

UNIVERSITY OF CAPE COAST

ASSESSING BASIC SCHOOL MATHEMATICS TEACHERS'
INFORMATION COMMUNICATION TECHNOLOGY INTEGRATION IN
THE TEACHING AND LEARNING OF MATHEMATICS

PHILIP ADJEI ACHEAMPONG

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BY

PHILIP ADJEI ACHEAMPONG

Thesis submitted to the Department of Mathematics and ICT Education of the
Faculty of Science and Technology Education, College of Educational
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for the award of Master of Philosophy degree in Mathematics Education

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DECLARATION

Candidate's Declaration

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

Candidate's Signature: Date:

Name: Philip Adjei Acheampong

Supervisors' Declaration

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

Principal Supervisor's Signature: Date:

Name: Prof. Douglas Darko Agyei

Co-Supervisor's Signature: Date:

Name: Mr. Alexander Asare Inkoom

ABSTRACT

The purpose of the study was to assess basic school mathematics teachers Information Communication Technology integration in the classroom. Survey method was used as the design for study. The study employed a survey method as a design. Cluster sampling technique was used to select 148 mathematics teachers in Bibiani in the western region of Ghana. The study employed questionnaires in the data collection. The findings of the study indicated that basic school mathematics teachers reported high ICT knowledge and skills (Technological Pedagogical Content Knowledge) required for ICT integration. Majority of the Basic School Mathematics Teachers (BSMT) do not employ ICT during mathematics classroom instructions. To determine the School related factor that best predicted ICT usage, the current study also revealed that availability of ICT tools was the major predictor of effective ICT use followed by technical support whiles planning and policy was the least predictor of classroom ICT use in the basic school level. In addition, basic school mathematics teachers have a positive attitude towards ICT use in the classroom. Finally, effective ICT integration in the basic school classroom is most affected by the school-related factors followed by teachers' knowledge and skills (TPACK) whiles teachers attitude have no effect on effective ICT usage. Stakeholders of education should make ICT tools available in the classroom and explicitly state how ICT tools are used in the mathematics classroom in the Junior High and Primary school teaching syllabus.

KEY WORDS

Effective ICT usage

Information Communication Technology Usage

Mathematics Assessment

Mathematics Instructional Delivery

Mathematics Learning

Technology Integration

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DEDICATION

To my dear mother,

Rose Denkyi.

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LIST OF ACRONYMS

BSMT	Basic School Mathematics Teachers
CK	Content Knowledge
CRDD	Curriculum Research and Development Division
GSGDA	Ghana Shared Growth Development Agenda
ICT	Information Communication Technology
ICT4AD	ICT for Accelerated Development
PCK	Pedagogical Content Knowledge
PK	Pedagogical Knowledge
TCK	Technological Content Knowledge
TK	Technology Knowledge
TPACK	Technological Pedagogical Content Knowledge

CHAPTER ONE

INTRODUCTION

This chapter provides the background to the study that highlighted some previous literature, the effort being made by the government of Ghana towards technology integration, development of concepts in the area of technology integration in education, the statement of the problem, the purpose of the research, research questions that the research seeks to answer.

Background to the Study

In this recent digital age, globalization and rapid technological advancement have created a new economy that is driven by technological knowledge (Varghese, 2013). In this regard, Information Communications technology (ICT) has become undoubtedly the critical enabler of a knowledge-based economy for many nations (Mutula & Brakel, 2007). Countries recognise ICT as potential tools for change and innovation in education (Papanastasiou & Angeli, 2008; Staff, 2001). Both developed and developing countries have adopted ICT into their educational policies in order to increase quality in education (Sang, Valcke, van Braak, Tondeur, & Zhu, 2011).

Developments about and widespread use of Information Communication Technology influence all fields of life, one of which is education. Countries see ICT as potential tools for change and innovation in education (Papanastasiou & Angeli, 2008; Staff, 2001). In Section 6.4 of the GSGDA document Vol 1 (December 2010), ICTs have been identified as a key driver to Ghana's growth and a number of interventions including investment in ICT infrastructure to support education and other sectors in Ghana have been made. As noted by Swart (2011), ICTs can be powerful

essential tools for learning: understanding, interpreting and communicating about the real world.

In Watson (2001) description, ICTs have revolutionized the way people work today and are now transforming education systems. Since the introduction of information and communication technologies (ICT), their integration into education and the associated financial investments have been policy concerns in many countries. The initiatives that were taken to give ICT a place in education have resulted in a need to monitor these developments, using reliable and valid indicators. Once these indicators are available through standardized international data collection efforts, policymakers can review progress of their countries over time in comparison with their nationally defined targets and other relevant reference countries (UNESCO, 2009)

It is believed that the use of ICT in education can increase access to learning opportunities. It can help to enhance the quality of education with advanced teaching methods, improve learning outcomes and enable reform or better management of education systems (UNESCO, 2009) Under the right conditions, it is believed that ICT can have a monumental impact on the expansion of learning opportunities for greater and more diverse populations, beyond cultural barriers, and outside the confines of teaching institutions or geographical boundaries (Hadley & Sheingold, 1993).Technologies can improve the teaching/learning process by reforming conventional delivery systems, enhancing the quality of learning achievements, facilitating a state-of-the-art skills formation, sustaining lifelong learning and improving institutional management (UNESCO 2009).

Access to ICT tools helps in the implementation of the problem-centered approach, which in turn may lead to more active and highly motivated students (Newhouse, 2002a). ICT provides students with immediate feedback (Tay, Lim, Lim, & Koh, 2012). Immediate feedback provides the student with encouragement to continue exploring and trying out new ideas until they find the answers they are looking for (Cheng & Chen, 2008)

A good example is the use of geogebra in plotting graphs, the use of excels in generating graphs etc. Feedback provided by ICT is a formative assessment tool allowing students to understand and manage their learning. Hennessy, Deaney, and Ruthven (2005) emphasise that using ICT supports students to check, trial and refine their work which means ICT facilitates immediate feedback and encourages self-correction. When students disagree while using ICT, they are more likely to find successful resolutions by using the technology to prove their point (Hammond, Reynolds, & Ingram, 2011)

ICT helps students to construct their own understanding and knowledge of a topic (Vonkova & Hrabak, 2015). ICT could increase students' enjoyment of learning and confidence in their ability as fun and games are being brought into the classroom (Sivasubramaniam, 2000). ICT is also perceived to have many advantages in education including: pursuing problem-solving skills, fostering collaborative learning, providing flexible learning opportunities and increasing productivity (Smeets, 2005).

ICT is changing processes of teaching and learning by adding elements of vitality to learning environments including virtual environments. ICT is a potentially powerful tool for offering educational opportunities. It is difficult and may be impossible to imagine future learning environments that are not

supported, in one way or another, by Information and Communication Technologies (ICT).

The prospects of using emerging and digital technologies to improve the teaching and learning process as well as students' academic performance have been recognised by researchers, scholars, teachers and teacher educators (Dexter & Riedel, 2003) with some proponents of technology hailing technology as a panacea to education's problems (Wang et al., 2005). Digital technology can provide students the opportunity to engage in "virtual reality". Students are given a virtual environment in which they can explore without encountering the risks they would have had if they were learning such content in the "real" world (Rizzo et al., 2011)

Students in one country are now able to sit in a virtual laboratory, conduct experiments and share ideas across countries through technology as reported by Potkonjak et al. (2016). The potential of ICT in education more succinctly by indicating that they help in expediting and enhancing production of school work; improving motivation and engagement; supporting exploration and experimentation as well as fostering self-regulated and collaborative learning (Osborne & Hennessy, 2003). National Council of Teachers of Mathematics (2008) cited that technology is essential in teaching and learning mathematics. ICT improves the way mathematics should be taught and enhances student understanding of basic concepts.

Many researchers have carried out studies to evaluate the benefits of using ICT in mathematics. Zakaria and Khalid (2016) summarised the key benefits: ICT promotes greater collaboration among students and encourages communication and the sharing of knowledge. ICT gives rapid and accurate

feedbacks to students and this contributes towards positive motivation. It also allows students to focus on strategies and interpretations of answers rather than spend time on tedious computational calculations.

ICT also supports constructivist pedagogy, where students use technology to explore and reach an understanding of mathematical concepts. This approach promotes higher order thinking and better problem-solving strategies which are in line with the recommendations forwarded by the National Council of Teachers of Mathematics (NCTM); students would then use technology to concentrate on problem-solving processes rather than on calculations related to the problems (Griffin & Guez, 2014).

Learning approaches using contemporary ICTs provide many opportunities for constructivist learning through their provision and support for resource-based, student-centered settings and by enabling learning to be related to context and to practice (Hung & Khine, 2006). ICT can help deepen students' content knowledge, engage them in constructing their own knowledge, and support the development of complex thinking skills (Kozma, 2005; Kulik, 2003; Webb & Cox, 2004). Studies have identified a variety of constructivist learning strategies (e.g., students work in collaborative groups or students create products that represent what they are learning) that can change the way students interact with the content (Pallant, 2013).

The use of ICT in teaching mathematics can make the teaching process more effective as well as enhance the students' capabilities in understanding basic concepts (Chong & Michael, 2000). ICT has also been regarded as a strategy to improve teaching and learning and to implement and facilitate the new pedagogy of the information society (Becker, 2000). ICT has affected the

field of Education, which intends affect teaching, learning and research (Voogt, Knezek, Cox, Knezek, & Brummelhuis, 2013). ICT can potentially simplify and enhance the learning process in many subject areas Balanskat, Blamire, and Kefala (2006) acting sometimes as a catalyst for innovation.

ICTs have the potential to innovate, accelerate, enrich, and deepen skills, to motivate and engage students, to help relate school experience to work practices, create economic viability for tomorrow's workers, as well as strengthening teaching and helping schools change (Kereluik, Kristen, & Koehler, 2011). As a consequence, the use of ICT will not only enhance learning environments but also prepare next generation for future lives and careers (Harris, Mishra, & Koehler, 2009). The changed pool of teachers will come and changed responsibilities and skill sets for future teaching involving high levels of ICT and the need for more facilitative than didactic teaching roles (Archambault & Crippen, 2009).

As noted by Swarts (2006), ICTs can be powerful, essential tools for learning: understanding, interpreting and communicating about the real world. However, effectively integrating ICTs into educational planning and delivery can be a complicated process, leading to further disparities and challenges in the system. These may include lack of focus on educational objectives where ICTs are seen as an end itself, rather than a means (tools) to an end.

In summary, before ICT integration into national education systems can be effective, an adequate mix of the following policy and operational measures is needed:

- i) Clear goals and a policy environment enabled by national authorities that support the use of ICT in education.

- ii) Support and/or incentives for both public and private educational institutions to purchase ICT facilities (e.g., dedicated government funding, including a budget for maintenance services; tax rebates on ICT hardware and software for educational institutions; investment in or sponsoring of research in developing low-cost ICT hardware and software, etc.).
- iii) Adaptation of curricula to ICT integration and development or acquisition of standardized quality-assured digital educational contents and software;
- iv) Deliberate mass teacher training programmes on teaching ICT subjects or using ICT to teach other subjects more effectively.
- v) Favourable and flexible school policies enabling well-planned access by teachers and learners to ICT resources in support of curricula delivery; and
- vi) Appropriate national-level monitoring and evaluation systems that make it possible to perform regular assessments of outcomes and efficiency gains, and to detect early potential shortcomings so that policy implementation can be more effective (UNESCO, 2009).

The latest Ghanaian Education Reform that was launched in 2007, highlights ICTs as an important cross-cutting issue in the sector, and seeks to address this through several strategies including: equipping all educational institutions with computer equipment and ICT tools in a prioritised manner; implementing ICT programmes at the pre-tertiary level in a phased one. A study conducted by Sipil (2011), found that teachers frequently use ICT for informative, organisational, recreational, lesson planning purposes.

In a similar study conducted by Usluel, Mumcu and Demiraslan (2007) in basic schools, they revealed that teachers mostly used ICT for administrative tasks such as preparation of lecture notes, students' reports and scores, rather than for instructional purposes. These findings were supported by Wikan and Molster (2011) who found that most teachers used ICT for lesson preparation and information searching, while only a few teachers integrate ICT into their teaching to enhance students' learning and engagement. When making such investments, the general assumption is that once hardware and software are available in schools, ICT integration will automatically follow.

While ICT investments for educational innovations and developments have an important potential, it is neglected that there are teachers who will use it in the classrooms as a part of the curriculum (Cohen, L., Manion, L., & Morrison, 2007). However, how these teachers perceive these reform efforts are closely related to certain variables such as belief and experience, level of knowledge, attitude toward ICT, educational applications, achievement expectations and learning-teaching approaches (Hew & Brush, 2007; Kozma, 2005; Angela McFarlane & Sakellariou, 2002; Tay, Lim, Lim, & Koh, 2012).

As a result, integrating ICT investments with school curricula requires that teachers' knowledge, level of use and attitudes towards those technologies are determined and guided. ICT integration in mathematics provides the opportunity to gather, store, retrieve, process, analyze, and transmit information. Improvement and dissemination of ICT have begun to change the traditional class image (Sang et al., 2011; Jo Tondeur, Valcke, & Braak, 2008). The effort of integrating ICT has received great attention in educational

systems in many nations especially in Ghana. The reason for this development is that ICT has the capability to revolutionize the education sector by improving the quality and transforming the teaching and learning methods (Hammond, Reynolds, & Ingram, 2011).

Wikan and Molster (2011) concluded that ICT integration is seldom used to stimulate students' higher-order thinking and for allowing constructivist learning. This conclusion is supported by the statement that there is little understanding of teachers' integration of ICT into teaching and the factors that affect their pedagogical use of ICT (Chen, Jia, & Wang, 2009). Therefore, a research study is needed to identify the way ICT is used in schools and to identify the factors that contribute to students' use of ICT (Chen, Jia, & Wang, 2009).

When teachers integrate technology into instruction their students become more interested in the subject (Admiraal et al., 2017; Handler, 1993). The literature (National Council of Teachers of Mathematics, 2008) suggests that teachers' use of educational technology requires comprehensive and multi-faceted knowledge. For successful integration of technology in the classroom, teachers should be able to blend technology effectively with pedagogy and content (Koehler & Mishra, 2006). This study therefore assessed basic school mathematics teachers ICT integration in mathematics teaching.

Statement of the Problem

The impact of the use of technology in teaching cannot be underestimated. As noted by Swart (2011), ICTs can be powerful, essential tools for learning: understanding, interpreting and communicating about the

real world. Electronic media are suitable for students because they provide students with information quickly, meet their curiosity; ensure the possibility of fast ideas exchange, acquisition of knowledge through fun, etc. (Neyland, 2011).

The discussion or researches have shifted from the benefits of technology in teaching and learning to how technology can be integrated into the teaching and learning. The mere introduction of technology into the classroom will not necessarily yield the needed results of students maximizing their learning (Koehler & Mishra, 2005). The teacher is required not only to have knowledge of specific technology but also the knowledge of the affordances and constraints of the technology, use adaptive strategies coupled with how to use these properties of technology to enhance comprehensive learning (Kereluik, Kristen & Koehler, 2011)

A lot of researches have been conducted in this area focus on the pre-service teachers TPACK (Agyei & Voogt, 2010; Smith, Hardman, & Higgins, 2006), factors that affect teachers in integrating technology in their lessons, how teachers can use technology in teaching specific subjects (Agyei & Voogt, 2012; Graham et al., 2009). In addition, Most of the research in this area only concentrated at the Senior high school and tertiary levels, neglecting the basic level which is the foundation of the education in the country.

This research therefore examined basic school mathematics teachers' ICT integration in the teaching and learning of mathematics in Bibiani in the western region of Ghana. This in effect helped to determine whether Ghanaian basic school mathematics teachers have the adequate knowledge for successful integration of technology in mathematics instruction, factors affecting

technology integration and how technology is adopted in the Ghanaian classroom among mathematics teachers. This was done to achieve one of the major aims of the primary school mathematics syllabus in Ghana, that is to help children become mathematically literate in a world that is information technology (IT) oriented (Curriculum Research and Development Division, 2007). This research also helped to inform policy makers and other stakeholders in the allocation of ICT resources to the stage of education that is much needed. It has also helped the Ghana Education Service and the Ministry of Education to know how prepared teachers are in integrating technology in teaching mathematics as stated in the national ICT policy.

Research Objectives

Specifically, the objectives of this study are:

1. To determine the extent to which Ghanaian basic school mathematics teachers' are using ICT in their classrooms.
2. To describe the level of technological pedagogical content knowledge (TPACK) among Ghanaian basic school mathematics teachers.
3. To determine the extent to which Ghanaian basic school mathematics teachers' attitudes affect ICT integrating into their classrooms.
4. To determine the extent to which School related factors affect ICT integration among Ghanaian basic school mathematics teachers.
5. To determine the extent to which the factors: the Knowledge and Skill ; School related factors affecting ICT integration and teachers attitude predict ICT integration in the classroom.

Research Questions

The study sought to answer the following research questions:

1. To what extent are basic school mathematics teachers integrating ICT into their Classroom?
2. What are the technological pedagogical content knowledge (TPACK) levels of Ghanaian basic school mathematics teachers' (GBSMT)?
3. To what extent do basic school mathematics teachers attitude influence ICT integrating into their classroom?
4. To what extent do school-related factors affect Ghanaian basic schools mathematics teachers' use of ICT in the classrooms?
5. To what extent do the factors: Knowledge and skill; School related factors affecting ICT integration and teachers attitude predict ICT integration in the basic school mathematics classroom?

Significance of the Study

The study is significant because it offers insight into basic school mathematics teachers ICT usage in the mathematics classroom. The study provided the extent of ICT usage in the basic school classroom. It also provided the level of teachers' knowledge and skills that will be required in teaching mathematics at the basic level. The study also added to the knowledge that teachers attitude have no effect on ICT usage in the basic school classroom. The study also pointed out that, School related factors are very influential in ICT usage followed by teachers' knowledge and skills. Among the School related factors it was found out that availability of ICT tools is the major determinant of ICT usage. This could provide guidance for

policy makers and stakeholders in education when structuring and introducing ICT integration into basic school level

Delimitations

This study concerned with assessing basic school mathematics teachers ICT integration in the teaching of mathematics. The study was confined to only mathematics teachers at the basic school level. That is, how basic school mathematics teachers are successfully integrating information communication technology into mathematics classroom. The study was done in Bibiani in the Western region of Ghana.

Limitation

Self-reporting scales were used in the questionnaire to measure variables for analysis. This might have affected the result of the study since some of the respondents may have over-estimated their responses. Also, this study covers only one town in Ghana which is Bibiani. Furthermore, the integration of ICT into the teaching of mathematics is a dynamic stage in Ghana, which means that things are gradually changing on daily basis in the town. That is, the current study should be seen as “snapshots” that were current at the time the research was conducted; it is expected that certain facts and data may change and become absolute rapidly due to new development.

The use of Bibiani basic school mathematics teachers may be too small to represents the entire basic school mathematics teachers in the country. Also, this research considered only mathematics teachers neglecting other teachers of the different disciplines. The teachers who took part in this study were teaching mathematics at the basic school level in Bibiani in the western

region of Ghana and the outcome might be different from participants in basic schools from different districts.

Definition of Terms

Basic school mathematics teachers: Basic school mathematics teachers used in this context refers to all teachers who teach mathematics at the various levels at the basic school in Ghana.

Public schools: Schools that are formally supported by the government especially in terms of recruitment of teachers and provision of other teaching and learning resources.

Effective technology integration: Effective technology integration refers to the usage of technology in the classroom to maximise students learning.

Content Knowledge (CK): Content knowledge (CK) refers to any subject-matter knowledge that a teacher is responsible for teaching.

Pedagogical Knowledge (PK): Pedagogical knowledge (PK) refers to teacher knowledge about a variety of instructional practices, strategies, and methods to promote students' learning.

Technology Knowledge (TK): Technology knowledge (TK) refers to teacher knowledge about traditional and new technologies that can be integrated into the curriculum.

Technological Content Knowledge (TCK): Technological Content Knowledge (TCK) refers to knowledge of the reciprocal relationship between technology and content.

Pedagogical Content Knowledge (PCK): Pedagogical Content Knowledge (PCK) is to Shulman (1987), notion of “an understanding of how particular

topics, problems, or issues are organised, represented, and adapted to the diverse interests and abilities of learners, and presented for instruction” (p. 8).

Technological Pedagogical Knowledge (TCK): Technological Pedagogical Knowledge (TCK) refers to knowledge of using technology to implement different teaching methods.

Technological Pedagogical Content Knowledge: Technological Pedagogical Content Knowledge (TPACK) refers to knowledge about the complex relations among technology, pedagogy, and content that enable teachers to develop appropriate and context-specific teaching strategies.

Organisation of the Rest of the Study

This research was organised into five chapters. Chapter One deals with the introduction of the research that comprises of the background to the study, the statement of the problem, the purpose of the study, the research objectives, the research questions and the significance of the study, delimitation, limitation, definition of terms and the organisation of the rest of the study. Chapter Two describes literature review on the previous research concerned with technology integration in the classroom, the measurement of the constructs TPACK as well as the conceptual framework of the study.

Chapter Three takes a critical look at the research design, the population, the sampling procedure, the data collection instruments, the data collection procedure, the data processing and analysis. Results and discussion of data were presented in Chapter Four. The summary of findings, discussions, recommendations and suggestions for further studies into the problem, based on the findings of this study were discussed in Chapter Five.

Chapter Summary

Chapter One has laid the foundation for the present research study. It has introduced the research problem and the question to be investigated, which is the extent to which basic school mathematics teachers integrate ICT into the teaching of mathematic. This research is significant due to the paucity of research in this area within the Ghanaian Context.

CHAPTER TWO

LITERATURE REVIEW

Introduction

This chapter takes a critical look at the literature review on the previous research concerned with technology integration in the classroom, ICT and mathematics education, factors affecting technology integration, teachers' adoption of technology, effective ICT integration, the measurement of the constructs TPACK as well as the conceptual framework of the study.

Theoretical Framework

The theoretical framework highlighted the benefit of ICT in mathematics education, the TPACK framework, the effective usage of ICT in the classroom, factors affecting ICT usage in the teaching of mathematics, as well as the conceptual framework of the study.

ICT and Mathematics Education

Developments about and widespread use of Communication and Information Technologies (ICT) influence all fields in life, one of which is education. Undoubtedly the recent advancement in information technology innovations and computer usage is rapidly transforming work culture and teachers cannot escape the fact that today's classrooms must provide technology-supported learning (Angers & Machtmes, 2005). Countries see ICT as potential tools for change and innovation in education (McFarlane & Sakellariou, 2002; Papanastasiou & Angeli, 2008; Staff, 2001) and, thus, make investments in ICT. Information and communication technology (ICT) has changed the world in which we live and the way in which we learn to live. The ability to use ICT has become the new literacy for the 21st century (Levin &

Wadmany, 2008) and, around the globe, countries see ICT as a potential tool in enhancing education. Since ICT is beneficial in all aspect of life, education cannot be left alone.

ICT is becoming most essential aspect in the field of mathematics especially in the mathematics classroom. A number of studies have shown the potentials of effective use of ICT integration in the mathematics classroom learning experiences in the following ways: Understanding of mathematical concepts (Hennessy, Ruthven, & Brindley, 2005; Jarrett et al., 1968; A. McFarlane & Sakellariou, 2002; Šorgo, Verčkovnik, & Kocijančič, 2010; Tay et al., 2012). Evaluation and Feedback (Cheng & Chen, 2008; Sivasubramaniam, 2000) Computation and Exploration (Hennessy et al., 2005). Independent and Cooperative Studies (Chou, 2003; Jang, 2010; Yelland, 1993), Student Centered and motivation (Chen, Jia, & Wang, 2009; Koehler & Mishra, 2009; Kozma, 2003; Levin & Wadmany, 2008; Richardson, 2009), Problem-solving (Robert B Kozma, 2005; Kulik, 2003; P. Newhouse, 2002b; Webb & Cox, 2004; Yelland, 1993). The potentials of ICT usage in the classroom are elaborated below:

Understanding of mathematical concepts

ICT-based tools provide pupils with an advanced communication capability, allowing them to use graphics, images and text together, to demonstrate their understanding of mathematical concepts (Peltenburg, Panhuizen, & Doig, 2009). Using Logo develops higher levels of mathematical thinking (Clements & Battista, 1990). Computer algebra systems (CAS) can improve pupils' skills in unaided algebra and its understanding (Hennessy, Fung, & Scanlon, 2001). When pupils understand the context of the figures used in graphing,

they are more likely to understand the relationships demonstrated between variables (McFarlane & Sakellariou, 2002). ICT helps students to construct their own understanding and knowledge of a topic (Vonkova & Hrabak, 2015).

ICT is also perceived to have many advantages in education including: pursuing problem-solving skills, fostering collaborative learning, providing flexible learning opportunities and increasing productivity (Smeets, 2005). The prospects of using emerging and digital technologies to improve the teaching and learning process as well as students' academic performance have been recognised by researchers, scholars, teachers and teacher educators (Chai, Koh, & Tsai, 2010) with some proponents of technology hailing technology as a panacea to education's problems (Lai & Pratt, 2008).

ICT improves the way mathematics should be taught and enhances student understanding of basic concepts. ICT also supports constructivist pedagogy, where students use technology to explore and reach an understanding of mathematical concepts. This approach promotes higher order thinking and better problem-solving strategies which are in line with the recommendations forwarded by the National Council of Teachers of Mathematics (NCTM); students would then use technology to concentrate on problem-solving processes rather than on calculations related to the problems (Kim & Hannafin, 2011).

The use of ICT in teaching mathematics can make the teaching process more effective as well as enhance the students' capabilities in understanding basic concepts (Petras, 2010). ICT could assist students in their understanding of the mathematics concept and problem-solving. Technology gives students

access to new ways of exploring detailed concepts and it saves plenty of time. Using ICT in teaching and learning is essential as its exploration of new ways of learning mathematics and would improve students understanding of basic concept enhance their concentration in mathematics classroom (Sutherland et al., 2004). Logo encourages pupils to develop problem-solving skills, leads them to develop higher levels of mathematical thinking as well as learn geometric concepts (Clements & Battista, 1990). According to (Watson, 2001). ICT supports constructivist pedagogy, which allows students explore and reach an understanding of mathematical concepts.

This approach promotes higher order thinking and better problem-solving strategies for mathematics learning (Watson, 2001). Hammond, Reynolds and Ingram (2011) reiterated that teachers can maximize the impact of ICT in mathematics teaching by using ICT as a tool in working towards learning objectives. It gives the teacher the opportunity to learn current innovations in teaching from other countries that may be utilized in his/her her class to strengthen pupils' self-esteem. It adds further information about the topic he/she is teaching. He/she can make the content more colourful and purposeful by integrating slide show and videos related to the topic.

Evaluation and feedback

Technology provides different assessment tools such as Checklists, rating scales and rubrics to assess the 21st century skills such as creativity, problem-solving, decision making and leadership skills which are criteria for project based learning. The rubrics for Research Report document, Power point presentation, Role Play help the users. Teachers can access a number of printable worksheets for Mathematics. Checklists, rating scales and rubrics are

readily available in some educational websites which can be employed in the classroom. The students can do self-assessment through different online tools and get immediate feedback for correction. The computer often provides fast and reliable feedback which is non-judgmental and impartial. This can encourage students to make their own conjectures and to test out and modify their ideas.

Technology helps students to receive instant feedback from computer programs when trying out ideas encourages pupils to use conjecture and to keep exploring (Clements & Battista, 1990). Pupils are guaranteed correct representations of their input data (Sivasubramaniam, 2000). ICT provides students with feedback immediately when learners are allowed to exploit them. Immediate feedback provides the student with encouragement to continue exploring and trying out new ideas until they find the answers they are looking for (Cheng & Chen, 2008). A good example is the use of geogebra in plotting graphs, the use of Excel in generating graphs etc. Feedback provided by ICT is a formative assessment tool allowing students to understand and manage their learning.

Hennessey, Deaney and Ruthven (2005) emphasis that using ICT supports students to check, trial and refines their work which means ICT facilitates immediate feedback and encourages self-correction. Students they are more likely to find successful resolutions by using the technology to prove their point when disagree while using ICT, (Clements & Battista, 1990). ICT gives rapid and accurate feedbacks to students and this contributes towards positive motivation. It also allows them to focus on strategies and

interpretations of answers rather than spend time on tedious computational calculations (Becta, 2003).

Computation and exploration

Using the technology to carry out the manual labour of computations or drawing, frees the student to focus on strategies, and encourages a process of trial and error (Hennessy, Deaney, & Ruthven, 2005). Technology speeds up the graphing process, freeing pupils to analyse and reflect on the relationships between data (Hennessy et al., 2005). ICT has been shown to produce learning gains in graph interpretation among pupils (Hennessy, 2000). Data is easily re-sorted and reordered in different ways, which supports the exploring of problems (Clements & Battista, 1990). Logo helps pupils to learn geometric concepts and related skills in mathematics.

Dynamic geometry systems (DGS) allow pupils to manipulate and measure shapes on the screen, and have been shown to produce a higher level of learning among pupils (Clements, 2000). Pupils can take an active role in collecting or generating data for work in numeracy by using portable equipment. Digital technology can provide students the opportunity to engage in “virtual reality”. Students are given a virtual environment in which they can explore without encountering the risks they would have had if they were learning such content in the , “real” world (Campbell, 2009).

The potential of ICT in education is more succinctly by indicating that they help in expediting and enhancing production of school work; improving motivation and engagement; supporting exploration and experimentation as well as fostering self-regulated and collaborative learning (Osborne & Hennessy, 2003). ICT provides the opportunity to gather, store, retrieve,

process, analyze, and transmit information. Improvement and dissemination of ICT have begun to change the traditional class image (Tondeur, Braak, & Valcke, 2007). Studies have shown that a range of portable devices exists which allow pupils to collect data, and manipulate it using spreadsheets and databases for work in numeracy. Some portable equipment also enables the study of mathematics to move out of the classroom and to incorporate fieldwork investigations (Speer & Wagner, 2009).

Independent and cooperative studies

Working with Logo leads to developing and enhancing social interaction between collaborating pupils (Yelland, 2003). Individually or in groups, students, through ICT, are given the ability to develop multiple strategies and solutions to problems and receive immediate feedback (Genlott & Grönlund, 2016). For instance, Mathletics, which is an educational resource that contains many online activities and games geared toward teaching and learning mathematics, is one of the most important and widely used computer-aided assessment and learning tools in mathematics (Hatt, 2007). Becta (2003) pointed out that, ICT promotes greater collaboration among students and encourages communication and the sharing of knowledge.

ICT motivates pupils to learn independently, continuously provides pupils with opportunities to experience learning as enjoyable and satisfying, to increase their self-motivation. Consistently provides a range of opportunities for pupils to direct their own learning; provides independent learning options, and enables pupils to access these. ICT helps primary school teachers to be more effective in their teaching, especially if they are well resourced (Becta, 2003). Wikan and Molster (2011) concluded that ICT integration is seldom

used to stimulate students' higher-order thinking and for allowing constructivist learning. ICT has been widely used to assist teachers' teaching in the classroom.

In fact, research suggests that the use of technology-related systems can create opportunities to increase interactions and communications between teachers and students (Chou, 2003; Jang, 2010; Wang, 2008). Appropriate uses of ICTs allow Learners to have the freedom of choice, to decide their own time, place, pace, or path to study. Learning materials that are enhanced with various media such as sound, narration, video, animation, graphics etc. provide learners choices to enhance their different intelligence or learning styles. If designed and implemented properly, ICT-supported education can promote the acquisition of the knowledge and 21st century skills such as creativity, critical thinking and problem-solving. Learners are able to exchange ideas more personally and directly.

The new ways of teaching and learning are underpinned by constructivist theories of learning and constitute a shift from a teacher-centered pedagogy to one that is learner centered. There are a lot of internet sites providing interactive learning tools for students. Blogs, Forums, Communities, Webcast, Pod Cast, User Groups, Picassa (Google) and Flickr (Yahoo), Wikis, Web conferencing, Video Conferencing, Chat, E-mail, Instant Messaging, Bulletin Board, Data Conferencing, Shout Box, Image Board, YouTube, Slide Share, Think quest, Schools online ,e-pal and British Council Schools Online. Hennessy, Ruthven and Brindley (2005) found that the use of ICT was associated with a decrease in a direction from and exposition by the

teacher, a corresponding increase in pupil self-regulation, and more collaboration between pupils.

Student centered and motivation

Students can literally initiate the process, proceeding by discovering, inventing, or inquiring, to prepare their own representations and transformations. Then it is the role of the teacher to respond actively and creatively to those student initiatives. In each case the teacher needs to possess both the comprehension and the capacities for transformation. In the student initiated case, the flexibility to respond, judge, nurture, and provoke student creativity will depend on the teacher's own capacities for sympathetic transformation and interpretation.' (Shulman, 1987).

It is interesting to note that the development of pupils as independent learners, an ability that is often considered to be crucial for making effective use of ICT, and which is categorised under 'passion for learning', is only demonstrated at the highest level: 'Motivates pupils to learn independently, continuously provides pupils with opportunities to experience learning as enjoyable and satisfying, to increase their self-motivation. Consistently provides a range of opportunities for pupils to direct their own learning; provides independent learning options, and enables pupils to access these. Encourages self and peer evaluation, builds pupils' capacity to question themselves (Hammond et al., 2011).

The ability to use ICT has become the new literacy for the 21st century (Levin & Wadmany, 2008) and, around the globe, countries see ICT as a potential tool in enhancing education. Since ICT is beneficial in all aspect of life, education cannot be left alone. ICT provides students with tools for

organising, visualising and intuitive manipulation of the problem to make educated decisions more quickly and effectively. This makes it possible for students to become more active and highly motivated (Chen, Jia, & Wang, 2009). Used in conjunction with an interactive whiteboard, the software can be used in whole-class teaching to overcome pupils' apprehensions, to reward them, and let them demonstrate their ability (Kirschner, Sweller, & Clark, 2006). Mathematics curriculum software has been shown to motivate both teachers and pupils, leading to a deeper understanding of the subject matter and enhanced learning opportunities. ICT could increase students' enjoyment of learning and confidence in their ability as fun and games are being brought into the classroom (Tay, Lim, Lim, & Koh, 2012)

Problem-solving

Logo encourages pupils to develop problem-solving skills and to act on feedback (Yelland, 2003). Access to ICT tools helps in the implementation of the problem-centered approach, which in turn may lead to more active and highly motivated students (Newhouse, 2002a). Schools today face ever-increasing demands in their attempt to ensure that students are well equipped to enter the workforce and navigate a complex world. Research indicates that computer technology can help support learning, and that it is especially useful in developing the higher order skills of critical thinking, analysis, and scientific inquiry. Our aim was to encourage far higher levels of active student engagement, where knowledge is obtained by sharing, problem-solving and creating, rather than by passive listening.

This classroom enables both active engagement and equal access, by lead researcher (Burd, 2012). When effectively integrated into a high-quality

learning environment, researchers have demonstrated that ICT can help deepen students' content knowledge, engage them in constructing their own knowledge, and support the development of complex thinking skills (Kozma, 2005; Kulik, 2003; Webb & Cox, 2004). McFarlane and Sakellariou 2002) stated that utilizing ICT tools can benefit students in developing their scientific investigations and reasoning as technology can serve as a conduit between students' practical work and construction of scientific knowledge.

Conceptual Framework

The conceptual framework of the study is shown in Figure 1.

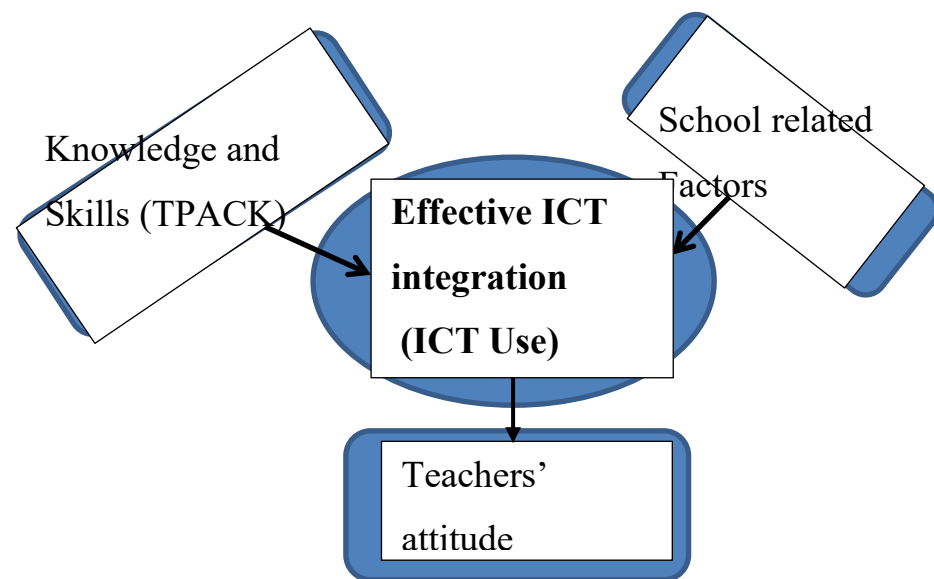


Figure 1: Conceptual Framework of the Study.

Figure 1 shows the conceptual framework of the effective ICT integration in the teaching of mathematics. From Figure 1, teachers' knowledge and skills, teachers' attitude and school related factors can affect effective ICT usage in the classroom. Literature has shown enormous potentials of effective integration ICT in the mathematics classroom. Some of these potentials include an understanding of the mathematical concepts,

Problem-solving, student centered and motivation, etc. Effective ICT integration in this study refers to the actual usage of ICT in teaching and learning of mathematics. In this study effective ICT integration concerns much with the use of ICT preparing lesson notes, lessons, presentations, exploration of the internet during teaching, using of electronic resources, assessment to enhance students learning and mathematical understanding.

Literature also points out clearly that, effective ICT usage in the mathematics classroom is affected by the following; Knowledge and of the teacher (TPACK), School related factors and teachers attitude. Knowledge and skills refer to all the necessary skills including pedagogy and content that aids the teacher in integrating ICT in their lesson. This was determined or measured by Using the TPACK constructs as it reveals all the necessary knowledge and skill that the teachers need to integrate ICT into their classroom.

School related factors refer to all the necessary factors that are in the school environment that hinder or promote ICT integration in the mathematics classroom. School related factors were determined by considering certain variables such as ICT resources, school policies, technical supports, etc. Teachers' attitude used in this study refers to the teacher's anxiety towards ICT usage in the classroom. Teachers' attitudes were estimated by considering teachers anxiety in the use of ICT in the mathematics classroom.

The purpose of this conceptual frame work was to guide the research processes and helped in the interpretation of the data in view of the theoretical contest. This captured teachers TPACK; factors affect technology adoption as

well as teachers' adoption of technology in the classroom as effective for classroom technology integration.

Effective ICT Integration

Effective ICT integration in the conceptual framework helped to determine the extent to which teachers are integrating ICT in the mathematics classroom. This aspect was much concerned with the use of ICT in the mathematics classroom teaching, preparing of lesson notes, assessments of learners as well as lesson presentations. It also looks at the consistent and frequent use of ICT in the mathematics teaching and learning. For instance, if teachers' often use ICT in lesson note preparations, teaching aids preparations, lesson presentation and classroom assessment, then we can conclude that, teachers are effectively integrating ICT in mathematics teaching and learning.

The ability to provide interactive content, give immediate feedback, diagnose student needs, provide effective remediation, assess learning, and store examples of student work that are provided by technological advancement (Watson, 2011) help improve students' learning. Osborne & Hennessy (2003), summarised the potential of ICT in education more succinctly by indicating that they help in expediting and enhancing production of school work; improving motivation and engagement; supporting exploration and experimentation as well as fostering self-regulated and collaborative learning.

The teachers' role is creating the right environment for the students to learn as well as guiding them in the right direction (Owusu, 2014). This role should not be done through the old methods alone but rather teachers need to be aware of the potential of technologies to help them facilitate effective

teaching and learning (Owusu 2014). However, it is accepted that technological skills alone do not necessitate the effective use of technology in teaching (Angeli & Valanides, 2005; Chai, Koh, & Tsai, 2010; Graham et al., 2009; So & Kim, 2009). The mere introduction of technology into the classroom will not necessarily yield the needed results of students maximizing their learning (Koehler & Mishra, 2005).

The teacher is required not only to have knowledge of specific technology but also the knowledge of the affordances and constraints of the technology, use adaptive strategies coupled with how to use these properties of technology to enhance comprehensive learning (Chai, Koh, & Tsai, 2010; Kereluik, Kristen, & Koehler, 2011). The new era of ICT in education should be developed rapidly to appropriate extent in order to match the capability of students as well as teachers in educational experience due to the development of new information technology.

There are a number of significant aspects required for effective implementation of ICT in the classroom (Simin & Sani, 2015). These aspects include: (1) avoiding techno-centric thinking, (2) starting with the identification of educational problems, and (3) promoting constructivist learning environments. The following paragraphs discuss each of these aspects in detail (Harbi 2014). Without appropriate directions, making ICT available in classrooms does not “in itself” lead to better education (Curriculum Corporation, 2005). ICT has to be used in an effective way; otherwise, it may be a waste of time (Romeo, 2006). The use of ICT to support the educational process should start from “dissatisfaction with the educational opportunities offered to students and a striving to do better” (Newhouse, 2002a).

Effective ICT integration reflects using ICT as knowledge construction tools rather than instructional tools (Jonassen, 1996). Jonassen, 1996 advocated the use of ICT as *mindtools* to assist students in organising and interpreting what they learn, instead of as instructional tools to present facts and information to them, which allowing students “function as designers”, and ICT as cognitive amplification tools “for interpreting and organizing their personal knowledge” (Jonassen, 1996). Mind tools are computer applications that engage students in critical, higher order thinking about content (Kirschner et al., 2006). Thus effective ICT implementation promotes constructivist learning environments where students engage with ICT to facilitate creative and critical thinking involving real world learning (Harbi, 2014).

This aspect was also used to exploit how teachers use technology and the different ways by which teachers use technology in the classroom. This is to help to exploit how teachers modify their teaching to accommodate the use of ICT and how to do ICT tools change teachers teaching at the basic level. This will also help to highlight the different in teaching with technology from teaching without technology. In the classroom, there are different ways by which teachers can use technology at the basic level. For example technology can be used to make mathematics lesson more interesting, provide feedback, assessment tools, evaluation, exploration, etc. This aspect aim at exploiting how Ghanaian basic school mathematics teachers use technology in the classroom.

Technology provides different assessment tools such as Checklists, rating scales and rubrics to assess the 21st century skills such as creativity, problem-solving, decision making and leadership skills which are criteria for

project based learning. Hennessy, Deaney, & Ruthven (2005) emphasis that using ICT supports students to check, trial and refines their work which means ICT facilitates immediate feedback and encourages self-correction.

Using the technology to carry out the manual labour of computations or drawing, frees the student to focus on strategies, and encourages a process of trial and error (Hennessy et al., 2005; Jarrett et al., 1968). Technology speeds up the graphing process, freeing pupils to analyse and reflect on the relationships between data (Hennessy et al., 2005). ICT-based tools provide pupils with an advanced communication capability, allowing them to use graphics, images and text together, to demonstrate their understanding of mathematical concepts (Jarrett, 1996).

Knowledge and Skill (TPACK)

The study adopted TPACK framework to assess the knowledge and skills that mathematics teachers have developed about technology, pedagogy and content. Based on TPACK theory, this study assumed that teachers with high TPACK demonstrated more effective technology integration in their classrooms.

Shulman (1986) proposed that effective teaching requires a special type of knowledge, pedagogical content knowledge (or PCK), that represents “the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organised, represented, and adapted to the diverse interests and abilities of learners, and presented for instruction” (p. 8). The central idea of PCK is that learning to teach a particular subject matter requires not only understanding the content itself but also developing appropriate instructional strategies and skills that are appropriate for learners.

Shulman considered teaching as a complex and multidimensional task that does not require only the content area acquired by a teacher in a particular topic but also the pedagogy in the successful implementation of the proposed content (PCK). That is the combination of both the content and the pedagogy in teaching a particular topic. Shulman (1986) conceptualized Pedagogical Content Knowledge (PCK) as distinct from knowledge of content (CK) or pedagogy (PK).

Mishra and Koehler(2006) argued that new technologies (ICT) have changed the classroom to a sufficient extent to justify an extension of Shulman’s model to incorporate the intersections of technological knowledge (TK) with both CK and PK, producing three more intersections (TPK, TCK, and TPCK) as represented in Figure 1. The acronym, TPCK, was later changed to TPACK to reflect the idea that the three knowledge domains form a “Total PACKAGE” (Thompson & Mishra, 2007, p. 38). A combination of TK, CK and PK form TPACK which enables teachers in delivering their subject content to the learners using the most appropriate available technology with suitable pedagogy (Koehler & Mishra, 2006).

The TPACK framework suggests a way of thinking about the knowledge teachers need in order to teach well with technology. It is not enough for teachers to simply know about technology; instead, effectively adopting technology in teaching and learning requires alignment with the content being taught and the pedagogical practices being used. Mishra and Koehler(2006) suggested that the recent importance of digital technologies in education necessitated changes to Shulman’s (1986) framework of the knowledge needed by teachers.

For successful integration of technology in the classroom, teachers should be able to blend technology effectively with pedagogy and content (Koehler & Mishra, 2006). Positive attitudes to ICT and related skills, though necessary, are not sufficient for teachers to solve the “wicked problem” of teaching with technology (Koehler & Mishra, 2008).

In addition to recognizing three distinct bodies of knowledge and the interactions between them, the TPACK framework also takes context into account (Koehler & Mishra, 2008; Rosenberg & Koehler, 2014). Integrating technology is not about technology – it is primarily about content and effective instructional practices. The technology involves the tools with which we deliver content and implement practices in better ways. Its focus must be on curriculum and learning. Integration is defined not by the amount or type of technology used, but by how and why it is used. The TPACK Framework is shown in Figure 2.

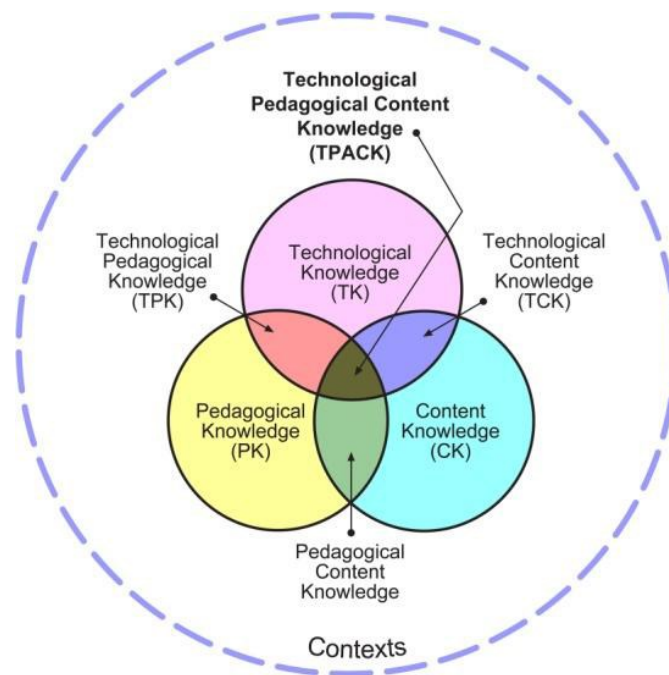


Figure 2: TPACK Framework , Source: Koehler and Mishra, 2008

From the TPCK Framework, three main knowledge component could be identified; technology knowledge (TK), pedagogy knowledge (PK), and content knowledge (CK).

Content knowledge (CK): It includes terms, theories, ideas, constructs, and applications specific to a content area (Shulman, 1986). It is knowledge about an actual subject matter that is to be learnt or taught (Koehler & Mishra, 2006, p.1026). Teachers must know the content they are going to teach and how the nature of knowledge is different for various content areas. This type of knowledge may consist of facts, concepts, ideas, and structure of a subject area, as well as knowledge of evidence, proofs, theories and accepted ways of developing such knowledge established within that content area (Harbi, 2014). This type of knowledge is the subject area a teacher instructs (Kereluik, Kristen, Mathew J. Koehler, 2011). Content knowledge determines what is to be taught in the classroom. A teacher with less content knowledge will find his/her teaching very difficult and may teach wrong facts. Content Knowledge (CK) emphasizes knowledge of the subject matter that is to be taught or learnt. This is the knowledge about the concepts, frameworks, and processes in a given field (Owusu, 2014). Shulman (1987) claimed that “teaching necessarily begins with a teacher's understanding of what is to be learned” (p.7). Mathematics teachers are expected to have mastery over the subject they teach. Teachers should have adequate knowledge of the content as well as the process and the products involved in presenting those content. They should be able to understand the “disciplinary „habits of mind” appropriate to the subject they teach” (Harris & Hofer, 2009). An individual without this knowledge

may have misconceptions or misleading facts regarding the area (Koehler & Mishra, 2009).

Pedagogical knowledge: Pedagogical Content Knowledge (PCK) indicates the manner in which the content can be represented and formulated to make it comprehensible to others (Shulman, 1986). Pedagogical knowledge refers to the methods and processes of teaching and includes knowledge in the classroom management, assessment, lesson plan development, and student learning (Chai, Koh, & Tsai, 2010). This is the knowledge one needs to be able to implement the content knowledge successfully in the classroom. In other words, it refers to the practice, procedure, or methods necessary for teaching and learning (Koehler et al., 2007).

PCK encompasses knowledge of pedagogies and the planning processes that are appropriate and applicable to the teaching of a given content at any given time (Abbitt, 2011). For effective teaching, Harris et al. (2009) maintained that knowledge of teaching and learning, assessment procedures, awareness of students' prior knowledge and content-related misconceptions are very essential. It deals with how to design specific subject matter or problems and teach it effectively to suit learners of diverse abilities (Owusu, 2014). It involves knowledge about overall educational objectives, values, aims, lesson planning, classroom management and assessment (Harbi, 2014). It also includes an understanding of students' learning, the nature of the target audience and the different types of learning theories (Koehler & Mishra, 2009). More importantly, teachers need this knowledge to present the content in more digestible and understandable to the learners and also to develop a positive attitude towards teaching.

Technological knowledge: Defining technology is notoriously difficult because it is always in a state of flux (Mishra, & Koehler, 2009). It is therefore difficult to keep up to date with technology which makes it more difficult to define technological knowledge because such definition has a very high propensity of becoming obsolete within the shortest possible time (Owusu, 2014). Technology knowledge refers to the knowledge about various technologies, ranging from low-tech technologies such as pencils and paper to digital technologies such as the internet, digital video, interactive whiteboards, and software programs (Schmidt et al., 2010). This knowledge includes all instructional materials from the blackboard to advanced technologies (Koehler et al., 2007). Technological knowledge is the ever evolving knowledge base of how to use different digital and emerging technologies in different settings (Owusu, 2014). This means TK has no finality about it but rather assumes a developmental posture which means that it will be “evolving over a time of generative interactions with multiple technologies” (Graham et al., 2009).

In addition, the model has the three dyadic components of knowledge: technological pedagogical knowledge (TPK), technological content knowledge (TCK), and pedagogical content knowledge (PCK) these include the following:

Pedagogical content knowledge (PCK) indicates the manner in which the content can be represented and formulated to make it comprehensible to others (Shulman, 1986). PCK goes beyond just pedagogy and content. It looks at how these two relate and interact for effective teaching (Owusu, 2014). PCK encompasses knowledge of pedagogies and the planning processes that are appropriate and applicable to the teaching of a given content at any given time

(Abbitt, 2011). Pedagogical Content Knowledge is different for various content areas, as it blends both content knowledge and pedagogy with the goal being to develop better teaching practices in the content areas (Schmidt et al., 2010). PCK is knowledge about what teaching approaches fit the content and how elements of the content can be arranged for better teaching (Chai, Koh, & Tsai, 2010). PCK also includes anticipating what types of questions and problems teachers most likely will encounter and knowledge of what makes specific content difficult or easy to learn (Koehler & Mishra, 2005). PCK includes “knowledge of teaching strategies that incorporate appropriate conceptual representations in order to address learner difficulties and misconceptions and foster meaningful understanding (Koehler & Mishra, 2005).

Technological content knowledge: Technological knowledge content Knowledge refers to the knowledge of how technology can create new representations for specific content (Schmidt-et.al.2010).It suggests that teachers understand that, by using a specific technology, they can change the way learners practice and understand concepts in the specific content area (Schmidt-et.al.2010). Koehler and Mishra (2009) defined TCK as the knowledge of “the manner in which technology and content influence and constrain one another” (p. 65). Teachers need to understand the “manner in which the subject matter can be changed by the application of technology” (Koehler & Mishra, 2009, p.65). TCK involves an understanding of facilitating content representation (Cox & Graham, 2009). The availability of specific technology can help make the delivery of certain content easy to learn, concrete and real to students. It is the knowledge of how to utilize an

emerging technology to represent specific concepts in a given content domain (Cox & Graham, 2009). Harris et al., (2009) argue that Teachers must understand which technologies are best suited for addressing which types of subject-matter, and how content dictates or shapes specific educational technological uses, and vice versa.

Technological pedagogical knowledge: Technological Pedagogical Knowledge (TPK) refers to knowledge of using technology to implement different teaching methods. It is the “knowledge of how various technologies can be used in teaching and to understanding that using technology may change the way teachers teach” (Schmidt et al., 2009, p. 125). TPK deals with the ability to realize how technology affects the methods and strategies for teaching and how effective teaching and learning can be achieved with technology (Owusu, 2014). According to Koehler and Mishra (2009), TPK is “an understanding of how teaching and learning can change when particular technologies are used in particular ways” (p. 65). It seems that TPK is the understanding of how to use technology to support general teaching strategies without reference to specific content (Harbi 2014). Teachers need to “look beyond the immediate technology and ‘reconfigure’ it for their own pedagogical purposes” (Koehler & Mishra, 2008, p. 17).

Technological pedagogical content knowledge: TPCK is the understanding that emerges from the interactions and interplays between and among technology, content and pedagogical knowledge that underlies meaningful teaching with technology (Koehler & Mishra, 2009). The basis of effective teaching with technology, requiring an understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in

constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face; knowledge of students' prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge to develop new epistemologies or strengthen old ones (Koehler & Mishra, 2009, p. 66).

Abbitt (2011) insisted that the complex relationships between the constructs provide a basis for understanding teacher knowledge that supports successful technology integration into classroom learning environments. Technological pedagogical content knowledge refers to the knowledge required by teachers for integrating technology into their teaching in any content area. Teachers have an intuitive understanding of the complex interplay between the three basic components of knowledge (CK, PK, TK) by teaching content using appropriate pedagogical methods and technologies (Schmidt et.al. 2010).

TPCK is different from knowledge of all three concepts individually. It is the basis of effective teaching with technology and requires an understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face; knowledge of students' prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge and to develop new epistemologies or strengthen old ones (p. 17-18).

Teacher Attitude towards Effective Technology Integration

The attitude in this contexts, concerned with teachers' anxiety in the use of the computer in teaching and learning of mathematics. This aspect was used to exploit teachers' anxiety in the use of ICT in teaching mathematics. Teachers that ware too anxious about the use of ICT tend to developed negative attitudes towards computers and hence will resist their usage and vice versa. According to Mueller, Wood, Willoughby, Ross and Specht (2008) *computer anxiety* is the most important dimension of attitude towards computer scale; indicating that teachers who are anxious about computers tend to develop negative attitudes toward computers and express opposition to their use.

Ertmer (2005) stated that the decision of whether and how to use ICT for educational purposes significantly depends on the teachers and their related factors, for example, beliefs, confidence and skills, with regards to ICT implementation. Effective use of ICT in the classroom is also linked to teachers' attitudes and levels of knowledge (Garland & Noyes, 2004). According to Becta, (2004) when teachers lack technical skills, they are likely to be anxious "about possible technical problems, as they would have less of an understanding of how to avoid or solve such problems independently" (Becta, 2004, p. 21). Gibson et al., (2014) assert that teachers' attitudes play an important role in the teaching-learning process that utilises computers and Internet connections. Unfortunately, according to Wheeler (2000), whilst some have the passionately integrated technology (such as computers), others have guardedly welcomed it whilst others have out rightly rejected it. The resistance in the acceptance of ICT in the classroom is often said to be primarily based

on the “risk of teachers losing influence over the values and directions of classroom activity” (Trinidad, Newhouse, & Clarkson, 2005).

School related Factors Affecting Technology Adoption in the Classroom

This aspect dealt with the factors that affect ICT adoption in Ghanaian basic school mathematics classroom. This helped to exploit the factors presents in schools that facilitate or hinder the adoption of Technology in mathematics classroom at the basic level. In this context, school factors refer to policy planning, ICT tools, technical support and school factors that facilitate ICT integration in mathematics Classroom. If these factors are favourable, then ICT integration in the mathematics classroom is likely to follow. ICT implementation can be affected by a number of factors. The Success of ICT implementation in education is how effectively and efficiently ICT is used in teaching and learning. A lot of factors have been identified as a barrier to the successful implementation in education (Abbitt, 2011; Mumtaz, 2000; Jo Tondeur, Valcke, & Braak, 2008). Not surprisingly, then, appropriate and effective classroom use of ICT is found to be rare (e.g., Ofsted 2001). In practice, established curricula and teaching methods remain in place under a thin coating of technological glitter, and available technology is often underused and poorly integrated into classroom practice.

In addition to the new interpersonal and pedagogic skills that teachers require to use ICT in their classrooms, other contextual factors that can act as barriers to using ICT include: lack of confidence, experience, motivation, and training; access to resources and timetabled use of dedicated ICT suites; unreliability of equipment; classroom practices which clash with the culture of student exploration, collaboration, debate and interactivity within which much

technology-based activity is said to be situated (Becker, 2000; Bell, 1996; Hadley & Sheingold, 1993). Technology as a double cutting sword needs to be well adopted in the classroom to enhance or to promote teaching and learning. Even though technology has a lot of positive impact on the teaching and learning of mathematics, its adoption could be restricted by a lot of factors.

Technical support

Technical support can hinder effective technology integration in the classroom situation especially new teachers who are unfamiliar with the new technology and tools. For student teachers who may be unfamiliar with new labs, new tools, or different software versions, providing technical and instructional support is a key factor for successful integration of technology (Bullock, 2004; Dexter & Riedel, 2003; Doering, Hughes, & Huffman, 2003; Grove, Strudler, & Odell, 2004). Because, support to ICT does not simply refer to bridging the hardware-divide rather the access to infrastructure and services should help users in getting knowledge, skills, and consistent support of organisational structures to achieve broader social and community objectives (Ågerfalk, Goldkuhl, Fitzgerald, & Bannon, 2006; Macleod, 2005).

Technical support is an important part of the implementation and integration of ICT in education however, often technical support is not available requiring the teachers and students to command some basic troubleshooting skills to overcome technical problems when using ICTs (Sife, Lwoga, & Sanga, 2007). The ICT support covers resolving hardware problems, implementing software installations and helping users in common applications of ICTs in e Teaching, eLearning and e Education (Chen et al.,

2009). Technological sustainability involves choosing technology that will be effective over the long term (Tinio & Browne, 2003).

Access to ICT resources

An important influence on the use made of ICT in subjects and classes is the amount and range of ICT resources available to the teachers. Where there are limited numbers of computers in a class, mostly in primary schools, this limits their impact, because each individual pupil is only able to use the computer for a few minutes. Whole-class use of an electronic whiteboard has both positive and negative effects. It promotes pupils' debates and helps them visualise difficult concepts and processes. However, some teachers focus only on the presentation aspects, disregarding the use of simulations and modeling which might be more challenging for the pupils. In a study by Korte and Hüsing (2006) the majority of teachers stated that the lack of ICT infrastructure in schools prohibited them from using ICT in their practices.

Lacks of resources include lack of availability of technology in a school as well as lack of access to this technology (Hew & Brush, 2007). Balanskat, Blamire, and Kefala (2006) emphasised that, the accessibility of ICT equipment does not necessarily lead to its effective implementation. The lack of high quality hardware and suitable educational software are also considered by the majority of educators to be significant barriers to effective ICT implementation (Harbi, 2014). Teachers and students, have limited or no access to ICT infrastructure and equipment such as digital microscopes, digital cameras, computer labs, laptop computers and scanners needed for effective ICT integration into education (Klieger, Ben-Hur, & Bar-Yossef, 2010).

Policy and planning

Policy and planning have been identified as one of the major determinants of ICT implementation in Schools. This policy includes the national policy (Macro level) and the School policy (micro level). Visscher and Coe, (2003) pointed at the variability between schools, suggesting that general, central policies and reforms do not automatically lead to an educational change in schools. It is important to examine the extent that policy captures the importance of teacher usage of ICTs and plans for its roll-out. It is emphasized by the Ghana ICT Education policy, that government's desire is, through the deployment of information and communication technology (ICT) in education, the culture and practice of traditional memory-based learning will be transformed into education that stimulates thinking and creativity necessary to meet the challenges of the 21st Century (MOE, 2007).

The presence of national and/or education sector-specific policy, plan or regulatory framework for ICT implementation strategy has a direct influence on teachers' motivation but also the general environment in which ICTs are rolled-out. The policy can provide for motivation to make use of ICT in the classroom such as pay incentives, additional professional development opportunities and peer recognition. For instance, governments often support or give incentives to teachers to purchase ICT devices, including for out of class use.

The implementation of ICT is not just about the individual teacher but about an organisation that affects and is affected by the process (Sang, Valcke, van Braak, Tondeur, & Zhu, 2011). Therefore, when designing and implementing learning software, software developers have to look beyond the

paradigms of their own discipline through an interdisciplinary exchange with teachers, authors and learners (Santos, Boticario, & Pérez-Marín, 2014). High-quality IT literacy teaching requires the administration to provide support for faculty by adequately funding the staffing of IT services personnel to levels that can accommodate the demands placed upon them (Ezziane, 2007).

School culture

The culture of a school can greatly affect technology integration in the mathematics classroom. A school's culture establishes the conditions for ICT practices in schools or at the level of organisations (Umar, Hussin, Naufal, & Khasraw, 2014). When the school culture is favourable for the integration of the ICT, then it is likely that, some of the teachers may start using ICT in their lessons. According to (Hsu, 2011; Romeo, 2006) favourable school culture will promote beginning teachers to successfully enact ICT usage in their schools.

Chapter Summary

This chapter presented literatures that are relevant to the study. The chapter began with the discussion of the benefits of ICT in education. The literature indicated that teachers' knowledge was essential in the ICT integration in education. The literature also indicated some factors that affected the effective ICT integration in education as well as a component of effective ICT integration. The literature indicated that, the mere presents of the ICT resources in the classroom do not guarantee its integration.

Rather the integration of ICT in the classroom depends much on the teacher's Knowledge and skills (TPACK) and other factors such as Policy and planning, availability of ICT resources, Management and support and teacher

attitude. The literature also highlighted the policies of Ghana government in relation to ICT implementation as well as school policies. Finally, the literature pointed out that school culture can influence ICT integration in the mathematics classroom.

In the next Chapter, the methodology and methods that will be employed in the study of Ghanaian basic school mathematics ICT integration will be highlighted in detailed.

CHAPTER THREE

RESEARCH METHODS

This chapter describes the methodology that was used to study basic school mathematics teachers effective ICT integration. The chapter includes the following sections: research design, population and sample, data collection instrument, pilot study, Sampling procedure, data analysis methods and ethical considerations.

Research Design

The main research design adopted for the study was survey. A survey design provides a quantitative or numeric description of trends, attitudes, or opinions of a population by studying a sample of that population (Creswell, 2013). From sample results, the researcher generalizes or draws inferences to the population. The purpose of this survey is to generalize from a sample to a population so that inferences can be made about some characteristic, attitude, or behavior of this population.

Survey research design provides a quantitative or numeric description of trends, attitudes, or opinions of a population by studying a sample of that population. It includes cross-sectional and longitudinal studies using questionnaires or structured interviews for data collection-with the intent of generalizing from a sample to a population (Fowler, 2008). This research adopted the longitudinal studies using questionnaire.

Surveys have been found to have the ability to provide an opportunity to reach a large sample size which increases the generalization of the findings. They also provide an opportunity for the participants to respond to the items on the survey, a place and time convenient to them as well as producing

responses that are easy to code (Gray, 2004). There is greater anonymity associated with surveys. They also provide consistent and uniform measures and respondents are not affected by the presence and or attitudes of the researcher (Sarantakos, 2013). Surveys are also capable of providing descriptive, inferential and explanatory information that can be used to ascertain correlations and relationships between the items and themes of the survey (Byrne, 2007).

On the other hand, surveys also have their own deficiencies among which are the inability to ask probing questions as well as seek clarifications, inability to determine the conditions under which the respondent responded to the questionnaire items as well the ability to generate high unresponsive rate (Sarantakos, 2013). The survey was an appropriate design for this quantitative research since it helped to answer the stated research questions and achieve the objective of this research. The survey was also chosen because its strength in this research outweighs its weakness hence it is suitable for this study.

Survey design is a quantitative approach and is sometimes called the scientific method, or doing science research. It is also called positivist/postpositivist research, empirical science, and postpositivism. This is called post-positivism because it represents the thinking after positivism, challenging the traditional notion of the absolute truth of knowledge (Gibson et al., 2014) and recognizing that we cannot be positive about our claims of knowledge when studying the behavior and actions of humans.

The post positivist tradition comes from 19th-century writers, such as Comte, Mill, Durkheim, Newton, and Locke (Smith, 1983) and more recently from writers such as Phillips and Burbules (2000). The quantitative approach

falls under the Post positivism paradigm which believes that knowledge is objective and the absolute truth of knowledge (Philips & Burbules, 2000) and recognizes that we cannot be positive about our claim of knowledge when studying the behavior and actions of humans.

Post positivists hold a deterministic philosophy in which causes (probably) determine effects or outcomes. Thus, the problems studied by post positivists reflect the need to identify and assess the causes that influence outcomes, such as found in experiments (Creswell, 2013). The quantitative method was used in this study since is a means for testing objective theories by examining the relationship between variables. These variables, in turn, can be measured, typically on instruments, so that numbered data can be analysed using statistical procedures.

The final written report has a set structure consisting of introduction, literature and theory, methods, results, and discussion (Creswell, 2008). A survey was used because surveys are able to assist “gather data at a particular point in time with the intention of describing the nature of existing conditions, or identifying standards against which existing conditions can be compared, or determining the relationships that exist between specific events” (Cohen, Manion, & Morrison, 2007, p. 169).

Study Area

The study was conducted in Bibiani in the western region of Ghana. It is a district capital of Bibiani/Anhwiaso/Bekwai district. Its population is about 26,352. The town’s economy is dominated by services followed by mining and farming.

Population

The population of the study included all the mathematics teachers at the basic school level in Bibiani in the western region of Ghana. This included all teachers that teach mathematics at the Public Junior High School level, teachers that teach mathematics at the Public primary school level and Pre-School level. The primary level includes the upper primary and lower primary teachers. For the purpose of this research, the teachers were sampled from Bibiani in the Western region of Ghana basic schools. Bibiani was chosen because teachers from the different cultural background, educational level, among others teach at the area. In addition, Bibiani was chosen because it has all the types of basic schools in the country: government schools, missions' schools, day school etc.

Bibiani community has three education Circuits: Circuit A, Circuit B and Circuit C. According to western regional education director, the 2015/2016 teachers enrolment in Bibiani are as follows: There are thirty-two (32) public pre-schools, thirty-two (32) public primary schools and 37 public Junior High Schools making a total of One hundred and one (101) public basic schools in Bibiani. Circuit A has 40 pre-school teachers, 65 primary school teachers and 61 Junior High School teachers making a total of 166: circuit B have 36 pre-school teachers, 60 basic school teachers and 70 Junior High Schools teachers making a total of 166: Circuit C have 35 pre-school teachers, 119 primary school teachers and 51 Junior high school teachers making a total of 205 .The total number of basic school teachers in Bibiani is Five hundred and thirty-seven (537) of which all the mathematics teachers were considered

as the population for the study. The sample chosen from this region has similar characteristics to the other teachers in the other regions in Ghana.

Sampling Procedure

The circuit A, B and C were considered as clusters and had already been grouped by the education directorate with each circuit having homogeneous groups. Since the circuits were considered as clusters, the adoption of cluster sampling techniques was suitable for this study. Cluster sampling was used for this study for the following purposes; it is cheap, quick and easy as compared to other probabilistic methods. Circuit C was chosen randomly from the three main clusters (Circuit A, Circuit B and Circuit C) for this study. All government basic school mathematics teachers in Bibiani Circuit C were used for this study.

This included all teachers who teach mathematics at the Junior High School as well as teachers that teaches mathematics at the primary level. In Bibiani, some schools employ subject teaching at the primary level especially the upper primary level whiles some schools go by the class teaching method. For the subject teachers, only the mathematics teachers were selected for the study whiles for the class teaching since teachers teach all subjects, it presupposes that they are also mathematics teachers and hence were considered for the study.

Data Collection Instruments

A questionnaire was used to collect data for this study. This is because large amounts of information can be collected from a large number of people in a short period of time and in a relatively cost effective way (Creswell, 2013). The results of the questionnaires can usually be quickly and easily

quantified by either a researcher or through the use of a software package, can be analysed more 'scientifically' and objectively than other forms of research instruments, Positivists believe that quantitative data can be used to create new theories and/or test existing hypotheses (Creswell, 2013).

For a collection of the quantitative data, the researcher used a five-part, self-report questionnaire, designed for this study. The sections are entitled: Part A: Demographics of the respondents, Part B: TPACK Scale, Part C: School related-factors affecting technology integration, Part D: teachers' attitude towards ICT integration in the teaching of mathematics and Part E: Effective ICT integration in the teaching and learning of mathematics.

Part A (Demographics of respondents)

The first section of the questionnaire was used to collect data for demographical characteristics; gender, educational level, class teachers teach and year of teaching experience of the teachers.

Part B (TPACK Scale)

This questionnaire was based on the seven construct of TPACK (Koehler & Mishra, 2005, 2008; Koehler & Mishra, 2006). The questionnaire that was used to assess teachers TPACK level was adopted from Schmidt et al, (2009) surveys for assessing TPACK. TPACK survey was adopted since; it has been estimated to have high validity and reliability. This was done because for a complex and multidimensional variable, it is appropriate to use an existing instrument if one exists (Punch, 2009). It is mostly adopted by a lot of researchers in an attempt to assess teachers TPACK. The questionnaire has seven sections about the constructs of TPACK. Section one to section seven measured the various construct of the TPACK framework. There are 29

numbers of questionnaires under the TPACK survey which are divided into the seven construct. The numbers of questionnaire under each construct are as follows: Technology Knowledge (TK), 7; Content Knowledge (CK), 3; Pedagogy Knowledge (PK), 7; Pedagogical Content Knowledge (PCK), 1; Technological Content Knowledge (TCK), 1; Technological Pedagogical Knowledge (TPK), 5; and Technological Pedagogical Content Knowledge (TPACK), 5.

Participants responded to each item on the questionnaire using the five-level likert scale: strongly disagree (1), disagree (2), neither agree or disagree(3), agree(4) and strongly agree(5).

Part C: School related factors affecting ICT integration

This part concerned with factors that may affect effective technology integration which contained twenty five items. The questionnaire from this part was designed by the researcher from previous research (Ertmer, 2005; Kennewell & Morgan, 2006; Newhouse, 2002a). This has 25 items grouped under sections availability of ICT resources, management and support, policy and planning and school culture. Participants responded to this part using a 5-point, Likert-type scales, ranging from (1) strongly disagree to (5) strongly agreed.” Also the questionnaire was pilot tested with samples that have the same characteristics as the population and the internal validity was ensured by using Chronbach alpha. Since the instruments were modified, it was given to my supervisor who is experienced in the use of ICT to review the questionnaire as well as mathematics teachers that use technology in teaching. This ensured content validity. Also the questionnaire was pilot tested with

samples that have the same characteristics as the population and the internal validity was ensured by using Chronbach alpha.

The questionnaire was pilot-tested and modified before the actual research was carried out. This was achieved through the use of self-administered questionnaire without the presence of the researcher to collect data for the study.

Part D: Teachers attitude towards ICT integration

Teachers' Attitudes toward Computers (TAC) was adopted to assessed teachers attitude towards ICT integration. The TAC has been developed based on existing computer attitudes scales (Christensen & Knezek, 2009). These measurement instruments are confirmed to be reliable by previous research (Knezek & Christensen, 1998).The TAC have many sub scales. For the purpose of this research, the subscale anxiety (fear to use and talk about computers) was adopted for the study. Questionnaires have 6 items measuring the teachers' anxiety towards ICT integration. Participants will respond to this part using a 5-point, Likert-type scales, ranging from (1) strongly disagree to (5) strongly agreed.” Rescaling of some items of the anxiety scale was done, so that a high score on computer anxiety could be interpreted as lack of anxiety.

Part E: Effective integration of ICT in mathematics teaching and learning

This part concerned with teachers' effective integration of technology in their teaching. The questionnaire that was used for this quantitative study were adopted and adapted from the original questionnaire designed by Gulbahar and Guven (2008). This part of the questionnaire consisted of 10 items measuring effective ICT integration. Participants responded to this part

using a 5-point, Likert-type scales, ranging from (1) Never to (5) Always.” Since the instruments were modified, it was given to my supervisor who is experienced in the use of ICT to review the questionnaire as well as mathematics teachers that use technology in teaching. This ensured content validity. Also the questionnaire was pilot tested with samples that have the same characteristics as the population and the internal validity and reliability were ensured.

The questionnaire was pilot-tested in Sefwi-Bekwai and modified before the actual research was carried out. This was achieved through the use of self-administered questionnaire without the presence of the researcher to collect data for the study.

This was conducted by randomly selecting a sample of 40 teachers with 50% from primary and Junior High School mathematics teachers respectively and the questionnaire was given to the teachers to respond. The results of the pilot test were presented. According to Cohen, Manion and Morrison (2007), pilot test is important for the following reasons; to check the clarity of the questionnaire items, instructions and layout, to gain feedback on the validity of the questionnaire items, the operationalization of the constructs and the purposes of the research, to identify omissions, redundant and irrelevant items, to gain feedback on the attractiveness and appearance of the questionnaire, gain feedback on the layout, sectionalizing, numbering and itemization of the questionnaire, to check whether the questionnaire is too long or too short, too easy or too difficult, to identify which items are too easy, too difficult, too complex or too remote from the respondents’ experience, to identify commonly misunderstood or non-completed items (e.g., by studying

common patterns of unexpected response and nonresponse (Verma & Mallick 1999: 120).

This was achieved through the use of self-administered questionnaire without the presence of the researcher to collect data for the study. This enabled respondents to complete the questionnaire in private, to devote as much time as they wish to complete, to be in familiar environments, to avoid potential treat or pressure to participate caused by the researcher presence, it is inexpensive and is more anonymous than having the researcher presence.

Validity and reliability of the survey instruments

The validity and reliability of the survey are much more important for the statistical analysis of basic school mathematics teachers TPACK. It has been suggested that for an item to be considered reliable, a value of Cronbach's alpha should be 0.7 or more (Kline, 2000, Anastasi, 1982; Tavsancil, 2002).

The reliability scores of the various constructs of the TPACK are as follows: Technology Knowledge (TK) 0.82, Content Knowledge (CK) 0.85, Pedagogy Knowledge (PK) 0.84, Pedagogical Content Knowledge (PCK). 0.85, Technological Pedagogical Knowledge (TPK) 0.86, Technological Content Knowledge (TCK) 0.80, Technological Pedagogical Content Knowledge (TPACK). 0.92. Since all the reliability coefficients of the various construct are more than 0.7 the items under the subscales are considered to be reliable.

The validity and reliability of the survey were much more important for the statistical analysis of basic school mathematics teachers' effective ICT integration. The feedback of the respondents helped the researcher to improve the quality of the survey in terms of content coverage, content validity and

reliability. In this research, the construct validity and the internal reliability of each of Part C, Part D and part E survey were found.

Reliability coefficients are measured by using a scale from 0.00 (very unreliable) to 1.00 (perfectly reliable) (Gray, 2004). It has been suggested that for an item to be considered reliable, a value of Cronbach's alpha should be 0.7 or more (Kline, 2000, Anastasi, 1982; Tavascil, 2002). Since all the reliability scores of the various subscales: technical support (0.897), teachers' attitude (0.834), effective ICT usage (0.867), Availability of ICT tools (0.847), School culture (0.834) and Policy and planning (0.763) are more than 0.7, the items under the subscales are considered to be reliable.

Data Collection Procedure

The researcher collected a letter from the department of Mathematics and ICT education to be given to the district education director and the head teachers to seek permission to undertake this research in their schools. The researcher administered the questionnaire by himself. There are two types of self-administered questionnaire: those that are completed in the presence of the researcher and those that are filled in which the researcher is absent (e.g. at home, in the workplace) (Cohen, Manion, & Morrison, 2007).

This was achieved through the use of self-administered questionnaire without the presence of the researcher to collect data for the study. This enabled respondents to complete the questionnaire in private, to devote as much time as they wish to complete, to be in familiar environments, to avoid potential treat or pressure to participate caused by the researcher presence, it is inexpensive and is more anonymous than having the researcher presence.

The presence of the researcher is helpful in that it enables any queries or uncertainties to be addressed immediately with the questionnaire designer. Further, it typically ensures a good response rate (e.g., undertaken with teachers at a staff meeting or with students in one or more classes). It also ensures that all the questions are completed (the researcher can check these before finally receiving the questionnaire) and filled in correctly.

On the other hand, having the researcher present may be threatening and exert a sense of compulsion, where respondents may feel uncomfortable about completing the questionnaire, and may not want to complete it or even start it. Respondents may also want extra time to think about and complete the questionnaire, maybe at home, and they are denied the opportunity to do this.

Having the researcher present also places pressure on the researcher to attend at an agreed time and in an agreed place, and this may be time consuming and require the researcher to travel extensively, thereby extending the time frame for data collection. Since the benefit of the self-administration without the presence of the researcher out ways that of the self-administration with the presence of the researcher for this research, the former was much preferred.

Data Processing and Analysis

The data were exported to the Statistical Package for the Social Sciences (SPSS) version 21. Only responses from completed questionnaires were analysed. Before the analyses of the data were done, the researcher did preliminary data screening. This involved checking for missing values, checking for assumptions of outliers and normality. The data entries were done by the researcher in order to check the accuracy of the data. Data was

cleaned before running any analysis. Cleaning the data helped the researcher to get rid of errors that could result from coding, recording, missing information, influential cases or outliers.

Research Question One was analysed by using descriptive such as means and standard deviations to determine the extent of effective ICT integration among basic school mathematics teachers.

Research Question Two was analysed by using descriptive such as means and standard deviations to determine the teachers TPACK, Independent t-test was used to find the mean difference on TPACK constructs based on gender and level taught.

Research Question Three was analysed by using descriptive such as means and standard deviation to estimate teachers' attitude toward ICT integration in the classroom. The correlation was used to find the relationship between teachers' attitude and effective ICT usage.

Research Question Four, was analysed by using descriptive such as means and standard deviations to assess the extent by which School related factors affect effective ICT integration at the basic level. The correlation was also used to determine how the school related factors relate to effective ICT usage. Also, linear multiple regression was used to show the school related factor that best predicts ICT usage in the classroom.

Research Question Five was analysed by using correlation to find the relationship between components that affect effective ICT integration and effective ICT usage. Also, Linear multiple regression analysis was used to determine the components (Teachers TPACK, School related factors and

Teachers attitude towards ICT integration) that best predicts Teachers' effective ICT integration.

Ethical clearance

In conducting a research ethical issue is essential and must be paid attention to. The researcher obtained the Ethics approvals from the University of Cape Coast Ethical Approved Board and the Ministry of Education in Ghana through the district director. The aim and the objectives of this research were stated clearly to show what the research was about. The researcher stated the participants involved and how the research could carry low risk of harm to participants or no harm at all. For instance sensitive information provided by the teacher was treated with care and the teachers' anonymity and confidentiality of their information were assured. This encouraged the participants to contribute their maximum cooperation in providing vital information for the study.

Chapter Summary

The methodology adopted in this chapter was informed by the research questions, and the Purpose of the research. The aim of the research is to examine basic school mathematics Teachers effective ICT integration. Therefore the Post positivism paradigm which is quantitative research method was used for the study. This was achieved through the use of a survey .With the survey; the respondents were given a questionnaire to fill by the researcher. The data generated from the survey was analysed to find the mean responses for each of the TPACK constructs.

The ethics in conducting research was also followed prior to the data collection. In the next chapter, data was collected and analysed with the aim to answer the research questions.

CHAPTER FOUR

RESULTS AND DISCUSSION

This chapter discusses the results of the survey data. The current study investigated basic school mathematics teachers' ICT integration in the teaching and learning of mathematics; their level of knowledge and skills (TPACK), school-related factors that affect ICT integration in the mathematics classroom as well as teacher's attitude that affect ICT integration in the mathematics classroom. The purpose was to explore the extent to which basic school mathematics teachers in Bibiani in the Western region of Ghana are integrating ICT into teaching of mathematics. The research sought to describe the level of Technological Pedagogical Content Knowledge (TPACK) among Ghanaian basic school mathematics teachers, determine the extent to which school-related factors affect ICT integration among Ghanaian basic school mathematics teachers, determine the extent to which Ghanaian basic school mathematics teachers attitude affect ICT integration into their classroom and to determine the extent to which Ghanaian basic school mathematics teachers use ICT in their classroom. The study also sought to determine the extent to which teachers' Knowledge and Skill (TPACK) of ICT, teachers' attitude towards ICT use, school-related factors affecting ICT integration predicts teachers' ICT integration in the classroom.

For the purpose of this study, the researcher used questionnaires as the instrument for the study. The questionnaire composed of five sections; demographics of the respondents, teachers ICT knowledge and skills levels (TPACK), their school-related factors (availability of ICT tools, planning, and policy, technical support, and school culture), teachers' attitudes (anxiety)

toward ICT usage and effective ICT usage. The data were analysed using IBM SPSS Statistics version 21 package. The data were analysed using descriptive statistics such as percentages, frequencies, means, standard deviations, and inferential statistics such as independent t-test, correlations, and linear multiple regressions. The demographic characteristics of the respondents are shown in Table 1. The rest of the pages in this chapter show how the data have been organised and discussed under various headings

Demographic Information of Basic School Mathematics Teachers

The demographic information of mathematics teachers included gender, educational level, the class that teachers teach and years of experience as shown in Table1.

Table 1 - *Distribution of Respondents According to Demographics*

Demographics	Frequency	Percentages (%)
Gender		
Male	80	54.1
Female	68	45.9
Educational level		
Certificate A	12	8.1
Diploma	76	51.3
Degree	58	39.2
Masters	2	1.4
Class taught		
Lower Primary	47	31.7
Upper Primary	54	36.5
JHS	47	31.8
Years of experience		
Below 1 year	8	5.4
2-5 Years	56	37.8
6-9 Years	46	31.1
10 Years and Above	38	25.7

Source: Field survey (2017)

Table 1 shows the distribution of respondents according to gender, educational level, class teachers teach and years of experience. The percentage of male respondent accounted for 54.1% (80) while there were 45.9% (68) females. With respect to the educational level, the highest percentage was recorded by diploma teachers 51.3% (76), followed by teachers with degree 39.2% (58), 12

teachers have certificate A while two teachers had a master of education degrees. The percentage of respondents from lower primary, upper primary and JHS levels were 31.7, 36.5 and 31.8 percent respectively. Majority of the respondents had taught from two to nine years accounting for 68.9% of the respondents while 5.4% of the respondents had less than a year in teaching experience.

Extent of ICT Usage in Basic School Mathematics Classroom

The study sought to investigate the extent to which teachers are integrating ICT in the mathematics classroom. This was done to address Research Question one.

Research Question One

To what extent are basic school mathematics teachers integrating ICT into their Classroom?

To answer this research question, the researcher calculated the means and standard deviations for each of the statement. Table 2 shows the various use of ICT in the mathematics classroom by the basic school mathematics teachers.

Table 2 - *ICT Usage among Basic School Mathematics Teachers*

Effective ICT integration	Never Freq (%)	Rarely Freq (%)	Sometime Freq (%)	Often Freq (%)	Always Freq (%)	Mean	SD
1. I use technology during mathematics instruction	61(41.2)	16(10.8)	54(36.5)	15(10.1)	2(1.4)	2.2	1.13
2. I use technology to prepare my mathematics teaching aids and my notes	59(39.9)	11(7.4)	54(36.5)	14(9.5)	10(6.8)	2.4	1.28
3. I engage students in learning activities that require them to analyze information, think creatively, make predictions, and/or draw conclusions using the digital tools and resources available in my classroom.	35(23.6)	24(16.2)	42(28.4)	30(20.3)	17(11.5)	2.7	1.32
4. My students use the classroom digital tools and resources to engage in relevant, challenging, self-directed learning experiences that address the content standards.	49(33.1)	22(14.9)	49(33.1)	21(14.2)	7(4.7)	2.4	1.22
5. I use ICT in Mathematics classroom assessment	60(40.5)	22(14.9)	39(26.4)	19(12.8)	8(5.4)	2.3	1.25

Source: Field survey (2017)

Table 2 continued

6. ICT is mostly used in my lesson to elicit and sustain my students' interest	51(34.5)	31(20.9)	49(33.1)	9(6.1)	8(5.4)	2.3	1.16
7. I use the digital tools and resources in my classroom to promote student creativity and innovative thinking (e.g., thinking outside the box, exploring multiple solutions).	45(30.4)	21(14.2)	57(38.5)	17(11.5)	8(5.4)	2.5	1.19
8. Problem-based learning occurs in my classroom because it allows students to use the classroom digital tools and resources for higher-order thinking (e.g., analyzing, evaluating, creating) and personal inquiry.	49(33.1)	17(11.5)	57(38.5)	25(16.9)	0(0.0)	2.4	1.12
9. My students apply their classroom content learning to real-world problems within the local or global community using the digital tools and resources at our disposal.	43(29.1)	21(14.2)	62(41.9)	11(7.4)	11(7.4)	2.5	1.20
Overall						2.4	0.90

Source: Field survey (2017)

Table 2 shows an overall mean (mean = 2.4, SD = 0.90) that indicated that most basic school mathematics teachers are not using ICT effectively in their mathematics classrooms. The number of teachers who do not use ICT in teaching is 61 out of 148 representing, 41.2 percent. Out of 184 teachers, about one-third of teachers representing (54) 36.5 percent use ICT sometimes in their lessons. The mean of 2.2 indicated that most teachers do not usually use ICT in teaching mathematics even though, they believe that ICT has a potential of improving teaching and learning of mathematics. Again, it could be seen that only 10 (6.6%) of the respondents use ICT frequently in preparing their lesson notes.

Also about thirty-nine percent of the respondents indicated that, they have never used ICT in preparing their lesson notes before. This indicates that even though teachers are aware of the potential of ICT in mathematics classroom but they are still not using it. Moreover, Table 2 shows that 40.5% (60) of the basic school mathematics teachers have never used ICT in the assessment of their students. The number of teachers that use ICT often in classroom assessment is only 5.4%. Table 2 also shows that the use of ICT in classroom assessment is below the average score (mean = 2.5). This may be due to the fact that most teachers may not have access to ICT tools to be used in the classroom and other factors affecting ICT usage.

However, when teachers are teaching mathematics that involves engaging students in learning activities that require them to analyse information, think creatively, make predictions, and /or draw conclusions using the digital tools and resources, they try to employ more technology that

resulted in the mean score of 2.7. This is still low because only a few number of teachers employ the technology in their teaching. In addition, 51 teachers representing 34.5% of the respondents do not use ICT to elicit and sustain their student's interest which resulted in a low mean score of 2.3.

Ghanaian Basic School Mathematics Teachers Level of Technological Pedagogical Content Knowledge (TPACK)

In examining the levels of Technological Pedagogical Content Knowledge (TPACK) among basic school mathematics teachers, research Question Two was addressed.

Research Question Two

What are the Technological Pedagogical Content Knowledge (TPACK) levels of Ghanaian basic school mathematics teachers' (GBSMT)?

The researcher sought to estimate the TPACK level of the basic school mathematics teachers. Since assessment gives basis for comparisons, the study also sought to compare the TPACK levels of the various categories of the respondents using statistical tools such as independent t-test. These are shown in the Tables 3 and 4.

Table 3 - *TPACK Level of the Respondents*

TPACK	Mean	SD	Coefficient of Variation (CV) (%)
TK	3.7	0.90	24
CK	4.3	0.35	8
PK	4.3	0.35	8
PCK	4.1	0.72	18
TPK	3.7	0.71	19
TCK	3.6	1.06	29
TPACK	3.5	0.90	26
Overall	3.9	0.44	11

Source: Field survey (2017)

Basic school mathematics teachers in this survey scored high means for all the various TPACK constructs. Teachers' high mean scores indicated that they agreed with most of the items on the various constructs and therefore possessed a high knowledge of the constructs of TPACK. The overall mean of 3.9 with a standard deviation of 0.44 and coefficient of variation of 11% indicated that most of the teachers agreed to the items under the TPACK constructs. The small standard deviation shows that there were not many differences in the choices of the responses. The evidence shows that the teachers had more knowledge of the content (mean = 4.3, standard deviation = 0.35, coefficient of variation coefficient of variation = 8%) and pedagogical knowledge (mean = 4.3, standard deviation = 0.35, coefficient of variation = 8%). The small standard deviation of 0.35 and coefficient of variation of 8%

shows that there were only a few teachers who disagreed with some of the items under the two constructs. Teachers' TPACK construct recorded the lowest mean score of 3.6, standard deviation of 0.9 and coefficient of variation of 26%. That is, the responses deviated from the mean by 26%.

The study also reported on the teachers' TPACK based on the demographic characteristics; gender and level teachers teach. These are discussed in Table 4. Table 4 presents the results for independent sample t-test on TPACK construct based on gender and level taught by the teachers.

Table 4 - *Independent Samples t-test on TPACK Construct Based on Gender and Level Taught*

TPACK Construct	Gender		p-value	Level Taught		P-value
	Male (N=68)	Female (N=80)		JHS (N=100)	Primary (N=48)	
TK	3.6(0.69)	3.6(0.71)	0.407	3.6(0.71)	3.7(0.69)	0.691
CK	4.1(0.56)	4.1(0.67)	0.135	4.2(0.58)	4.0(0.63)	0.241
PK	4.4(0.31)	4.3(0.40)	0.11	4.4(0.37)	4.4(0.37)	0.312
PCK	3.8(0.70)	3.6(0.80)	0.775	4.3(0.64)	4.1(0.76)	0.238
TPK	3.7(0.99)	3.6(0.80)	0.050	3.6(0.73)	3.7(0.70)	0.190
TCK	4.1(0.66)	4.2(0.79)	0.072	3.6(1.04)	3.6(1.06)	0.803
TPACK	3.5(1.07)	3.8(1.04)	0.366	3.6(0.78)	3.7(0.96)	0.653
Overall	3.9(0.45)	3.9(0.45)	0.896	3.9(0.46)	3.9(0.40)	0.894

Significant Level (p) > 0.05 (two-tailed), Degree of Freedom (Df) = 146,

Source: Field survey (2017)

Table 4 shows the result of the independent t-test on TPACK construct based on gender and level taught. The overall result indicated that there was

no statistical difference between male and female teachers' TPACK, $t(-0.131)$, $p = 0.896$. Also, the results from the Table 4 indicated that there were no significant differences on various TPACK constructs between level teachers taught.

Relationship between Teachers' Attitude and Effective ICT Usage in Mathematics Classroom

In order to examine the influence of teachers' attitude on effective use of ICT in the classroom, the research Question Three was addressed.

Research Question Three

To what extent do basic school mathematics teachers attitude influence ICT integrating into their classroom?

Table 5 shows the mean and standards deviations of teachers' attitude towards effective ICT usage. The items under teachers' attitude were rescaled from the original items. That is, the negative items were changed to positive statements and the result is shown in Table 5.

Table 5 - Mean and Standard Deviations of Teachers' Attitude

Teachers Attitude	Mean	SD	CV(%)
1. Working with a computer does not make me nervous (R)	3.9	1.16	30
2. Using a computer is not frustrating (R)	4.1	0.99	24
3 Computers are not difficult to use (R)	4.1	1.04	25
4. I think that it does not take a long time to finish a task when I use a computer (R)	4.2	1.05	25
5. I do not get a sinking feeling when I think of trying to use a computer	4.0	1.07	27
Overall (R)	4.1	0.87	21

R- Rescale of the items

Source: Field survey (2017)

The overall attitudes (mean = 4.1, SD = 0.87, CV = 21%) toward computer usage among the basic school mathematics teachers was high. This shows that basic school mathematics teachers are not anxious in the use of ICT in the mathematics classroom. In determining whether or not a significant relationship existed between basic school mathematics teachers' attitude towards ICT usage in the classroom and the effective usage of ICT, a correlation analysis was run. The detailed results are shown in Table 6.

Table 6 - *Relationship between Teachers Attitude and Effective ICT Usage*

		Effective ICT usage
Teachers Attitude	Pearson Correlation	0.031
	Sig. (2-tailed)	0.710

*Correlation is significant at 0.05 levels (2-tailed)

Source: Field survey (2017)

Table 6 revealed that there was low positive correlation between teachers' attitude and effective ICT usage but the correlation is not significant ($r = 0.031$, $p = 0.710$).

Predicting Basic School Mathematics Teachers' (BSMT) Effective ICT Usage from School-related Factors

The assessment of the influence of school-related factors on effective ICT usage in mathematics classroom was addressed in the Research Question Four.

Research Question Four

To what extent do school-related factors affect Ghanaian basic schools mathematics teachers' use of ICT in the classroom?

As indicated earlier, research question 4 sought to find the extent to which school-related factors: availability of ICT tools, planning and policy, technical support and school culture affect ICT usage in mathematics teaching at the basic level. Table 7 shows the mean scores and standard deviations of the School-related factors.

Table 7 - *Mean Scores and Standard Deviations of the School-related**Factors*

School-related factors	Mean	SD	CV (%)
Availability of ICT tools	2.4	0.98	41
Planning and policy	3.4	0.82	24
Technical support	2.4	0.84	35
School culture	2.8	0.96	3.4
Overall (School-related factors)	2.7	0.69	2.6

Source: Field survey (2017)

Table 7 shows that, planning and policy had the highest mean score (mean = 3.4, standard deviation = 0.82) as compared to other school-related factors. Most of the schools do not have technical expertise and tools to help integrate ICT in mathematics teaching resulting in the low mean score of (2.4) and standard deviation of 0.84. From Table 7, it could also be seen that all the conditions except the planning and policy are not favorable in the schools to enhance ICT integration in the mathematics teaching at the basic level.

Most of the schools have a culture that favours the integration of ICT in the mathematics teaching and learning. However, most of the schools do not have the ICT tools that will enhance the adoption of technology in the classroom. The study further estimated the correlation between school-related factors and effective ICT usage to ascertain if there exists a relationship between them as shown in Table 8.

Table 8 - *Correlation between School-related Factors and Effective ICT**Usage*

School-related factors	Effective ICT usage	Sig
Availability of ICT tools	0.607*	0.00
Planning and Policy	0.371*	0.00
Technical Support	0.656*	0.00
School Culture	0.495*	0.00
Overall (School-related factors)	0.704*	0.00

* Correlation is significant at 0.01 level (2-tailed)

Source: Field survey (2017)

From Table 8, there were positive correlations between school-related factors (availability of ICT tools, planning, and policy, technical support, and school culture) and the dependent variable effective ICT usage in the mathematics classroom. The strongest correlation was found between technical support and effective ICT usage ($r = 0.607$, $p = 0.00$) while planning and policy were the least among the other factors that correlated with effective ICT usage ($r = 0.371$, $p = 0.00$). A regression analysis was performed to ascertain the effect of school-related factors (availability of ICT tools, planning and, technical support, and school culture) on the teachers ICT integration. The result is presented in Table 9.

Table 9 - *Coefficients of Predictors (Availability of ICT tools, Planning and Policy, Technical Support and School culture) on Effective ICT usage*

Variable	Coefficients of predictors	Standardized Coefficients	Sig	F(sig)
Intercepts	0.130		0.591	40.976(.000)
Availability of ICT tools	0.340	0.370	0.000	
Planning and policy	0.060	0.055	0.450	
Technical support	0.306	0.286	0.002	
School culture	0.191	0.204	0.006	

Multiple R = 0.731, R² = 0.534, Adjusted R² = 0.521, Standard Error = 0.624
Significant at P < 0.05

Source: Field survey (2017)

From the Table 9, it could be seen that approximately 53.4% of the variation in the effective ICT usage in the classroom is explained by the variations in school-related factors (availability of ICT tools, planning and, technical support, school culture). Since the F-calculated is in the region ($p < 0.05$), there is evidence from Table 9 that at least one of the school-related factors affects effective use of ICT in the mathematics classroom. The regression model 1 is shown as follows:

$$A = 0.130 + 0.340 W + 0.060 X + 0.306 Y + 0.191 Z$$

From the regression model 1, when the availability of ICT tool (W), planning and policy (X), technical support (Y), and school culture (Z) are zero, the estimated mean value of Basic school mathematics teachers' effective ICT

usage (A) in the classroom is 0.130. The coefficient, 0.340 measures the mean change in the average value of basic school mathematics teachers' "effective ICT usage" as a result of a unit change in the availability of ICT tool when the effect of planning and policy, technical support, and school culture are held constant.

Also, the coefficient 0.060 measures the mean change in the average value of basic school mathematics teachers' "effective ICT usage" as a result of a unit change in planning and policy when technical support, availability of ICT tool and school culture are held constant. In addition, when the effects of the availability of tools, planning and policy and school culture are held constants, a unit change in technical support results in 0.306 increases in effective ICT usage.

Finally, the value (0.191) indicates that for every unit change in school culture, the mean change in the average value of basic school mathematics teachers' "effective ICT usage" will increase by 0.191 when the effects of the availability of ICT tools, planning, and policy and technical support are held constant. The standardized coefficients of the various predictors were 0.370, 0.055, 0.286 and 0.204 for the availability of ICT tools, planning and policy, technical support and school culture respectively.

According to the Standardized coefficients the regression Model 2 is as follows: $A = 0.370 W + 0.0550 X + 0.286 Y + 0.204 Z$

From Model 2, availability of ICT tools appears to be the strongest predictor of classroom ICT integration for these teachers; technical support appears to be the next predictor of teachers ICT integration; school culture was

quite acceptable while planning and policy was a weaker and perhaps an unacceptable predictor. Also, from the model 2 above, an increase in one standard deviation of the availability of ICT tools resulted in an increased of effective ICT use by 0.370 when the effect of planning and policy, technical support, and school culture are held constant. Also, as planning and policy increased by one standard deviation, effective ICT use increased by 0.0550 standard deviation when the effect of availability of ICT tools, technical support and school culture are held constant.

In addition, as technical support is increased by one standard deviation, effective ICT use increased by 0.286 standard deviation when the effect of availability of ICT tools, planning and policy and school culture are held constant. Finally, as effective ICT use increased by 0.204 standard deviations, school culture increased by one standard deviation when the effect of planning and policy, school-related factors, and technical support are held constant.

This means that availability of ICT tools is the most influential factor that affects BSMTS' ICT use followed by technical support while planning and policy was the least factor that affects BSMTs' ICT usage. This means that, for effective integration of ICT into mathematics classroom, the availability of ICT tools in the classroom must be critically examined before the other factors.

Effect of Knowledge and Skill (TPACK); School-related Factors; and Teachers Attitude on ICT Integration

In examining the effect of knowledge and skill (TPACK); school-related factors; and Teachers attitude on ICT usage, the Research Question Five was addressed.

Research Question Five

To what extent are the factors: Knowledge and skill (TPACK); School-related factors affecting ICT integration and teachers attitude predict BSMT ICT integration in the classroom?

Table 10 shows the means and standard deviations of the various constructs that affect ICT integration in the basic school mathematics classroom.

Table 10 - *Means and Standard Deviations of the Various Constructs Affecting ICT Integration*

Factors	Mean	SD
School factor	2.7	0.686
Knowledge and skill(TPACK)	3.9	0.445
Teachers attitude	4.1	0.0856
Overall	3.2	0.569

Effective ICT usage (mean = 2.4, SD = 0.902)
Source: Field survey (2017)

From Table 10, it has been observed that the highest score was obtained by teachers' attitude (4.1), followed by teachers' knowledge and skills (TPACK). This is followed by School-related factors that contributed to

ICT integration. The overall mean of 3.2 with a standard deviation of 0.568 indicated that these factors may have a significant effect on effective ICT usage in the mathematics classroom. Most of the teachers are not integrating ICT into their mathematics teaching which resulted in the low mean score of (2.4) with a standard deviation of 0.902. To explore if there existed any relationship between the factors (School factor, Knowledge and skill and Teachers' attitude) and effective ICT usage, a correlation was used and the result is shown in Table 11.

Table 11 - *Correlation Results for TPACK, Teachers Attitude, School-related Factors and Effective ICT Usage*

Variables	Effective ICT usage	P-value
TPACK	0.441**	0.000
Teachers attitude	0.031	0.721
School-related factors	0.495**	0.000

** . Correlation is significant at the 0.01 level (2-tailed).
Source: Field survey (2017)

The evidence from Table 11 shows that TPACK has a moderate positive correlation ($r = 0.441$, $p = 0.000$) with effective ICT Usage. The strongest Correlation was found between school-related factors and effective ICT usage ($r = 0.495$, $p = .000$). However, teachers' attitude did not correlate with Effective ICT usage. This implies that school-related factors and teachers TPACK have a relationship with the effective use of ICT in the mathematics classroom while there was no relationship between teachers' attitude and effective ICT usage. A regression analysis was performed to ascertain the amount of the effective ICT usage which was a result of the two factors:

school-related factors and teachers' knowledge and skills (TPACK) since the coefficient of teachers' attitude did not correlate with effective ICT usage. The result of regression analysis is shown in Table 12.

Table 12 - *Coefficients of Predictors (School-Related factors and Teachers Knowledge (TPACK) on Effective ICT usage*

Variable	Coefficients of predictors	Std. Error	Beta	t-stat	Sig.	F(Sig)
(Constant)	-1.233	0.456		-2.706	.008	0.000
TPACK	0.355	0.129	0.175	2.762	0.006	
School- related factors	0.829	0.083	0.630	9.936	0.000	

Multiple R = 0.722, $R^2 = 0.521$, Adjusted $R^2 = 0.511$, Standard Error = 0.623,
Significant at $P < 0.05$
 Source: Field survey (2017)

The standard multiple regression with the two independent predictors (TPACK and School-related factors) to predict Effective ICT usage revealed that the two constructs accounted for 51.4% of the variance ($R^2 = 0.522$, $F(2, 145) = 78.748$, $p = 0.000 < .001$) in effective ICT usage. Thus the overall multiple regressions were statistically significant. The summary of model 3 can be seen in Table 12. According to the coefficients, the regression model 3

is as follows: $Effective\ ICT\ Usage = -1.233 + 0.355\ TPACK + 0.829\ School-related\ factors$

The model 3 above shows that when teachers' TPACK and School-related factors are zero, the estimated mean value of basic school mathematics teacher's effective ICT usage in the classroom is -1.233. The coefficient, 0.355 measures the mean change in the average value of basic school mathematics teachers "effective ICT usage" as a result of a unit change in teachers TPACK when the effect of School-related factors is held constants. Also, a unit change in school-related factors, effective ICT usage will be increased by 0.829 when the effect of TPACK is held constant.

To determine the independent variables that best predicted effective use of ICT, standard coefficients were considered. The standardized coefficients of the two predictors were 0.630 and 0.175 for school-related factors and Teachers' TPACK respectively. According to the standardized coefficients, the regression model 4 is as follows:

$$Effective\ ICT\ usage = .630\ School-related\ factors + .175\ Teachers'\ TPACK.$$

From the model 4 above, school-related factors were the strong predictor of the effective ICT integration in the classroom while teachers' TPACK was the least predictor of the classroom ICT integration. That is, school-related factors were the most influential factor in determining BSMTs' ICT usage while teachers' TPACK was the next factor that affects ICT usage in the classroom. Also from the model 4, when school-related factors are increased by one standard deviation, effective ICT usage increased by 0.630 standard deviation when the effect of teachers' TPACK is held constant. Also, when

teachers' TPACK is increased by one standard deviation, effective ICT usage was increased by 0.175 standards deviation, when the effect of school-related factors is held constant.

Discussion of Results

The findings of the study are discussed in line with the Research Questions: extent of ICT usage in basic school mathematics classroom, BSMTs' level of technological pedagogical content knowledge (TPACK), influence of teachers' attitude on effective use of ICT in the classroom, effect of school-related factors on effective use of ICT in the classroom and extent by which the factors: Knowledge and skill (TPACK); school-related factors and teachers' attitude predict BSMTs' ICT integration in the classroom.

In reference to Research Question which sought to determine the extent of effective ICT usage among BSMT, the current study found out that, the majority of the teachers do not use ICT during mathematics instruction. However, some teachers use ICT in their teaching but not often. The current studies also pointed out that majority of basic school mathematics teachers do not use technology to prepare their mathematics teaching aids and lesson notes. These findings contradict those of Sipilä (2011), found that teachers frequently use ICT for informative, organisational, recreational, lesson planning purposes which contradict the current study. The study also reveals that when teachers are teaching mathematics that requires learners to analyze information, think creatively, make predictions, and/or draw conclusions using the digital tools and resources available in my classroom, they intend using ICT. This confirmed the previous studies by Wikan and Molster (2011) who

concluded that ICT integration is seldom used to stimulate students' higher-order thinking and for allowing constructivist learning.

In addition, the current study also confirmed the evidence that ICTs have the potential to innovate, accelerate, enrich, and deepen skills, to motivate and engage students, to help relate school experience to work practices, create economic viability for tomorrow's workers, as well as strengthening teaching and helping schools change (Yusuf, 2005). As noted by Swarts (2006) ICTs can be powerful, essential tools for learning: understanding, interpreting and communicating about the real world. Notwithstanding the potential of ICT in the classroom, only a few teachers use ICT for assessment. Majority of the teachers do not use ICT in the assessment of their students in the mathematics classroom. This conclusion is supported by the statement that there is little understanding of teachers' integration of ICT into teaching (Salehi & Salehi, 2012).

In conclusion, the study found out that most teachers are not using ICT in their classroom as confirmed by Tondeur, Valcke, and Braak (2008), that it is not surprising, then, appropriate and effective classroom use of ICT is found to be rare. Furthermore, the finding of the current study is supported by the growing body of international research studies which has demonstrated that many teachers are not using ICT effectively in their classrooms (Chen et al., 2009; Mueller et al., 2008)

Basic school mathematics teachers' level of knowledge and skills was addressed in research question two. The study revealed that basic school mathematics teachers have high TPACK knowledge in the various constructs.

The knowledge level was very high in relation to PK and CK. This could be attributed to the fact that, the teacher education places much emphasis on the content and the pedagogical aspect during the training of the teachers. This is not surprising and could be due to the fact that traditionally teacher education programmes have focused on CK and PK as noted by Archambault and Crippen (2009) when they found that online educators in the US scored high means on the constructs of CK and PK.

This also confirmed the study conducted by Archambault and Crippen among American K-12 online teachers which revealed that teachers' knowledge relative to the TPACK framework was highest among the domains of PK, CK, and PCK, "indicating that they, overall, felt very good about their knowledge related to these domains" (Archambault & Crippen, 2009, p. 84). Archambault and Crippen (2009) provided possible reasons for the high scores of teachers on the constructs of CK and PK. They found out that teachers may have been well prepared by their initial teacher education programme in terms of their content knowledge and pedagogical skills. This may be true for Ghanaian basic school mathematics teachers. This study also contradicted the study done by Harbi (2014) by assessing Saudi Arabian senior high school teachers TPACK, who demonstrated that, Saudi Arabian teachers demonstrated low to moderate level of TPACK. Owusu (2014) conducted a research to find out New Zealand high school science teachers' Technological Pedagogical Content Knowledge and concluded that the mean score of the CK and PK were very high as compared to other TPACK constructs. This also confirmed the results obtained in the current study of Ghanaian basic school

mathematics teachers TPACK. The finding that Ghanaian basic school mathematics teachers demonstrated a high level of TPACK is also consistent with findings of a number of studies (Archambault & Crippen, 2009; Tay et al., 2012). This shows that most of the research conducted to support the evidence that teachers demonstrated high knowledge of TPACK as confirmed by the current study. This may be due to the fact that most of the colleges of educations and the university have introduced ICT into their curriculum which compares teacher trainees to learn the usage of ICT. Also, the Junior high school mathematics syllabus requires the teachers to teach the students to be able to exploit mathematical relations and do investigations using computers and calculators and as such teachers must have high knowledge in ICT.

However, the low mean score was recorded by TPK, TCK, and TPACK. This could be attributed to the fact that most of the teacher education teaches content, pedagogy, and technology in isolation. It is through experience that the teachers come to develop a strong base of TPK, TCK, and TPACK. This confirmed what Owusu (2014) found “This finding was not surprising since most teacher education programmes teach content, pedagogy, and technology differently and in isolation to pre-service teachers”. The recently graduated teachers in this study, therefore, needed practice and experience to develop these constructs (TCK and PCK)”. It is however not surprising those teachers who have less than one-year teaching experience have high TK than their counterparts with more than one-year teaching experience. This may be due to the fact that, the recent curriculum provides an avenue for ICT teaching during teachers training.

With regard to the Research Question 3 that sought to determine the influence of teachers' attitude on effective ICT usage. The study revealed that basic school mathematics teachers have a positive attitude towards ICT integration. The attitude used here refers to the teacher's anxiety in the use of computers in the classroom. Most of the teachers disagreed that they have anxiety in the use of computers. This shows that teachers' use of ICT may be determined by other factors not necessarily teachers' attitude. The study also shows that teachers attitude do not affect effective usage of ICT in the mathematics classroom. Thus, even though teachers have no anxiety with the use of ICT, yet they are not using it effectively in the classroom. This is supported by Cheng and Chen (2008) that there is no resonance between teachers' beliefs and their actual practice while integrating technology in the classroom. Choy, Wong and Gao (2009) stated that teachers need to feel confident in their ability to facilitate student learning with technology in order to integrate technology into their classrooms. This evidence is mirrored the finding of the study by Hammond, Reynolds and Ingram (2011) that the strongest predictor of future ICT use was teachers' attitudes toward it. This result also contradicts the finding from Sang, Valcke, van Braak, Tondeur, and Zhu (2011) that that "Teacher attitude is one of the most critical factors that enhance or inhibit the integration of ICT into classroom instruction". The results from current study also contradict some of the previous studies as shown as follows:

Zhao and Jiang (2010) mentioned that teachers' attitudes towards ICT usage have significant implications for their behaviors in the use of computers

for teaching. Additionally, other studies show that teachers' knowledge and attitudes function as major predictors of the use of ICTs in the educational context (Judith Harris, Mishra, & Koehler, 2009; Sang et al., 2011) adds that during the process of combining ICT with education, teachers' attitude towards using knowledge besides their talent and desire will be a crucial point affecting the results of the application (Agyei & Voogt, 2010; Sang et al., 2011).

Ertmer (2005) stated that the decision of whether and how to use ICT for educational purposes significantly depends on the teachers and their related factors, for example, beliefs, confidence, and skills, with regards to ICT implementation. Effective use of ICT in the classroom is also linked to teachers' attitudes and levels of knowledge (Garland & Noyes, 2004). All these evidence contradicts the current studies report that teachers are not anxious in the use of computers in their classroom but they resist their usage of ICT in the classroom.

With reference to the Research Question Four that sought to determine the effect of the type of School-related factors on effective use of ICT in the classroom, the evidence from the standard coefficients revealed that availability of ICT tools appears to be a strong predictor of classroom ICT integration for these teachers. This is in support of the findings of Aguti and Fraser (2006) that lack of ready access to technologies by teachers is a key barrier to technology integration in many developing countries. The School related factor that had to go to do with technical Support appears to be the next predictor of teachers ICT integration; School Culture was quite acceptable

while planning and policy was a weaker and perhaps an unacceptable predictor. This means that availability of ICT tools is the most influential factor that affects BSMT ICT usage followed by technical support while planning and policy was the least factor that affects BSMTs' ICT usage.

That is, the mere presence of all ICT tools in the school does not necessarily guarantee that ICT usage will automatically follow. For effective ICT integration to occur there should be favorable planning and policies, school culture. Schools should be able to provide needed technical support to the BSMTs. This is supported by previous studies; Al-zaidiyeen and Mei (2010) who found that some external factors were positively associated with technology integration, including the availability of technology and support from technicians, teachers, and principals. Thus, technology availability and overall support are important to technology integration. The higher the support structure and technology availability, the higher the technology integration efforts are made by teachers. This is also supported by Habi (2014) who found out that, lack of technical maintenance services was considered by most of the participating teachers to be a significant obstacle as it left their devices broken for a long time which influenced their use of them in teaching. Harbi (2014) also found out that, availability of ICT resources, planning and policy, and management and support were generally important requirements for ICT implementation which confirm the present study.

Finally, the last Research Question that sought to explore the extent to which the parameters; Knowledge and skill (TPACK), teachers' attitude, school-related factors contribute to predicting teachers' classroom integration

of technology revealed that, school-related factors is the strongest predictor of the effective ICT integration in the classroom while Teachers' TPACK was the least predictor of the classroom ICT integration. That is, school-related factors are the most influential factor in determining classroom ICT usage followed by teachers' knowledge and skills (TPACK) while teachers attitude do not have an effect on the BSMT's ICT usage. This statement is also supported by the previous studies that a substantial proportion of the variation in educational ICT use is due to school improvement related aspects (Des,2008; Tondeur,Vacke, & Braak, 2008; Zhao & Jiang, 2010).

This is also supported by a previous study that reveals that ICT works in some schools and hardly in other schools because of school-related factors (Aesaert & Van Braak, 2014; Umar et al., 2014). Teachers' knowledge and skills (TPACK) is the next most predictive variable on the teachers ICT integration in the classroom. This confirmed that teachers' knowledge is very important in the integration of ICT in the classroom. This is supported by a number of researchers; the literature suggests that teachers' use of educational technology requires comprehensive and multi-faceted knowledge. For successful integration of technology in the classroom, teachers should be able to blend technology effectively with pedagogy and content (Koehler & Mishra, 2006).

Summary of Key Findings

Basic school mathematics teachers reported high ICT knowledge and skills (TPACK) required for ICT integration into the teaching and learning of mathematics. Majority of the BSMTs' teachers do not employ ICT during

mathematics classroom instructions. To determine the School related factor that best predicted ICT usage, the current study also revealed that availability of ICT tools was the major predictor of effective ICT use followed by technical support whiles planning and policy was the least predictor of classroom ICT use in the basic school level. In addition, basic school mathematics teachers have a positive attitude towards ICT use in the classroom. Finally, effective ICT integration in the basic school classroom is most affected by the school-related factors followed by teachers' knowledge and skills (TPACK) whiles teachers attitude have no effect on effective ICT usage.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

The study aimed to provide information on the basic school mathematics teachers' usage of ICT in their classroom. The study was conducted in Bibiani in the western region of Ghana. Five research questions that guided the study were; 1) to what extent are basic school mathematics teachers integrating ICT into their Classroom? 2) What are the technological pedagogical content knowledge (TPACK) levels of Ghanaian basic school mathematics teachers' (GBSMT)? 3) To what extent do basic school mathematics teachers attitude influence ICT integrating into their classroom? 4) To what extent do schools related factors affect Ghanaian basic schools mathematics teachers' use of ICT in the classroom? 5) To what extent do the factors: Knowledge and skill (TPACK); School-related factors affecting ICT integration and teachers attitude predict ICT integration in the classroom? In order to provide answers to the research questions in this study, a survey was employed. The questionnaire was the main instrument used to collect the requisite data to answer the research questions. Cluster sampling was employed to select 148 mathematics teachers from Bibiani in the Western region of Ghana. The data gathered were analysed through the computation of descriptive statistics, independent t-test, correlation analysis, regression analysis.

Summary of the Results of the Study

The study showed that majority of the BSMTs' teachers do not use ICT during mathematics instruction. Most of the respondents have never used ICT in their lesson delivery before. However, some teachers use ICT in their teaching but not often.

Next, the study revealed that basic school mathematics teachers have high knowledge and skill (TPACK) in the various constructs. The knowledge and skill level was very high in relation to pedagogical knowledge and content knowledge. The study further revealed that there was statistically no significant difference between; male and female teachers'; Primary and JHS teachers' knowledge and skills (TPACK).

The study also found out that, school-related factors (availability of ICT tools, policy and planning and School culture) have a great effect on the effective ICT usage in the basic school mathematics classroom. Among the school-related factors, it was also revealed that availability of ICT tools was the most predictive factor on effective ICT usage. The next school-related factor that predicts ICT usage was technical support whiles planning and policy was the least predictor of ICT integration in the mathematics classroom at the basic level.

In addition, the study also revealed that basic school mathematics teachers have a positive attitude towards ICT integration. This shows that teachers' use of ICT may be determined by other factors not necessary teachers' attitude. Thus, even though teachers have no anxiety with the use of ICT, yet they are not using it effectively in the classroom.

Finally, the current study also showed that effective ICT integration into the basic school classroom is most predicted (affected) by the school-related factors followed by teachers' knowledge and skills (TPACK) while teachers' attitude have no effect on effective ICT usage.

Conclusions

Empirical evidence from the literature indicated that, ICTs have the potential to innovate, accelerate, enrich, and deepen skills, to motivate and engage students, to help relate school experience to work practices, create economic viability for tomorrow's workers, as well as strengthening teaching and helping schools change (Davis & Tearle, 1999; Lemke & Coughlin, 1998; cited by Yusuf, 2005), yet most teachers are not using them in their classroom teaching despite the awareness of potentials of ICT in the classroom.

One interesting finding from this study was that teachers have high knowledge and skills with respect to ICT usage yet they are not using ICT effectively in the classroom. This can be seen as a contradiction that the current study has revealed. This could be attributed to the fact that, teachers' know the actual usage yet how to use ICT in the classroom becomes an issue. Also, other factors might have hindered the teacher's usage of ICT in their teaching which the researcher did not pay attention to.

Furthermore, the study pointed out that, basic school mathematics teachers have a positive attitude towards ICT integration in their classroom. However, teachers' attitude was found to have no influence on the effective ICT integration in their classroom. That is, even though teachers have a positive attitude towards ICT integration, yet they are still not integrating it

into their classroom teaching. This means that their refusal in the use of ICT in mathematics classroom could be attributed to other factors other than teachers' attitude. This finding is a deviation from most of the findings from the literature which means that teachers' attitude towards ICT usage has changed recently.

In addition, the study has shown that availability of ICT tools is the major predictor of ICT usage in the classroom followed by technical support. This is not surprising because most of the Ghanaian public basic schools have not gotten even a single computer in their classroom. These factors may be the major factors that hinder teacher's usage of ICT in Ghanaian basic schools. Thus easy access to ICT facilities will certainly contribute to teachers' use of ICT innovations in schools provided other school-related factors are favourable.

Finally, this study brought to light that, school-related factors and teachers' knowledge and skills are essential with respect to teachers ICT usage.

Recommendations

Based on the summary of the major findings, the following recommendations are made

1. Teacher education institutions need to include courses on pedagogical issues related to technology integration in their curriculum. In-service training should also be organised for Ghanaian basic school teachers on how to use ICT effectively in their lessons.

2. The government, Parent-Teachers' Association, School Management and Boards must join forces and put a priority on the provision of ICT facilities in Ghanaian basic schools (example computers, printers and projection devices in classrooms) to facilitate and increase access to ICT of teachers.
3. There should be incentives for basic school teachers that use technology in their classroom and also must be supported by their colleagues and school authorities in using technology.
4. School-related factors such as school culture should be made favourable for the adoption of technology in the classroom. Also, technical support should be provided by the schools to enable the teachers to effectively use ICT in teaching of mathematics.
5. The study recommends that Ghana Education Service (GES) strengthen and enforce policies regarding the practical use of ICT for educational practices in the curriculum.

Suggestions for Further Research

This study assesses basic school mathematics teachers' effective ICT usage in Bibiani in the western region of Ghana. It is therefore suggested that:

1. The study should be replicated in other regions in the country to find out what persists there.
2. Research should be conducted to find out other factors that predict ICT usage since the best model from this study accounted for only 51%.

3. Future studies may incorporate the use of qualitative instruments to make the study more interactive and to get an in-depth understanding of the problem.
4. The study may be conducted in the teacher educations to find what they actually teach in reference to ICT usage in the classroom.
5. The study was conducted at the basic school level; further studies can be done in the Senior High Schools in Ghana.

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APPENDICES

APPENDIX A

INTRODUCTORY LETTER

UNIVERSITY OF CAPE COAST
COLLEGE OF EDUCATION STUDIES
FACULTY OF SCIENCE AND TECHNOLOGY EDUCATION
DEPARTMENT OF MATHEMATICS AND I.C.T EDUCATION

Telephone: 0332096951
Telex: 2552, UCC, GH
Telegrams & Cables: University, Cape Coast
Email: dmicte@ucc.edu.gh



University Post Office
Cape Coast, Ghana

Your Ref:

Our Ref: DMICTE/U.1/V.1/033

Date: 29th June, 2017

TO WHOM IT MAY CONCERN:

Dear Sir/Madam,

INTRODUCTORY LETTER – MR. PHILIP ADJEI ACHEAMPONG

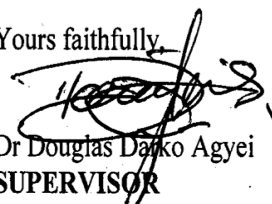
The bearer of this letter, **Mr. Philip Adjei Acheampong** with registration number ED/MDP/15/0006 is an MPhil (Mathematics Education) Student of the Department of Mathematics and ICT Education, College of Education Studies, University of Cape Coast.

The above named student is currently under taking his project titled **“ASSESSING BASIC SCHOOL MATHEMATICS TEACHERS’ ICT INTEGRATION IN BIBIANI IN THE WESTERN REGION”**. Currently, he need information that will enable him to continue with the project work.

We would therefore, be grateful if he is given the needed assistance in terms of information to support his studies.

Thank you.

Yours faithfully,


Dr Douglas Darko Agyei
SUPERVISOR

APPENDIX B

MATHEMATICS TEACHERS' QUESTIONNAIRE

The aim of this research is to assess Basic school mathematics teachers ICT integration.

Questionnaire for Teachers

Thank you for taking time to complete this questionnaire. Please answer each question to the best of your knowledge. Your thoughtfulness and responses will be greatly appreciated.

Your responses will be kept completely confidential.

PART A (Demographics of respondents)

Sex: Male [] Female []

Educational level: Certificate A [] Diploma [] Degree []
masters []

Class you teach : lower primary [] upper primary []

JHS []

Years of experience: below 1 year [] 2- 5 years [] 6-9 years []
10 years and above []

PART B: TPACK

TK (Technology Knowledge)	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
1. I know how to solve my own technical problems.					
2. I can learn technology easily.					
3. I keep up with important new technologies.					
4. I frequently play with the technology.					
5. I know about a lot of different technologies.					
6. I have the technical skills I need to use					

technology.					
7. I have had sufficient opportunities to work with different technologies.					
CK(Content Knowledge)					
8. I have sufficient knowledge about mathematics.					
9. I can use a mathematical way of thinking.					
10. I have various ways and strategies for developing my understanding of mathematics.					
PK (Pedagogical Knowledge)					
11. I know how to assess student performance in a classroom.					
12. I can adapt my teaching based-upon what students currently understand or do not understand.					
13. I can adapt my teaching style to different learners.					
14. I can assess student learning in multiple ways.					
15. I can use a wide range of teaching approaches in a classroom setting (collaborative learning, direct instruction, inquiry learning, problem/project based learning etc.).					

16. I am familiar with common student understandings and misconceptions.					
17. I know how to organize and maintain classroom management.					
PCK (Pedagogical Content Knowledge)					
18. I know how to select effective teaching approaches to guide student thinking and learning in mathematics.					
TCK (Technological Content Knowledge)					
19. I know about technologies that I can use for understanding and do mathematics.					
TPK (Technological Pedagogical Knowledge)					
20. I can choose technologies that enhance the teaching approaches for a lesson.					
21. I can choose technologies that enhance students' learning for a lesson.					
22. My teacher education program has caused me to think more deeply about how technology could influence the teaching approaches I use in my classroom.					
23. I am thinking critically about how to use technology in my classroom.					
24. I can adapt the use of the technologies					

that I am learning about to different teaching activities.					
TPACK (Technology Pedagogy and Content Knowledge)					
25. I can teach lessons that appropriately combine mathematics, technologies and teaching approaches.					
26. I can select technologies to use in my classroom that enhance what I teach, how I teach and what students learn.					
27. I can use strategies that combine content, technologies and teaching approaches that I learned about in my coursework in my classroom.					
28. I can provide leadership in helping others to coordinate the use of content, technologies and teaching approaches at my school and/or district.					
29. I can choose technologies that enhance the content of a lesson.					

PART C: SCHOOL RELATED FACTORS AFFECTING ICT INTEGRATION

Please answer all of the questions. For each item, select only one option that best describes you. If you uncertain of or neutral about your response, you may always select “neither agree nor disagree.”

My school has the following ICT tools to enhance technology integration in the Mathematics classroom

AVAILABILITY OF ICT TOOLS	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
1. Personal computer					
2. Computer for students					
3. Scanners					
4. Printers					
5. presentation tools					
6. Internet					
7. Digital cameras					
8. Software programs					

Policy and planning	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
1. My school has a future plan of ICT integration					
2. My school has a policy for ICT integration at student, teacher and system level					
3. My school has a system for monitoring and evaluating the integration of ICT					

within the school.					
4. My school has a vision that ICT can benefit teaching and learning processes.					
5. My school provide motivation for ICT integration					

TECHNICAL SUPPORT	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
1. There is ICT technician in my school					
2. My school does provide adequate technical maintenance for ICT use.					
3. I can solve most of the software and hardware problems					
4. It is adequate of professional development opportunities for teachers in ICT use.					
5. My school has a system for monitoring and evaluating the integration of ICT within the school.					
6. My school has most hardware accessories and other software for ICT maintenance and repairs					
7. My school organise ICT integration workshop for the teachers					

SCHOOL CULTURE					
1. The culture in my school favors ICT integration					
2. My school allows students to use ICT in the classroom					
3. My school encourages the adoption of new technology in the classroom					
4. My school organize ICT training for the teacher					
5. My school provide opportunities for the teachers to upgrade themselves in ICT training					
6. My school provide in-service training for new teachers in ICT usage					

PART D: TEACHERS ATTITUDE

TEACHERS ATTITUDE	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
1. Working with a computer makes me nervous					
2. Using a computer is very frustrating					
3 Computers are difficult to use					
4. I think that it takes a long time to finish a task when I use a computer					
5. I get a sinking feeling when I think of trying to use a computer					

PART E: EFFECTIVE ICT INTEGRATION

Please answer all of the questions. For each item, select only one option that best describes you. If you uncertain of or neutral about your response, you may always select “uncertain.”

EFFECTIVE ICT INTEGRATION	Never	Rarely	Sometime	Often	Always
1. I use technology during mathematics instruction					
2. I use technology to prepare my mathematics teaching aids and my notes					
3. I engage students in learning activities that require them to analyze information, think creatively, make predictions, and/or draw conclusions using the digital tools and resources available in my classroom.					
4. My students use the classroom digital tools and resources to engage in relevant, challenging, self-directed learning experiences that address the content standards.					
5. I use ICT in Mathematics classroom assessment					
7. ICT is mostly used in my lesson to elicit and sustain my student's interest					
8. I use the digital tools and resources in my classroom to promote student creativity and innovative thinking (e.g., thinking outside the box, exploring multiple solutions).					
9. Problem-based learning occurs in my classroom because it allows students to use the classroom digital tools and resources for higher-order thinking (e.g., analyzing, evaluating,					

creating) and personal inquiry.					
10. My students apply their classroom content learning to real-world problems within the local or global community using the digital tools and resources at our disposal.					

APPENDIX C

ETHICAL CLEARANCE

UNIVERSITY OF CAPE COAST

INSTITUTIONAL REVIEW BOARD SECRETARIAT

TEL: 03321-33172/3 / 0307355665/ 0244207814

C/O Directorate of Research, Innovation and Consultancy

E-MAIL: irb@ucc.edu.gh

OUR REF: UCC/IRB/A/2016/184

YOUR REF:

OMB NO: 0990-0279

IORG #: IORG0009096

24TH NOVEMBER, 2017



Mr. Philip Adjei Acheampong
Department of Mathematics Education
University of Cape Coast

Dear Mr. Acheampong,

ETHICAL CLEARANCE –ID: (UCCIRB/CES/2017/15)

The University of Cape Coast Institutional Review Board (UCCIRB) has granted **Provisional Approval** for the implementation of your research protocol titled '*Assessing Basic School Mathematics Teachers' ICT integration in Bibiani in the Western Region*'. This approval requires that you submit periodic review of the protocol to the Board and a final full review to the UCCIRB on completion of the research. The UCCIRB may observe or cause to be observed procedures and records of the research during and after implementation.

Please note that any modification of the project must be submitted to the UCCIRB for review and approval before its implementation.

You are also required to report all serious adverse events related to this study to the UCCIRB within seven days verbally and fourteen days in writing.

Always quote the protocol identification number in all future correspondence with us in relation to this protocol.

Yours faithfully,

A handwritten signature in black ink, appearing to read 'ASIEDU OWUSU'.

Dr. Samuel Asiedu Owusu
Administrator

ADMINISTRATOR
INSTITUTIONAL REVIEW BOARD
UNIVERSITY OF CAPE COAST
Date: 22/11/17