics Educator.Vol.15, No.1 pp18-24.

Mishra, P. & Koehler, M.J. (2007). *Technological Pedagogical Content Knowledge (TPCK): Confronting the Wicked Problems of Teaching with Technology*. In R. Carlsen et al. (Eds.), Proceedings of Society for Information Technology & Teacher Education International Conference 2007 (pp. 2214-2226). Chesapeake, VA: AACE.

Ministry of Education Science and Sports (MOESS). (2007). *Teaching Syllabus for Mathematics.* Accra, Ghana; Ministry of Education

Ministry of Education, Youth and Sports. (2010). *Teaching Syllabus for Mathematics (Senior High School).* Accra: Curriculum Research and Development Division (CRDD)

Ministry of Education, Science and Sports. (2007*). Teaching Syllabus for Information and Communications Technology (Core) (Senior High School*). Accra, Ghana: Curriculum Research and Development Division (CRDD).

MOEYS & GES (2002). *Introduction of communication technology in education*. A policy framework.

Moreira, C. & Noss, R. (1995*) Understanding teachers' attitudes to change in a Logomathematics environment.* Educational Studies in Mathematics, 28, 155-176.

Moos, D. C., & Azevedo, R. (2009). *Learning with computer-based learnin environments:* A literature review of computer self-efficacy. Review of Educational Research, 79, 576- 600.

Moseley, D., & Higgins, S. (1999). *Ways forward with ICT: Effective pedagogy using information and communications technology for literacy and numeracy in primary schools*. London: Teacher Training Agency.

Muijs, D. (2004). *Doing quantitative research in education with SPSS*. London: SAGE Publishers Ltd

National Council of Teachers of Mathematics (NCTM). (2008). *Technology in Teaching and Learning Mathematics.* Reston, VA: National Council of Teachers of Mathematics

National Council of Teachers of Mathematics (NCTM). (2011). *Technology in Teaching and Learning Reston*, VA: National Council of Teachers of Mathematics

National Council of Teachers of Mathematics. (2000*). Principles and standards for school. mathematics.* Reston, VA: Author

National Council of Teachers of Mathematics (2002). Principles and Standards for Schools. Reston, VA: Author.

National Center for Education Statistics (NCES) (2000). *Teachers Tools for the 21st Century: A Report on Teachers' Use of Technology* (NCES 2000102). Washington, D.C.: U.S. Government Printing Office. Retrieved March 23, 2010 http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2000102

National Council for the Accreditation of Teacher Education. (2002). *Professional standards for the accreditation of schools, colleges, and department of education.* Retrieved March, 19, 2006 from http://www.ncate.org/public/programStandards.asp?ch=4.

Onley, A. C. & Barnes, S. (2008*). Collecting and analyzing evaluation data. Planning and Evaluating Health Information Outreach Projects*, Booklet 3. Outreach Evaluation Resource Center. National Network of Libraries of Medicine, National Library of Medicine.

Papert, S. (1993) The Children's Machine: Rethinking school in the Age of the Computer, New York: BasicBooks, a division of HarperCollins.

Palak, D. and Walls, R. T. 2009. Teachers' *beliefs and technology practices: A mixed methods approach,* Journal of Research on Technology in Education, vol. 41, pp.157-181.

Pea, R. D. (1987*). Cognitive technologies for mathematics education*. In a Schoenfeld (Ed.), Cognitive science and mathematics education (89–122). Hillsdale, NJ: Erlbaum.

Pedretti, E., Myer-Smith, J. & Woodrow, J. (1998). Technology, Text and Talk: Student Perspectives on Teaching and Learning in a Technology-Enhanced Secondary Science Classroom, *Science Education*, 82, 5, 569-589.

Pelgrim, W.J. (2001). *Obstacle to the integration of ICT in education: results from a worldwide educational assessment*, Computers & Education. 37, 163-178

Pelgrum, W. and Law, N. (2003) *ICT in Education around the World: Trends, Problems and Prospects*, Paris: UNESCO, International Institute for Educational Planning

Pierce, R., Stacey, K., & Bartaksas, A. (2007). *A scale for monitoring students' attitudes to learning mathematics with technology*. Computers & Education, 48(2), 285–300. doi:10.1016/j.com- pedu.2005.01.006.

Prensky, M. (2010). *Teaching digital natives: Partnering for real learning. Thousand Oaks, CA: Corwin. Renaissance Partnership for Improving Teacher Quality (2001). Teacher work sample: Performance prompt, teaching process standards, scoring rubrics*. Retrieved on July 1, 2009 fromhttp://fp.uni.due/itq/ProjectActivities/ index.htm

Polland , A. & Tann, S. (1993). *Reflective teaching in the primary school: a handbook for the* classroom*,* London, Cassell.

Reid, S., 2002. *The integration of ICT into classroom teaching*. Alberta Journal of Educational Research, vol. 48, pp.30-46

Roblyer, M.D. & Edwards, Jack. (2000). *Integrating Educational Technology into Teaching. Second Edition*. Merrill an imprint of Prentice Hall

Rosen, C., & Maguire, B., (1990). *A review of literature on understanding teachers perception towards computers and computerized instruction*. Journal of Research and Development in Education, 28(2), 60-65

Roschelle, J., Pea, R., Hoadley, C., Gordin, D., & Means, B. (2001). *Changing how and what children learn in school with computer-based technologies*. The Future of Children, 10(2), 76-101.

Rowand, C. (2000). *Teacher use of computers and the internet in public schools*. Stats in Brief, ERIC Document Reproduction Service No. 442463

Samuelsson, J. (2003). Nytt, på nytt sätt? En studie över datorn som förändringsagent av matematikundervisningens villkor, metoder och resultat i skolår 7–9. Avhandling (PhD thesis). Uppsala: Uppsala universitet, Institutionen för pedagogic

Sang, G., Valcke, M., Braak, J. and Tondeur, J., 2010. *Student teachers' thinking processes and ICT integration: Predictors of prospective teaching behaviors with educational technology, Computer and Education*, vol. 54, pp.103-112.

Sang, G., Valcke, M., Braak, J., Tondeur, J. and Zhu, C., 2011. *Predicting ICT integration into classroom teaching in Chinese primary schools: Exploring the complex interplay of teacher-related variables, Journal of Computer Assisted Learning*, vol. 27, pp.160-172.

Saunders, M., Lewis, P. and Thornhill, A. (2007). *Research Methods for Business Students* (4th ed). England: Pearson Education Limited.

Saye, J. W., & Brush, T. (2004). Scaffolding problem-based teaching in a traditional social studies classroom. Theory and Research in Social Education, 32(3), 349-378.

Schacter, J. (1999). *The impact of education technology on student achievement: what the most current research hasto say*.Santa Monica, CA: Milken Exchange on Education technology.

Serhan, D., 2009. *Preparing pre-service teachers for computer technology integration.* International Journal of Instructional Media, vol. 36, pp.439-447.

Simonson, M. (2004). *Technology use of Hispanic bilingual teachers: A function of their beliefs, attitudes and perceptions on peer technology use in the classroom*. Journal of Instructional Technology, 31(3), 257-266.

Snoeyink, R. , & Ertner, P. A. (2002). *Thrust into technology: How veteran teachers respond.* Journal of Educational Technology system, 30(10), 85-111

Sorgo, A., Verckovnik, T., & Kocijancic, S. (2010). *Information and communication technologies (ICT) in biology teaching in Slovenian secondary schools*. Eurasia Journal of Mathematics, Science and Technology Education, 6, 37-46.

Spodark, E. (2003). *Five obstacles to technology integration at a small liberal arts university.* Technological Horizons in Education, 30(8), 14-24.

Sudman, S. & Bradburn, N.M. (1982). Asking questions: *A practical guide to questionnaire design*. Washington, DC: Jossey-Bass.

Sugar, W., Crawley, F., & Fine, B. (2005). *Critiquing theory of planned behaviour as a method to assess teacher's technology integration attitudes*. British Journal of Educational Technology, 36(2), 331–334. doi:10.1111/j.1467-8535.2005.00462.x

Tashakkori, A., & Teddlie, C. (Eds.). (2003). *Handbook of mixed methods in social and behavioral research*. New York, NY: Thousand Oaks, CA: Sage Inc.

Teaching with Technology (2006)http://cte.uwaterloo.ca/teaching_with_technology/

Technology Integration. (2005). Computing Technology for Math Excellence (CT4ME). Web-site: http://www.ct4me.net/ technology_integr.htm

Tella, A., Tella, A., Toyobo, O. M., Adika, L. O., & Adeyinka, A. A. (2007). *An Assessment of Secondary School Teachers Uses of ICTs: Implications for Further Development of ICT's Use in Nigerian Secondary Schools*. Online Submission, 6(3).

Tezci, E., (2011a). *Factors that influence preservice teachers' ICT usage in education*. European Journal of Teacher Education, vol. 34, pp.483-499.

Teo, T. (2008). *Pre-service teachers' attitudes towards computer use: A Singapore survey*. Australasian Journal of Educational Technology, 24(4), 413-424.

Teo, T., Chai, C. S., Hung, D. and Lee, C. B.,(2008). *Beliefs about teaching and uses of technology among pre-service teachers*. Asia-Pacific Journal of Teacher Education, vol. 36, pp.163-174.

The-Star-Trek-style-classroom-future-replacing-blackboards-books(2012) http://www.dailymail.co.uk/sciencetech/article-2236967/The-Star-Trek-style-classroom- future-replacing-blackboards-books.html?ito=feeds-newsxml

Thompson, A.G. (1992) Teachers' *beliefs and conceptions: a synthesis of the research*. In D.A. Grouws (ed.), Handbook of research on mathematics teaching and learning (pp. 127-146). New York: Macmillan.

Thomas, M. O. J., Tyrrell, J., & Bullock, J. (1996). *Using computers in the mathematics classroom: the role of the teacher*. Mathematics Education Research Journal, 8(1), 38–57.

Tobin, P., Routitsky, A., & Jones, P. (1999). *Graphics calculators in Victorian secondary schools: Teacher perceptions*. In J. M. Truran, & K. M. Truran (Eds.), Making the difference. Proceedings of 22nd Annual Conference of the Mathematics Education Research Group of Australasia (pp. 502–506). Sydney: MERGA.

UNESCO. (2002). *ICT in Education*. Retrieved May 3rd, 2011 from http://portal.unesco.org/ci/en/ev.php

UNESCO. (2006). *ICT in Education*. Retrieved March 12th, 2010 from http://portal.unesco.org/ci/en/ev.php

United States Department of Education. (2010). *National Education Technology Plan*: Transforming American Education Learning. Washington DC: Author

United States Department of Education, Office of Educational Technology. (2013). Expanding evidence approaches for learning in a digital world. Washington, D.C.: Author. Retrieved at http://www.ed.gov/edblogs/technology/files/2013/02/Expanding-Evidence-Approaches.pdf

Underwood, J.,& Brown, J.(1997) Integrated Learning Systems: Potentialint Practice.Oxford: Heinemann.

Vale, C., & Leder, G. (2004). *Student views of computer based mathematics in the middle years: Does gender make a difference*? Educational Studies in Mathematics, 56(3), 287–312

Walden University (2010). Educators, Technology and 21st Century Skills: Dispelling Five Myths. Retrieved July 2, 2010 from http://www.waldenu.edu/Degree-Programs/Masters/36427.htm

Wellington, J. (2001).*Exploring the Secret Garden: The growing importance of ICT in the home*', British Journal of Educational Technology, 32, 2, 233-244.

Weert, T. V. and Tatnall, A., 2005. *Information and Communication Technologies and Real-Life Learning:* New Education for the New Knowledge Society, Springer, NewYork.

Whelan, R., 2008. *Use of ICT in education in the South Pacific: findings of the Pacific eLearning Observatory*. Distance Education, vol. 29, pp.53-70.

Wishart, J., & Blease, D. (1999). *Theories underlying perceived changes in teaching and learning after installing a computer network in a secondary school*. British journal of Educational Technology, 30(1), 25-41.

Wilson,J.(2000).*Technologies in Secondary Schools. [online]. Available*: http://jwilson.coe.uga.edu/TiMER/TiMER.S.html [2004 November 11]

Xiaoming, H. & Seet Kay, C. (2004): *Factors Affecting Internet Development*: An Asian Survey

Zhao, Y., & Frank, K. A. (2003). *Factors affecting technology use in schools: An ecological perspective*. American Educational Research Journal, 40, 807-840.

Zimmermann, W. & Cunningham, S. (1991). *Visualization in teaching and learning mathematics,* Washington D. C: Mathematical Association of America.

APPENDIX A

STUDENTS' QUESTIONNAIRE

Dear Student

The purpose of this questionnaire is to gather data on your observations on the contribution of the Information and Communication Technology (ICT) to the teaching and learning of Mathematics in SHS mathematics classrooms in your school. Do not write your name. I assure you that the information obtained in this questionnaire will be kept in the strictest confidence and will only be used for the stated purpose.

A. Background information

1. Gender Female [ ] Male [ ]

2. Age ……years

3. Form ……

Instructions

Please write the appropriate number in the space provided below

1=Strongly agree, 2=Agree, 3=Not sure, 4= Disagree, 5=Strongly disagree

B. Students Computer Usage

1. I have less trouble learning how to use a computer than I do learning other things. [ ]

2. When I have difficulties using a computer I know I can handle them. [ ]

3. I am not what I would call a computer person. [ ]

4. It takes me much longer to understand how to use computers than the average person. [ ]

5. I have never felt myself able to learn how to use computers. [ ]

6. I enjoy trying new things on a computer. [ ]

7. I find having to use computers frightening. [ ]

8. I find many aspects of using computers interesting and challenging. [ ]

9. I don‘t understand how some people can seem to enjoy spending so much time using computers. [ ]

10. I have never been very excited about using computers [ ]

11. I find using computers confusing. [ ]

C. Perceptions toward using computers in learning mathematics

12. Computing power makes it easier to explore mathematical ideas. [ ]

13. I know computers are important but I don‘t feel I need to use them to learn mathematics [ ]

14 .Computers and graphics calculators are good tools for calculation, but not for my learning of mathematics. [ ]

15. I think using technology is too new and strange to make it worthwhile for learning mathematics. [ ]

16. I think using technology wastes too much time in the learning of mathematics. [ ]

17. I prefer to do all the calculations and graphing myself, without using a computer or graphics calculator. [ ]

18. Using technologies for the calculations make it easier for me to do more realistic applications. [ ]

19. I like the idea of exploring mathematical methods and ideas using technology. [ ]

APPENDIX B

TEACHERS' QUESTIONNAIRE

Dear Colleague

The purpose of this questionnaire is to gather data on your observations on 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. How long have you been teaching? 0 – 1 yrs [ ] 2 – 5 yrs [ ]

6 – 10 yrs [ ] 11 – 15 yrs [ ] 15 & above [ ]

B. Teachers computer usage

4. How would you rate your experience with computers (Tick all that apply)

a) Have never used a computer and do not intend to [ ]

b) I have never used a computer but would like to learn [ ]

c) I use applications such as word processing, spread sheets, the internet etc [ ]

d) I use computers extensively in my teaching [ ]

5. Have you attended a computer training session before? YES [ ] NO [ ]

6. 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? .....

7. Are any of the computers connected to internet? YES [ ] NO [ ]

b. If yes, how many……

8. Do you own a computer? YES [ ] NO [ ]

9. How many years have you been using computers?

Less than a year [ ] 1 – 3 yrs [ ] 4 – 6 yrs [ ] 7 – 9 yrs [ ] 10 yrs & above [ ]

10. Where do you use or have access to the computer in the school?

Computer lab [ ] Staff common room [ ] In my office [ ] Classroom [ ]

Other (please specify)

11. How many hours per week is it permissible for you or get the chance to use the computers in the school? Less than an hour [ ] 1 – 3 hours [ ] 4 – 6 hours [ ] 7 – 9 hrs [ ] Above 10 hrs [ ]

12. Do you have projector(s) in the ICT laboratory? YES [ ] NO [ ]

13.Are specialized software for teaching mathematics installed on the lab computers?

YES [ ] NO [ ]

14. What motivated you the most to undertake the training (Tick all that apply)

a) To use ICT in class [ ]

b) Personal interest [ ]

c) Required to do so [ ]

d) Increase career prospects [ ]

e) Other (please specify) [ ]

15. Do you have any professional ICT qualification

Yes [ ] No [ ]

16. Do you have access to computers in the school?

Yes [ ] No [ ]

17. Do you use it

Yes [ ] No [ ]

18. Do you have access to internet in the school? YES [ ] NO [ ]

19. Do you use computers in your teaching?

Yes [ ] No [ ]

C. What are the potential barriers hindering the effective integration of ICT in the classroom?

20. (Tick all that apply)

a) Lack of time to use computers [ ]

b) Lack of knowledge about computers [ ]

c) Lack of confidence [ ]

d) Fear [ ]

e) Lack of training [ ]

f) My age [ ]

g) Little previous experience [ ]

h) Not sure how useful computers are [ ]

i) Computers not accessible [ ]

j) Management don‘t care if I use computers or not [ ]

k) Computer equipment is unreliable [ ]

l) Teachers do not have sufficient time to integrate ICT [ ]

m) Schools are unsure as to how to effectively integrate ICT [ ]

n) Lack of technical support regarding ICT integration [ ]

o) Inadequate supports from the administration [ ]

p) Lack of sufficient ICT training [ ]

q) Schools are not interested in integrating ICT [ ]

s) Lack of ICT infrastructure [ ]

t) No support if something goes wrong with computer [ ]

D. Teachers Perceptions on the use of computers in the classroom

21. Please use the likert scale below to indicate your level of agree or disagreement with the following statements

1 = Strongly disagree 2 = Disagree 3 = Indecisive 4 = Agree 5 = Strongly agree

a) I do not have enough time to use computers in class [ ]

b) I could look stupid if something goes wrong [ ]

c) I feel that I need more training in computers [ ]

d) I know how to work with a computer but have no idea how to integrate it into my teaching [ ]

e) I am too old to learn how to use a computer [ ]

f) I do not have enough experience in using computers [ ]

g) Computers are a thing for young people [ ]

h) I am encouraged to make use of computers in my teaching [ ]

i) There is never any help if something goes wrong [ ]

j) The equipment available to me at work is unreliable [ ]

k) Teachers should know how to use computers in their classroom [ ]

l) If there is a computer in my future classroom, it would help me to be a better teacher [ ]

m) I believe that the more teachers use computers, the more students will enjoy school [ ]

n) I enjoy using new tools for instruction [ ]

o) Computers could enhance remedial instruction [ ]

p) Computers can help accommodate different teaching styles [ ]

q) Computers can help teachers provide more individualised feedback to students [ ]

r) I believe that the roles of schools will be dramatically changed because of the internet [ ]

s) Computers will relieve teachers of some routine duties [ ]

22. Please indicate by writing T for TRUE or F for FALSE for the following statements

a) ICT should be a standalone subject and not used in other classes [ ]

b) I have the necessary skills to use the computer for teaching my subject [ ]

c) I avoid using computers in my classroom [ ]

d) There are sufficient computer resources (printers, software, etc.) [ ]

e) There are enough professional development/training opportunities in ICT [ ]

f) There is effective access to the Internet [ ]

g) There is good quality software available to me [ ]

h) There is clear support from Headmasters (s)/Clear school based ICT plan [ ]

i) There is support from other teachers for me to use ICT [ ]

j) There is reliable technical support if something goes wrong [ ]

k) I have adequate time to plan for technology use in my class [ ]

23. Would you welcome an extensive training in your school to help you develop your ICT skills YES [ ] NO [ ]