UNIVERSITY OF EDUCATION, WINNEBA

TEACHERS' INTEGRATION OF ICT IN THE TEACHING OF MATHEMATICS AT THE SENIOR HIGH SCHOOL LEVEL IN THE UPPER DENKYIRA EAST MUNICIPALITY AND UPPER DENKYIRA WEST DISTRICT

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JANUARY, 2022

DECLARATION

Student's Declaration

I, Francis Ennin declare that this dissertation, 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.

SIGNATURE: ……  ……

DATE: ……

Supervisor's Declaration

I hereby declare that the preparation and presentation of this work was supervised in accordance with the guidelines for supervision of dissertation as laid down by the University of Education, Winneba

NAME OF SUPERVISOR: JOSEPH ISSAH NYALA (PHD)

SIGNATURE: ……

DATE: ……

DEDICATION

This dissertation is dedicated to my family for their support and inspiration.

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ABSTRACT

The purpose of this study was to investigate mathematics teachers‘ integration of ICT in the teaching of mathematics in Senior High School level in Ghana. A sample of 27 mathematics teachers was selected out of a total of 44 teachers in the Upper Denkyira East Municipality and Upper Denkyira West District. A questionnaire and an interview guide were administered to gather data from the participants who were a sample of mathematics teachers from both private and public Senior High Schools in the Upper Denkyira East Municipality and the Upper Denkyira West District. The participants were made to answer questions on their competency, their use as well as factors which hindered their use of ICT in the teaching of mathematics. The results of the study revealed that the teachers‘ methods were frequently teacher centered and that employment of ICT tools were primarily for organizational and informative purposes. The lack of use of ICT tools in the teaching of mathematics was credited primarily to the lack of technological resources (i.e. hardware, software and the internet) and insufficiency on the job training of teachers to boost their motivation as well as knowledge for the use of ICT tools since new technological tools keeps on emerging. For mathematics teachers to be able to integrate ICT in their lessons, it is recommended that ICT tools are made available to the teachers, most importantly, the teachers are motivated and also time allocation for mathematics lessons should factor the integration of ICT tools.

CHAPTER 1

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

A critical look at the history of computers, the evolution it has gone through and its importance and influence in all activities in todays' world make the discovery of computers very important. It is so difficult to complete a task today without a bit of Information and Communication Technology (ICT) involved. Many may look at the use of ICT to be the direct use of a computer for a task, but ICT comes in many forms and usage in different fields. It appears that every electronic machine today uses a bit of ICT to function, from cars, heavy duty machines, home appliances, medical machinery just to mention but a few.

The role ICT has played in education, its influence and impact over the years cannot be overemphasized. Technology education seeks to improve the teaching and learning process to enhance the understanding of concepts. Educational technology refers to an area of technology devoted to the development and application of tools (including software, hardware, and processes) intended to promote education or in other words the study and ethical practice for facilitating learning and improving performance by creating, using and managing appropriate technological processes and resources (Lazaro, 2014). This definition is an indication that educational technology and ICT

integration work hand in hand. For teachers to be able to integrate ICT in the teaching of mathematics, they will have to be able to develop and also apply technological tools in the classroom.

The definition of technology comes in different forms from different perspectives. To some authors, it is seen as machines, equipment and computers, whilst others view it as advancement in scientific knowledge. According to MacMillan (2012) technology is an advanced scientific knowledge used for practical purposes. Afari-Kumah and Tanye (2009) argue that the emergence and convergence of technologies have been termed Information and Communication Technology (ICT), a term sometimes synonymously used with Information Technology (IT). IT is defined as the combination of computer technology with telecommunications technology. According to Wilson, Ayebi-Arthur and Tenkorang (2011), the term includes computer hardware and digital/analogue devices and software applications.

According to Ajayi and Ekundayo (2009) ICT is simply about sharing and having access to data easily with the use of ICT tools such as computers, printers, scanners, etc. Maqbulin (2020) also defined ICT as a technological means of collecting (inputting/gathering), collating (processing/analyzing), and conveying (outputting/transferring) information via technology. The term ICT stands for "Information and Communication Technologies". ICT refers to technologies that provide access to information through telecommunications. It is similar to Information Technology (IT), but focuses primarily on communication technologies. This includes the Internet, wireless networks, cell phones, and other communication mediums (Per, 2010).

Information and communications technology (ICT) is therefore, a generic term for any piece of communication equipment, such as radio, television, cellular phone,

computer and network hardware and software, satellite systems and so on, as well as the various services and their associated applications. No matter how one decides to look at it, ICT is basically about the use of a technological medium for communication.

Currently in this 21st century, the use of ICT in education for instructional delivery and learning have received a massive boost due to its ability to offer the child different dimensions to be able to understand concepts better throughout the world and this tells why successive governments have tried to coin educational policies around ICT. ICT is regarded as the enabler, which facilitates productivity and enhances the quality of output and also enhances most aspects of human activities in the information era (Afari-kuma & Tanye, 2009). They further asserted that modern technology such as Computer and Telecommunication technologies have been the most remarkable and transformative of the technologies emerging over the past 30 years.

The growing concern of many about the role ICT plays in the daily lives of all humans recently has intensified the need for teachers to integrate ICT in their delivery. The crescendo of ICT in the 21st century and its effect on human activities is very noticeable. Lau and Sim (2008) reported that despite the apparent benefits of the use of ICT for educational purposes, studies showed that in many cases, the learning potential of ICT is deprived as many teachers are still not fully ICT literates. They mentioned that activities such as education, sports and recreation, commerce, agriculture, entertainment, politics, medicine, architecture, art and music, communication, transportation and religion have all felt the overwhelming sway of technological advancement.

The international community places so much importance on the integration of ICT in the teachers‘ classroom delivery. In May 2015, UNESCO organized the World Education Forum in Incheon, Republic of Korea to bring together the international community, and lead the way to build a powerful new agenda that will transform lives. In the Incheon declaration, the vital role of ICT in achieving the new global education targets is reflected in Article 10 of the text where it states that: ―ICTs must be harnessed to strengthen education systems, knowledge dissemination, information access, quality and effective learning, and more effective service provision" (UNESCO-UIS, 2016, p. 4). This declaration is evidence enough as to how important the integration of ICT in teaching and learning is to the international community.

ICT integration in the mathematics classroom has the ability to improve students‘ understanding. Ali (2009) concluded that post intervention results found an improvement in performance in Probability when MS Excel was used. There was no disparity in performance, with respect to whether a student is a male or female. This is an indication of the positive effect the use of ICT (MS Excel) had on students‘ understanding of probability. Technology although not capable of replacing the teacher in the classroom has the ability to improve the learning of mathematics and also has enough potential to change the traditional role of the teacher being the source of knowledge to be poured into the student in the classroom (Hudson, 2012). In their findings, Safdar, Yousuf, Parveen & Behlol (2011) stated that there was a significant difference in the achievement of the experimental group compared to the control group which is evidence of the effectiveness of the integration of ICT in the teaching of mathematics compared to the traditional classroom. Due to this, todays‘ teacher must be well versed in the use of ICT to be more effective in the delivery of their lessons.

It is clear that education also has its fair share of the overwhelming influence of technology. Based on this, various stakeholders and researchers have advocated for the integration of Information and Communication Technology (ICT) in the teaching and learning process. Oye, Iahad & Ab-Rahim (2012) argue that knowledge of ICT and its usage improves human capacity in all aspects of life in general. In view of the technological advancement and how it has affected every component of life currently, it is important that teachers in general are able to integrate ICT in their delivery to help students to better understand concepts.

With the impact ICT has on students' learning and concept understanding as well as providing teachers with numerous platforms and avenues to deliver in the classroom, the Ministry of Educations' ICT in Education Policy (Ministry of Education, 2015) had the objective to serve as a platform to launch a systematic ICT in Education delivery to ensure its efforts deliver on these three pillars: ICT as a learning and operating tool, ICT as integrated into teaching and learning and ICT as a career option for students. Colleges of education as well as Universities are tasked with the mandate of training their students to integrate ICT in the classroom. It is therefore not surprising that the University of Education, Winneba's Mathematics Education Department mounts at least one ICT course every semester to empower its students to integrate ICT in the classroom both at the undergraduate and postgraduate levels. According to Assuah (2010), teacher educators are challenged with the task of preparing teachers to utilizing technology (ICT integration) as an essential tool in developing a deep understanding of mathematics for themselves and for their students and to emphasize the importance of learning with technology rather than learning about technology. This tells and shows how important the integration of ICT is in

education and therefore the need to find out whether teachers are effectively adhering to this task and are equal to the challenge.

Whenever the idea of the impact of ICT in education comes to mind, it raises attention towards the effect it has on the academic performance of students. Several researchers have backed the assertion that ICT positively affects the performance of students (Ali, 2009; Lau & Sim, 2008).

Khan, Siraj-U-Din, Hafiz and Khattak (2015) in their conclusions stipulated that ICT tools are very helpful in that they help students to do assignments. Teachers also realized that ICT enables students with special needs or difficulties to easily understand concepts. It also helps to reduce the social disparities between students, since they work in teams in order to achieve a given task. Students also assume responsibilities when they use ICT to organize their work through digital portfolios or projects. In addition, the study showed that ICT has significant impact on students and learning processes. Youssef and Dahmani (2014) observed that ICT seems to have a profound impact on the process of learning in higher education by offering new possibilities for learners and teachers. These possibilities can have an impact on student performance and achievement. The above research findings clearly show the positive effect ICT has on both students‘ performance and participation in the learning environment as well as it ability to assist students in their studies. Various authors in their bid to find out whether ICT really has an impact on mathematics learning have proven that ICT can have a positive influence on the teaching of mathematics.

According to Chesitit (2015) ICT integration in teaching of mathematics brings about better results in concept understanding. The key findings of the study were that the experimental groups performed extremely better than the control groups in all schools and their combined achievement test results testified that. This was attributed to the

use of ICT tools for the experimental group. This indicates that students who are taught using ICT tools grasp concepts better than students taught without ICT tools. The result of learning using technological tools can help students develop an understanding of mathematics (Muhtadi, Wahyudin, Kartasasmita, & Prahmana R, 2017). These works are indications that the mathematics teachers' ability to integrate ICT tools in his/her delivery is very important and evidently can enhance students' understanding of concepts but Mintah (2015) concluded that although teachers claim they have access to computers in their schools through ICT laboratories, they are not using ICT tools during lesson delivery.

Global investments in ICT to improve teaching and learning in schools have been initiated by many governments. Despite all these investments in ICT infrastructure, equipment and professional development to improve education in many countries, ICT adoption and integration in teaching and learning have been limited Buabeng-Andoh (2012).

1.2 Statement of the Problem

The general performance of SHS students in mathematics has been of concern for a long time. This has brought the teaching methods of teachers of the subject under scrutiny which has necessitated the assessments of possible instructional methods and procedures to be able to minimize the problems associated with student performance in mathematics.

Mubarik (2018) reported a decrease in the performance of students in Mathematics as compared to the previous year's according to WAEC analyses of the results of the examination. The researcher found that WAEC analyses of the provisional results at the time indicated that entry figures were made up of 158,550 (50.02 %) males and 158,449 (49.98%) females. The examinations were conducted for 946 participating

schools. Out of this, by comparison of the performance of students in the core subjects, based on provisional results from the 2018 WASSCE examinations, the performance at Al- C6 in Social Studies showed a marked improvement over that of 2017 (52.25% to 73.27%), while Integrated Science recorded a slight improvement (43.66% to 50.52%). On the contrary, Mathematics (Core) showed a drop in performance compared to 2017 (42.73% to 38.33%).

Report from the National Education Assessment (NEA) in 2016 recorded that pupils' performances were ~~n~~oticeably lower for mathematics than for English, with only 22% of P4 pupils and 25% of P6 pupils achieving proficiency in mathematics compared to 37% of P4 pupils and 36% of P6 pupils achieving proficiency in English" (Ministry of Education, 2016). Similarly, the Chief Examiner's report for 2016 shows that the performance of candidates in mathematics did not meet expectations since about 65% of the candidates scored marks below 50% (WAEC, 2016).

These trends in the performance of students in mathematics have been attributed to many factors of which, one is the ability of the teacher to sustain the students' interest in the classroom through the use of strategies which make the classroom environment more activity oriented and interactive. With the influence of ICT in almost all aspects of life and its ability to keep the individual interactive, researchers have indicated its relevance in the teaching and learning of mathematics.

The 2007 educational reforms by the Ministry of education youth and sports focus on skill acquisition, creativity and the art of enquiry and problem solving. The curriculum places emphasis on the use of ICT as a tool for teaching mathematics (MOESS, 2007). The 2010 core mathematics syllabus has one of its aims as to help students to use calculators and computers for problem solving and investigations of

real life situations (GES, 2010). In spite of this, from the researcher‘s studies, Agyei (2012) concluded that there is not yet widespread use of ICT in education in Ghana.

Hatlevik & Arnseth (2012) posited that in addition to preparing students for the current trends and era, teachers are seen as the main architects to ICT usage in their classrooms due to the ability of ICT to provide dynamic and proactive teaching-learning environment. Agyei & Voogt (2011a, 2011b) in their research stated that although successive governments have made efforts to put up computer laboratories and procured computers which should be an enzyme to encourage the integration of technology in the teaching of mathematics, mathematics teachers are still not integrating ICT in their lessons.

Although the integration of ICT in the teaching and learning of mathematics from the elaborations above clearly is relevant to the academic development of the student supported by the works of researchers such as Unwin (2004) who stipulated the importance of ICT to the efficacy of the teaching and learning process, this seems not to be the case in the Ghanaian classroom evident to the outcome of the work of Afari-Kuma & Tanye (2009) who asserted that academia was not on the same wavelength as ICT in terms of modern developments despite the curriculum clearly indicating its inclusiveness in the teaching process. Item eight (8) of the general aim for teaching core mathematics states that the curriculum has been designed to assist the student to use the calculator and the computer for problem solving and investigations of real life situations (Ministry of Education, 2010).

Though there are works on the topic in the country as a whole, it appears that there is none in the setting where the researcher embarked on this study. This has necessitated the need to investigate teachers‘ integration of ICT in the teaching of mathematics at

the SHS level in the Upper Denkyira East Municipality and the Upper Denkyira West District.

1.3 Purpose of the Study

The purpose of the study was to investigate teachers' integration of ICT in the teaching of Mathematics at the Senior High School level.

1.4 Research Objectives

The objectives of the study were to:

1. Examine mathematics teachers' competency in using computers.
2. Determine if there is a relationship between the mathematics teachers' ICT competency and ICT integration.
3. Determine how mathematics teachers' demographic characteristics influence their integration of ICT in the teaching and learning of mathematics in the Senior High School.
4. Identify the challenges mathematics teachers face in an effort to integrate ICT in their delivery.
5. Determine the extent to which the mathematics teacher integrates ICT in the teaching process.

1.5 Research Questions

Based on the objectives of the study, the following research questions were answered:

1. What competencies do mathematics teachers' have in using computers?
2. Is there a relationship between the mathematics teachers' ICT competency and ICT integration?
3. How do mathematics teachers' demographic characteristics influence their integration of ICT in the teaching and learning of mathematics?

4. What challenges do mathematics teachers face in an effort to integrate ICT in the teaching and learning of mathematics?
5. To what extent do mathematics teachers integrate ICT in the teaching and learning of mathematics?

1.6 Significance of the Study

The findings of the study will serve as a reference point for the Ministry of Education and the Ghana Education Service to make informed decisions on the measures to put in place to ensure the successful integration of ICT by mathematics teachers.

The outcome will also be of assistance to the curriculum research division to put together syllabi which will enhance the integration of ICT in the teaching of mathematics.

Again, the study will inform heads of schools, Human Resource Department officers, and circuit supervisors, managers of education units and directors of education among others on the skills teachers need to successfully integrate ICTs in teaching mathematics.

The study will also bring to bear the challenges and difficulties teachers as well as head of institutions face in a bid to see to the integration of ICT in the teaching and learning of mathematics. This will enable appropriate measures to be instituted to support successful ICT integration.

Furthermore, the study will add to the stock of research materials on ICT integration in mathematics. It will be useful to researchers seeking information related to ICT integration in mathematics, specifically at the high school level and also inform through recommendation other related areas worthy of further research.

1.7 Delimitations of the Study

Although the study intends to focus on the integration of ICT in the teaching and learning of mathematics in Ghana as a whole, it will be delimited to only the integration of ICT in the teaching of mathematics in the Upper Denkyira East Municipality and Upper Denkyira West District in the Central region of Ghana. The delimitations of a study are those characteristics that arise from limitations in the scope of the study (defining the boundaries) and by the conscious exclusionary and inclusionary decisions made during the development of the study plan (Simon & Goes, 2013).

For reliability and representation of the outcome of the study, it would have been prudent to use a larger sample from the population than the targeted sample, but due to constraints such as finance and the ability to reach the entire population in time the study looked at the ICT integration of mathematics teachers in the Upper Denkira East Municipality and Upper Denkyira West District.

It covered the use of ICT as an instructive tool in teaching mathematics in SHS. It will additionally focus on the factors that influence technology use among teachers as well as the obstacles associated with the adoption of technology in the mathematics classroom at the SHS level.

1.8 Limitations of the Study

The limitations of a study are those situations which are out of the control of the researcher. The researcher can do little or sometimes nothing to avert those situations. Simon & Goes (2013) defined limitations as those shortcomings, conditions or influences that cannot be controlled by the researcher that place restrictions on your methodology and conclusion. Some of the limitations which this study encountered are:

Some teachers were not willing to partake in the answering of the questionnaire as well as subjecting themselves to be interviewed and even though they accepted, they might have misrepresented the facts in order to present to me a favorable impression or to save the image of their school. This can misrepresent the true situation of the existing state of affairs thus affecting the internal validity.

There was also the difficulty in contacting school authorities to seek permission to undertake the study thereby delaying collection of data which in turn affected the timeline for the completion of the study. There was also the issue of being able to reach all teachers earmarked to partake in the questionnaire due to the outbreak of the corona virus pandemic which coincided with the administering of the questionnaire. This also delayed the process thereby affecting the timeline for the study as a whole.

1.9 Basic Assumptions of the Study

The study is based on the following assumptions:

i. The information given by the respondents was true and free from bias.
ii. That there is a positive impact if ICT is used appropriately in teaching and learning mathematics.
iii. The information given by the respondents was treated as confidential.

1.10 Organization of the Study

The study is represented in five main chapters. Chapter One is the introduction of the study. It describes the background to the study, statement of the problem and purpose of the study. It also sets out the research questions the study is expected to answer, significance of the study, delimitations and limitations of the study. It further explains the organization of the study and the assumptions of the study.

Chapter Two touches on an in-depth review of literature on the topic. It looked at the literature on the main issues affecting the topic being researched about such as factors affecting ICT integration of ICT, the concept ICT itself, teachers' integration of ICT, etc. The chapter will end with a summary of the literature.

Chapter Three describes the methods used in the conduction of the research. It comprises the research design, population of the study, sample size, sampling procedure, data collection instrument, pilot testing, administration of instruments and data analysis plan.

The analyses of the results and findings from the study will be discussed in the fourth chapter and finally Chapter Five contains summary of the main findings, conclusions drawn from the findings, recommendations of the study and suggestions for further study.

CHAPTER 2

LITERATURE REVIEW

2.0 Overview

This chapter of the study provides a vivid review of literature behind the study. Specifically the chapter discussed literature on what make up the integration of ICT in the teaching and learning of mathematics, theoretical back-ground in using the of ICT in teaching and learning, learning theories that support ICT integration, issues relating to ICT integration, the mathematics teachers competency in using ICT and the challenges the mathematics teacher faces in an effort to integrate ICT.

2.1 Theoretical Framework

This study is supported by the constructivist school of thought. Other theories such as the behaviorist and the cognitive theories also support the integration of ICT in teaching and learning, but according to Hung and Nichani (2001), the constructivist approach suits this school of thought best compared to the other two theories, which are the behaviorists and cognitive approaches. The constructivist school of thought was first introduced by Jean Piaget (1936). Piaget regarded children as ―builders of their own intellectual structures". Constructivism is a theory of knowledge that argues that humans generate knowledge and meaning from an interaction between their experiences and their ideas.

To the constructivist the teachers' role in the learning environment changes from being the dictator and the bank of knowledge to be poured into the child to being a facilitator and a guide to help the child learn from his own experiences. Sikander (2015) posited that a teachers' primary purpose is to increase freedom of the children to enable them to explore their environments. The constructivist believes that the learning environment should be planned to suit each child's learning needs and also

each child‘s past experience but not a one method for all as many teachers practice in todays‘ classroom. According to Sikandar (2015) teachers should realize that there is no one-for-all concept of teaching and learning. Learning processes should be planned considering the aptitude, learners‘ former experiences, and their present experiences. The rapid development of increasingly powerful computer and communication systems has great implications for the constructivist approach to education. It offers a tremendous amount of information, tools for creativity and development, and various environments and forums for communication (Shukla, 2015).

Another constructivist theorist whose work support the integration of ICT in teaching and learning is Russian psychologist Lev Vygotsky. Vygostky (1978) work differs in some ways from that of Piaget (1936). Vygostky (1978) introduced a theory known as the social development theory. It asserts three major themes, social interaction, the more knowledgeable other, and the zone of proximal development. Piaget (1936) asserts that the child‘s development precedes learning but Vygotsky (1978) felt social learning precedes development. He indicated that every function in the child‘s cultural development appears twice; first, on the social level, and later, on the individual level; first, between people (inter-psychological) and then inside the child (intra-psychological).

From Kurt (2020) who worked on Vigostky (1978) theory of learning, deduced that learners learn from interaction with the environment in which they live. They acquire knowledge through social interaction and also through interaction within the child. The child also gains experience and develop through interaction with others and these can be persons with much more experience than them for example their parents or people at the same level of experience as them, for example their peers but more

knowledgeable than them with respect to what they will be learning at a particular time.

The Zone of Proximal Development refers to the distance between a student‘s ability to perform a task under adult guidance and/or with peer collaboration and the student‘s ability to solve the problem independently. Within this space learning takes place according to (Vigostky, 1978). This indicates that Vgostky‘s work rest on the use of tools as the basis for intellectual development and this supports the idea of ICT integration since the computer can serve as the tool through which the child gains his experience.

According to Obonyo (2013), Vigostky (1978) posited that learning takes place by learners completing tasks for which support (scaffolding) is initially required. This support may include a tutor, peer or technology such as the applications of computers. This has led to the term computer supported learning. Computer supported learning environments are those in which computers are used to either maintain a learning environment or used to support the student learner in this Vygotskian sense.

2.2 Conceptual Framework

To effectively integrate ICT in teaching and learning of mathematics, many factors interrelate to create an enabling and conducive environment for teaching and learning. Factors which influence the integration of ICT in the teaching and learning of mathematics and how they can influence the integration of ICT are as shown in the Figure 2.0.

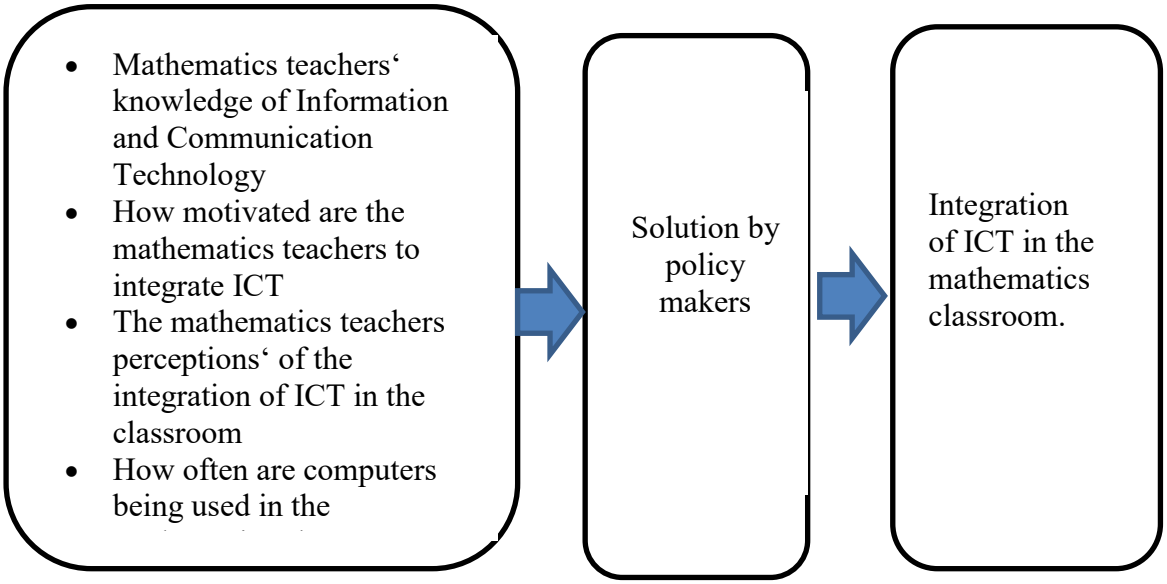

Figure 2.1: Factors that affect the integration of ICT in the teaching and learning of mathematics.

1. **The mathematics teachers' knowledge of information and communication technology:** to be able to help students to learn the teacher must knowledgeable in his/her subject area in the first place, and in this context to be able to integrate ICT in the teaching and learning of mathematics, the teacher must be knowledgeable enough as far as ICT is concerned to be able to effectively integrate ICT in the teaching and learning of mathematics. According to Beck (1997) cited in Mensah (2013) teachers' competence in ICT presupposes positive attitude to ICT, understanding of the educational potential of ICT, ability to use ICT effectively in the curriculum, ability to manage ICT use in the classroom, ability to evaluate ICT use, ability to differentiation and progression and technical capability.
2. **How motivated are the mathematics teachers to integrate ICT:** If the teacher is knowledgeable enough, how motivated he is to integrate ICT in his/her lesson which is also a factor which could affect negatively the integration of ICT is

important and needs to be given attention. Motivation is what moves, guides, pushes and retains behaviors towards the achievement of goals (Cherry, 2020).

Motivation can come from within (intrinsic) or initiated through conditions from the environment (extrinsic). For the mathematics teacher to be motivated to integrate ICT in his lessons depends on other factors and it beholds on educational administrators to ensure that the best of conditions are in place to motivate the teacher to integrate ICT in his/her lessons.

Schulz, Isabwe and Reichert (2015) in their study outlined factors which can influence the motivation of the teacher to integrate ICT as external factors such as teachers skills, attitudes and opinions towards the tools and intrinsic values such as teacher satisfaction, level of interest, joy and entertainment as well as factors related to ICT tools including usability, level of interactivity, adaptability and tools meeting learning requirements.

3. **The mathematics teachers' perception of the integration of ICT:** One's perception about something has a great influence on what the individual is likely to do with respect to that particular subject. Stols, et al.(2015) in his conclusion stipulated that teachers' perceptions that their own knowledge and skills were limited, seemingly weighed heavier than externally supportive facilitating conditions in the integration of ICT in teaching. This is a clear indication that although all the needed facilities and support can be available to the teacher, his own beliefs can be an impediment to the integration of ICT in the mathematics classroom. Wondemtegegn (2018) stating his problem posited that the attitude and perception of teachers and students' towards educational technology may affect its implementation and utilization for the teaching and

learning processes and purposes. This is a clear indication that for the integration of ICT in the teaching of mathematics to be as effective as expected the perceptions of teachers needs to be swayed positively.

4. **How often are computers being used in mathematics teaching:** the question of how often teachers are utilizing computers in the mathematics classroom rest on so many factors. Some of these factors are availability of computers in our classrooms, time allocation for ICT integration, the availability of facilitators, etc. Almekhlafi & Almeqdadi (2010) in their conclusion stipulated that in order to increase effective technology integration, both male and female teachers recommended the following: (1) regular professional development workshops, (2) enhancing curriculum with technology-enhanced materials such as CDs and videos, (3) increasing collaboration between schools across the country, and (4) giving enough freedom for teachers in the selection and coverage of curriculum materials. Without any doubt these are factors which any nation serious with ICT integration must take into consideration. To encourage and ensure the effective integration of ICT which is the major headache of most policy makers, these four factors above must be seriously considered and rectified to help mathematics teachers integrate ICT in their lessons.

2.3 Learning Theories that Support ICT Integration

Learning in its simplest form is experiencing a new challenge and coming out stronger/more knowledgeable on the other side either from completing a challenge or failing. As educators, it is our responsibility to create a safe and accessible environment for this to happen (Rose, 2017). Learning may be a common word among educators but researchers have not been able to come to common grounds when it comes to the meaning of the word learning itself. Many researchers have

defined learning in various ways probably due to the fact that people have different views and hold different perceptions when it comes to the meaning of a commonly used word among educationists as learning. Learning has been defined functionally as changes in behavior that result from experience or mechanistically as changes in the organism that result from experience. Both types of definitions are problematic. Houwer, Barnes-Holmes and Moors (2013) defined learning as ontogenetic adaptation — that is, as changes in the behavior of an organism that result from regularities in the environment of the organism. Lachman (1997) defined learning as a relatively permanent change in behavior brought about by practice or experience. In all the definitions, what is common is the change in behavior of the individual involved in the learning process, learning in general can therefore be defined as the change in behavior exhibited by learners due to exposure to various forms of experiences.

According to Mouza (2018), theory is conceptualized differently by different people and does not have a single meaning. However, it is commonly agreed that theory attempts to provide explanations to phenomena. Hammond, Austin, Orcutt and Rosso (2012) defined theory as a way of thinking and a model of how things work, how principles are related, and what causes things to work together.

By definition, theory must have four basic criteria: conceptual definitions, domain limitations, relationship-building, and predictions. Theory-building is important because it provides a framework for analysis, facilitates the efficient development of the field, and is needed for the applicability to practical real world problems. To be a good theory, a theory must follow the virtues (criteria) for a ~~–~~good" theory, including uniqueness, parsimony, conservation, generalizability, fecundity, internal consistency, empirical riskiness, and abstraction which apply to all research methods (Wacker, 1998). According to Darling-Hammond, Rosso, Austin, Orcutt & Martin (2001) as

cited in Dotse (2017), a theory is an idea that explains a set of relationships that can be tested. They added that a theory is developed from research as well as practical experience and systematic observation can be modified over time on the basis of practitioners' insights as well as the work of researchers, and is interrelated, thus, they come together to help explain a more complex phenomena.

Dotse (2017) defined theory as a framework for studying and analyzing the truth or falsity of a phenomenon. One can therefore from the above definitions conclude that theories are facts that seek to explain phenomena and give detail description as to why an idea or a concept is valid.

"Theory in Social Science" (n.d) outlined the following as the functions of a good theory:

1. Help us classify things: entities, processes, and causal relationships
2. Help us understand how and why already observed regularities have occurred
3. Help us predict as yet unobserved relationships
4. Guide research in useful directions
5. Serve as a basis for action. "There is nothing as practical as a good theory."

The researcher also listed the following points below as the characteristics of a good theory

1. Parsimony: the ability to explain in relatively few terms and statements
2. Breadth of phenomena explained
3. Accuracy of predictions of new phenomena
4. Ability to be disproved

Akdeniz et al. (2016) in their work stipulated that theory is a group of predictions that brings proposals in order to find the reasons why events take place. They further threw more light on the definition that theory helps in realizing how certain ideas are

in line with previously designed plans. Considering the definitions for ‗Learning' and ‗theory' above, learning theory can be defined as models put forward to justify different phenomena through which an organism acquires knowledge. McCain (2013) defined learning theory as an explanation of what happens when the process of learning takes place and further asserted that explaining the process of learning is an attempt by theorists to illustrate how people discover and enhance their comprehension.

2.3.1 The constructivist learning theory

The constructivist learning theory largely attributed to Vygotsky is a learning theory which talks about learning through experience. Constructivism is of the notion that learning is based on the individuals' experience. Vygotsky explained that the culture from which an individual emanates has an influence on what the person learns as well as how he learns.

According to Vygotsky (1978), culture seems to make two kinds of contributions to children's intellectual development. Firstly, children acquire much of the content of their thinking (cognition) from it and, secondly, they acquire the processes or means of their thinking from it. In short, culture teaches children both what to think and how to think. In this way, children are very likely to model their behavior on the observed behavior of their parents. Learning is therefore dependent on ***social interaction***.

The constructivist approach is based on the premise that, by reflecting on our experiences, we construct our own understanding of the world we live in. Thus individuals use their own mental constructs to make sense of their experiences.

The following are some of the basic principles of constructivism:

1. Learning is a search for meaning. Therefore, learning must be based on the issues that require personal interpretation.

2. The construction of meaning requires an understanding of _wholes‘ (the bigger picture) as well as parts, and parts must be understood in the context of wholes. Therefore, the learning process focuses on primary concepts, not on isolated facts.
3. Emphasis is placed on the application of knowledge as opposed to a mere acquisition of decontextualized facts.
4. Social aspects of learning form a crucial part of the constructivist view of learning. This means that people also learn from one another and not only in isolation but from others.

With constructivism, two concepts are very important when it comes to how the individual learns and what they learn. These two concepts are assimilation and accommodation. Assimilation is where the individual combine new ideas being learnt into older ones. Here the learner develop a new thinking and basically understands a situation which was difficult to understand before and also changes their perceptions about other situations. Accommodation, on the other hand, is reframing the world and new experiences into the mental capacity already present. Individuals conceive a particular fashion in which the world operates. When things do not operate within that context, they must accommodate and reframe the expectations with the new outcomes.

In the classroom, the role the teacher plays as far as the constructivist is concerned is different from the idea from other theories. Here the teachers instead of the expectation of being the carrier of the knowledge to be poured into the learner mostly by giving lectures act as a facilitator whose main task is to guide the learner to streamline his own ideas and understanding. This takes the focus of the learning from the teachers to the learner and what is being learnt. How the lesson is planned, how it

is initiated as well as the resources committed to learning is far different from that of the traditional classroom where the teacher is the focus and everything lies on him. The constructivist expect the teachers to be asking instead of telling, to allow student to make conclusions to situation based on their experience and ideas instead of answering questions based on only the curriculum being learnt.

Also, teachers are continually in conversation with the students, creating the learning experience that is open to new directions depending upon the needs of the student as the learning progresses. Teachers following Piaget's theory of constructivism must challenge the student by making them effective critical thinkers and not being merely a "teacher" but also a mentor, a consultant, and a coach. Instead of having the students relying on someone else's information and accepting it as the truth, the constructivism learning theory supports that students should be exposed to data, primary sources, and the ability to interact with other students so that they can learn from the incorporation of their experiences. The classroom experience should be an invitation for a myriad of different backgrounds and the learning experience which allows the different backgrounds to come together and observe and analyze information and ideas.

Khine and Fisher (2003), stressed on the need for the teacher to use the Web for learning instructions and also the relevance of using student centered approaches for such instructions. The web provides access to rich sources of information; encourages meaningful interactions with content; and brings people together to challenge, support, or respond to each other. Although the web is capable of all this, the learning process will not be smooth without the assistance of the teacher. Merely providing students with access to the web does not guarantee constructivist learning. The teacher is required to provide some guidance, or coaching to allow students to create their own meanings (Ng'ambi & Johnston, 2006). Constructivism from the above

presentations is all about the learner being afforded the chance to create his own understanding of the world around him from his previous experience with the guidance of the teacher in the capacity as more of a facilitator than the one imparting the knowledge. ICT is able to provide the learner with the needed environment and the resources with which the learner is able to construct his own knowledge and also understand concept which are not clear to the learner better.

2.3.2 The behaviorists learning theory

Behaviorism as the term itself predicts is about the behavior of animals towards stimulus. Behaviorists believe that psychology should focus on measureable and observable physical behaviors and how these behaviors can be manipulated by changes in the external environment. There is no room in behaviorist theory for thoughts or emotions, a contrast to other theories of psychology (Floyd, 2018). Behaviorism is more about reflex action, which is how animals react to stimuli within their environment. Behaviorism is a systematic approach to understanding the behavior of humans and other animals. It assumes that all behaviors are either reflexes produced by a response to certain stimuli in the environment, or a consequence of that individual's history, including special reinforcement and punishment, together with the individual's current motivational state and controlling stimuli. Although behaviorists generally accept the important role of inheritance in determining behavior, they focus primarily on environmental factors (Behaviorism, 2011).

Thorndike (1905) used a puzzle box to explain how animals behave when they have learnt through try and error how to escape a wooden box. Thorndike locked a cat in a box where the cat had to perform three steps to exit the box for a reward. It was realized that after the first instance where the animal used try and error to determine how to exit the box, in subsequent phases the animal easily identified how it exited

the box without try and error and the more the animal is put into the box the easier it became for it to perform the steps needed to exit the box. This according to Thorndike is an indication that the animal has learnt the procedure to exit the box. Thorndike's initial aim was to show that the anecdotal achievements of cats and dogs could be replicated in controlled, standardized circumstances; however, he soon realized that he could now measure animal intelligence using this equipment. His method was to set an animal the same task repeatedly, each time measuring the time it took to solve it. Thorndike could then compare these 'learning-curves' across different situations and different species (Kentridge, 1995).

Through this experiment Thorndike concluded that organisms are more likely to replicate an action which produces desired results than those which do not. Thorndike through this propounded the law of effect. Kentridge (1995) explained that of several responses made to the same situation those which are accompanied or closely followed by satisfaction to the animal will, other things being equal, be more firmly connected with the situation, so that, when it recurs, they will be more likely to recur; those which are accompanied or closely followed by discomfort to the animal will, other things being equal, have their connections to the situation weakened, so that, when it recurs, they will be less likely to occur. The greater the satisfaction or discomfort, the greater the strengthening or weakening of the bond. The law of effect principle sited by Gray (2011), in McLeod (2018) suggested that "responses that produce a satisfying effect in a particular situation become more likely to occur again in that situation, and responses that produce a discomforting effect become less likely to occur again in that situation". Thorndike‘s work is an implication by extension that humans are motivated to produce good results when the outcome of their results produces a desired result and vice versa.

Watson and Rayner (1920) also contributed to the behaviorism school of taught. Watson‘s work became popular with his conditioning experiment which was popularly known as the Little Albert experiment. In his experiment Watson exposed the participant, a child that Watson called "Albert B." but is known popularly today as Little Albert to external stimuli. Around the age of 9 months, Watson and Rayner exposed the child to a series of stimuli including a white rat, a rabbit, a monkey, masks, and burning newspapers and observed the boy's reactions. The boy initially showed no fear of any of the objects he was shown. The next time Albert was exposed to the rat, Watson made a loud noise by hitting a metal pipe with a hammer. Naturally, the child began to cry after hearing the loud noise. After repeatedly pairing the white rat with the loud noise, Albert began to cry simply after seeing the rat. This is an indication that little albert had associated the loud noise with the appearance of the animals and such exhibited the response (fear) even in the absence of the noise.

Cherry (2018) listed the elements of classical conditioning in the Little Albert experiment as

1. Neutral stimulus: the animal example white cat
2. Unconditioned stimulus: the loud noise
3. Unconditioned response: fear
4. Conditioned stimulus: the animal example white cat
5. Conditioned response: fear

In general, Watson‘s experiment was an indication that emotional responses can be conditioned in humans and also stimulus generalization can also be conditioned in humans as well. This is because after the experiment it was realized that Little Albert did not only fear the animal used for the experiment but all animal of similar look and even coat with similar hair as the animal.

Burrhus Frederic Skinner was an American psychologist whose contribution to the behaviorism school of taught cannot be overlooked. Skinner's contribution to behaviorism is more attributed to his operant conditioning experiment. He believed that what come just after a behavior influences it instead of what comes after a behavior as proposed by Watson. Operant conditioning is a method of learning that occurs through rewards and punishments for behavior. Through operant conditioning, an individual makes an association between a particular behavior and a consequence (Skinner, 1938).

Skinner studied his operant conditioning using a box which is similar to that of Watson with an animal placed in the box. The operant conditioning introduced the terms reinforcement, that is behaviors which are reinforced tends to be repeated whilst behaviors which are not reinforced tends to die out. This is evidence of positive reinforcement and negative reinforcement. In skinner's experiment, he showed positive reinforcement worked by placing a hungry rat in his Skinner box. The box contained a lever on the side, and as the rat moved about the box, it would accidentally knock the lever. Immediately it did so a food pellet would drop into a container next to the lever.

In quick successions the rat would go straight to the lever to knock it after a number of times of being placed in the Skinner box. The outcome of receiving food from knocking the lever made the rat repeat this action which is what is termed positive reinforcement. Example if your mother rewarded you with toffee as a child each time you completed your homework correctly after school, you would always want to complete your homework on time after school to have the toffee from your mother. The removal of unpleasant reinforcement can also strengthen behavior, for example if

you do not complete your homework you will forfeit half of your money for school will also force you to do everything possible to complete your homework.

2.3.3 The cognitive learning theory

Cognitive Learning Theory implies that the different processes concerning learning can be explained by analyzing the mental processes first. It posits that with effective cognitive processes, learning is easier and new information can be stored in the memory for a long time. On the other hand, ineffective cognitive processes result to learning difficulties that can be seen anytime during the lifetime of an individual (Sincero, 2013). According to Mechlova and Malcik (2012), Cognitive learning theories are concerned with processes which occur inside the brain and the nervous system as a person learns. They share the idea that people actively process information and learning takes place through the efforts of the learner. The researchers also noted that internal mental processes including inputing, organizing, storing, retrieving, and finding relationships between information takes place when learning and also new information is linked to old ones, schema and scripts. Cognitive Learning Theory implies that the different processes concerning learning can be explained by analyzing the mental processes first. It posits that with effective cognitive processes, learning is easier and new information can be stored in the memory for a long time. On the other hand, ineffective cognitive processes result to learning difficulties that can be seen anytime during the lifetime of an individual (Priyanka, 2017).

From the above advancements, it is clear that the cognitive learning theory is more of the brain and how it functions during learning than the behavior learner‘s exhibit during learning and after learning as well as what behaviors or experiences affect learning as in the case of the behaviorist learning theory. The cognitive theory is more

about how brain activities such as inputing, organizing, storing, retrieving, and finding relationships between information takes place when learning and also new information is linked to old ones, schema and scripts as indicated by (Mechlova & Malcik, 2012).

2.3.4 Piaget's theory of cognitive development

Piaget (1936), a Scientist, Psychologist and Biologist, Jean Piaget's work as far as Cognitive theories are concerned played an integral role. The researcher was the first psychologist to make a systematic study of cognitive development. His contributions include a stage theory of the child's cognitive development, detailed observational studies of cognition in children, and a series of simple but ingenious tests to reveal different cognitive abilities. His work dates back to the 20th century and explains cognitively the development of the child. McLeod (2018) stipulates that Piaget's (1936) theory of cognitive development explains how a child constructs a mental model of the world. He disagreed with the idea that intelligence was a fixed trait, and regarded cognitive development as a process which occurs due to biological maturation and interaction with the environment.

Components of Piaget's cognitive theory

There are three components to Piagets' cognitive theory, these are:

1. Schemas
2. Adaptation processes that enable the transition from one stage to another, that is equilibrium, assimilation, and accommodation**.**
3. Stages of Cognitive Development : the sensorimotor stage (from birth to age 2), Preoperational stage, concrete operational stage, formal operational stage.

Schemas

Cherry (2019) defines schema as a cognitive framework or concept that helps organize and interpret information. From Mcleod (2018), Piaget defined schemas as a cohesive, repeatable action sequence possessing component actions that are tightly interconnected and governed by a core meaning. The researcher went on to explain that Piaget in simple terms wanted to say that schemas are the basic building blocks of intelligent behavior, a way of organizing knowledge. Mcleod defined schema as a set of linked mental representations of the world, which we use both to understand and to respond to situations.

Cherry (2019) stipulated that the Piaget's theory was explaining schema in terms of human thinking and learning as both the category of knowledge as well as the process of acquiring that knowledge. The researcher also said Piaget believed that people are constantly adapting to the environment as they take in new information and learn new things, that is as experiences happen and new information is presented, new schemas are developed and old schemas are changed or modified.

Schemas are the knowledge and information we form about situations and objects when one is growing as a child or learning about a new unknown situation. These schemas can be wrong or correct initially but as we learn and gain more experience about the situation or object, the wrong schemas are corrected and the correct ones are affirmed. For example, a child who initially comes across a rat as an animal with fair may assume that all animal with fair are rats and might even call a dog a big rat but as the child grows and gain more experience about animals with hair, he will later realize that a dog is a dog and not a big rat. In this instant the old schema of all animals with fair being a rat is replaced with a new one which now tells the child that there are other animals with fair which are not rats.

Adaptation Processes that Enable the Transition from One Stage to another (Equilibrium, Assimilation, and Accommodation)

Talking of the adaptation processes Piaget mentioned three stages:

1. **Equilibrium:** Since all wrong schemas ought to be replaced with new once to make the learning process complete, there is the need to be an equilibrium formed between the lead schemas and new schemas to lead to assimilation.
2. **Assimilation:** this is the ability of the brain to receive and accept new ideas into old ones. Gilles (2015) defined assimilation as a cognitive process that manages how we take in new information and incorporate that new information into our existing knowledge. He acknowledges that the concept was developed by Piaget, example when a young child learns the word dog for a family pet, he eventually begins to identify every similar-looking canine as a dog. The child has extended his learning, or assimilated the concept of dog to include all similar 4-footed friends.
3. **Accommodation:** According to Williams (2015) accommodation is a term developed by Jean Piaget to describe the process in which we modify existing cognitive schemas in order to include new information. In simple terms accommodation is the process of accepting other schemas different from existing once but similar in concept. A child who lives in the village and knows only birds fly upon seeing a plane for the first time might point at it and say what a big bird. When he is told is rather a plan not a bird, he will use the information to modify his initial concept of flying which will mean accommodating new information about flying.

Stages of cognitive development

To Piaget (1936), every child goes through four stages of cognitive development as their taught and mental structures become sophisticated. Piaget (1936) indicated that each child goes through these stages in a way but did not insist that every child get to each stage at the same age although he attached ages to the very stages as an indication of the average child's age of getting to the various stages. These stages he named as:

1. **The Sensorimotor Stage (from birth to age 2):** this stage begins from the time the child is born to age 24 months. During the early stages infants know nothing but things in hand and things in front of them. Their focus is on what they see and physical interaction within their immediate environment. Huitt and Hummel (2003) posited that, in this period, intelligence is demonstrated through activity without the use of symbols, they further posited that according to Piaget the child's world at this stage is limited although still developing since it is based on physical interaction. At this stage everything is about experimentation, shaking, throwing, and putting things in their mouth, basically learning about their environment through try and error.

   Later at the stage, around age 9 months, they begin to form concept of permanence, which is they begin to realize that objects exist although they are not in site. This is a sign of memory development. Increase in physical activities such as crawling, standing and walking leads to an increase in cognitive development. At the latter stages of this stage the child develops symbolic abilities through early language development. Sensorimotor behavior provides the model for all of the stages; each succeeding operating system for each succeeding stage is built using similar mechanisms, goes through similar sub stages, reaches a halfway turning

point, and then is applied in similar ways, pushed to its limits until another, more powerful system is built (Feldman, 2004).

2. **Preoperational Stage:** This stage follows right after the sensorimotor stage, which is from the child being a toddler to age 7. At this stage the use of early language increases leading to language development. The child also develops the skill of symbolism that is they think about things symbolically. Memory and imagination also develop at this stage, which enables them to differentiate between the past and the future. Although they develop in all these aspects of thinking as mentioned above, their thinking is still intuitive and not logical. They still cannot grasp more complex concepts such as cause and effect, time, and comparing. Another characteristic of preoperational child's thinking is his/her inability to reason successfully about transformations (Heo, Han, Koch, & Aydin, 2011).
3. **Concrete operational Stage:** At this stage the child begins demonstrating logical reasoning as well as concrete reasoning. This stage falls between age 7 and age 11, known predominantly as the elementary age and the preadolescent age. Children at this stage become less egocentric and are more aware of external events (Blake & Pope, 2008). During this period, children are able to do one-step logic problems, develop language, continue to be egocentric, and complete operations. They also come to realize that one's thinking is unique to the individual as well as their feeling and that they may not be shared by others. Heo, Han, Koch, and Aydin (2011) also mentioned that the concrete operational stage can be viewed as a transition between pre-logical thought and complete logical thought of older children who have attained formal operational stage. Most children at this stage however cannot think abstractly or hypothetically.

4. **Formal Operational Stage:** At age 11 and above, most adolescents are at this stage. They are able to logically use symbols to relate to abstract concepts, such as algebra and science. At this stage they can also ponder abstract relationships and concepts such as justice. Formulation of hypothesis, multiple variables as well as considering of possibilities are also some of the things, they are able to do at this stage. Shroff (2017) stipulated that Although Piaget believed in lifelong intellectual development, he insisted that the formal operational stage is the final stage of cognitive development, and that continued intellectual development in adults depends on the accumulation of knowledge.

2.4 Cognitivist and ICT Integration

2.4.1 Issues relating to ICT integration

These are issues that directly or indirectly influence the integration of ICT in the teaching and learning of mathematics. Lavicza (2010) indicated that despite the vast investments in technological resources for schools and universities, the realities of schooling and the complexities of technology-equipped environments resulted in a much slower integration process than was predicted in the 1980s.

2.4.2 The concept of ICT integration

With a view back to the evolution that the invention of computers to the definitions and how people view the concept ICT to its meaning and conceptual understanding today is more than enough to tell us that ICT has had to go through a long way to arrive here today. The term –computer" comes from the Latin word –computus" and –computare". Both Latin words mean to determine by mathematical means or by numerical methods. The English verb –compute" has the same meaning Rhalmi (2016). The researcher further defined computer as a programmable electronic device

that performs mathematical calculations and logical operations, especially one that can process, store and retrieve large amounts of information very quickly.

The term "information technology" evolved in the 1970s. Its basic concept, however, can be traced to the World War II alliance of the military and industry in the development of electronics, computers, and information theory. After the 1940s, the military remained the major source of research and development funding for the expansion of automation to replace manpower with machine power (History of ICT, 2008). This is an indication of a shift of focus from computing as technology to the computer enhanced capability to store and retrieve information.

The term Information Technology (IT) consists of two terms, Information which is fact about someone or something and technology which is the application of scientific knowledge for practical purposes. Recently it has become popular to broaden the term to explicitly include the field of electronic communication so that people tend to use the abbreviation ICT (Information and Communications Technology**).** The introduction of the term _ICT' manifested around 1992, when e-mail started to become available to the general public (Obonyo, 2013).

AIMS (2013) referred to ICT as all conversation technology which includes the Internet, wi-fi networks, cellular phones, computers, software, middleware, video conferencing, social networking, and multimedia programs and services as well as different technological approaches that allow customers to access, retrieve, store, transmit and manage data in virtual format. The inclusion of the term Communication was an indication that people stopped looking for just technological equipment, but also the knowledge they could deliver. The introduction of the internet and emails made accessibility and dissemination of information easy.

These technologies include computers, the internet, broadcasting technologies (Radio and Television), and (Mobile) telephony. Basically, ICT is a tool. It can be hardware (such as Computers, Digital cameras), software (such excel, discussion forum) or both.

2.4.3 ICT Integration

Arguably ICT integration and computers emerged and evolve around the same time and has been around each other throughout the computer evolution process till today. As far back as the introduction of Abacus around 3000 BC till date, computers have been hand in hand with its‘ integration in teaching. Recently the technological demand in all fields and professions has necessitated enforcement of the integration of ICT in teaching and learning to prepare students for their future professions. Information and communication technology (ICT) has become an important part of most organizations and businesses these days (Zhang and Aikman, 2007). The attention of educators has been drawn to this fact and this has increased the need to integrate ICT not because of its availability, but its necessity and ability to provide the child with various means and avenues to be able to understand better concepts taught in the classroom as well as its‘ practicability in our daily lives. The use of ICT in the classroom is very important for providing opportunities for students to learn to operate in an information age (Bingimlas, 2009).

2.4.4 Effects of ICT on students’ academic performance

ICT refer to technologies which are used for collecting, storing, editing and passing on information in various forms. Many directly attribute the effect of ICT in education to the impact it has on students‘ performance, but it can have other effects different from the students‘ academic performance. A personal computer is an example of the

use of ICT in education which does not have direct impact on the students' performance but can improve the teachers' data management.

In actual sense the effect ICT has on students' performance is not directly identifiable. Even though this is the situation there are still a number of effects of ICT integration which research has proven, some of these factors are:

2.4.4.1 ICT and Student Performance

Whenever the idea of the impact of ICT in education comes to mind, it raises attention towards the effect it has on the academic performance of students. Several researchers have backed the assertion that ICT positively affect the performance of students (Bingimlas, 2009; Obonyo, 2013). Khan, Khan, Siraj-U-Din, Hafiz and Khattak (2015) in their conclusions stipulated that ICT tools are very helpful in that it helps students to do assignments. Teachers also realized that ICT enables students with special needs or difficulties to easily understand concepts. It also helps to reduce the social disparities between students, since they work in teams in order to achieve a given task. Students also assume responsibilities when they use ICT to organize their work through digital portfolios or projects. In addition, the study showed that ICT has significant impact on students and learning processes. Youssef and Dahmani (2014) also mentioned that ICT seems to have a profound impact on the process of learning in higher education by offering new possibilities for learners and teachers. These possibilities can have an impact on student performance and achievement.

The above research finding clearly shows the positive effect ICT has on both student performance and participation in the learning environment as well as its ability to assist students in their studies.

2.4.4.2 Learner interactivity

When the instructional procedure in the classroom makes the learners passive observers, more teacher-centered as far as activities are concerned, obviously the learner becomes bored and does not benefit fully from the learning process. It is always very important to keep the learners active to be able to sustain their attention and interest in the learning process.

The constructivist approach to learning supports learner interactivity. The constructivist approach involves students as active participants in making meaning, instead of passive recipients of information given to them by the instructor. The constructivist learning theory suggests that active learning environments are better for learning (Hrastinski, 2009). Constructivism implies that there is no definite meaning of the world that we try to understand, rather, there are multiple ways to structure the world and make meaning of events (Ihlstrom and Westerlund, 2013).

Beauchamp and Kennewell (2008) as cited in Beauchamp and kennewell (2010) outlined the various ways in which ICT can improve student participation in the learning environment as:

1. The object of interaction (i.e. resources to interact about: a purely passive role for an ICT resource).
2. A participant in interaction (i.e. a partner to interact with: ICT can itself orchestrate resources to support the learner through its contingent responses such as prompts and feedback).
3. A tool for interaction (i.e. a medium to interact through: ICT can be used by the teacher or learner to assist with the orchestration of resources).

These roles as mentioned by the researchers in their work are an indication of how interactive ICT can be to an individual in the learning process. According to

Alherbi (2014), effective use of ICT by the teacher can offer greater interactivity at both a deep and surface level.

2.4.4.3 Motivation of students

The ability of the teacher to motivate the learner is an important aspect of the teaching and learning process and incorporating ICT in the teaching process has the ability to do this for the teacher. Motivation can be categorized into two broad areas, which are intrinsic and extrinsic motivation. Intrinsic motivation comes from within and is normally exhibited by the interest of the student in a particular subject or aspect of it. Extrinsic motivation can be more sustaining and long lasting as the individual develops the interest himself without any motivating factors. On the other hand extrinsic motivation is evoked by external factors which can be in any form such as a gift. Extrinsic motivators more readily produce behavior changes and typically involve relatively little effort or preparation. Also, efforts at applying extrinsic motivators often do not require extensive knowledge of individual students.

Kreutz and Rhodin (2016) concluded that students believe it is fun when the teacher uses ICT, but it is even more fun when they use computers and tablets themselves. This clearly tells that ICT has the power to motivate students in the learning environment. ICT has a positive motivating effect on students‘ learning and thus teachers should take advantage of this fact and implement ICT in their delivery to motivate and sustain students‘ interest in their lessons (Klimova & Poulova, 2014).

2.5 The Mathematics Teacher’s Competency in Using Computers

Competency as far as the teacher is concerned with respect to the subject matter to be delivered is very important and needs a critical look at as it goes a long way to influence what and how the teacher goes about the teaching process. The Harvard

University Competency Dictionary defines competencies as in the most general terms, are ―things" that an individual must demonstrate to be effective in a job, role, function, task, or duty. These ―things" include job-relevant behavior (what a person says or does that results in good or poor performance), motivation (how a person feels about a job, organization, or geographic location), and technical knowledge/skills (what a person knows/demonstrates regarding facts, technologies, a profession, procedures, a job, an organization, etc.)". The business dictionary also defines competence as a cluster of related abilities, commitments, knowledge, and skills that enable a person (or an organization) to act effectively in a job or situation. Competence indicates sufficiency of knowledge and skills that enable someone to act in a wide variety of situations.

2.5.1 Teacher attitude in using ICT

It refers to effect and is an evaluative, emotional reaction (i.e., the degree of like, or dislike associated with attitudinal object) (Thamarana, 2017). The teacher's attitude towards the use of ICT has an effect on whether he will use or not use ICT in his delivery which goes a long way to affect his eagerness to learn to be competent in the integration of ICT. Bamidele and Bamigboye (2013) concluded that to promote effective integration of ICT resources into lectures, lecturers must have positive attitude and competency towards the use of ICT in their teaching. The researchers from their conclusion remarks were attesting to the fact that the attitude of the teacher has an impact on his competency as far as ICT integration is concerned. Thamarana (2017) also in his conclusions said the teachers' attitude and his competency has a bearing on each other. To be competent in the use of ICT in the classroom the teachers' attitude plays a major role, his attitude will drive his curiosity towards learning more about ICT and its usage in the teaching and learning process.

2.5.2 Teachers believes and attitudes towards ICT integration

The teachers believe and attitudes towards ICT integration have a long way to determine whether he integrates ICT in his lessons or not. Most teachers see ICT to be a subject on its own instead of being a means through which teaching can be made easy and concept can be understood better (Williams et al., 2000). It appears that, even though they recognize the importance of introducing ICT in education, teachers tend to be less positive about its extensive use in the classroom and far less convinced about its potential to improve teaching (Zhao & Cziko, 2001)

Although most teachers are aware of how great and helpful the integration of ICT is in the classroom, most teachers still resort to the use of narrow range of applications, mainly for personal purposes. Most of them continue to use computers for low-level supplemental tasks such as word processing (lesson plans, worksheets, assessment tests, registration of grades, etc.) or getting information from the Internet (Williams *et al*., 2000).

This all boils down to the fact that most teachers do not believe ICT should be an enzyme to stimulate classroom interactions and to provide a more interactive learning environment but rather should be a subject where various aspects of ICT are treated. Literature have proven that teachers and for that matter educationist prefer using ICT for other purposes such as administrative purposes, for lesson note preparation, for looking up information from the internet and for communication rather than using ICT for classroom instructional purposes (Wikan & Molster ,2011; Howie & Blignaut, 2009). In their conclusion, Buabeng-Andoh and Issifu (2015) stipulated that schools are yet to exploit the potentials of ICT in teaching. The use of ICT by teachers is mainly for organizational and informative purposes. However, the actual integration of ICT into teaching still remains an issue in schools.

2.5.3 Teachers' pedagogical content knowledge in the teaching and learning processes

It is clear the positive effect ICT can have on concept understanding if properly integrated in the teaching and learning process, but there is no doubt this rest on several factors of which the teachers' pedagogical content knowledge cannot be overlooked. Pedagogical knowledge has a direct impact on teachers' technological pedagogical content knowledge (Chai, Koh,Tsai and Tan, 2011). This makes it evidently clear that the teachers' ability to integrate ICT in his lessons also depends on the content knowledge of the subject matter itself. The teacher must know the content of the concept he wants to teach to be able to use the computer as a tool to achieve that objective. It is reasonable to teach technology in content that honor the rich connections between subject-matter (content), technology and the means of teaching it (the pedagogy).

Harris and Koehler (2009) mentioned in their submissions that technology integration do not necessarily reflect content area differences and might neglect the true realities of teaching. These are all indications of the importance of the teachers' content knowledge in the integration of ICT but researchers have indicated previously that traditionally, professional development has overemphasized hardware, software, technology skills rather than meaningful, content-area professional development and training (Harris & Hoffer, 2011; Bauer, 2013).

2.5.4 Self-improvement

The teachers' eagerness to improve as far as modern technology is concerned has an effect on the teachers' competency to be able to apply ICT in his delivery. The teacher will have to update his knowledge on new technological tools, software and updated technological equipment to be able to effectively integrate them in his delivery. This

is consistent with the finding of research conducted by Tambunan (2014), in the researchers‘ discussions it was stated that competency of teachers in the integration of ICT is also dependent on the teacher‘s self-improvement which education managers should endeavor to help their teachers attain by the organization of workshops and seminars on the use of information technology.

This is very important especially in the area of the teacher keeping himself abreast with the current trends in technology so as to apply them in the classroom. This is relevant since most students are exposed to new technologically advanced equipment‘s as well as software in their environment which will make the classroom activities boring if teachers are using old technological equipment‘s and software.

2.5.5 Interpersonal communication

Lichstein (1978) define interpersonal communication as the ability to establish effective therapeutic relationships with others, including families and colleagues; demonstrate ability in excellent relationship building; and possess listening, narrative, and non-verbal skills to educate and counsel patients, families, and colleagues. Interpersonal communication is the process by which people exchange information, feelings, and meaning through verbal and non-verbal messages: it is face-to-face communication. Interpersonal Communication is therefore the relationship between two or more people in search a way that each and every one of them is able to ask assistance of the other should the need be.

Interpersonal relationship can go a long way to improve upon the ICT competency of the teacher if he is able to create that environment where he can approach any of his colleagues for assistance in relation with the integration of ICT for teaching and learning. Teachers through interpersonal relationship can create an environment where all teachers are able to sort help from each other. In this way teachers who are

lacking with respect to current trends in education, especially concerning ICT integration in the teaching and learning process are able to sort help from their colleagues to update their knowledge on current technological issues and practices.

Siburian (2013) in the conclusions of his work stated that good interpersonal relationship has a direct impact on teacher job satisfaction. The researcher categorically stated that the better the interpersonal communication skills of the teacher the higher his job satisfaction. The researcher further stated that interpersonal communication directly affects teachers Organizational Commitment. In other words, the better the Interpersonal Communications, the higher teachers' Organizational Commitment. This is an indication that teachers‘ interpersonal communication has a direct effect on the teachers‘ performance, which stems from his competency on the subject matter. Bakic-Tomic, Dvorski, and Kirinic (2015) concluded that communication competence of the teacher is equally a necessity for the teachers‘ success in the teaching and learning process as it is as important as the teachers‘ methodology and his content knowledge on the subject matter.

2.5.6 Administration

Vitanova, Atanasova-Pachemska, Iliev and Pachemska (2014) stipulated in their conclusions that continually improving the technical equipment in the schools will positively affect the use of ICT by teachers. They also stated categorically the fact that access to hardware and computers contribute to greater development of ICT competencies of teachers. The administration cannot be overlooked when looking at contributing factors to the teachers‘ performance in the integration of ICT. The administration in actual fact will be required to set the ball rolling to enhance the integration of ICT in the classroom by making available the various resources needed to enhance the integration of ICT.

Just making these resources available is not enough but the administration should as well ensure that there is continual improvement in the technical equipment in the school as far as ICT is concerned by replacing outmoded equipment with ones which are tuned towards current trends in ICT integration as well as making sure the current and right software are always available to the teacher. In so doing the administration indirectly motivate teachers to use ICT in most of the things they do such as typing their own questions, typing their lesson notes, communicating via the internet with colleagues, looking up information from the internet which enhances the competency of the teacher as far as ICT integration is concerned.

The provision of in-service training also helps in shaping teachers‘ knowledge on current ICT integration practices in the classroom and the administration must ensure such trainings are available to the teacher. The more knowledgeable the teacher is the more competent he becomes which raises his confidence in the classroom thereby affecting his competency as a whole. Training teachers regarding spreadsheets, multimedia presentations, blogs and databases will have a positive impact on ICT knowledge and skills of teachers in the corresponding areas (Vitanova, Atanasova-Pachemska, Iliev & Pachemska, 2014)

2.5.7 Motivation

Motivation in the field of education as far as teaching and learning is concerned plays a very critical role. Putting in measures to motivate both the student and the teachers affects academic work positively. On the side of the student motivation, motivation improves academic performance by influencing student cognitive procedures and psychological state, which is the students‘ ability to concentrate on what is being taught, is enhanced. Motivation affects how an individual pays attention to specific information and attempts to understand the learning materials through experiences,

thoughts, ideas and senses rather than just going through the process of rote learning. Being motivated also affects positively the determination of the students, for examples if a student is motivated by the work of a mentor, he is motivated to work harder and even harder than the mentor based on the history behind the persons' success in order to be able to follow the footsteps of whoever the mentor is. Motivation also can go a long way to affect the behavior of students, which is students turn on good behavior when motivated the right way because they set goals to be achieved and to achieve these goals they must to put up certain good behaviors to be able to achieve their goals. Orhan-Ozen (2017) in concluding the finding of the researchers work categorically stated that motivation has positive effect on students' academic performance although it can be influenced by other factors such as cultural background, country of origin and others.

On the side of the teacher, motivation plays a major role in determining the performance of the teacher in the teaching and learning process. Many factors can be attributed to the motivation of the teacher. Put in two broad categories, factors which affect teacher performance are financial/extrinsic factors and non-financial/intrinsic factors. From their recommendations Ondima, Okito, Nyang'au, Mabeya and Nyamasega (2014) stated that the Ministry of Education in order to motivate teachers increases teachers' salary which will increase the motivation of the teachers to work harder. The researcher also indicated that non-financial motivation should also be provided. The researcher stated emphatically in the findings that non-financial motivation together with financial motivation has the ability to motivate teachers better.

Chigona (2014) concluded that motivating educators in the use of ICT is a major factor in the successful integration of ICT in the teaching and learning process. The

researcher continued by stating that the successful integration of ICT depends on educators who are motivated to integrate ICT in their teaching. Further, the researcher stipulated that whilst most educators believe that ICT integration in the teaching and learning process can be rewarding, they also encounter other factors which demotivate the use of ICT in the teaching process. This is an indication that motivation also has an effect on either the teacher will integrate ICT in the teaching and learning process or not.

2.5.8 Training

Teacher training as a matter of fact cannot be underrated when it comes to the overall competency of the teacher. Teacher training in this respect can be categorized into two broad areas, which are pre-service training and in-service training. There is a popular technological adage which states that –garbage in, garbage out" which in this context means what you give the teachers is what they will deliver to the students. Teacher training has a significant effect on the attitude of teachers towards teaching and learning of pupils (Singh, 2012). The researcher further stated that academic bodies should plan well teacher training programs in order to help groom competent and more motivated professionals. For the teacher to be effectively able to integrate ICT in the teaching process, the teacher need to be given a significant amount of training in the integration of ICT before the mathematics teacher graduates as a professional.

In-service training of the mathematics teachers as well as all other subject teachers on the integration of ICT is as important as the pre-service training of the teacher. Sanchez-Garcia, Marcos, Guanlin and Escribano (2013) in their conclusion clearly outlined that the effective use of ICT is bound on in-practice training as well as guided practice. The researcher also indicated that peer collaboration was also crucial

to teacher ICT integration. The continued improvement and organization of training, that is both in-service and pre-service training brings about excellent professional development and is vital in this age of information technology, which is full of constant change and development (Albion, Baruch, Tondeur & Peeraer, 2015).

This is evident of the importance the training of the mathematics teacher and teachers as a whole is before and during practice as far as the integration of ICT for the teaching and learning of mathematics is. With the evolving and continual improvement in the field of technology, the in-service training of teacher in particular is very vital if teachers will be able to effectively and competently integrate ICT in the teaching and learning process.

2.6 The Challenges Mathematics Teachers Face in an Effort to Integrate ICT in their Delivery

The integration of ICT in the teaching and learning of mathematics in Ghana over the years has encountered a lot of challenges along the way, some of which have been dealt with but others are still in the system and worth discussing. Schoepp (2005) called these challenges to the effective integration in the teaching and learning of mathematics and the integration of ICT in teaching as a whole as ~~"b~~arriers". The researcher further asserted that studying the obstacles to the use of ICT in the teaching and learning environments is important due to the fact that these factors if known will aid in providing guidance for ways to enhance technology integration which will encourage the greater use of ICT in the classroom. The basic factors influencing ICT use in the teaching-learning processes are defined by Williams, Coles, Wilson, Richardson, and Tuson (2000) as lack of information, skills and support and access to technology. A barrier in this respect is any form of challenge which impedes the successful integration of ICT in the teaching and learning process. According to

Bingimlas (2009) as cited in Nwankwaola, Daminabo and Agi (2013) a barrier is defined as any condition that makes it difficult to make progress or to achieve an objective. Balanskat et al. (2006) as cited in Bingimlas (2009) outlined that although educators appear to acknowledge the value of ICT in schools, difficulties continue to be encountered during the process of adopting these technologies. Yalin, Karadeniz and Sahin (2007) indicated in their submissions that most school directors and teachers stated that barriers they mostly faced during ICT integration are lack of training, lack of hardware and lack of technical support. Some of the barriers are as explained below:

2.6.1 School-level barriers

2.6.1.1 Insufficient resources

According to Nkhwalume (2013), some teachers expressed concern that regardless of their requests to have departmental computers with projectors for use in mathematics classrooms, this has not been achieved on the grounds that ‗funds are not available'. One of the major challenges to the integration of ICT in teaching and learning in Ghana and Africa as a whole is the lack of sufficient resources to enhance the integration process. Researchers on numerous occasions (Wiiliams *et al*., 2000; Comber and Lawson, 2013) indicated the availability of resources as a major impediment in the successful integration of ICT in the sciences of which mathematics forms an integral part of. Lawton (1994) stipulated that access to technological materials is a major barrier as far as the integration of ICT in education is concerned. Bingimlas (2009) in his conclusion indicated that lack of access to resources is a major barrier in the successful integration of ICT in the sciences.

One may be quick to conclude that insufficient resources is as a result of the non-availability of these resources to the teacher but a critical look at the situation in most

schools point out to the fact that, these resources are available in the schools, but are not available to the teachers as and when they need them due to poor management and planning of the usage of these resources as such making the situation seem as if the resources are not available. Becta (2004) mentioned the fact that most of the time the insufficiency of ICT resources are not due to the fact that technological material such as software and hardware as well as other ICT material are not available, but might emanate from a couple of factors such as poor organization of resources, poor quality hardware, inappropriate software or lack of personal access to teachers. This is an indication that although the necessary technological tools can be available in the educational institution, lack of proper internal organization and arrangement can render these tools useless making it seem as if they are actually not available to the teacher.

2.6.1.2 Limited time on the school timetable

One of the major barriers teachers face in the integration of ICT in the teaching of mathematics is the lack of enough time on the school timetable. Ghana Education Service (GES) has stipulated time allocated to both elective and core subjects at the secondary level of which one will find it difficult to tell if the integration of ICT in the teaching and learning process was considered considering the content to be covered per period and how involving and time consuming the integration of ICT especially in the teaching of mathematics is although the syllabus itself encourages the integration of ICT in the teaching and learning process with one of it general aims indicating the use of calculator and the computer for problem solving and investigations of real life situations (Ghana Education Service, 2010).

Kamau (2014) as cited in Saal (2017) indicated that the teacher is always under pressure to complete the curriculum in preparation towards examination. This is major

hindrance to ICT integration since teachers are always racing against time to be able to complete the syllabus which makes it very difficult to involve ICT in the teaching process looking at the limited time allocated to the subject with how involving the subject itself is in the first place talk of involving ICT which demands more time.

A survey of professional development needs, experiences and impacts" conducted by Bennison and Goose (2010) found that lack of time prevented teachers from familiarizing themselves with ICT's. Jones (2004) also cited lack of time as a hindrance to the integration of ICT. The findings from the above literature are a strong indication of the hindrance the lack of time pose to the effective integration of ICT in the classroom.

In view of this the Ghana Education Service as well as curriculum developers should liaise with stockholders in the teaching profession such as the teacher unions to be able to allocate enough time to encourage teachers especially mathematics teachers to be able to integrate ICT in the teaching process.

2.6.1.3 Internet Connectivity

There is a common adage in recent times, which says that ~~"t~~he world is a global village". People believe this is so for the fact that all can get access to things from all over the world and also communicate with people across all continents which are made possible by technology of which internet connectivity forms and integral part of. The internet has changed the world. It has greatly impacted communication virtually reducing the world to a global village by enabling individuals to communicate easily and quickly. The internet has also changed the conventional ways of buying and selling and has transformed commercial activities (LawTeacher, 2013).

The internet if available to the teacher as well as the students during classroom delivery enhances the learning environment in the sense that with the internet the teacher has available to him the whole world to choose from. The teacher can get access to different software of which some of them can only be accessed via the internet to choose from. The students can also get access to a lot of e-learning activities and software via the internet which makes the learning environment lively and more interactive. Though all these benefits are available to both teachers and students with the availability of internet connection the classroom, most classrooms and computer laboratories where the integration of ICT takes place do not have internet connection.

2.6.1.4 Software-related barrier

The world is changing fast towards the technological era and teachers will have to be skilled enough to adapt to this new trend. Educational software today is more than basic instructional programs. Increasingly sophisticated and prevalent in today's schools, free and for-cost software is now designed to help students and educators with organization, productivity, research, presentation and learning (Lachner, 2017). One of the major barriers that confront the integration of ICT in the teaching of mathematics is got to do with modern software. Without any doubt there are a large number of electronic tools available for mathematics instructions such as Geogebra and Maple but teachers prefer other manual methods such as Abacus. Most teachers prefer the use of old traditional methods to the use of computer software due to lack of knowledge of the use of these software. According to Ertmer et al. (2012) as cited in Johnson, Jacovina, Russell, and Soto (2016), the most commonly cited reason for lack of technology implementation in the classroom is inadequate professional development and training. When teachers are not well trained to handle educational

software they tend to lose interest in exploring these software in the first place to be able to effectively use it in the classroom.

2.6.2 Teacher level barrier

2.6.2.1 Lack of motivation

For the effective integration of ICT in the teaching of mathematics, one basic requirement the teacher needs is motivation. Motivation can be either from within (intrinsic) or as a result of external factors (extrinsic). For the teacher to want to practically involve technology during classroom delivery, he needs to be motivated either from within or from environmental factors. Johnson , Amy, Jacovina, Russel and Soto (2016) stipulated that if teachers do not expect new technology to be useful or do not think they have the required experience to use such technologies, they are more likely to persist using more traditional methods. Habibu and Clement (2012) indicated that teachers‘ lack of confidence plays an important role to determine whether the teacher will use technology in the classroom or not. The researchers concluded by stressing on the fact that confidence, competence and accessibility are critical component for technology integration in every institution.

This makes it glare how vital the confidence of the mathematics teacher building up to his motivation really is as far as the incorporate of technology in the day to day delivery in the classroom is and the devastating effect it could have on the subject if not taken care of.

2.6.2.2 Teacher reluctance to new technology

The problem of the mathematics teacher accepting and realizing the need to incorporate new technologies into his classroom delivery is also a major concern as many teachers exhibit reluctance to the use of new technologies in the teaching of mathematics. Habibu and Clement (2012) stipulated that the teachers‘ attitude have

been found to be the major predictors of the use of new technologies in instructional settings; the successful use of new technology in the classroom depends largely on the teachers‘ attitudes towards these tools. This is an indication that the teachers‘ acceptance of these tools is critical to the integration of ICT in education.

The adaptation to new technologies poses new challenges to the teachers as well as increasing the workload of the teacher when it comes to preparation towards lessons. Cleaver (2014) stated as indicated in Johnson , Jacovina, Russell and Soto (2016) that when adopting new classroom technologies, educators face the problem known online as the ―double innovation" problem. With the mention of double innovation the researcher wanted to clearly establish that technology essentially adds an additional layer of preparation teachers must work through. The teacher in this respect must ensure initially that he is knowledgeable enough with respect to the new technology to be able to utilize it in a classroom setting as well as deciding how to integrate the technology with classroom objectives and the curriculum. Although educational technologies are becoming easier to learn, the double innovation problem still results in additional preparation time.

2.6.2.3 Lack of confidence

Lack of confidence is a major factor which has negative effect on the mathematics teachers‘ readiness to integrate ICT in classroom delivery. According to Habibu and Clement (2012), teachers‘ lack of confidence to integrate ICT in their lessons stems from the fear of failure of not being able to effectively use technological tools in the classroom. Teachers feel they are not skilled enough and fear any attempt to use ICT may not go well and so do not want to try it at all in the classroom. Johnson, Jacovina, Russell and Soto (2016) stipulated that teachers lack of confidence may stem from the fact that they grew in environment where computers were had to come by therefore

might not have enough training and experience with the use of the computers. The teachers therefore may decide to ignore the use of technology in the classroom due to the fear of failure. To curb this, educational administrators must ensure adequate training programs are in place to enrich the technological skills of the teacher enough to make the teacher confident.

2.6.2.3 Lack of knowledge

Being knowledgeable in what you do or want to do is a boost and a motivational factor for one to confidently go into something and the teacher cannot be left out when it comes to the integration of ICT in the teaching of mathematics. If the is teacher knowledgeable, he is confident and motivated to integrate ICT in mathematics lessons. According to Swart (2008) preparing teachers for a changing world, a more technology enriched environment entails equipping them with adequate technological subject knowledge, effective teaching practices, an understanding of technology and the ability to work with others (colleagues, management, parents). The researcher further reiterated that research clearly establish that many of primary school teachers lack adequate academic qualifications, training and content knowledge, especially in developing countries.

27 Summary

Achieving the motive of the total use of ICT tools in the teaching and learning of mathematics obviously needs a lot of attention both by policy makers as well as the finals implementers which includes school administrators as well as teachers. Although the implementation of these ICT methods obviously is not on the cheaper side, governments and other stake holders should endeavor to push resources into it

proper implementation as it offers the teacher numerous means of teaching and learning as well as education resources.

Despite the expensiveness and other challenges such us internet connectivity across all secondary schools in the country to ensure the implementation of ICT usage nationwide, there is widespread effort to embrace the use of ICT in the whole of Africa. These efforts are being put across to ensure teachers are well equipped for life as professionals as well as people to fit into society.

CHAPTER 3

METHODOLOGY

3.0 Overview

This chapter gives details of the methodology that was used to conduct the study. It elaborates on the research design that was employed for the study, the population, the sample and sampling technique as well as the instruments that were utilized for the data collection. The details of data collection procedures and data analysis plan for the study is discussed in this chapter.

3.1 Research Design

The study was carried out using the descriptive survey design and utilized the mixed methods approach of collecting data, which is a combination of both quantitative and qualitative methods of data collection. Specifically, the concurrent triangular mixed method design of research was employed. Cresswell (2008) explained mixed method as an approach in research in which the researcher collects and analyses data, integrates the findings, and draws inferences using both qualitative and quantitative methods in a single study. Cohen, Manion and Morrison (2007) also pointed out the importance of combining qualitative and quantitative research methods when collecting data as a mixed method approach as it results in a more valid and reliable data collection process.

According to Creswell (2012), survey designs are practices in quantitative research in which investigators administer a survey to a sample or to an entire population of people to explain the attitudes, beliefs, behaviors, or characteristics of the population. Onley and Barnes (2008) similarly stipulate that surveys use a set standard of questions to get a broad overview of a group‘s opinions, attitudes, self-reported behaviors, demographic and background information. Surveys are therefore designed

to obtain information, which concerns the current status of phenomenon (Shields and Rangarajan, 2013).

Babbie (2007) categorizes survey into cross-sectional and longitudinal. Whereas cross-sectional surveys, gather information on a particular population at a distinct time, longitudinal surveys on the other hand, collect information over a period of time. Like Babbie (2007), Creswell (2012) argues that despite the numerous applications of surveys recently, there are still only two basic types of research surveys (which are cross sectional and longitudinal). The researcher explained that survey researchers use cross-sectional designs to collect data about current attitudes, opinions, or beliefs and longitudinal designs are used to study individuals over time.

This study used a cross-sectional survey to collect information on the integration of ICT into teaching of mathematics. Creswell (2012) designates that cross-sectional survey design has the benefit of determining current attitudes or practices. It also provides evidence in a short amount of time, such as the time required for administering the survey and collecting the information.

Cross-sectional survey was the preferred design for data collection over others in this particular study due to the fact that many questions were asked and it was possible to reach the entire sample of SHS mathematics teachers within a short period of time.

3.2 Population

The outcome of this work is envisaged to be a representation of what mathematics teachers and their students are experiencing throughout the central region of Ghana as far as the integration of ICT in the teaching and learning of mathematics is concerned. The population was all Senior High School mathematics teachers in the Upper Denkira East Municipal and the Upper Denkyira West District. Most Senior High Schools in the region had been provided with computer laboratories equipped with

computers and even some with internet connectivity to help both teachers and students of such institutions to be able to enhance teaching methodology and their studies through various media, using ICT.

The accessible population for the study was mathematics teachers in the Upper Denkyira East Municipality and the Upper Denkyira West district. The two geographical locations the Upper Denkyira East Municipality and the Upper Denkyira West District have three public Senior High Schools and two private Senior High Schools.

3.3 Sample and Sampling Technique

By simple definition, sampling is the selection of participants of a study to be representative of the population for which the outcome of the work will be generalized. Sampling can be of any nature or form depending on how convenient it will be for the researcher to reach his intended target and also be able to get from the sample what he/she needs to make the work a success. According to McLeod (2014), sampling is the process of selecting a representative group from the population under study and the sample is the group of people who take part in the investigation. This work employed simple random sampling for the collection of data. There was a random sample of 27 teachers in the three public and two private Senior High Schools in the Upper Denkyira East Municipality and Upper Denkyira West District. In all, 38 mathematics teachers were in these schools combined.

3.4 Research Instruments

In survey, literature has it that questionnaire is the best way of getting the best out of your participants (Dobois, 2016; Sincero, 2013). Dobois (2016) defined a questionnaire as an instrument for collecting data, and almost always involves asking

a given subject to respond to a set of written questions. It is also the best way to ensure anonymity of the respondent which prevents the study from being influenced by external factors to skew the findings. Also, since the work was cross-sectional, questionnaire was the best form of instrument to get the right responses from the participants at a time.

Since questionnaire is most of the time effective with close ended items, both close ended and open ended items were utilized and the researcher also included a structured interview to solicit responses from the participants. The interview as well as the open ended questions allowed participants to give detailed explanations to the questions asked and also to be allowed the opportunity to attach reasons to their choices as far as the close ended questions were concerned.

3.5 Questionnaire

Farooq (2013) defines questionnaire as a document which contains a series of questions designed to gather particular information or a research instrument having a sequence of questions with a purpose to getting information from respondents and extracting desired statistical data. The researcher further simplifies the definition as a document consisting of questions along with their answers prepared by a researcher and given to the respondents to complete and return to the researcher for further use. Roopa and Satya (2012) states that questionnaire is a chain of questions that human being (research participants) are requested to answer statistically on a selected topic. They further explained that when well designed and dealt with responsibly, questionnaires come to be a crucial device for making statements approximately precise about companies or people. A questionnaire therefore is a list of questions presented to the target audience of a study to solicit their views on a particular subject.

This study employed the structured questionnaire format. Section A consisted of information with regards to respondents‘ biographical data. Section B consisted of both closed ended and open ended questions, specifically a close ended question and an open ended question on the mathematics teachers ability to use computer based technology for teaching mathematics to begin with and seven (7) close ended five point likert scale tabulated questions which sought to establish the competency of SHS mathematics teachers as far as the integration of ICT in the teaching of mathematics is in the Upper Denkyira East Municipality and Upper Denkyira West District. The motivation behind the mixture is to be clearly able to know the views of the teachers behind their answers to the close ended questions.

Section C, consist of close ended questions. The section consists of six (6) close ended questions about the rate at which mathematics teachers are integrationg ICT in their delivery.

Sections D was rated based on a four-point likert scale, where SA = Strongly Agree, A = Agree, D= Disagree and SD= strongly disagree in a tabular form about the challenges teachers face in their bid to integrate ICT in the teaching and learning of mathematics. Every section of the questionnaire began with specific instructions as to the intent of the items as well as how to respond to items in that section.

3.6 Interview Guide

A structured interview guide consisting of the twelve (12) questions, which are six (6) questions and a follow up question each, was used to solicit responses from the participants as to how often they used the various ICT software packages/ technological instruments in the teaching and learning process and also reasons for the answers provided.

3.7 Validity and Reliability of the Instrument

The extent to which a test can be repeated to produce similar results measures its reliability. For a test to be valid, it has to be reliable. Neil (2004) stated that measurement procedures have the potential for error, so the aim is to minimize it. An observed test score is made up of the true score plus measurement error. The following ways can be used to measure the reliability of a test.

1. Test-retest Reliability
2. Internal Consistency
3. Interrater Reliability

The researcher to ascertain the reliability of the instruments for this work employed the internal consistency method, which is the use of the Cronbach's Alpha. In the researcher‘s publication, Glen (2017) outlined that the Cronbach‘s alpha tests is used to verify if multiple-questioned likert scale surveys are reliable. These questions measure latent variables — hidden or unobservable variables like: a person‘s perception, neurosis or openness by asking questions both open and close ended to solicit a person‘s views on issues. These are very difficult to measure in real life. Cronbach‘s alpha will tell you if the test you have designed is accurately measuring the variable of interest. It is important to know how reliable the questionnaire for a research work is because the more reliable the test or questionnaire are, increases the ability to use the result of the study in similar situations. For example, if the findings of a study reveal that students benefit more from study groups as compared to individual learning in one school by using a particular questionnaire then a similar result is expected in a similar environment if the same questionnaire is used.

Mondal and Mondal (2017) in their publication revealed that the Cronbach‘s alpha can be calculated by the relation $a = \left(\frac{k}{k-1}\right) * (1 - (\frac{\sum s_i^2}{s_t^2}))$, where

Where, k = number of items (question/statement) in questionnaire

s_i = SD of ith item

s_t = SD of sum score.

Using this relation, the researcher found the Cronbach's alpha for the questionnaire on teachers' competency to be 0.7627 and that of the questionnaire on teachers' challenges to ICT integration to be 0.6557 which indicates that the questionnaire were reliable to be used for the study. According to GEBA (2013) a general accepted rule is that Cronbach's alpha of 0.6-0.7 indicates an acceptable level of reliability, and 0.8 or greater a very good level.

The validity of questionnaire is the measure of how the items on the questionnaire are able to measure the intent of the research. Bryman (2008) identified two forms of validity, content validity and face validity. The researcher Bryman (2008) further explained that validity involves stages where data is collected to ascertain the claim that the questionnaire measures the intent of the researcher as far as the subject being investigated is concerned.

For validity, the instrument is pilot tested to be pronounced valid by expects in the field of mathematics education. According to Pasmore, Dobbie, Parchman and Tysinger (2002), Pilot testing helps to identify redundant or poor questions and provide an early indication of the reproducibility of the responses. This also enables the researcher not to pick up questions, or items that may affect any respondent.

According to Neil (2004), many researchers resort to simply selecting whatever they can get their hands on, or they resort to using instruments that have commonly been used in the past, resulting to availability bias which can affect the outcome of a study negatively since such an instrument might not measure what is intended to be

measured by the study. The researcher clearly stipulated that the time spent critically reviewing possible instruments is time well spent.

3.8 Piloting of the instrument

To pilot test is a means of discovering if your survey questionnaire, key informant interview guide or observation form will be able to work in the ―real world" by auditioning it out first on a few people. The motive is to make sure that everyone in your sample not only understands the questions, but understands them in the same way. This way, too, you can see if any question makes respondents feel uncomfortable. You'll also be able to find out how long it takes to complete the survey in real time ―Pilot testing" (2011).

In this study the researcher pilot tested the instruments to be sure that the instruments will measure what the researcher intends to measure. The questionnaire was administered to a different group of people with similar characteristics as the targeted participants for the study (Senior High School mathematics teachers). After pilot testing, the responses from the participants were critically analyzed with the help of other professional in the same field of study to ensure the questionnaire measured the intended purpose for which it was formulated.

3.9 Data Collection Procedure

Permission was sought from the head of department of the mathematics education, University of Education, Winneba. Permission was then sought from the headmasters of the schools where participants of the research teach. After this the head of departments of the various schools where these teachers teach were also consulted to give their consent for the exercise to be carried out. The researcher then met all

teachers who were involved in the study to explain to them the intent of the researcher as to why the questionnaire was administered.

The questionnaire were administered personally by the researcher and the researcher administered and collected the questionnaire at the same time to enhance early collection of responses and also to discourage the possibility of respondents asking their colleagues about their responses for the answering of the questionnaires which could influence their responses to affect the outcome of the study.

For the study to be ethically principled, the researcher sorted for the consent of the HOD of the department of mathematics education, University of Education, Winneba and the HOD‘s of the various schools where the participants were sampled for the study. The participants were also assured that their responses in the answering of the questionnaire will be kept secret and confidential.

3.10 Data Analysis

In the view of the responsible conduct of research (2005), data analysis is the process of systematically applying statistical and/or logical techniques to describe and illustrate, condense and recap, and evaluate data.

The data which were collected after the survey were analyzed using Statistical Package for Social Sciences (SPSS) and Microsoft Office Excel due to their user friendliness and flexibility for analyzing survey data.

The data on the demographic characteristics of the participant were analyzed using Microsoft Office excel. Descriptive statistics was used to analyze the data on the demographic characteristics (age, University attended, educational level, year after completing University) of the participants.

In other to be able to convert the responses of the participants on their competence and extent of ICT integration to quantitative data to be able to use SPSS (CHI

SQUARE) for the analyses, their responses were scored using the equivalent score of Excellent – 10 marks, Very Good – 8 marks, Good – 6 marks, Not Good – 4 marks and can‘t use – 0 for the competence of the mathematics teacher and Everyday – 10 marks, Once a Week – 8 marks, Once Every Two Weeks – 6 marks, Once a Month – 4 marks and Never – 0 for extent of integration of ICT based on their choices on the five point likert scale for competence and the extent of ICT integration respectively.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.0 Overview

This chapter highlights the outcome and interpretation of the investigations into the integration of ICT in the teaching of mathematics at the Senior High School. It touches on the questionnaire return rate, demographic information of respondents, competency of the mathematics teachers, integration of ICT tools as well as the challenges mathematics teachers face in the integration process. The presentation of the results was based on the sequence

1. Demographic information of teachers
2. The competency of the mathematics teacher
3. The relationship between the mathematics teachers' ICT competency and ICT integration
4. The effect of the mathematics teachers' demographic information on ICT integration
5. Challenges to ICT integration at the SHS level
6. The extent to which the mathematics teacher integrates ICT in the teaching process

4.1 Questionnaire Return Rate

The return rate of questionnaire in a survey has to do with the number of participants who completed and submitted their questionnaire to the researcher. According to Willot (2019), a survey response rate of 50% or higher should be considered excellent in most circumstances. Willot (2009) also indicated that a high response rate can be due to other external factors such as high levels of motivation to complete the survey

or a strong relationship between the researcher or research institution and the participants.

In all, 27 questionnaires were distributed to the various head of departments of the selected schools as the sample size for the study was 27. Out of the 27 distributed questionnaire 27 were received which represents a return rate of 100%.

4.2 Demographic Information of Respondents

This section deals with demographical information of the respondents, who are mathematics teachers in the various schools that participated in the survey.

4.2.1Gender distribution of participants

The teachers were made to indicate their gender as part of responses to the questionnaire. The gender distribution is as indicated in the Table 4.1.

Table 4.1: Gender Distribution of Teachers

Gender	Frequency	Percentage
Male	25	92.59
Female	2	7.41
Total	**27**	**100**

The data as represented by Table 4.1 indicates that majority of the participants were male. With as low as 7.41% of the sample representing female participants, this indicates how low female representation is as far as the teaching of mathematics in Senior High Schools is. Kishore (2008), McCarty (2003) and Elis (2003) as mentioned in Iwu and Azoro (2017) indicated that the participation of women in science, mathematics and technology education has been low around the world.

This confirms the assertion that female representation in the sciences as one climbs up the educational ladder decreases. Adetunde and Akensina (2008) indicated that in

higher education in Ghana, female students are mostly under-represented in science, mathematics and technology courses and a mass of the women are in traditional studies like humanities, languages and arts.

Despite calls for gender equality and support for women, the conscious effort by stakeholders to increase female participation in all spheres of life especially in education and particularly science education, the goal of increasing female participation is yet to materialize in the field of science with respect to education, in the authors work. Cacace-ASDO (2009) stated under strategy one: creating a friendly environment for women that 70% of programs has the creating of friendly environment for women as a core goal and none of the programs failed to consider that, the above statistics is an indication of the dominance of the male gender as far as mathematics and science education is concerned in spite of effort to bridge the gap and efforts being lined up to increase female participation.

4.2.2 Age distribution of respondents

The researcher further sought to establish the age distribution of the respondents. This was to establish whether age was affecting the integration of ICT in the teaching of mathematics in any way. The responses are presented in Table 4.2.

Table 4.2: Age Distribution of the Teachers

Age	Frequency	Percentage
20 – 30	10	37.04
31 – 40	15	55.55
41 – 50	2	7.41
51 – 60	0	0.00
Total	**27**	**100**

From Table 4.2, it is obvious that most mathematics teachers fell between the ages of 20 and 40 years representing 92.6 % of the sample. This is positive due to the fact that young teachers tend to want to use technology more than older teachers as indicated by Lakkala & Lehitinen (2001) who pointed out that the youngest group of teachers has increased their self-evaluated ICT use than the oldest group. Obonyo (2013) also elaborated that this is an essential factor behind ICT usage as younger teachers have the hunger for ICT usage compared to older teachers.

The above literature clearly shows that the teacher with respect to their youthful nature should be able to integrate ICT tools in the teaching and learning of mathematics to enhance understanding of concept.

4.2.3 Educational level of teachers

The respondents were asked to indicate their level of education. Figure 4.1 represents their responses.

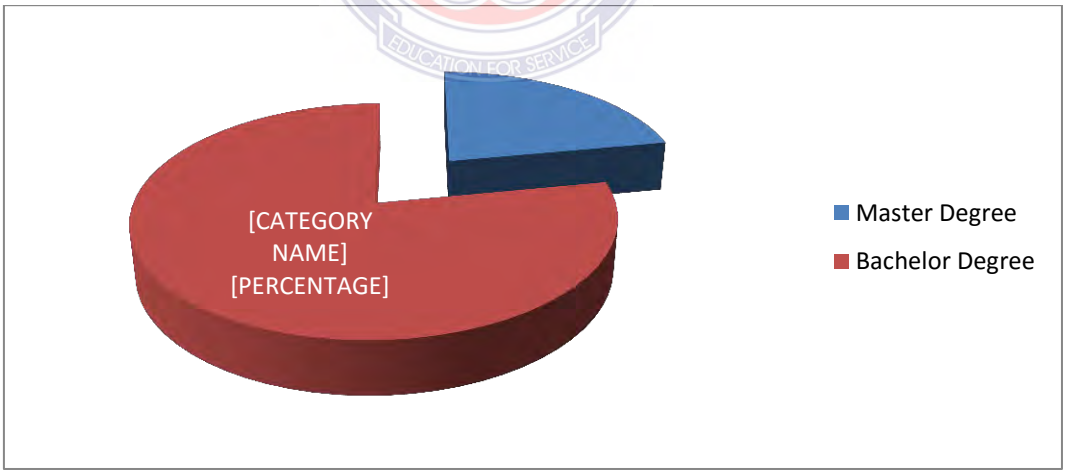

Figure 4.1: The Educational Level of Teachers

Figure 4.1 reveals that all the mathematics teachers are at least first degree holders. The figure indicates that 78% of the respondents have their first degrees whilst the remaining 22% have their second (masters) degrees. This is an indication that all the

teachers qualify to teach at the SHS level with respect to their educational qualifications.

In addition, the number of years since the teachers completed university was sorted. The descriptive statistics of the number of years since the teachers completed university is represented in Table 4.3.

Table 4.3: Teachers' Number of Years after Completing University

No. of Years after University	Frequency	Percentage
1 – 5	12	44.44
6 – 10	9	33.33
11 – 15	6	22.22
16 – 20	0	0.00
21 – 25	0	0.00
Total	**27**	**100**

The relevance of the number of years since the mathematics teacher completed university which might determine whether they were trained on ICT or not at the second circle level of the educational ladder (Senior High School) cannot be over emphasized when it comes to the integration of ICT in the teaching of mathematics at the Senior High School level, the basic educational requirement for teaching in the Senior High School is attaining a University first degree.

From Table 4.3, a total of 12 out of the 27 teachers, which represents 44.44% of the sample of the teachers had obtained university degrees between 1 and 5 years and 9 out of the 27 teachers representing 33.33% had obtained University degrees between 6 to 10 years. This also suggests that 77.77 % of the mathematics teachers, representing a total of 21 teachers graduated within the last 10 years by which time policies on the integration of ICT in tertiary institutions were in full force in the country. This is an indication that all these teachers might have had training on ICT

integration in their various study areas during their university education. The results also show that 6 out of the 27 teachers, representing 22.22% had their university education 11 to15 years ago. This indicates that they might have been teaching mathematics between that period which is positive for the teaching and learning of mathematics as a whole.

The above statistics shows that most of the teachers had their University Education within the last ten years of which all tertiary institutions were obliged to train students on the integration of ICT in their respective professional fields. Therefore, the mathematics teachers must have received enough training to be able to integrate ICT in their lessons. The Ghana ICT for Accelerated Development Policy ICT4AD (2003) recognized that for Ghana as a country to move his industrially weak subsistence agriculture base economy to a more productive information and knowledge economy, she will need to adopt comprehensive ICT integrated led socio-economic policies, strategies and plans.

4.2.4 Study of courses involving ICT

The participants were asked to state whether they offered any course that involved ICT/computer application in mathematics while in the university.

Table 4.4: Frequency and Percentage Distribution of Respondents to the Study of ICT Courses

Response	Frequency	Percentage
Yes	25	92.59%
No	2	7.41%
Total	**27**	**100%**

From Table 4.4, majority (n=25, 92.59%) of the mathematics teachers revealed they had offered courses that involved ICT/computer application in mathematics and very

few of them (n=2, 7.41%) indicated they did not offer any course that involved ICT/computer application in mathematics. This result indicates that most of the mathematics teachers had knowledge in using ICT in mathematics teaching and learning since they had received training on the use of ICT during their University education.

4.3 Research Question 1 What Competencies do Mathematics Teachers' Possess in the Use of Computers?

To answer research question 1, the respondents were made to indicate on a five point likert scale ranging from excellent, very good, good, not good and can't use, to indicate their competence with respect to the various software packages and instruments applicable to the integration of ICT in the teaching and learning of mathematics. Table 4.5 shows the results obtained from the respondents.

Table 4.5: Frequencies and Percentages of Competencies Mathematics Teachers Possess in the Use of the Computer Software package/Instrument.

Software package/instrument	Excellent Freq. (%)	Very good Freq. (%)	Good Freq. (%)	Not good Freq. (%)	Can't use Freq. (%)
Microsoft word	12.0 (44.4%)	7.0 (25.9%)	7.0 (25.9%)	0.0 (0.0%)	1.0 (3.7%)
Microsoft Excel	2.0 (7.4%)	6.0 (22.2%)	15.0 (55.6%)	3.0 (11.1%)	1.0 (3.7%)
Microsoft power point	4.0 (14.8%)	9.0 (33.3%)	11.0 (40.7%)	2.0 (7.4%)	1.0 (3.7%)
Geogebra and Derive 5	1.0 (3.7%)	1.0 (3.7%)	12.0 (44.4%)	5.0 (18.5%)	8.0 (29.6%)
Knowledge of computer Programming (any programming language)	1.0 (3.7%)	8.0 (29.6%)	7.0 (25.9%)	7.0 (25.9%)	4.0 (14.8%)
Scientific Calculator	16.0 (59.3%)	9.0 (33.3%)	2.0 (7.4%)	0.0 (0.0%)	0.0 (0.0%)
Projector	4.0 (14.8%)	11.0 (40.7%)	8.0 (29.6%)	3.0 (11.1%)	1.0 (3.7%)
Total	40	51	62	20	16

The results from Table 4.5 indicate that most of the teachers had mastery of the use of Microsoft word, with 26 (96.3%) indicating their mastery of the use of Microsoft word ranges from being excellent with Microsoft word to being good with it whilst 1.0 (3.7%) teachers indicated that he/she cannot use Microsoft word.

Also, 15 (55.6%) of the teachers indicated that they are good with the use of Microsoft excel with 1.0 (3.7%) indicating to not being able to use Microsoft excel which shows that most teachers could use Microsoft excel.

It can also be seen that, 9.0 (33.3%) teachers revealed they are very good with Microsoft PowerPoint and 11.0 (40.7%) also revealed they are good with Microsoft PowerPoint. However 1.0 (3.7%) indicated they were not able to use Microsoft PowerPoint.

With the teachers ability to use Derive 5 and Geogebra, 1.0 (3.5%) revealed to be excellent with the software packages and the same number indicated to be very good with it. Also 8 (29.6%) of the teachers indicated that they cannot use Derive 5 and Geograbra which indicates a sizable number of the teachers did not have the expertise to use the software packages.

The teachers‘ ability to use programming languages is extra incentive of the teachers‘ ability to integrate ICT in his lessons as it enables him to be creative with his technological knowhow to create a better environment for teaching and learning. Fifteen (55.6%) of the teachers revealed their ability to use any programming language lied between being very good and good whilst 11 (40.7%) of the teachers indicated not being good and can‘t use any programming language. This is an indication that the teachers‘ knowledge in programming was not good enough.

Again it could be realized that all the teachers 27 (100%) fell between being excellent to being good with the scientific calculator with 16 (59.3%) indicating to being

excellent with scientific calculators. This showed that the teachers‘ competency with the use of the scientific calculator is very high.

On the use of a projectors, it could be seen that 11 (40.7%) and 8 (29.6%) of the teachers indicated to being very good and good with it respectively whilst 1(3.7%) of the teachers indicated not being able to use it.

The statistics from their responses indicates that 153 (81%) of the responses fell between being excellent with the software packages or ICT instrument to being good with it. This is an indication that 81% of the mathematics teachers had high competencies in the use of these software packages/ICT instrument whilst 36 (19%) of the teachers had their responses between not good with software packages/ICT instrument and not able to use it, which also indicated that only 19% of the teachers were not good enough to integrate ICT in the teaching and learning of mathematics.

Moreover, all the teachers were competent in the use of the Scientific Calculator and also only one of the teachers‘ indicated not being able to use word processing. This clearly shows that the mathematics teachers are competent enough with respect to these software packages/ICT instruments to be able to integrate ICT in the teaching process.

4.4 Research Question 2: Is there a relationship between the mathematics teachers’ ICT competency and ICT integration

To determine whether there is a relationship between the mathematics teacher‘s ICT competency and ICT integration in the teaching and learning of mathematics in the Senior High School in Ghana, the teachers‘ responses from the questionnaire on competency and ICT integration were scored by assigning values to the options on the questionnaire.

The marks allocation for the options for the questionnaire on ICT competency were excellent – 10 marks, Very good – 8 marks, Good – 6 marks, Not good – 4 marks and Can‘t use – 0 mark and the marks for the options for the questionnaire on ICT integration were Everyday – 10 marks, Once a week – 8 marks, Once every two weeks – 6 marks, Once a month – 4 marks, Never – 0 mark. Table 4.05 shows the scores of the participants from their responses on the ICT competence and ICT integration questionnaire.

Table 4.6: Scores of participants from answers of their answered questionnaire

	Scores	
Participant	**Competency**	**Integration**
1	56	42
2	52	24
3	48	26
4	58	20
5	48	6
6	34	16
7	46	22
8	64	54
9	28	34
10	26	8
11	52	14
12	68	20
13	42	36
14	50	4
15	54	10
16	52	40
17	42	8
18	24	20
19	46	8
20	36	8
21	48	16
22	50	32
23	60	4
24	40	0
25	52	18
26	44	14
27	40	10

The scores from the questionnaire on ICT competency were then categorized under being low (less or equal to 22 marks), medium (greater than 22 marks but less than 45 marks), high (greater or equal than 45 marks) and that of the questionnaire on ICT integration were categorized under being low (less or equal to 20 marks), medium (greater than 20 but less than 40 marks) and high (greater or equal to 40 marks). Tables 4.7 and 4.8 shows the Cross Tabulation and Chi-Square Tests of the results from the categorization of the scores of the mathematics teachers ICT competency and ICT integration.

Table 4.7: Cross Tabulation of the Mathematics Teacher's ICT Competency against ICT Integration

ICT competency * ICT Integration Cross tabulation					
		Ictintegration			Total
		Low	Medium	High	
ICT competency	Medium	8	3	0	11
	High	10	3	3	16
Total		18	6	3	27

Table 4.8: Chi Square Test of the Mathematics Teachers' ICT Competency and the Mathematics Teachers' ICT Integration

	Chi-Square Tests		
	Value	Df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.378[a]	2	.305
Likelihood Ratio	3.450	2	.178
Linear-by-Linear Association	1.124	1	.289
N of Valid Cases	27		

From Table 4.8, it can be realized that the p-value is 0.305 which is greater than the significant value of 0.05. This implies that there is no relationship between the mathematics teachers' ICT competency and ICT integration.

It can therefore according to the statistics be concluded that although the mathematics teachers can be competent which should be an enzyme for the integration of ICT as Wei, Piaw, Kannan, and Moulod (2016) indicated in their study a statistically significant slightly positive strong correlation between teachers ICT competence, acceptance and use, other factors can hinder this process which makes the mathematics teachers ICT integration in the teaching and learning process independent of how competent he/she is.

4.5 Research Question 3: How Do Mathematics Teachers' Demographic Characteristics Influence their Integration of ICT in the Teaching and Learning of Mathematics in the Senior High School?

Research question 3 was raised to investigate whether demographic characteristics (age, gender, educational level) of the mathematics teachers affect their ICT integration in the teaching and learning of mathematics at the Senior High School. To determine whether the demographic characteristics of the mathematics teachers affect their ICT integration in the teaching and learning of mathematics in the Senior High School, the teachers' responses from the questionnaire on the teacher's integration of ICT was analyzed with respect to the teachers' age, gender, educational level and university attended to ascertain if these characteristics affects the mathematics teachers' integration of ICT in his/her delivery.

The teachers' responses were analyzed with respect to the demographic characteristics to find out whether their demographic characteristics influenced their ICT integration in any way based on the questions below as in the questionnaire:

1. How often do you use the internet during preparation for a lesson?
2. How often do you use Microsoft Office Word during preparation for a lesson?
3. How often do you have students use computer technology to find information?

4. How often do you make students use computer to process and analyze data?
5. How often do you use Microsoft power point and other mathematical softwares such as GeoGebra during delivery?
6. How often do you use computer and projector for the presentation of concept?

The options they had to choose from were

Every day [ ] Once a week [ ] Once every two weeks [ ] Once a month [ ] Never [ ]

Tables 4.9, 4.10, 4.11 and 4.12 respectively represent the teacher's responses with respect to their gender, age, educational level and University attended.

Table 4.9: Result of the Teachers Responses to the Integration of ICT with Respect to their Gender

Gender	Question No. / Question No.	Everyday F (%)	Once A Week F (%)	Once Every Two Weeks F (%)	Once A Month F (%)	Never F (%)
	1	8 (5.3)	8 (5.3)	2 (1.3)	5 (3.3)	2 (1.3)
Male	2	5 (3.3)	2 (1.3)	2 (1.3)	6 (4.0)	10 (6.7)
	3	2 (1.3)	5 (3.3)	0 (0.0)	5 (3.3)	13 (8.7)
	4	1 (0.7)	2 (1.3)	0 (0.0)	6 (4.0)	16 (10.7)
	5	0 (0.0)	1 (0.7)	0 (0.0)	3 (2.0)	21 (14.0)
	6	1 (0.7)	2 (1.3)	0 (0.0)	4 (2.7)	18 (12.0)
Total (%)		**17 (11.3%)**	**20 (13.3%)**	**4 (2.7%)**	**29 (19.3%)**	**80 (53.3%)**
	1	0 (0.0)	1 (8.3)	0 (0.0)	0 (8.3)	0 (0.0)
Female	2	0 (0.0)	2 (16.7)	0 (0.0)	1 (8.3)	0 (0.0)
	3	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (8.3)
	4	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (16.7)
	5	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (16.7)
	6	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (16.7)
Total (%)		**0 (0%)**	**3 (25.0%)**	**0 (0%)**	**2 (16.7%)**	**7 (58.3%)**

From Table 4.9 it can be deduced that 80 responses representing 53.3% from the male teachers indicted that they never used the ICT tools for delivery of their lessons and 29 (19.3%) revealing to using these ICT tools once in a month. It can also be seen that 4 (2.7%) of the responses indicated to using these ICT tools once every two weeks.

Seven responses of the female mathematics teachers representing 58.3% indicated that they never utilized ICT tools in their lessons whilst 16.7% indicated to using these tools once in a month in their lesson delivery. It can also be seen that none of the responses of the female teachers indicated to using these ICT tools every day and every two weeks in both cases. These responses show that regardless of the gender of the mathematics teachers, they are not integrating ICT in their delivery enough as in both cases more than 50% of their responses indicate they are not integrating ICT tools in their delivery.

Table 4.10: Result of the Teachers Responses to the Integration of ICT with Respect To their Age

Age	Question No.	Everyday F (%)	Once a week F (%)	Once every two weeks F (%)	Once a month F (%)	Never F (%)
20-30	1.	5 (8.3)	2 (3.3)	0 (0.0)	2 (3.3)	1 (1.7)
	2.	3 (5.0)	1 (1.7)	0 (0.0)	2 (3.3)	4 (6.7)
	3.	1 (1.7)	1 (1.7)	0 (0.0)	2 (3.3)	6 (10.0)
	4.	1 (1.7)	1 (1.7)	0 (0.0)	1 (1.7)	7 (11.7)
	5.	0 (0.0)	1 (1.7)	0 (0.0)	1 (1.7)	8 (13.3)
	6.	0 (0.0)	1 (1.7)	0 (0.0)	1 (1.7)	8 (13.3)
Total (%)		**10 (16.7%)**	**7 (11.7%)**	**0**	**9 (15.0%)**	**34 (56.7%)**
31-40	1.	3 (3.3)	8 (8.9)	1 (1.1)	3 (3.3)	0 (0.0)
	2.	2 (2.2)	2 (2.2)	1 (1.1)	6 (6.7)	4 (4.4)
	3.	1 (1.1)	3 (3.3)	0 (0.0)	2 (2.2)	9 (10.0)
	4.	0 (0.0)	1 (1.1)	0 (2.2)	3 (3.3)	9 (10.0)
	5.	0 (0.0)	0 (0.0)	0 (0.0)	2 (2.2)	13(14.4)
	6.	1 (1.1)	1 (1.1)	0 (0.0)	2 (2.2)	11 (12.2)
Total (%)		**7 (7.8%)**	**15 (16.7%)**	**4 (4.4%)**	**18 (20.0%)**	**46 (51.1%)**
41-50	1.	0 (0.0)	1 (8.3)	0 (0.0)	1 (8.3)	0 (0.0)
	2.	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (16.7)
	3.	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	2 (16.7)
	4.	0 (0.0)	0 (0.0)	0 (0.0)	1 (8.3)	1 (8.3)
	5.	0 (0.0)	0 (0.0)	0 (0.0)	1 (8.3)	1 (8.3)
	6.	0 (0.0)	0 (0.0)	0 (0.0)	1 (8.3)	1 (8.3)
Total (%)		**0**	**1 (8.3%)**	**0**	**4 (33.3%)**	**7 (58.3%)**

From Table 4.10, it can be deduced that, the mathematics teachers' age has no actual influence on whether they are integrating ICT or not. From Table 4.09, the teachers between the ages of 20 – 30 had 34 (56.7%) and 9 (15.0%) of their responses saying they are never using these ICT tools and using it once in a month respectively. Also, none of them from their responses used ICT tools once every two weeks.

The teachers between the ages of 41-50 also had 46 (51.1%) and 18 (20.0%) of their responses indicating that they never used ICT tools and used these ICT tools once a month respectively. None of them used ICT tools once every two weeks according to their responses.

Seven of the responses of the teachers between 41-50 years representing 58.3% indicated to never using the ICT tools in their delivery with none of them using ICT tools once a week and every day.

This shows that regardless of the age of the mathematics teachers, the teachers are still not integrating ICT in their lesson delivery in the classroom as such shows that the teachers' ICT integration does not depend on his/her age.

Table 4.11: Result of the Teachers Responses to the Integration of ICT with Respect to their Education Level

Educational Level	Question No.	Everyday F (%)	Once a week F (%)	Once every two weeks F (%)	Once a month F (%)	Never F (%)
Masters Degree	1.	2 (8.3)	2 (8.3)	0 (0.0)	0 (0.0)	0 (0.0)
	2.	1 (4.2)	0 (0.0)	0 (0.0)	1 (4.2)	2 (8.3)
	3.	1 (4.2)	0 (0.0)	0 (0.0)	0 (0.0)	3 (12.5)
	4.	1 (4.2)	0 (0.0)	0 (0.0)	0 (0.0)	3 (12.5)
	5.	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	4 (16.7)
	6.	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	4 (16.7)
Total (%)		**5 (20.8%)**	**2 (8.3%)**	**0**	**1 (4.2%)**	**16 (66.7%)**

First Degree	1.	7 (5.1)	9 (6.5)	2 (1.4)	4 (2.9)	1 (0.7)
	2.	4 (2.9)	3 (2.2)	2 (1.4)	8 (5.8)	7 (4.3)
	3.	1 (0.7)	4 (2.9)	0 (0.0)	5 (3.6)	13 (9.4)
	4.	0 (0.0)	3 (2.2)	0 (0.0)	6 (4.3)	14 (10.1)
	5.	0 (0.0)	0 (0.0)	0 (0.0)	3 (2.2)	20 (14.5)
	6.	0 (0.0)	2 (1.4)	0 (0.0)	4 (2.9)	17 (51.4)
Total (%)		**12 (8.7%)**	**21 (15.2%)**	**4 (2.9%)**	**30 (21.7%)**	**71 (51.4%)**

From Table 4.11, it can be realized that as indicated earlier, all the mathematics teachers have attained at least their first degree which is an indication that all the teachers are qualified and are capable of integrating ICT in their classroom delivery. It can also be realized that 16 (66.7%) of the responses of the teachers with master's degree indicated that they were not using these ICT tools in their classroom delivery with 20.8% of their responses saying they use these ICT tools on daily basis. Also none of them uses ICT tools once every two weeks according to their responses.

Also, 71 (51.4%) of the responses from the teachers with first degree indicated that they never use these ICT tools with 30 (21.7%) of their responses indicating that they use these ICT tools once every month. Regardless of the fact that 20.8% of the responses of the teachers with masters degrees and 21.7% of the teachers with first degrees indicating to using ICT tools in their delivery on daily basis and on monthly basis respectively, more than 50% of the responses from both groups indicated that the teachers were never using these ICT tools for their lessons. Again, none of the teachers and 4 (2.9%) respectively from the teachers with master's degree and first degree indicated to using the ICT tools once every two weeks.

Clearly, the above statistics is an indication that the mathematics teacher's ICT integration is not dependent on his/her educational qualification.

Table 4.12: Result of the Teachers Responses to the Integration of ICT with Respect to Universities Attended

University completed	Question No.	Everyday F (%)	Once a Week F (%)	Once Every two weeks F (%)	Once a month F (%)	Never F (%)
University of Cape Coast	1	4 (7.4)	3 (5.6)	0 (0.0)	1 (1.9)	1 (1.9)
	2	0 (0.0)	3 (5.6)	0 (0.0)	4 (7.4)	2 (3.7)
	3	1 (1.9)	0 (0.0)	0 (0.0)	2 (3.7)	6 (11.1)
	4	0 (0.0)	1 (1.9)	0 (0.0)	3 (5.6)	5 (9.3)
	5	0 (0.0)	0 (0.0)	1 (1.9)	1 (1.9)	7 (13.0)
	6	0 (0.0)	0 (0.0)	0 (0.0)	3 (5.6)	6 (11.1)
Total (%)		**5 (9.3%)**	**7 (13.0%)**	**1 (1.9%)**	**14 (25.9%)**	**27 (50.0%)**
University of Education, Winneba	1	2 (3.3)	3 (5.0)	1 (1.7)	4 (6.7)	0 (0.0)
	2	1 (1.7)	0 (0.0)	2 (3.3)	2 (3.3)	5 (8.3)
	3	0 (0.0)	2 (3.3)	0 (0.0)	1 (1.7)	7 (11.7)
	4	0 (0.0)	3 (5.0)	0 (0.0)	0 (0.0)	7 (11.7)
	5	0 (0.0)	0 (0.0)	0 (0.0)	2 (3.3)	8 (13.3)
	6	0 (0.0)	1 (1.7)	0 (0.0)	1 (1.7)	8 (13.3)
Total (%)		**3 (5.0%)**	**9 (15.0%)**	**3 (5.0%)**	**10 (16.7%)**	**35 (58.3%)**
University of Development Studies	1	1 (4.2)	2 (8.3)	0 (0.0)	1 (4.2)	0 (0.0)
	2	2 (8.3)	1 (4.2)	0 (0.0)	0 (0.0)	1 (4.2)
	3	0 (0.0)	1 (4.2)	0 (0.0)	1 (4.2)	2 (8.3)
	4	0 (0.0)	0 (0.0)	0 (0.0)	1 (4.2)	3 (12.5)
	5	0 (0.0)	0 (0.0)	0 (0.0)	1 (4.2)	3 (12.5)
	6	0 (0.0)	0 (0.0)	0 (0.0)	1 (4.2)	3 (12.5)
Total (%)		**3 (12.5%)**	**4 (16.7%)**	**0**	**5 (20.8%)**	**12 (50%)**
Others						
	1	3 (12.5)	2 (8.3)	0 (0.0)	0 (0.0)	0 (0.0)
	2	1 (4.2)	0 (0.0)	0 (0.0)	1 (4.2)	2 (8.3)
	3	1 (4.2)	1 (4.2)	0 (0.0)	0 (0.0)	2 (8.3)
	4	1 (4.2)	0 (0.0)	0 (0.0)	1 (4.2)	2 (8.3)
	5	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	4 (16.7)
	6	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	3 (12.5)
Total (%)		**6 (25.0%)**	**3 (12.5%)**	**0**	**2 (8.3%)**	**13 (54.2%)**

From Table 4.12, it can be realized that within all the groups at least 50% of the responses indicate that the teachers were not involving the ICT tools in the classroom. The teachers who attended University of Cape Coast (UCC) had 27 (50.0%) and 14 (25.9%) indicating to never using ICT tools and using ICT tools once

a month respectively from their responses. One of the teachers form their responses indicated to using ICT tools once every two weeks.

With the teachers who attended University of Education, Winneba, 35 (58.3%) and 10 (16.7%) revealed to never using ICT tools and using ICT tools once in a month respectively while 3 (5.0%) indicated to using ICT tools once every two weeks.

Form the teachers who attended University of Development Studies, 12 (50%) and 5 (20.8%) revealed to never using ICT tools and using ICT tools once in a month respectively while none of them indicated to using ICT tools once every two weeks.

The responses from the teachers who attended other Universities apart from the three mentioned above revealed that 13 (54.2%) and 2 (8.3%) were never using ICT tools and using ICT tools once in a month respectively while none of them indicated to using ICT tools once every two weeks as well. This shows that the University attended by the teachers has no influence on whether they integrate ICT tools in their delivery or not.

In conclusion, the above statistics clearly shows that these demographic characteristics (age, gender, educational level and University attended) have no influence on the mathematics teachers‘ integration of ICT in the teaching and learning of mathematics at the Senior High School level.

4.7 Research Question 4: What Challenges Do Mathematics Teachers Face in an Effort to Integrate ICT in the Teaching and Learning of Mathematics?

The fourth research question was raised to assess what the mathematics teacher‘s difficulties are as far as the integration of ICT is. To know their challenges with respect to the integration of ICT the teachers were made to respond to a five-point Likert scale questionnaire. The responses are as shown in Table 4.13.

Table 4.13: Teachers Challenges to ICT Integration

Challenge to integration of ICT	Strongly Agree Freq. (%)	Agree Freq. (%)	Disagree Freq. (%)	Strongly Disagree Freq. (%)
The time allocated for mathematics lessons are not enough for ICT integration.	2.0 (7.4%)	10.0 (37%)	12.0 (44.4%)	3.0 (11.1)
Teachers are not given enough motivation to integrate ICT in the teaching of mathematics	7.0 (25.9%)	18.0 (66.7%)	1.0 (3.7%)	1.0 (3.7%)
Colleges of education and Universities do not empower mathematics teacher with enough skills to integrate ICT	7.0 (25.9%)	10.0 (37.0%)	8.0 (29.6%)	2.0 (7.4%)
There are not enough ICT infrastructure for the teaching and learning of mathematics	14.0 (51.9%)	13.0 (48.1%)	0 (0.0%)	0 (0.0%)
There is no technical support for mathematics teachers to integrate ICT	9.0 (33.3%)	15.0 (55.6%)	3.0 (11.1%)	0 (0.0%)
Mathematics teachers lack support from administrators to integrate ICT in mathematics.	7.0 (25.9%)	15.0 (55.6%)	4.0 (14.8%)	1.0 (3.7%)
Total	**46**	**81**	**28**	**7**

From Table 4.13, most of the teachers agree teachers are not given enough motivation to integrate ICT in the teaching of mathematics (n = 18, 66.7 %) and 7(25.9%) strongly agree to that. One of the teachers each agrees and disagree with this assertion.

Also, 10 (37.0%) agree to the fact that colleges of education and Universities do not empower mathematics teachers with enough skills to integrate ICT and 7 (25.9%) strongly agree to this assertion whilst 2 (7.4%) of the teachers strongly disagree with this. In addition to that many of the teachers strongly agree that there is not enough ICT infrastructure for the teaching and learning of mathematics, 14 (51.9%) and 13.0 (48.1%) agree to this with none of them disagreeing to it.

Nine (9) of the teachers representing 33.3% agree to the fact that there is no technical support for mathematics teachers to integrate ICT whilst 15 (55.6%) agree to this. However, none of the teachers disagree to this claim. On the premise that mathematics teachers lack support from administrators to integrate ICT, 15 (55.6%) agree to it and 7 (25.9%) strongly agree to that. Only one (1) of the teachers disagreed to this statement.

It can be recognized from the above statistics that all these factors as shown in Table 4.13 are major factors that hinders the teachers‘ ability to integrate ICT in his lessons. Although time allocation for mathematics lessons and Colleges of Education and Universities not empowering teachers with enough skills were seen as not being challenges by a substantial number of teachers, with 55.5% and 37% disagreeing respectively with the above points as challenges, 44.5% and 62.9% agree with the fact that these factors are hindrances and as such must be considered as challenges to the mathematics teacher in his bid to integrate ICT in his lessons. With 46 and 81 responses representing 78.4% of the responses strongly agreeing and agreeing that these factors are challenges, it is important that these factors are looked at to ensure the mathematics teacher is able to integrate ICT in his/her lessons.

4.8 Research Question 5: To What Extent Do Mathematics Teachers Integrate ICT in the Teaching and Learning of Mathematics?

To ascertain the extent to which the mathematics teacher integrates ICT in the teaching and learning of mathematics, the mathematics teachers answered a five point Likert scale questionnaire on how often they used various ICT integration activities in the teaching process ranging from every day, once a week, once a month and never using ICT tools as well as giving reasons as to why they involve these activities or not

in the teaching and learning process through interview conducted for five of the teachers. The results from the questionnaire are as shown in Table 4.14.

Table 4.14: The Extent to which Mathematics Teachers Integrate ICT

ICT Integration Activity	Everyday Freq. (%)	Once A week Freq. (%)	Once every two weeks Freq. (%)	Once A month Freq. (%)	Never Freq. (%)
How often do you use the internet during preparation	8 (29.6%)	10 (37.0%)	2 (7.4%)	5 (18.5%)	2 (7.4%)
how often do you use Microsoft office word during preparation for a lesson	5 (18.5%)	3 (11.1%)	2 (7.4%)	7 (25.9%)	10 (37.0%)
how often do you have students use computer technology to find information	2 (7.4%)	5 (18.5%)	0 (0%)	5 (18.5%)	15 (55.6%)
how often do you make students use computer to process and analyze data	1 (3.7%)	2 (7.4%)	0 (0%)	6 (22.2%)	18 (66.7%)
how often do you use Microsoft power point and other mathematical softwares such Geogebra during delivery	0 (0%)	1 (3.7%)	0 (0%)	3 (11.1%)	23 (85.2%)
how often do you use computer and projector for the presentation of concept	1 (3.7%)	2 (7.4%)	0 (0%)	5 (18.5%)	19 (70.4%)
Total	**17**	**22**	**4**	**31**	**62**

From Table 4.14, it can be observed that 8 (29.6%) and 10 (37.0%) indicated they used the internet when preparing for their lessons every day and once a week respectively. One (1) out of the 27 respondent indicated that he never use the internet to prepare for his lessons. This shows that the teachers use of technology when preparing for lessons is on the high.

On the use of Microsoft word for preparation before lessons, 7 (25.9%) and 10 (37.0%) revealed they use Microsoft word once a month and never using Microsoft word respectively. 2 (7.4%) revealed to using Microsoft word once every two weeks. This is an indication that the teachers use of word for preparation is on the low side.

Again, the teachers‘ response with respect to how often they use computer technology to find information reveal that 5 (18.5%) and 15 (55.6%) revealed that they use ICT for such a purpose once a month and never using it respectively. None of the teachers indicated to going through this activity with his/her students once every two weeks.

The teachers also revealed that 6 (22.2%) and 18 (66.7%) of them make their students use computer to process and analyze data once a month and never allowing their students do that respectively. One of the teachers indicated to going through this activity with his/her students on daily basis.

Also, 23 (85.2%) indicated that they never use Microsoft power point and other mathematical software‘s such GeoGebra during delivery with none of them using it on daily basis. Furthermore, 19 (70.4%) indicated to never use computers and projectors in their lesson deliveries whilst 1 (3.7%) indicated to be using computer and projector on a daily basis.

From the teachers‘ responses as shown in Table 4.11, it can be deduced that 62 (45.6%) of the responses showed that they never use ICT tools in the teaching and learning process, 31 (22.8%) responses indicated they used ICT once a month and as low as 17 (12.5%) of the responses indicated to use ICT on daily basis. Even though 18 (72.0%) revealed to use the internet for preparation daily and once a week between them, the whole analysis shows that although the teachers might be using ICT (the internet) for preparations, the actual integration in the classroom is very minimal. This proves that the mathematics teachers are not integrating ICT enough in their lessons although they have the training and skills to be able to do so.

The researcher conducted a structured interview for five (5) teachers. The interviewees were selected randomly from the sample. The interview was meant to solicit the teachers‘ views on the reasons why they gave the responses as shown in

Table 4.14. Data collected from the interview supported the finding as responses from the interviewees indicated that the teachers are not integrating ICT in the classroom as analyses of data from Table 4.12 from the questionnaire stipulated. The responses of teachers during the interviews were as shown below:

From the interview, the responses of the teachers showed that most of the teachers are not integrating ICT as the curriculum demands and gave reasons for that. The most predominant of the reasons given is lack of ICT infrastructure in their school. One important reason which was also mentioned by the teachers is the limited time allocation for mathematics lessons which make it difficult to integrate technology in the mathematics classroom.

Question 1: How often do you use the internet during preparation for a lesson?

Participant	***Responses***	***Reason for response***
Teacher A:	*once a week:*	*In order to have enough time to make adequate research*
Teacher B:	*once a month:*	*I don't have enough time and also money to purchase data to be doing that on regular basis*
Teacher C:	*Every day:*	*it opens doorways to a wealth of information, knowledge and educational resources, increasing the opportunity for learning beyond the classroom*
Teacher D:	*Every day:*	*helps to get different methodologies for teaching a concept*
Teacher E:	*Once a week:*	*I use the internet for preparation of my weekly lesson plant*

The interviewees responses to the first question shows that the teachers frequently use the internet for preparation and see the use of internet for preparation to be crucial to getting enough information for preparation.

Question 2: How often do you use Microsoft Office Word during preparation for a lesson?

Teacher A:	*once every two weeks:*	*Since I will be busy with classroom work during the week days, I use word to prepare my lesson plan during the weekend every two week*
Teacher B:	*Never:*	*Typing of the lessons notes is time consuming*
Teacher C:	*Never:*	*I do not have a personal computer*
Teacher D:	*Every day:*	*Word makes lesson preparation easy*
Teacher E:	*Never:*	*Computers are not readily available to me*

From the above responses to question 2, two of the interviewees see the use of word to be time consuming and two of them gave availability as reason for not using word for preparation. One of the interviewees indicated to using it every day for making preparation easier.

Question 3: How often do you have your students use computer technology to find information?

Teacher A:	*once a week:*	*they cannot have access to computers on daily basis*
Teacher B:	*Never:*	*the students don't have access to computers not to talk of internet*
Teacher C:	*Never:*	*Students don't have access to technological devices such as phones and laptops*
Teacher D:	*Every day:*	*it helps students to get more information and methods on a concept*
Teacher E:	*Never:*	*Computers are not readily available to me*

On question 3, four (4) out of the five (5) interviewees revealed not to going through the said activity because of non-availability of computers to both students and teachers.

Question 4: How often do you have your students use computer to process and analyze data?

Teacher A: once a month: there are inadequate computers in the schools and also limited time for lessons does not allow that

Teacher B: Never: The students don't have access to computers

Teacher C: Never: lack of computers in the school and also not enough time allocation for lessons

Teacher D: Every day: makes teaching easy

Teacher E: Never: the schools ICT center is not equipped for students' usage

The responses from the interviewees on question 4 have four of the teachers citing non-availability of computers as the main reason why they are not able to take their students through the said activity in their lessons.

Question 5: How often do you use Microsoft PowerPoint and other mathematical software such as GeoGebra during delivery?

Teacher A: Never: I use it when there is the need is but can't recall a specific time interval, I have been doing that

Teacher B: Never: they are not available in my school

Teacher C: Never: I don't have the skill and knowledge to use mathematical software such as GeoGebra

Teacher D: Never: Projectors are not available for presentation

Teacher E, Never: There no projectors in my schools

With respect to question 5, three (3) of the teachers again cited non-availability as the reason why they are not able to go through the ICT integration activity with one of them indication lack of the requisite skills as the reason for not going through the above activity

Question 6: How often do you use computer and projector for the presentation of concept?

Teacher A: Once a week: I only use it when I have a special lesson with my students and when I have a special program.

Teacher B: Never: Projectors are not always available in my school

Teacher C: Never: The projector in the school is mostly not available

Teacher D: Never: Projectors are not available

Teacher E: Never: There no projectors in my schools

The responses to question 6 show that non-availability of ICT tools is the main reason why they do not use the ICT integration activity for lesson delivery. Four (4) out of the five (5) interviewees reveal that they do not have projectors in their school for the activity.

The responses from the interviewees to the 6 questions point mostly to the lack of ICT tools in their schools as the main reason why they are not able to integrate ICT tools in the teaching and learning of mathematics. Out of the thirty (30) responses, 17 (56.7%) revealed that non-availability of ICT tools in their schools is the reason why they are not able to undertake the mentioned ICT integrating activity they were asked about. With the responses given for question 1, it reveals that as was ascertained form the teachers responses form the questions form Table 4.11, although the teachers are using ICT tools for preparations (the internet), the actual integration of ICT in the classroom is not being done as expected.

4.8 Findings

The demographic information reveals that there are only two female teachers among the respondents. Two (2) female teachers out of twenty seven (27) is a clear indication of the low representation of the female gender in Science and Mathematics and the

need to motivate women to opt for Science and Mathematics related courses especially at the tertiary education level as many tend to opt for courses in humanities. It was also realized that 25 out of the 27 teachers, that is 92.6% of the teachers have their ages between 20 and 40 years and as Obonyo (2013) indicated, this is an essential factor behind ICT use.

From the findings of research question 1 which was meant to examine the mathematics teacher‘s competency of the use of ICT tools, it was realized that most of the teachers had enough knowledge of the basic ICT tools needed to integrate ICT in the classroom. The statistics from their responses indicated that 40 responses were for being excellent in the various ICT software/instrument, 51 for being very good and 62 for being good in the various ICT softwares/instruments.

Question 2 was set up to find out whether the ICT competency of the mathematics teacher has any bearing on his ability to integrate ICT in the delivery of lessons. The findings revealed that the competency of the mathematics teachers has no effect on the integration of ICT in the teaching of mathematics.

Question 3 was also set up to find out whether demographic characteristics of the mathematics teacher have any bearing on his ability to integrate ICT in the delivery of lessons. The findings revealed that demographic characteristics of the mathematics teacher have no effect on the integration of ICT in the teaching of mathematics.

Answering research question 4 which was set up to investigate the challenges mathematics teachers face in the integration of ICT in the Senior high School, it was recognized that teachers not being given enough motivation, not enough ICT infrastructure for teaching and learning of mathematics, no technical support for mathematics teachers to integrate ICT and lack of support from administrators are all major challenges to ICT integration in the Senior High School. Although not enough

time allocation for mathematics lessons and Colleges of Education and Universities not empowering teachers with enough skills were also seen as challenges by some of the teachers, with only 37% and 55.5% disagreeing respectively with the above points as challenges, it indicates that they must be considered challenges to the mathematics teacher in his bid to integrate ICT in his lessons.

In answering question 5 of this work which seeks to find out the extent to which the mathematics teacher is integrating ICT in teaching and learning of mathematics at the Senior High School level, it was realized that, the teachers are mostly using the internet and Microsoft office word for preparations before lessons but the teachers are not integrating ICT enough in the delivery of mathematics lessons.

4.9 Discussion of Findings

Yazilitas, Svensson, De Vries and Saharso (2013) from their study cited Eurostat (2010), revealing that currently, about 56% of all students in the European Union are women, and this figure is still rising yet this increase in female student participation does not apply to all academic fields, the researchers further stressed that in mathematics, science, and technology (MST) where women have always been underrepresented, their participation rate has actually decreased over the last years, from 41% at the end of the 1990s, to 38% in 2010. From the authors findings Acheampong (2013) also concluded that the participation of the male gender far outweighs that of the female gender in Engineering as male representation forms 90% of total enrolment whereas female participation stood below 10%.

Bridging the wide gap between male and female with respect to the representation of the genders when it comes to the study of Science and Mathematics courses especially at the tertiary level is yet to materializes despite all stakeholders and governments year after year including the international communities efforts to see this come to

fruition. In the authors work Akinsowon and Osisanwo (2014) stated that it has been noted by observation and different surveys that throughout the continent, there is a higher record of boys who opt for scientific and technological subjects and the performances of the boys are significantly higher than that of the girls in Sciences, Technology, Engineering and Mathematics (STEM), The above representation is an indication of the dominance of the male gender as far as mathematics and science education is concerned in spite of effort to bridge the gap.

Asare-Danso (2017) stated that in 1987, science, Technology, Engineering and Mathematics (STME) clinics for girls were opened to encourage girls to pursue science related courses in tertiary institutions. Though governments both old and new has made conscious efforts to promote girl child education with enfaces on science education, Forgasz (2006) contented that female (Girls) do not pursue higher studies and/or careers in mathematics related areas.

The teachers ICT integration as far as the findings of this work tells is not dependent upon either his/he demographic characteristics or his/her competency of the use of the various ICT tools and instruments. Mensah (2013) who worked on mathematics tutors‘ integration of ICT in the Colleges of Education in his conclusions stated that the ICT integration of the tutors is not dependent on their demographic characteristics but by barriers such as lack of ICT infrastructure.

Research has also over the years showed that younger teachers tend to want to integrate ICT as compared to their older counterparts. Lakkala and Lehitinen (2001) pointed out that the youngest groups of teachers have increased their self-evaluated ICT use than the oldest group. This shows that the younger the mathematics teacher the more likely he/she is to integrate ICT in his/her lessons. In addition, each one of

the entireties of teachers were at least a university first degree holder which is the basic requirement in terms of qualification to teach at the Senior High School level.

From the findings it was realized that the teachers are competent enough to integrate ICT in their lessons and this confirms the outcome of the question asked the participants in the questionnaire about receiving ICT training during their University education when the participants from their responses as revealed in Table 4.04 indicated that 25 of them representing 92.59% were taken through ICT related courses that exposed them to the use of ICT tools for teaching and learning during their University education. Moreover, all the teachers are competent in the use of Scientific Calculator and also only one (1) of the teachers‘ indication not able to use word processing.

Also, although the teachers are utilizing ICT tools in their preparation for their lessons, the main activities which constitute the use of ICT tools for lesson delivery to enhance students understanding and to evoke their interest in the subject by making lessons lively and practical such us the use of projectors for presentation, the use of computers for analyzing data and the use of ICT packages such as Geogebra to make lessons practical are sparingly being used by the mathematics teachers.

Moreover, it was seen from their responses during the interview that the most prevalent cause of the teachers‘ inability to integrate these ICT tools in their lessons is the unavailability of resources. Asabere, Togo, Acakpovi, Torgby and Ampadu (2017) in their conclusions outlined that a major barrier to the integration of ICT is inappropriate physical environment and ICT infrastructure as well as unsatisfactory number of computers and inadequate hardware/software. Ghavifek, Ibrahim, Rahmi and Wong (2016) also detailed that the mathematics teachers‘ challenges were mostly

related to internet services, speed and ICT facilities, that is the number of computers connected to the internet and resources.

CHAPTER 5

SUMMARY, CONCLUSIONS AND FINDINGS

5.0 Overview

This chapter of the study presents the summary of findings, conclusions, recommendations and suggestions for further studies into the problem based on the findings of this study.

5.1 Summary

This study was meant to explore the mathematics teachers ICT integration in the teaching and learning of mathematics at the Senior High School level specifically in the Upper Denkyira West District and Upper Denkyira East Municipalities. The study was carried out with the descriptive survey design and utilized the mixed method approach of collecting data, which is a combination of both quantitative and qualitative methods of data collection. Specifically, the concurrent triangular mixed method design of research was employed. Both types of data collecting techniques were employed with the view of being able to get in depth information of the mathematics teachers ICT integration in the teaching of mathematics.

The population used for the study was all mathematics teachers in the Upper Denkyira West District and Upper Denkyira East Municipalities. The study used a sample size of twenty-seven (27), these are mathematics teachers from the Upper Denkyira West District and Upper Denkyira East Municipalities of the Central Region of Ghana. For the sample of the study, random sampling technique was employed. Both open ended and closed ended questions were used for the questionnaire as well as interview guide. Cross sectional survey administering techniques was used to administer the questionnaire. Some of the questions on the questionnaire were self-developed whilst others were adopted from studies of Mensah (2013), Forgasz (2006).

To achieve the objectives of the study, five research questions were formulated, these are:

1. What competencies do mathematics teachers‘ have in using computers?
2. Is there a relationship between the mathematics teachers‘ ICT competency and ICT integration?
3. How do mathematics teachers‘ demographic characteristics influence their mathematics tutors‘ integration of ICT in the teaching and learning of mathematics?
4. What challenges do mathematics teachers face in an effort to integrate ICT in the teaching and learning of mathematics?
5. To what extent do mathematics teachers integrate ICT in the teaching and learning of mathematics?

5.1.1 Summary of key Findings

The findings showed that most of the mathematics teachers were young, that is 25 out of the 27 teachers had their ages between 20 and 40 which according to Obonyo (2013) is a very good recipe for ICT integration but was not really the case according to the study. Also, the findings showed that female representation in Science and Mathematics is very low evident from the female representation on the sample. Only two (2) out of a total of 27 mathematics teachers were women.

The mathematics teachers were also generally found to be competent enough to integrate ICT in their lessons. With 153 (81.0%) out of 189 of the teachers responses on their competence in the use of various ICT software packages/tools between being excellent with a software package/ICT tool to being good with it and as many as 26 (96.3%) out of 27 teachers indicating to receiving training during their University

education confirms that the mathematics teachers are competent enough to integrate ICT in their lessons.

It is evidently clear from the findings of the study that even though the mathematics teacher‘s utilization of ICT tools in activities before their lessons such as the use of the internet to look up information for preparation and the use of Microsoft word for preparation of their lesson was high, the actual use of ICT tools during delivery is limited. The teachers‘ use of projectors for presentation, making students use computers to process and analyze data is on the low and this indicates that the extent of the use of ICT tools in the teaching and learning of mathematics is very little among mathematics teachers at the Senior High School level although it has been established in this work that the mathematics teachers are competent enough to integrate ICT tools in their classroom delivery.

Also, it was realized that demographic factors (gender, age, educational level, university attended) has no influence on the mathematics teachers‘ integration of ICT in the teaching and learning of mathematics.

The findings made bare the challenges mathematics teachers at the Senior High School level face in their bid to integrate ICT in their delivery. Although lack of support from administrators, lack of ICT infrastructure, lack of motivation, little time allocation for mathematics lessons were all found to be challenges, the most prevalent and the most mentioned of them all was non-availability of ICT tools in the various Senior High Schools. From the interview conducted for five of the teachers, most of the teachers mentioned lack of resources as the major hindrance to ICT integration in the teaching and learning of mathematics at the Senior High School level.

Finally, it was revealed that although the mathematics teachers are competent enough as enquires into research question 1 indicated, the mathematics teachers are using ICT

tools in their preparation for their lessons but the actual integration during lesson delivery is not as expected of the mathematics teachers.

5.2 Conclusions

The purpose of this study was to explore mathematics teachers' ICT integration in teaching and learning of mathematics in the Senior High School in the Upper Denkyira East Municipality and the Upper Denkyira West District of Ghana. Based on the findings of this study, it can be concluded that:

1. Female representation in science and mathematics is very low
2. The mathematics teachers ICT competence and ICT integration in the classroom does not depend on each other.
3. Barriers such as little time allocation for mathematics lessons, lack of ICT tools, lack of motivation to mention but a few are inhibiting integration of ICT in the teaching and learning of mathematics.
4. ICT integration in the teaching and learning of mathematics among mathematics teachers is not affected by the age, gender, educational level and university attended by the mathematics teacher.
5. Mathematics teachers' ICT integration into teaching and learning of mathematics is little.

5.3 Recommendations

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

1. The administrators of the various Senior High Schools should collaborate with the mathematics department to develop the skills and ability of teachers to raise the integration of ICT in the teaching and learning process in the Senior High School to a higher level.

2. The Senior High School administrators should finance to motivate the mathematics department to organize in-service training for the mathematics tutors on how to integrate ICT tools and software in their teaching and learning instructions.
3. Curriculum developers should help mathematics teachers by suggesting at least one ICT tool and software to teach each of the mathematics topics in the curriculum.
4. The Senior High School administrators should ensure that ICT laboratories are made available for mathematics lessons.
5. The Senior High School administrators should ensure that key ICT tools such as projectors and software such as derive 5, sketch pad, internet, etc. are made available to mathematics teachers so that they can efficiently integrate ICT in the teaching and learning of mathematics.
6. Curriculum developers should find solution to the lack of enough time allocation for mathematics lessons to encourage the use of ICT tools during mathematics lessons.

5.4 Educational Implication of the Study for Mathematics Teaching and Learning

1. ICT integration as revealed by the study may not be affected by demographic factors such us age, university attended, educational level and years after completing University. This means that regardless the age or University attended, the most important of it all is the mathematics teachers‘ ability to integrate ICT in his delivery. The study also did reveal that competency of the mathematics teacher in the use of ICT tools may not influence the integration of ICT in the classroom. Base on this, although it is important for universities

to train their students on the use of these ICT tools regardless of their age, educational level, years of completion of University as well as the University attended, it is important for administrators of the various Senior High Schools to ensure that measures are put in place to motivate the teachers on their various staffs to integrate ICT in their lessons.

2. It was found in the study that mathematics teachers are actually utilizing ICT tools mostly during preparations for their lessons such as the use of the internet to find more information and the use of Microsoft office word for lesson notes preparation. This means that the teachers need a little bit of encouragement to be able to integrate ICT tools in their lessons of which administrators should be able to keep the teachers motivated enough to do that. Therefore, there is the need for the Ministry of Education in collaboration with the Ghana Education service to organize and encourage mathematics teachers with many on the job training to enable them to use computers and mathematics software to integrate ICT more often in the teaching and learning of mathematics. There should also be on going technological training for mathematics teachers to keep them abreast with current technology so that they will develop the requisite skills and knowledge as well as the interest for ICT integration in teaching and learning.
3. The teachers from the study also revealed factors which hinder the integration of ICT in the teaching and learning of mathematics as lack of motivation, little time allocation for mathematics lessons, lack of support from administrators and most importantly unavailability of ICT tools for the integration of ICT in the teaching and learning process. It is therefore very vital for the Ministry of Education together with the Ghana Education Service to ensure that the

necessary measures are put in place to cater for these challenges for administrators for them to be able to create an enabling environment for the smooth and consistent integration of ICT in the teaching and learning of mathematics.

5.5 Suggestion for Further Research

It is suggested that the study is extended to other regions of the country and also the population is extended to enable easy generalization of the outcome of the study.

Also, the type of training given to the teachers form the various Universities they attended should be investigated into to ensure that the training programs at the various training schools are good enough to equip the mathematics teachers with the requisite skills to integrate ICT in the classroom.

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APPENDIX A

Questionnaire for Teachers

UNIVERSITY OF EDUCATION, WINNEBA

Department of Mathematics Education

TEACHERS USE OF ICT IN THE TEACHING OF MATHEMATICS AT THE S.H.S LEVEL QUESTIONNAIRE

Dear Colleague,

Questionnaire to explore mathematics teachers' ICT integration into teaching and learning of mathematics at the S.H.S level. I therefore call on your objective responses to facilitate accuracy of the evaluation process. Thank you.

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

A. Background information

1. Gender: Male [ ] Female [ ]

2. Age range of respondents: 20-30 [ ] 31-40 [ ] 41-50 [ ] 51-60 [ ]

3. Educational level: Masters [ ] Degree [ ] Diploma [ ] Other (please specify)…….

4. How many years has it been since you completed university? 1-5 [ ] 6-10 [ ] 11-15 [ ] 16-20 [ ] 21-25 [ ] 26-30 [ ] 30-above [ ]

5. Did you offer any course that involved ICT/computer applications in mathematics while in school, college or university? Yes [ ] No [ ]

6. Name of university attended …….

TEACHERS COMPETENCY IN ICT INTEGRATION

1. Can you use ICT or computer-based technology in teaching of mathematics?
   Yes [ ] No [ ]
2. Provide reason why you can use or not use computer based technology in teaching of mathematics.
   ……

Tick appropriately how best you can use the software packages and technological instruments in the teaching and learning of mathematics in the table below. Please indicate your level of competency by ticking (√) the appropriate response using the following key:

E – Excellent, VG – Very good, G – Good, NG– Not good, CN – Can‘t use.

	Software package/instrument	Excellent	Very good	good	Not good	Can‘t use
1	Microsoft word					
2	Microsoft Excel					
3	Microsoft power point					
4	Geogebra and Derive 5					
5	Knowledge of computer Programming (any programming language)					
6	Scientific Calculator					
7	Projector					

TEACHERS INTEGRATION OF ICT

Below are questions about how often mathematics teachers integrate ICT in teaching, please tick [√] the appropriate box to indicate how often you undertake the activity.

7. How often do you use the internet during preparation for a lesson?

Every day [ ] Once a week [ ] Once every two weeks [ ] Once a month [ ] Never [ ]

8. How often do you use Microsoft Office Word during preparation for a lesson?

Every day [ ] Once a week [ ] Once every two weeks [ ] Once a month [ ]

Never [ ]

9. How often do you have students use computer technology to find information?

Every day [ ] Once a week [ ] Once every two weeks [ ] Once a month [ ]

Never [ ]

10. How often do you make students use computer to process and analyze data?

Everyday [ ] Once a week [ ] Once every two weeks [ ] Once a month [ ]

Never [ ]

11. How often do you use Microsoft power point and other mathematical software such as Geogebra during delivery?

Every day [ ] Once a week [ ] Once every two weeks [ ] Once a month [ ]

Never [ ]

12. How often do you use computer and projection for the presentation of concept.

Every day [ ] Once a week [ ] Once every two weeks [ ] Once a month [ ]

Never [ ]

TEACHERS CHALLENGES TO ICT INTEGRATION

Tick appropriately how the statement is a challenge to ICT integration in your school. Please indicate the level of the challenge by ticking (√) the appropriate response using the following key:

SA – Strongly Agree, A– Agree, D – Disagree, SD – Strongly Disagree.

	Statement	SA	A	D	SD
1	The time allocated for mathematics lessons are not enough for ICT integration.				
2	Teachers are not given enough motivation to integrate ICT in the teaching of mathematics				
3	Colleges of education and Universities do not empower mathematics teacher with enough skills to integrate ICT				
4	There are not enough ICT infrastructure for the teaching and learning of mathematics				
5	There is no technical support for mathematics teachers to integrate ICT				
6	Mathematics teachers lack support from administrators to integrate ICT in mathematics.				

APPENDIX B

STRUCTURED INTERVIEW GUIDE ON TEACHERS INTEGRATION OF ICT IN THE TEACHING AND LEARNING OF MATHEMATICS

1. How often do you use the internet during preparation for a lesson?
   Why?
2. How often do you use Microsoft Office Word during preparation for a lesson?
   Why?
3. How often do you have students use computer technology to find information?
   Why?
4. How often do you make students use computer to process and analyze data?
   Why?
5. How often do you use Microsoft power point and other mathematical software such as Geogebra during delivery?
   Why?
6. How often do you use computer and projection for the presentation of concept.
   Why?