UNIVERSITY OF CAPE COAST

EXPLORING MATHEMATICS TEACHERS' PERCEIVED USE OF ICT IN CLASSROOM INSTRUCTION USING THE WILL-SKILL-TOOL-PEDAGOGY MODEL

BY

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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: Annie Sawyerr

Supervisor's Declaration

I 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.

Supervisor's Signature: .... Date: ....

Name: Prof. Douglas Darko Agyei

ABSTRACT

This study models the essential factors for a teacher to incorporate ICT into mathematics classroom instruction effectively. This research focuses on the study participants will (positive attitudes), skill (ICT competence), tool (access to ICT tools) and pedagogy (teaching style and confidence in skill) WSTP as key indicators for the predictability of ICT integration. An attempt is made to understand how these variables varied among mathematics teachers and also to examine their impact on ICT integration in mathematics instruction. In modeling the process of ICT usage in the study, 92 senior high school mathematics teachers were selected to respond to a questionnaire. The study's survey of the mathematics teachers reported significant positive correlations between will, skill, tool and pedagogy variables and the stages of adoption of ICT use in teaching.

Partial least squares structural equation modeling (PLS-SEM) was used to explore the WSTP dimensions and to examine their relationship with ICT integration using SmartPLS 3 software. The predictive tendency of the factors was (0.21) indicating 21% proportion of variance was explained by WSTP in the adoption of ICT integration. The results also indicated that *Tool* was the strongest predictor of ICT usage in the classroom for the teachers. This means that increasing access to ICT tools should be the priority of the senior high schools for the mathematics teachers in the study to effectively integrate ICT in their teaching.

The study offered valuable insights into the factors affecting ICT integration in classroom instruction and provided new ideas for understanding ICT usage in the mathematics classroom context.

KEYWORDS

Attitude toward technology

Competence in the use of ICT

Access to ICT tools

Teaching style and confidence in skill

Models of ICT integration,

PLS structural equation modelling

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DEDICATION

To my family.

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CHAPTER ONE

INTRODUCTION

This chapter presents the context of the study, the problem statement, the purpose of the study, the research questions and the literature of the study. It also highlights the limitations and delimitations of the study.

Background to the Study

Information and Communications Technology (ICT) has become an omnipresent feature of everyday life for a little more than a generation. Like Ghana, several nations now consider recognising ICT and mastering its fundamental principles to be part of the centre of education (UNESCO, 2002). It was introduced in 2006 and was put into practice in 2007. Ghana's ICT education policy aims to enable Ghanaians to use ICT tools and resources confidently and creatively to improve the skills and knowledge required to be active participants in the global knowledge economy at all times (MOESS, 2006). The mathematics curriculum was reviewed in Ghana to comply with the 2007 New Education Reforms and the ICT for Accelerated Development (ICT4AD, 2003) policy in Ghana (Agyei & Voogt, 2011). It emphasizes ICT usage in mathematics instruction at all levels of education (MOESS, 2007).

Some studies have shown that incorporating ICT into mathematics education can make learning successful and interesting by offering initiatives for learners to acquire skills that will enable them in this new society to enhance student learning outcomes (e.g. Gill and Dalgarno, 2008; Kumar, 2008). The use of ICT in education is certainly capable of enhancing people's quality of life by teaching and learning. Optimism was high that ICT could transform the face of education in Ghana since its inception but the upward deployment of ICT in primary and secondary education is still in the drafting process. There are many advantages to the integration of ICT in education: "the sharing of resources and learning environment, the promotion of collective learning to achieve greater learner sovereignty" (Eze, Adu, & Ruramayi, 2013). Several efforts have been made by the Ghana Government together with its educational institutions to foster ICT usage in mathematics education because of its importance in education. Several attempts by the government and other institutions to supply schools with computers and communication networks. Mereku, Yidana, Hordzi, Tete-Mensah, Tete-Mensah, and Williams, (2009) reported that most schools have some computers or computer laboratories. It is also noted that ICT is rarely used in actual instruction, due to inadequate computers and internet connectivity in many educational institutions (Korte & Hüsing, 2006; Shewbridge, Ikeda, & Schleicher, 2006).

ICT is more than simply offering computers and internet connectivity; it requires incorporating learning experiences with pedagogically informed use of ICT tools (Mereku & Mereku, 2015). As schools prepare students to live in a world infused with technology and workplaces powered by technology, we need teachers who are well trained to facilitate the learning of students mediated by ICT. Unless teachers were qualified to be self-efficient to use these ICT resources to ensure effective teaching and learning, these investments would not pay off. To support the instructional process, they must assume that ICT is a valuable educational tool.

It depends heavily on the attitudes of teachers to effectively incorporate ICT in the school program. It is assumed that if teachers view ICT systems as neither meeting their own needs nor the needs of learners, it is anticipated that technology will not be incorporated in classroom instruction. Literature indicates that the attitudes of teachers impact the effective incorporation of ICT into teaching (Hew & Brush, 2007). If teachers' attitudes towards technology are constructive, they can easily provide a valuable understanding of the implementation and incorporation of ICT in instructional processes (Keengwe & Onchwari, 2008). Agyei (2013) indicates that the difficulties of using ICT in education lie not only in the lack of access to ICT tools but also the lack of teachers who do not have the pedagogical combination with ICT competence to ensure the use of ICT resources and facilities in the process of instruction.

Implementing ICT in the educational sector is necessary as it significantly enhances aspect of our lives (Hew & Brush, 2007). Hence it is very critical to investigate the perception of mathematics teacher's use of ICT to explain ICT integration in their mathematics instruction.

Statement of the Problem

The Ghanaian context has observed a quick change in the role of a teacher over the last few years. Teachers face numerous new development and obstacles and must adjust to the integration of ICT. ICT initiatives in Ghana aim to attain a massive increase in access to and use of ICT in classroom instruction, but this has not yet been achieved (Amanortsu, Dzandu, & Asabere, 2013). Many teachers express the need not just for visible policies but other opportunities to ensure better ICT integration into their schools. Despite seemingly high levels of computers in Ghanaian schools, government reports suggest that fewer than 6 in 10 (57%) school computers are fully functional (Ghana Ministry of Education, 2009).

Studies have reported teachers' attitudes, ICT training, lack of basic computer skills and knowledge as the main predictors of technology adoption in mathematics teaching and learning (Agyei, 2010; Enu, Nkum, Diabor & Korsah, 2018). Mensah (2017) also found that mathematics teachers have a high positive attitude towards ICT usage in teaching mathematics yet these attitudes were not reflecting in the actual use of ICT in classroom instruction. The present situation regarding ICT integration in Ghanaian schools demonstrates a shortfall in reaching the targets as laid out in the Ghana ICT in education policy. The shortfalls have become a problem that needs to be resolved if ICT is to enter our classrooms successfully, especially the mathematics classroom where learner performance is low.

Ghana is in search of a breakthrough to mediate mathematics instruction. The use of ICT is one strategy that can address challenges in the mathematics classroom. Mereku, Yidana, Hodzi, Tete-Mensah, Tete-Mensah, and Williams (2009) stated that for Ghana to completely incorporate ICT into classroom instruction, frequent collection and review of data on the use of ICT will be necessary. Combing through literature, it has been found that little research has been conducted to delve into this issue of prediction of teacher ICT integration in the classrooms using the WST model. Agyei and Voogt (2011); Morales (2006); Petko (2012) employed the WST model to predict ICT integration by teachers in different contexts.

Recommendations by these authors highlighted pedagogical issues as a factor related to ICT integration in education. Years on, the original authors were urged by Petko (2012) to add pedagogy to the model construct. A closer look at the present approach to teaching shows teachers use obsolete instructional techniques that are paired with the use of conventional teaching aids (Kozma, 2009; Roblyer, 2006). Many of these researches have shown ICT's important contribution to developing teaching strategies and having a positive effect on the learner (Kennewell & Beauchamp, 2007).

The recent ICT reforms in Ghana, therefore, provide an opportunity to enhance ICT usage in the classroom by investigating the possible predictors of ICT integration in mathematics instruction. This study therefore, extends on Agyei and Voogt (2011) that used the WST model to include Pedagogy (P) in the model in exploring senior high school mathematics teachers' perceived use of ICT in their classroom instruction from the same context. The researcher contends that teachers' pedagogical approach among others is an important variable to effectively incorporate ICT by the classroom teachers. Thus, the study adopted the Will, Skill, Tool, Pedagogy (WSTP) model and hypothesizes that a teacher needs four components to effectively incorporate ICT in classroom instruction: will (teacher attitudes towards technology), skill (competence in the use of ICT tools), tool (teacher access to ICT tools) and pedagogy (teachers teaching style and confidence in skill).

Purpose of the Study

This research aims to explore the relationships between the teacher's will, skill, tool and pedagogy on the ICT usage in mathematics instruction.

In particular, the study sought to evaluate the perceived use of ICT by mathematics teachers and to gain a better understanding of teachers' attitudes, competencies, access to ICT tools, teaching style and confidence in skill.

Research Questions

1. What are mathematics teachers' perceived attitudes (will), competencies (skill), access to ICT tools (tool) and teaching style and confidence in skill (pedagogy) in the use of ICT in teaching?
2. How do mathematics teacher's attitudes towards technology (will), competencies in the use of technology (skill), access to ICT tools (tool), teaching style and confidence in skill (pedagogy) relate to their perceived use of ICT?
3. To what extent do attitudes (will), competencies (skill), access to ICT tools (tool), and teaching style and confidence in skill (pedagogy) of the mathematics teachers predict their ICT integration levels.

Significance of the Study

It provides insights into teacher ICT integration and highlight areas that need to be targeted for improvement. The results of the current study will add new information to the existing literature on the perceived ICT usage by mathematics teachers in Ghana since there are few studies related to ICT. Also, school administrators will be notified of the condition of ICT facilities for use by teachers for instructional purposes. The research is important for educators of mathematics who want to learn more in their teaching regarding ICT implementation.

Delimitation of the Study

This research emphasized ICT implementation by mathematics teachers in their classroom instruction at Sekondi-Takoradi Metropolis. It centred primarily on if ICT resources are accessible and whether they are used by teachers in their teaching and learning phase. The scope of the study was restricted to Sekondi-Takoradi Metropolis in the Western Region of Ghana.

Limitations of the Study

This study used census survey method and purposive, a non-probability sampling in the selection of participants and Schools. Hence, the type of sampling used may generate inappropriate generalisation of the population.

The transformation of ICT requires training to allow ICT resources to be used and it is likely that there already may have been the need for retraining.

Organisation of the Study

This study was structured into five main chapters. Chapter One presents the introduction of the study. It describes the background to the study, statement of the problem and purpose of the study, research questions posed, the significance of the study, delimitation of the study and limitations of the study, and how it is accordingly organised.

A detailed analysis of the existing literature on ICT is found in Chapter Two. Additionally, the theoretical underpinning of factors that influence classroom ICT integration and these factors shall be explored with their probable linkages to the current study which sets the basis for which propositions for the current study are advanced. A synopsis of the literature concludes the chapter.

The research methodology used in the conduct of this study is listed in Chapter Three. It comprises the research design, study population, sample size, sampling technique, instrument for data collection, pilot testing, instrument administration, and plan for data analysis. Chapter Four addresses the interpretation of the results and findings from the study.

The conclusions and summary of the thesis are found in Chapter Five. It is then determined whether the questions posed in Chapter One have been answered and, in that way, address the purpose of the study. It will also provide recommendations and suggestions for future study.

CHAPTER TWO

LITERATURE REVIEW

Integrating information and communication technologies (ICTs) into mathematics instruction in Ghanaian schools is a task that if not properly done, can have far-reaching implications. Mathematics educators are confronted with the dilemma of failing to get hold of the new curriculum, which is a major challenge in itself. As a result, there could be a lot of resistance in terms of ICT integration, particularly as most of our Ghanaian schools get their ICT resources through donor collaborations. The literature review focuses on Mathematics teaching and the learning situation, ICT use in education, benefits and barriers that mathematics educators encounter in their attempts to use ICTs in classroom instruction.

Mathematics Teaching and Learning Situation

In Ghana, the basic education mathematics curriculum (syllabus) was developed based on the recognition that mathematics is not only a set of concepts and skills to be learned, but also includes stages that support the person improve his capacity to logically explore, conjecture, solve problems and reason (MOESS, 2007). For its relevance, mathematics is a major subject in basic education. The alarming concern over the success or failure of teaching and learning mathematics in Ghanaian schools has contended in recent years on current use in mathematics instruction at basic and senior high levels. High school students who wrote mathematics examinations showed poor results and these poor results continue to rise as the years go by.

Research conducted in 2003 and 2007 by the Trends in Mathematics and Science Study (TIMSS) and Ghana's 8th graders endorsed this claim i.e.

students at Junior High School (JHS) were ranked 43rd from 44 countries and 46th from 47 countries respectively (Enschede, 2010). This has been shown by the level of senior high schools having a high and not significant increase in mathematics failure rate. In mathematics, the low performance was due to variations in pedagogical orientation. Fredia-Kwarteng (2005) states the transmission and command models define mathematics teaching in Ghana. Students would not be inspired to take action and solve problems to understand what they are taught in terms of principle and procedure (Appiah, 2010; Fredia-Kwarteng, 2005). In Ghana, most JHS students have an insufficient conceptual understanding of the mathematics content taught at the basic level (Baffoe & Mereku, 2010). Moreover, these learning problems arise because teachers continually use undesirable classroom teaching methods (Baffoe & Mereku, 2010).

Despite all the initiatives taken by the Ghanaian government to overcome the massive failure of math students, the situation has remained turbulent year after year (O-saki, 2007). There is a rising call for current teaching strategies that aid student capacity building, including the ability to harness ICT for critical thinking, problem-solving and communication skills (e.g., Saavedra & Opfer, 2012). There is easy access to computers and ICT facilities at several schools, yet the pedagogical usage of education technology differ despite access to such tools (European Commission).

Learning using useful integration tools can result in a functional understanding of mathematical concepts and a better understanding of the nature of mathematics (Varughese, 2012). ICT implementation in mathematics education remains the only promising means of improving ICT teaching and learning. (Keong, Horan, & Danie, 2005). It was revealed in a study by Keong et al., (2005); Voogt (2003) that ICT usage in mathematics teaching enhances learning through increased student collaboration through an increased level of contact and information sharing. ICT has also been found to help teachers provide students with swift and reliable feedback and to enable students to aim at outcome tactics and expositions in place of wasting time on boring numerical calculations. Keong and colleagues also disclose that ICT is easily assisted by a constructivist pedagogical approach (Tilya, 2003; Voogt, 2003), where students use ICT to explore mathematical concepts by focusing on process-solving problems instead of problem-based computations. Thus, ICT integration in mathematics instruction can be a promising solution to the long existed students' failure in mathematics in Ghana.

ICT Usage in Education

ICTs are vitally useful tools for improving and reforming the curriculum. When properly used, various ICTs help to widen access to education, increase the value of education in order to improve the digital workforce and enhance the quality of education by allowing classroom instructions to establish an active process connected to real-life practice (Pedro, 2006). ICTs don't develop the academic skills of students themselves, but teachers who use ICTs wisely do so. In all countries that apply a constructivist approach to developing their educational systems, ICT use has become important in the educational field.

In Ghana, considering the recent and still evolving ICT usage in education, the education system has attempted to change the way ICT is used in education, not just to improve ICT skills, but also to improve the process of instruction. The correlation between ICT usage and the instructional goals that would be accomplished, together with the impact of ICT on the perceptions of teachers in their work, is important in this area (Barzel & Drijvers, 2009). Means (1994) classified technology into four different areas based on the suggested technology integration in her book, Technology and Education Reform: The Reality Behind the Promise. These areas include technology used: “as a tool, as a tutor, as a device for exploration, and as a communication tool”.

Technology as a Tool

The utmost popular feature is the technology used as a tool. It acts as an aid to help complete tasks and activities and has typically turn out to be an integral aspect of a home or office environment (Means, 1994). These tools are explicitly not intended to be used in an educational environment but are still used in some form in most schools. For teaching and/or learning, the device is used as a tool. This comprises, for instance: “the use of word processor, excel, and spreadsheet, databases, and graphics applications” in the instructional stage (Daugherty, Reese, & Merrill, 2010). The most often used mathematically-related tools are “computers, calculators, computer software and computer algebra systems”.

In most homes and schools, several types of calculator technology can be found, including: “simple four-function calculators, scientific calculators, or graphing calculators”. The assumption that the calculator is an important bit in mathematics instruction was endorsed by Lucas and Cady (2012): practical usage implies it can only be employed in tasks like computing, drilling and practice, and paper and pencil testing. They also believed that educators should use calculators to offer learners with tasks that support them improve their mathematical understanding of ideas like location significance, the meaning of operations and estimation, and it is the duty of each classroom teacher to choose suitable tasks and times to use instruction calculators.

Furthermore, Barzel and Drijvers (2009) noted that learners gain arithmetic skills and expertise before studying algebra in most approaches to mathematics. The use of graphical calculators impacts the transition from arithmetic to algebra. The use of calculators boosts the confidence of students in the accuracy of their graphs, allowing them to function less dependently on the facilitator (Bowker, Hennessy, Dawes, & Deaney, 2009). Comparably, Ruthven, Deaney, and Hennessy (2009) suggested that the calculator was regarded by mathematics facilitators as a useful tool for testing the sketches or manipulation of learners, referring to the theme of promoting checking stages.

Graphic calculators are mainly used in North America to produce graphic image patterns; most often by learners themselves; through a guided-discovery approach that was only made possible by the use of technology, some teachers have stated (Ruthven et al., 2009). The reasons why graphing technology is used by facilitators are mainly related to saving preserving instructional time and producing more examples, increasing instructional variety and increasing students' inspiration (Ruthven et al., 2009). Graphing was important to seek other answers or to make sure that all answers were revealed (Ruthven et al., 2009). Generally, graphing software is favoured over graphical calculators (Bowker et al., 2009).

In order to increase learners' understanding, calculators need to be used effectively; specifically, calculators can help teachers build in-depth mathematical understanding and not substitute that understanding (Masalski, 2005). Vanderlinde, Aesaert, and Van Braak (2014) posits that ICT promotes employing a constructivist method in instruction. ICT is used by teachers as a tool to assist learners to learn the skills of ICT (Anderson, 2008), encourage self-regulated learning methods (Karabenick, 2011), and engage learners in learning activities (Anderson, 2002). Several scholars have carried out research to explore the degree to which ICT is employed by teachers and how ICT is used in the classroom.

Technology as a Tutor

Technology used as a tutor directly teaches learners through a lecture-style or workbook process. This technology usage provides explanations, demonstrates activities for the specific mathematics instruction, gives exercises to develop the skills incorporated, and solutions as needed (Means, 1994). Computers may convert the logical-mathematical thinking of a computer programmer to interesting interactive video games Computers can change the logical-mathematical thought of a computer programmer to interesting interactive video games (Varghese, 2012). In an attempt to produce higher-quality study habits on the go, Calkins (2009) claimed that wireless technology can be used as a mentor, delivering software applications to learners.

For all requirement that follows ICT education policy documents to incorporate computer technology into the range of courses in the core learning domains of senior high school mathematics, there is proof proposing that computers are not commonly incorporated into senior high school mathematics classrooms in Australia and the USA (Hudson & Porter, 2010). It is illustrated in the results of Ottenbreit-Leftwich, Glazewski, Newby, and Ertmer (2010). Kadel (2005) that educators use computers to do administration tasks instead of incorporation. Instances like administration activities include encoding work schedule lesson plans, documenting the work covered, scheduling tests, and searching the Internet for visual aids. Despite the growing awareness and familiarity of teachers with ICT and resources to aid it, many mathematics facilitators still do not incorporate technology constructively in their lessons (Hudson & Porters, 2010).

Supportive use of lesson planning technologies to promote learning, communication, administrative tasks, or internet access for students. As a mentor, some basic examples of ICT may consist of: "word processing of lesson plans, Excel spreadsheets, email correspondence, grades and reporting for students, and the use of websites to study knowledge of mathematics material". Instructive usage represents the needed teacher ICT incorporation and refers to the use of technology for problem-solving, study, or as a constructive tool in the classroom (Salleh, 2005). In the United States, the literature of the past two decades shows that the usage of ICT advanced from non-use to low use over the years to use it as a supporting tool or as an instructive tool. For example, most educators never used the internet in the classroom in a study conducted by Mathews (1998) involving 3500 teachers in 55 rural school districts in south-eastern Idaho, whilst the majority of the teachers classified themselves as computer beginners.

Extant literature suggests the development of technology use is given by (Barron, Kember, Harmes, & Kalaydjian, 2003). In one of the largest school districts in the USA, their study included 2156 K-12 school teachers in Florida to investigate the use of ICT as a tool for classroom learning, collaboration, efficiency, and problem-solving. They reported that about 50 percent of the teachers participating in the study employed ICT for communicative purposes, whilst few teachers used technology as a tool for learning, problem-solving, and productivity.

In terms of the level of ICT usage and its correlation with the use of a learner-centred method in the classroom, evidence from the literature indicated a correlation between countries. A recent study by Agyei and Voogt (2015) was carried out which examined the actual implementation of ICT by teachers in the classroom. In the final year of their pre-service training program, the research included 100 newly trained teachers who attended a professional development program called "using technology through collaborative design".

By using ICT-based curriculum materials, the learning collaborative design course is intended to enhance the capabilities of teachers in ICT usage. The research findings revealed that starting teachers were optimistic about the use of ICT-enhanced activity-based learning activities in the classroom.

The findings also showed that facilitators used ICT-enhanced activity-based learning tasks in their teachings: "the use of collaboration with their students, the use of lesson notes to direct lessons, the use of activity-based pedagogical methods, interactive spreadsheet presentations, and the use of spreadsheet techniques". In school, these uses of ICT meant that teachers used ICT for instructive purposes. So far this literature review has identified the pattern in the ICT usage in terms of frequency of use and how some of these studies have employed ICT in the classroom reported that facilitators used ICT for educational goals (Agyei & Voogt, 2014; Pelgrum & Voogt, 2009).

Technology for Exploration

Key aspects of reform efforts in mathematics education have been the discovery and explanation of knowledge. Mathematical material exploration provides learners with the chance to explore and create their connections between knowledge of content and application (Means, 1994). There are also greater advantages of using technology to prompt discovery. Technology that is accessible via the World Wide Web now provides demonstrations of mathematics at the hands of our students. The main websites, including Youtube, Khan Academy, and search engines such as Google and Yahoo, include some well-known information discovery ICT accessible on the internet. Not only is Youtube a source of amusement, but it includes several kinds of video tutorials suitable for the mathematics classroom.

Learners can search for a topic, watch videos demonstrating certain principles of mathematics, and investigate historical and modern knowledge. For various secondary and higher education mathematics students, Khan Academy has become the go-to places (Thompson, 2011). As learners create their functional web pages on the server, the website is central to both courses. The website is also vital to the continued support of the teachers of mathematics after the courses. The website is user-friendly, with navigation that is simple but elegant. This helps to facilitate comprehension of the principles and skills necessary to maximise the use of the Internet as a medium for classroom instruction.

Before and during the lecture, Williams, Cowie, Khoo, Saunders, Taylor, & Otrel-Cass, (2013) used classroom observation, classroom video-recordings and transcripts. In their study, the e-networked tools used to assist learners to investigate, share, and co-construct were: “online knowledge search, YouTube, web quests, mobile devices for accessing ideas and resources, and communication presentation tools". These factors included: "efficient access to technology, versatile curricula and evaluation systems, teachers' awareness of the various technologies' affordances, and teacher preparation to integrate technology substantially into their teaching".

Technology to Communicate

For communication purposes, the last significant role of technology is. There are two kinds of contact: synchronous and asynchronous communication (Rogers, 2000). Synchronous contact is any communication where both parties involved are present at the same time as the conversation, be it face-to-face, video chat, instant messaging, or telephone conversations. By email, message forums, and messaging, asynchronous contact takes place. Our culture has increasingly changed into a more asynchronous society in which we tend not to interact with each other directly. Technology is becoming the medium of choice for people to communicate and direct face-to-face contact is increasingly declining. "Word processors (e.g. Microsoft Word, Clarisworks, etc.), spreadsheets (e.g. Microsoft Excel, Clarisworks, etc.), web browsers (e.g. Netscape Navigator, Microsoft Explorer, etc.), web page tools (e.g. Adobe PageMill, Netscape Gold, HTML Clarisworks, etc.), e-mails (e.g. Netscape Mail, Claris Mail, Eudora, etc.), and other utility applications are used in a variety of communication tools".

Mobile devices are also used as effective educational environment tools, enabling more efficient knowledge collection and study, contributing to a more meaningful and enlightening educational experience (Calkins, 2009). The Nokia mobile company has presented mobile learning programs and services, such as Nokia mobile Mathematics and Nokia education delivery, in the UNESCO (2011) report. They are used to offer improved access and better quality content to schools and outside school learning in both formal and informal learning environments. These programs give students an immersive learning environment and the opportunity to use the social network of learners for peer support through the combination of social media application and learning. For the effectual introduction and classroom ICT implementation, the ICT usage in mathematics instruction is important.

Integration of ICT in the Teaching and Learning of Mathematics

In the 21st century, ICT has been considered an important method for studying mathematics. The National Council of Mathematics Teachers (2008) notes that schools must ensure that technology is accessible to all their students. ICT's role in teaching and learning is highly flexible. Therefore, improving mathematics instruction has become a matter of great concern in recent years. Skills and expertise in mathematics are seen as significant factors in boosting economic growth (Parker, 2016). These standards have culminated in the transformation and implementation of a new curriculum for schools and teaching strategies.

Learning with helpful tools such as the use of Microsoft Excel, DERIVE, MATHEMATICA, and MAPLE software for algebra (Keong et al., 2005) for integration will contribute to a practical understanding of mathematical principles and a wider understanding of the essence of mathematics (Varughese, 2012). Gachenga (2007) described "assignments, demonstration, as well as drilling and practice as common methods used in mathematics instruction". It also provides numerous mathematical representations that, unlike in a paper and pencil setting, increase the generality of mathematical ideas and provide innovations for counter-examples (Ogwel, 2008).

Significant technology integration in mathematics education is accomplished when students can choose technology resources to help them access, interpret and synthesize information promptly and present it professionally (Sadik, 2008). For several purposes, teachers introduce ICT into mathematics instructions, such as: "fostering student participation, teaching 21st-century skills, best teaching practice, staying current, hands-on interactive learning, varying teaching methods, conducting laboratories and presentations, and study and communication" (Hechter, Phyfe, & Vermette, 2012). To promote student learning, mathematics educators use technology to assist in teaching (for example, computers, calculators, software applications). Also, many ICT implementations are inadequately tailored to the curriculum. Nobre, Amado, and Carreira (2012) emphasized that a spreadsheet is a powerful tool for solving mathematical problems and particularly for developing algebraic thinking embedded in the activities of problem-solving.

According to Sapiens (2013), as learning becomes exciting, technology teaching and learning are enhanced; it stimulates and challenges learners with new interactive approaches, it enhances cooperation so that students can collaborate with individuals from various places. ICTs encourage constructivist pedagogy in which learners utilise ICT to investigate and understand mathematical ideas by enabling them to focus on response methods and interpretations instead of wasting time on repetitive numerical calculations (Armah & Apeanti, 2012; Wahyudi, 2008). Consequently, ICTs can enhance the consistency of mathematics instruction as it may be employed in many ways to facilitate learning for learners (Niess, 2006). Ekawati (2008) notes that the introduction of ICT into mathematics instruction has been able to increase the incentive of students to learn mathematics, enables individual learning based on the style and speed of individual learning, and has been excellent in improving cognitive and affective skills compared to the conventional instructional process. ICT saves time and provides learners with access to powerful new methods of exploring topics in a depth that has not been possible in the past. With the aid of ICT, poorer students are also more able to excel as they can perform more lessons and exercises at their speed and based on their different learning styles. It would have a positive impact on academic performance if ICT is engaged in mathematics education. Positive attitudes towards the study of mathematics in schools will also exist and will also enhance the comprehension of abstract concepts of mathematics.

Benefits of Using ICT in Mathematics Teaching

Various researchers identified the benefits that will result from the effective introduction of ICT in Mathematics education. Technology is a way to increase student exploration and discovery learning (Neo, 2005). Graphing calculators in teaching and learning mathematical concepts provide students and teachers with comprehensive ways to investigate, explore, and discover concepts (Harskamp, Suhre, & Van Streun, 2000). Incorporating ICT into the mathematics classrooms as ICT advocates constructivist pedagogy, which aids learners to explore and appreciate mathematical concepts, according to Ittigson and Zewe (2003). This strategy facilitates higher-order analysis and better methods for problem-solving (Ittigson & Zewe, 2003).

Papert (1993) argues that ICT is a tool that enables higher-order thinking to be developed, enabling users to take responsibility for their learning. Technology integration can promote active learning in the mathematics classroom and enhance creativity and equality in learning opportunities. Teachers who effectively use technology in the mathematics classroom provide timely formative feedback (Bicer & Capraro, 2017; Kaleli-Yilmaz, 2015)

Osborne and Hennessy (2003) agreed that emerging technology can also help improve motivation for students, promote better thinking and foster information interpretation skills in mathematics. Technology is readily available to help teachers transform their classroom into an investigative environment and to get students actively engaged in learning. With technology integration as a tool to raise achievement, researchers hope that some knowledge of relevant implementation processes would benefit children in Ghana. The ultimate belief is that it will improve student attitudes and motivation in mathematics teaching and learning (Brown, 2017). With the use of technology, mathematics becomes easier and more accessible.

ICTs can also empower the motivation of facilitators and students, turn the instructional process from highly teacher-centred to student-centred, and the change can lead to improved learning gains for students; "creating and empowering learners to improve their imagination, problem-solving behaviours, knowledge reasoning skills, communication skills". It is expected to promote engagement and improve student attitude to motivate learners to achieve their full potential (Ker, 2016).

ICT usage in mathematics teaching and learning offer teachers with broad access to develop tools that enable learners' interactivity at high levels, according to Bullock (2004). This will contribute to the development of interesting and exciting interaction between learners and educational resources. Becta (2004) also reveals the significance of ICT to the interaction of learners, stating that ICT improves and promotes coordination between students, including between learners and technology itself. Several researchers have indicated that ICT for the next generation would be an important part of the education process. It is the necessity for instruction that must promote ICT action, instead of the ICTs themselves (Baylor & Ritchie, 2002).

Furthermore, it was reported that graphing calculators are more prevalent in high schools (Dion, Harvey, Jackson, Klag, Liu, & Wright, 2001), and their use promotes deeper conceptual understanding by exposing students to multiple representations of mathematical concepts (Doerr & Zangor, 2000). Geometer's Sketchpad provides students with dynamic multiple representations and supports their understanding as they interact with concepts in a variety of ways (Flores, Knaupp, Middleton, & Staley, 2002). Alagic and Palenz (2006) discussed the use of spreadsheets to provide visual and graphical multiple representations interconnected with appropriate simulations, meaningful time-efficient explorations of a variety of cases and nurturing problem-solving learning environment. With the widespread availability of technology tools such as scientific calculators, spreadsheets, CAS, and Geometer's Sketchpad, mathematics teachers are provided with this opportunity to incorporate such tools in their classrooms.

Obstacles that Prohibit Teachers from Using ICT in Mathematics Classroom

In improving teacher effectiveness and improving student learning, the introduction of a range of technical methods in teaching is essential. However, in their effort to incorporate technology into their classroom practices, teachers are bound to face such barriers. These challenges explain why teachers may be hesitant to implement ICT as an innovation in their teaching and should therefore be taken into account when researching the adoption of such innovations by teachers. Schoepp (2005) describes a barrier as any situation that makes advancement or the accomplishment of an objective difficult. Many reasons prevent ICT usage in classroom instruction.

Peeraer and Van Petegem (2009) argue that the computer skills and confidence in ICT usage of teacher educators are major obstacles to ICT usage in instruction. Teachers' ability to use technology as a teaching and learning tool is one of the main limitations in education across Ghana. Agyei and Voogt (2011) employed a survey to explore the extent to which ICT use in mathematics teaching at senior high school levels. A total of 180 mathematics teachers consisting of 60 in-service and 120 pre-service teachers participated in this study. The study found that mathematics teachers in Ghana did not use ICT in their mathematics teaching due to a lack of adequate skills about how computers could be used in mathematics instruction. According to Perrotta (2017), the inability to effectively use technology to enhance instructional materials aligned to the learning objectives is a challenge when teachers cannot use computers, visual aids, electronic boards, and mobile devices as learning aids.

From the participant's concern, a dependency on forms of ICT such as calculators can be detrimental to promote engaging and meaningful use of the technology (Bitner & Bitner, 2002). Technology is a convenient and powerful tool for students by helping them to do things quicker, technology may also eliminate the need for understanding underlying procedures involved in solving complex problems. Students should be able to accomplish the tasks they are given, or overcome the problems they encounter with or without the assistance of technology.

Research by Miima, Ondigi, and Mavisi (2013) found that the ICT adoption and usage in instruction were hampered by both extrinsic and intrinsic variables. The study results showed that all teachers lacked sufficient time and were thus unwilling to implement ICT into their instructional activities. In a study on teacher awareness, attitude and ICT usage, Kandasamy and Shah (2013) stated that majority of respondents faced the barrier of insufficient time. We take these obstacles into account in current research to analyse the acceptance of ICT as an advancement in the mathematics classroom by senior high school mathematics teachers. The endeavours of facilitators towards the successful ICT incorporation into the classroom environment aim to thwart these challenges.

Theoretical Underpinning the Study

Literature has revealed that the introduction of ICT into mathematics classrooms by teachers affects student performance (Hegedus, Tapper, & Dalton, 2016). In classrooms alone, access to ICT tools does not boost learner achievements. Educators play the main role in incorporating ICT into actual classroom instruction. It is the decisions of the teacher on how to incorporate

ICT in classroom instruction that will either promote or impede learner achievements. Considering the role of the teacher in ICT usage in the classroom, several theoretical models of ICT integration have been developed in the literature to explain teachers' ICT usage in mathematics instruction.

Under many different approaches, studies on ICT incorporation in classroom instruction has been discussed. For example, Ertmer (2005) indicates that inherent attitudes and the values that teachers have with regards to the advantages and logic of using ICT in the classroom are internal obstacles to technology integration. The TPACK model (Mishra & Koehler, 2006), which includes three dimensions: technological knowledge, pedagogical knowledge and content knowledge, is a conceptual model defining the competencies required for today's teachers. On a conceptual level, this model is essential, concentrating on the need for expertise in how the various types of information can be combined. A new approach takes external obstacles to the introduction of technology into account. External obstacles: "lack of hardware and software, lack of time, lack of funding, insufficient facilities and lack of support services", are described as challenges that hinder teachers from being effective in incorporating technology into their teaching (Del Favero & Hinson, 2007; Keengwe, Onchwari, & Wachira, 2008).

In the first half of 2000, the Practitioner Model of Computer (PMC) model was established through group discussions with seven group interviews with mathematics departments (Ruthven & Hennessy, 2002). Teachers defined the following external factors influencing ICT integration during the design of the PMC model: "working environment, resource framework, activity structure, curriculum script, and time economy".

Both internal and external sources of obstacles to technology adoption were established by Rogers (1999). Internal barriers were referred to as technology attitudes and perceptions, where teacher anxiety reflected a major negative feeling towards ICT adoption, and three external barriers were identified: (1) availability and usability, (2) growth of stakeholders, and (3) technical support, and one internal barrier (attitudes and perceptions of teachers) to ICT adoption. A significant assumption of this model is that external and internal barriers have influenced each other, but it has been said that the biggest obstacle to ICT acceptance is internal barriers (Rogers, 1999, p.19). The need to recognise and evaluate the degree of teacher ICT adoption, as a critical first step in understanding the barriers to ICT adoption, is another significant assumption.

A progressive model from the structural WST model is the will, skill, tool (WST) model of teacher ICT integration that describes the circumstances in which teachers are probably to use ICT in their classroom. The will, skill, tool (WST) model of integration of technology (Christensen & Knezek, 2008) was primarily designed to describe the reality of ICT implementation in educational contexts. From the perspective of Christensen and Knezek (2008), a teacher requires three factors of will, skill, and access to ICT tools for the effective integration of ICT in the classroom. These three key constructs in the model: will (attitudes towards technology), skill (competence in the use of ICT) and tools (access to ICT tools) (Christensen & Knezek, 2002). Past studies have shown that a very high degree of variation in the level of classroom ICT usage is explained by these three variables. (Agyei & Voogt, 2011; Christensen & Knezek, 2002; Morales, 2006; Petko, 2012).

Petko (2012) reported that one major significant predictor of ICT classroom usage is the perceived efficacy of ICT. For neglecting essential considerations such as pedagogy, the WST model has been criticised by (Petko, 2012). The model was transformed into the WSTP model (Knezek & Christensen, 2015). The Will, Skill, Tool, Pedagogy (WSTP) model suggests that a teacher now needs four components to effectively incorporate ICT in the classroom: will (teacher attitudes towards technology), skill (competence in the use of ICT), tool (teacher access to ICT tools) and pedagogy (teachers teaching style and confidence in skill).

Based on previous research, the WST model was updated to WSTP to improve the model's ability to predict more than 90 percent of the integration of teacher technology and to cover more detailed detection of areas to be targeted. Knezek and Christensen (2015) claim that these four variables can explain 90 percent and beyond of the variation in the degree of technology integration in the classroom.

Towards a Conceptual Framework of the Study

Relating Figure 1, the study was conceptualised concerning the constructs employed in the figure. The WSTP model constructs were adapted for application to mathematics teachers to analyse ICT usage in their classroom instruction. In this study, it is hypothesized that the variables will, skill, tool and pedagogy independently and simultaneously influence ICT usage in classroom instruction. The will, skill tool pedagogy is modified as follows: will (attitudes towards ICT usage in the classroom), skill (competence in the use of ICT tools), tool (teachers access to ICT tools) and pedagogy (teachers teaching style and confidence in skill).

It is assumed that a teachers' will, skill, access to tool and pedagogy will result in ICT adoption in mathematics classroom instruction. These four predictors explain much proportion of variance in classroom ICT use. This study used the WSTP model to investigate the relationship between will, skill, tool, pedagogy (independent variables) and ICT integration (dependent variable) and also confirms the predictive power of the four components of the WSTP model of ICT integration to predict beyond the previously reported study in the Ghanaian context (Agyei & Voogt, 2011).

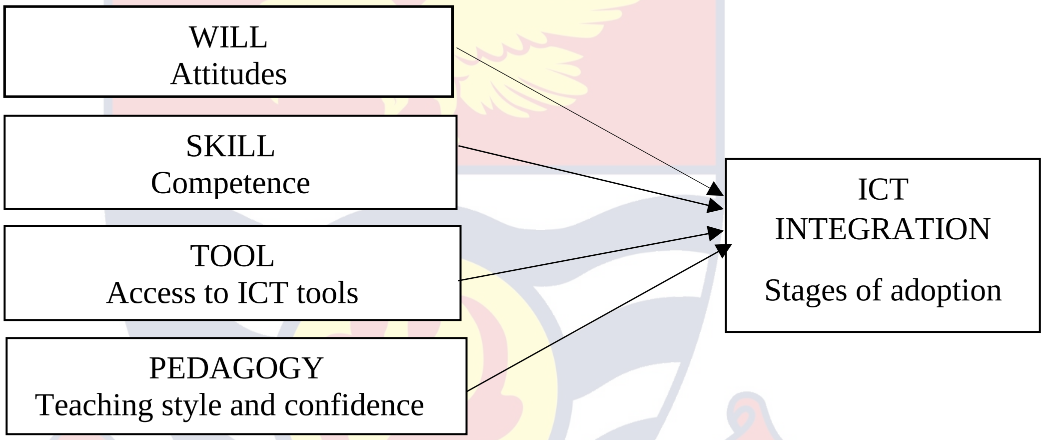

Figure 1: Conceptual Framework of Will, Skill, Tool, Pedagogy Model of ICT Integration (Knezek & Christensen, 2015)

The Specific Application of the Will-Skill-Tool-Pedagogy Model in the Study

Attitude towards Technology (Will)

Attitude can help to clarify decisions that teachers make to teaching and how they prepare to teach with ICT (Lumpe & Chambers, 2001). The attitudes of teachers are seen as a significant role in modern ICT usage in educational environment (Albirini, 2006). The attitudes of teachers' is one key determinant that affects the successful computer usage in instruction is the teacher's attitude toward computers (Owens, Magoun, & Anyan, 2000; Wambiri & Ndani, 2016).

Teachers' attitudes toward ICT integration in their instructional practice are based on their belief about the usefulness of ICT in teaching (Shirvani, 2014). They will use technology if teachers have a positive attitude towards computers (Gabriel & MacDonald, 1996).

Sa'ari, Luan, and Roslan (2005) argued that if teachers take a positive approach, they may influence and build confidence in the future use of computers in the classroom. It also contributes to the enhancement of self-efficacy. The success of teacher training programs is often strongly affected by their attitude. Dawes (2000) notes that teachers' recorded attitude to ICT informs us more about what resources the teacher has access to what preparation they have had, and what kind of culture they are part of than about the teacher's willingness to use ICT. The implication here, then is that the perceived aversion to change is a sign of barriers to ICT usage. In their research, Drent and Meelissen (2008) established that a positive ICT attitude has a direct positive impact on the teacher's creative ICT usage. Sometimes, optimistic attitudes inspire less technologically skilled teachers to develop the skills required to carry out classroom technology-based activities.

They concluded that it is important to shift the negative attitudes of individuals to improve their computer skills. Keengwe and Onchwari (2008) agree that optimistic educators' attitude towards ICT is profoundly influenced by the learners ICT experience. Hence if educators desire to utilise ICT effectively in their classrooms, they need to have a positive attitude about using ICT. There is evidence to suggest that the attitudes of teachers to technology impact its use in the classroom. The more teachers view technology favourably, the more likely they are to use it in the classroom (Domingo & Gargante, 2016).

In comparison, other studies have shown an inconsistency between teachers' values and their technology usage. It is important to recognise that our attitudes towards ICT usage impact how ICT is integrated and taught. Our view of the value of technology influences how we incorporate it into the learning environment. Allan and Will (2001) measured the attitudes of Chinese teachers toward the pedagogical usage of computers within Selwyn's suggested theoretical model. Teachers' Attitudes towards Computer (TAC) questionnaires are another commonly used method in this area. In all the scales, Likert-type scales are used. In order to facilitate instruction and efficient incorporation of computers in teaching, these attitude scales often play a significant task in productive investment in computer technology (Koohang, 1989).

Mathematics teachers' attitude towards technology usage is measured by teachers' attitude towards computers questionnaire (TAC) 6.1 developed by Christensen and Knezek (2006) in this study.

Competence in the Use of ICT (Skill)

ICT competence is described as the ability to manage different ICT applications for more than one purpose. Effective ICT use in classroom instruction supports the willingness of educators to combine technology and modern pedagogies to organise their learning experience in non-traditional ways. This involves a very different set of management skills in the classroom to be built along with creative approaches to ICT usage to strengthen learning and foster literacy in ICT, deepening awareness and generating knowledge. ICT aided teaching is the most necessary ability required of an educator, according to Prestride (2012), sadly, it is the least possessed by many. This could be because their preparation course was scarcely part of it.

Prestride (2012) summarised some of a senior high school teacher's ICT package, such as data processing, word processing, internet use, spreadsheet use, presentation tools such as "PowerPoint and e-mail". For teachers, these ICT packages are significant because they help to develop lesson plans, review and set assessments for learners, learn new information, and among others, present lessons in a simple way. One key indicator of ICT integration into classroom instruction is the teacher's competence, according to Bordbar (2010), and this aids more in effectively using ICT in teaching. Henson (2003) has found that the effectiveness of teachers is a relevant component of the success or failure of a classroom teacher. The essential role of educators in the effective application of ICT in the educational process is also recognized by UNESCO. The ability to transfer skills and experience to new circumstances is one of the main challenges in improving effective technology integration.

A very important determinant of the degree of participation of teachers in ICT is their level of confidence in the use of technology. Teachers who have little to no confidence in their work using computers will want to stop them entirely (Dawes, 2000). In his research, Albirini (2004) also stated that the computer competence of teachers predicted their positive attitudes toward technology in education. A disparity exists between what trainee teachers are taught in their courses and how teachers use technology in the classroom, according to studies carried out (Ottenbreit-Leftwich et al., 2010). Among the reasons found to understand why there is a difference between the real and planned use of technology were: inadequate access to ICT (Dawson, 2008) and lack of expertise in ICT (Dawson, 2008; Teo, 2009).

The success of educational developments, according to Pelgrum (2001), relies largely on the skills and knowledge of facilitators. He also reported that the lack of awareness and skills by teachers was the second most constraint barrier to ICT usage in instruction. Knezek and Christensen (2000) proposed that the higher teachers' ability levels and ICT expertise, levels of ICT usage will also show an increase to promote classroom instruction. Also, Berner (2003) concluded that with the help of ICT, educators may improve their expertise based on the educational objectives they want to achieve. Swarts and Wachira (2010) suggested that while teachers have basic ICT awareness, many do not understand how ICT is incorporated in instruction. The limited use of teaching technology is what prompted researchers to initiate a professional development curriculum to develop the skills and abilities of pre-service teachers to incorporate ICT into teaching mathematics. (cf. Agyei & Voogt, 2011; Alayyar, Fisser, & Voogt, 2012).

Various studies have revealed that teachers in senior high schools lack the skills to ICT usage as a pedagogical tool in the instructional process (Nihuka & Voogt, 2011). Awareness of the ICT skills of teachers is an integral component of effective ICT integration. Therefore, one of the strong obstacles to the introduction of ICT into education could be the lack of teacher competence. It can also be a key variable involved in change resistance.

Mathematics teachers' competence in the use of ICT is measured with TPSA developed by Ropp (1999).

Access to ICT Tools (Tool)

Dewey (1989) suggests that when the need occurs in the real world, the knowledge that is accessed but never put to use during that process can be tedious to retrieve and use. If educators are unable to access ICT services, then they are not going to use them. Research by Yildrim (2007) found that one of the important strategies for pedagogical ICT usage by teachers in instruction is access to technological tools. Restricted resources inside schools are a great impediment to the take-up of technology, according to Mumtaz (2000). The lack of computers and software in schools, for example, can significantly restrict the ICT usage by teachers. Access to ICT tools and school facilities is an important condition for incorporating ICT into education (Plomp, Pelgrum, & Law, 2009).

Successful ICT adoption and incorporation into school instruction relies primarily on the availability and accessibility of ICT tools such as hardware, software, etc. However, facilities provided, particularly in training institutions, provide a window and the required first step to use existing hardware and software in innovative and situation-specific ways to improve ICT instruction (Agyei, 2012). Mathematics teachers' access and availability to ICT tools is measured with access to ICT tools direct responses questions developed from the literature.

Teaching Style and Confidence in Skill (Pedagogy)

Pedagogy as the heart of teaching is defined by Pritchard and Woollard (2010). It is about rules and beliefs that govern efficient and effective practices that contribute to learning. Christensen and Knezek (2014) identified pedagogy as a style of teaching (constructivist, behaviourist, etc.) as well as the degree of confidence teachers feel in using ICT to improve learning in technology integration for their learners. In the debate on self-system, Pajares and Schunk (2001) added the aspect of competence and noted that self-efficacy is how a person perceives his or her competency. As a consequence, this understanding affects the willingness of a person to set realistic targets to achieve a task.

Self-efficacy is confidence in the competence of oneself (Knezek & Christensen, 2015). When assessing teacher education systems, Lim and Pannen (2012) related ICT competence and pedagogical consideration. These programs, however, can teach skills and knowledge, but still do not produce the required change in pedagogy (Lim & Chai, 2008). Bandura (2001) suggests that self-efficacy perceptions often aid to decide the number of effort individuals will put into an endeavour, how far they will endure while meeting barriers, and how resilient they will be in the face of adverse circumstances. The greater the sense of self-efficacy, the higher the commitment, determination and endurance, in other words. Therefore, the more individuals are self-assured, the more they use the talents and potential that already exist.

Artino (2012) reports that if people are not confident that through their acts they may achieve desired results, they have little motivation to act. To have good attitudes regarding their ability to thrive, they need to be motivated. They must move from the behaviourist to the constructivist teaching approach in order for teachers to incorporate technology effectively. It is argued that this shift in the pedagogical approach will transform the pedagogical perception that is encouraged in section by the use of powerful classroom ICT resources such as computers, as well as by the student learning outcomes experienced by teachers due to the use of modern ICT, teaching strategies (Guskey, 2002).

Research has shown that several facilitators who incorporate ICT into their classrooms do not change their teaching practices (Cuban, Kilpatrick, & Peck, 2001) and that those who alter their practices do not see the transformation as being affected by ICT itself, but as a result of school policy, involvement in an academic course (Windschitl & Sahl, 2002).

Teachers simply use modern technologies to continue their normal practices, according to them, although they also assert to have altered their instruction. Boaler (2013) found that practicing skills or techniques, teacher lectures and exploring concepts and values of mathematics were the most commonly adopted practices by mathematics teachers in her research report. He further reports that teachers, relative to curriculum objectives that centred on lifelong learning and connectivity, indicated that they value a more traditionally oriented curriculum.

Condie and Livingston (2007) showed that while some facilitators pursue to demonstrate a hesitance to experiment with current technologies, others remain anxious about trying current methods that they consider could harm the outcome of the test. Sa'ari, Wong, and Roslan (2005) have reported that educators who have shown a high degree of computer skills find ICT to be more effective. These teachers have more confidence and less anxiety about using ICT. For some teachers, using ICT to facilitate instruction and using more constructivist techniques tends to be seen as risky tactics and they tend to stick to tried and tested methods that they perceive allow them to more easily predict and control performance.

Mathematics teachers’ confidence in skill is measured by two new subscales in the updated TPSA developed by (Christensen & Knezek 2014).

ICT Integration

According to Buabeng-Andoh (2012), for successful implementation, educators must consider ICT to be better than previous experience and integration of ICT in instruction; harmony with their current attitudes, past experiences and needs; easy use, before deciding to implement, can be experimented with on a limited basis and finally the impact of innovation is noticeable to others. These three features or components of the adoption and incorporation of ICT in instruction by teachers include data on factors encouraging their ICT usage together with challenges to the implementation of ICT. Research shows that using ICT as a learning tool assists students develop the capability to gather, process and create data, although facilitators accept ICT-enabled learning as an aspect of their instruction (Ertmer & Ottenbreit-Leftwich, 2013).

Boakye and Banini (2008); Olatokun and Kebonye (2010) stated that there is a need for further investigation of the level of adoption and ICT usage in different contexts worldwide, especially in developing countries, as well as the impacts of its use. Chien, Wu, and Hsu (2014) revealed that the constraints to classroom ICT implementation are confidence, teacher competence and attitudes that reduce the percentage of ICT usage. Mathematics teachers' level of ICT integration in the mathematics classroom is measured with modified Stages of adoption developed by (Hancock, Knezek, & Christensen, 2007).

Summary

It is clear, according to the reviewed literature, that ICT is being accepted in teaching all over the world. To achieve the goal of ICT integration in teaching and learning, countries have constructed infrastructures, educated teachers, and ensured internet connectivity for schools and have cooperated with the nation's teachers. As a result, positive feedback on their successful incorporation of ICT in education is already being obtained. On the other hand, ICT incorporation in Ghana has recently developed a new strategy and plan for the inclusion of technology in its education system, is a relatively new concept. While they continue to follow the direction introduced by developed countries, due to numerous internal and external factors, it is becoming difficult for them.

Research has shown from previous literature that the culture of using ICT in education is developing around the world and the response to technology integration in education is very positive. Research is being conducted on the application of ICT in Ghana's education system. The challenges that inhibit the use of ICT to promote teaching have been reviewed in extant literature. In addition, issues like positive attitude towards technology, ICT competence, computer self-efficacy, accessibility and availability of ICT resources and their style of teaching, and other factors affecting the successful ICT usage in senior high school teaching were also established. This study, therefore, emanates from the researcher's thirst to explore the opinion of mathematics teachers about using ICT to promote classroom instruction in selected senior high schools in the metropolis of Sekondi-Takoradi.

CHAPTER THREE

RESEARCH METHODS

This chapter presents how the analysis was performed. The research design, population, sampling techniques, data collection tools, research method and data analysis techniques used in the study are discussed.

Research Design

A descriptive survey design was used for this research. The descriptive survey was used to collect data on the experience of teachers using ICT to promote senior high school teaching and learning in Ghana. Creswell (2003) also states that an analysis of a descriptive survey is useful in describing a specific population's attitudes, beliefs, behaviours or characteristics. A descriptive survey design's main objective is to collect data from a given group of individuals in order to generalise the findings of the sample to the population.

Study Area

The thesis will be performed in the metropolis of Sekondi-Takoradi, a district in the Western Region of Ghana. Mpohor-Wassa East borders the Metro to the north, the Gulf of Guinea to the south, Ahanta West District to the west, and Shama District to the east. It has a total area of 49.78 sq km of land. On the west coast, the metropolis is situated about 280km west of Accra and 130km east of La Cote D'voire. Because of limited resources for the research, this location is chosen for proximity.

Population

The study population consisted of all mathematics teachers from all ten (10) public senior high schools in the Sekondi-Takoradi Metropolitan Assembly (S.T.M.A.): Adiembra Senior High School, Ahantaman Senior High School, Archbishop Porter Girls Senior High School, Bompeh Senior Technical School, Diabene Senior Technical school, Fijai Senior High School, Ghana Senior Technical School, Methodist Senior High School, Sekondi College and St John's School. The mathematics teachers in all ten (10) SHS were 116. This shaped the study's open population.

Sampling Procedure

School Sample

Purposive sampling technique was used to identify the number of public senior high schools within Sekondi-Takoradi Metropolis with access to ICT tools in terms of ICT integration in mathematics instruction.

Table 1: Number of Schools and Mathematics Teachers 2018/2019 Academic Year

Name of school	Number of mathematics teachers 2018/2019 academic year
Adiembra Senior High	10
Ahantaman Senior High	13
Archbishop Porter Girls Senior High	8
Bompeh Senior High Technical	10
Diabene Senior High Technical	9
Fijai Senior High	17
Ghana Senior High Technical	15
Methodist Senior High	9
Saint John’s Senior High	12
Sekondi College	13
Total	116

Source: S.T.M.A. Ghana Education Service statistics (2019)

Teachers’ Sample

Census survey method was used since the target population in question was small, data was collected from all 116 mathematics teachers in Sekondi-Takoradi Metropolis. Out of the 116 questionnaires distributed to mathematics teachers, 79% were retrieved. Table 1 presents the total sampled mathematics teachers in Sekondi-Takoradi Metropolis been 116.

Data Collection Instruments

A questionnaire was employed to generate data for the current study. The first part of the questionnaire was the demographical characteristics of the teachers such as age, gender, professional qualification and rank of teachers. The subsequent sections on attitudes towards computers, ICT skills and competencies, teachers access to ICT tools, teaching style and their confidence and ICT integration. Participants had to present their opinions on a Likert-scale type of five marks.

Teachers' Attitudes toward Computers (TAC)

The Teachers' Attitudes toward Computers (TAC) questionnaire was employed to assess the teachers' attitudes towards computer use. It is a 46-item questionnaire that comprises of nine subscales of computer attitudes (appendix A). The nine (9) subscales by Christensen & Knezek, (2006) was used to investigate the attitudes of the teachers towards technology in the study comprising: "interest, comfort with computers, accommodation, e-mail, concern, utility, perception, absorption, and significance". Using the TAC on teachers in several attitudinal surveys in education, Christensen and Knezek (1997) revealed that the TAC possessed high reliability (alpha = 0.90).

Access to ICT Tools

A five-point Likert scale direct questions were used to assess teacher's access to ICT tools. These were senior high school mathematics teachers' access to a personal computer, Internet connectivity to these computers, whether in the school or at the computer laboratory they had access to a computer or in the common room, computers were accessible to them. Participants were to indicate their responses using five-point Likert scales to assess each of the items.

Technology Proficiency Self-Assessment (TPSA-C21)

The Technology Proficiency Self-Assessment questionnaire (TPSA-C21) comprises the original TPSA (Ropp, 1999) which is used to measure teachers' competence and new items developed by Christensen and Knezek (2014) used to measure teachers' confidence and pedagogy for implementing ICT in classroom instruction. The TPSA 2014 consist of 34 items assessing educator self-efficacy. The original TPSA is a self-rating Likert-type scale with 20 items distributed in four subscales. the four established domains are: "email, World Wide Web (WWW), integrated applications, and teaching with technology" while the 14 new items represent emerging technologies including mobile technologies, use with educators for planning professional development related to ICT usage. The updated version extend self-efficacy assessment to new fields like social media and mobile learning.

Stages of Adoption of Technology (SoA)

Stages of Adoption (SoA) was employed to assess the teachers' ICT integration levels. The SoA measures the stages of technology utilisation in education practices by teachers (Christensen & Knezek, 2000; 2008). This instrument is an ICT integration self-reporting measure. This instrument is a one item self-reporting measure of six responses modified to five responses:

Awareness, Learning the process, Computer self-efficacy, Adaptation to other contexts, Creative application to new contexts. Since the SoA is a one-item survey, internal consistency reliability could not be computed. However, the validation studies have provided high test-retest reliability estimates (0.91-0.96) (Hancock, Knezek, & Christensen, 2007).

Validity

The instrument was given to my supervisor to determine the face, content and construct validity of the instruments. In this process, the appropriateness of the language used was checked so that the teachers understood the items on it. Again, some wordings that were considered ambiguous were modified, including checking instruments in the subject matter. Several items were examined to ensure that the items measured what they were intended to measure.

Pilot Testing

The instruments were pilot-tested in senior high schools in the Cape Coast metropolitan district in the Central Region of Ghana with common features as those that were used for the actual research in the Sekondi-Takoradi Metropolitan Assembly (STMA) such as mathematics and access to ICT tools. To meet parametric assumptions, thirty (30) mathematics teachers were used in the pilot- test.

The instruments were collected from the participants after completion and the information acquired analysed by computing their reliabilities and inter-item correlations. Based upon the inter-item correlation, some of the items were modified and two items were deleted from the instrument.

Reliability

The reliabilities of the instruments were computed using the Cronbach Alpha to ascertain the internal consistency reliability of the variables and also if each item under the various subscales was correlated to each other after the pilot- testing. During pilot- testing exercise, the reliability estimates obtained using the Cronbach Alpha for Will, Skill, Pedagogy and Tool were 0.85, 0.92, 0.90 and 0.78 respectively. In conclusion, Fraenkel and Wallen (2000) assert that "for research purposes, a useful rule of thumb is that reliability should be at .70 and preferably higher" such as all instruments for this study are reliable.

Data Collection Procedure

An introductory letter was obtained from the Head of Department of the Mathematics and ICT education department of the University of Cape Coast and copies were sent to the headteachers of the selected schools for permission to undertake the study. The research questionnaires were then administered to the sampled teachers and the questionnaires were collected from the schools using a self-tracking form after 4 working days.

Data Processing and Analysis

All data were carefully coded and screened. To answer the research questions, all three (3) questionnaires i.e., Attitudes towards computer (TAC), Technology Proficiency Self-Assessment survey (TPSA-C21), and Access to ICT Tools were subjected to an exploratory factor analysis (EFA) to reduce data to a smaller set of summary variables (subscales) because the items were many. When running EFA, the data is explored for patterns. The assumptions of positive definiteness (the determinant of the correlation matrix should not be equal to zero), the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) and Bartlett's Test of Sphericity (testing the suitability of the sample for factor analysis) were assessed. All instruments were satisfactory proving that assumptions were not violated except Access to ICT Tools of which positive definiteness, the Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) and Bartlett's Test of Sphericity assumptions were violated.

Principal components method of extraction and varimax rotation was used for exploratory factor analysis of the attitude, competence and self-efficacy data, (Eigenvalues > 1.0 and item loading ≥ 0.5 were considered to be significant. This was done to evaluate the applicability of the measures in evaluating the construct validity of the scales. The obtained Eigenvalues were named as the components or subscales. The reliability (internal consistency) of the instrument was assessed using Cronbach's alpha coefficients (α) and all variables attitude (α = 0.925), competence (α = 0.923), confidence in skill and teaching style (α = 0.911) and access to ICT Tools (α = 0.744) were found to be reliable according to Fraenkel and Wallen (2000)

Attitudes towards Computer (TAC)

Attitude towards computer (TAC) items were many and as such there was the need for reducing items to a smaller set of indicators, twenty-three (23) out of the forty-six (46) items on the TAC questionnaire were selected as high loadings on the extracted factors after an exploratory factor analysis to derived four (4) subscales: *Anxiety* (feelings towards computers), *Usefulness* (a person's perceptions about the usefulness of computers in their classroom instructions), *Benefit* (help or advantage that results from computers usage), *Enjoyment* (likeness towards using computers). Respondents answered the TAC using a five-point scale of strongly disagree (1), disagree (2), neutral (3), agree (4), and strongly agree (5). Items forming the negative subscale: *anxiety* was reversed coded and changed to a positive subscale *lack of anxiety*. The TAC reliability co-efficient for the scales were Anxiety (α = 0.900), Usefulness (α = 0.898), Benefit (α = 0.807), and Enjoyment (α = 0.636). Table 2 shows the internal consistency reliabilities for the TAC sub-scales and the factor loadings for the selected items as reported by the SHS mathematics teachers.

Table 2: Internal Consistency Reliability for the Four Subscales of TAC

Subscales	Cronbach's Alpha	Items (N= 92)	Factor Loadings
Anxiety	**0.900**	Working with a computer makes me feel tense and uncomfortable.	0.823
		Computers intimidate me.	0.808
		Using a computer is very frustrating.	0.806
		Working with a computer makes me nervous.	0.793
		If I had a computer at my disposal, I would try to get rid of it.	0.745
		Studying about computers is a waste of time.	0.693
		I get a sinking feeling when I think of trying to use a computer.	0.589
		I can't think of any way that I will use computers in my career.	0.588
Usefulness	**0.898**	If a problem is left unsolved in a mathematics class, I continue to think about it afterward.	0.752
		Computers will improve mathematics education.	0.710
		It is important for students to learn about computers in order to be informed citizens.	0.702
		Computers can be useful instructional aids in the teaching and learning of mathematics.	0.680
		Having computer skills helps one get better jobs.	0.655
		All students should have an opportunity to learn about computers at school.	0.638

		Students should understand the role computers play in society.	0.615
		Computers are necessary tools in both educational and work settings.	0.537
Benefit	**0.807**	If there was a computer in my mathematics classroom it would help me to be a better teacher.	0.848
		Computers improve the overall quality of life.	0.676
		Computers could enhance mathematics remedial instruction.	0.609
		Computers can help me learn.	0.532
Enjoyment	**0.636**	I like reading about computers.	0.748
		I like to talk to others about computers.	0.613
		I enjoy working with computers.	0.545

Source: Fieldwork (2019)

Teacher Proficiency Self-Assessment for the 21st Century (TPSA-C21) - Competence

The first section of technology proficiency self-assessment survey TPSA-C21 measured competence, three-component were derived after factor analysis. Component 1 was tagged *Basic skills* (send documents, texts, messages over the internet), component 2 *Instructional use* (software for teaching and learning) and component 3 *Integrated apps* (newsletters, spreadsheet, pdf). The reliability coefficient observed for the scales were: basic skills (α = 0.911), Instructional use (α = 0.888), and Integrated app (α = 0.732). Table 3 presents the reliabilities for the TPSA sub-scales and the factor loadings for the selected items as reported by the SHS mathematics teachers

Table 3: Internal Consistency Reliability for Three Subscales of the Technology Proficiency Self-Assessment Survey TPSA

Subscales	Cronbach's Alpha	Items (N= 92)	Factor Loadings
Basic skills	**0.911**	use an Internet search engine (e.g., Google or Yahoo) to find Web pages related to mathematics.	0.812
		keep copies of outgoing messages that I send to others.	0.788
		send a document as an attachment to an e-mail message.	0.776
		Keep track of Web sites I have visited so that I can return to them later. (using bookmarks.)	0.723
		find primary sources of information on the Internet that I can use in my mathematics teaching.	0.704
		subscribe to a discussion list.	0.672
		use the computer to create a slideshow presentation.	0.672
		send an e-mail to a friend.	0.668
		create a "nickname" or an "alias" to send e-mail to several people at once.	0.553
Instructional use	**0.888**	create a lesson or unit that incorporates mathematical software as an integral part.	0.866
		use technology to collaborate with other interns, teachers, or students who are distant from my mathematics classroom.	0.793
		create a database of information about important authors in mathematics.	0.776
		describe 5 mathematical software programs (Geogebra, khan academy, Wolfram Alpha etc) that I would use in my teaching.	0.696
		write a plan with a budget to buy technology for my mathematics classroom.	0.682

		write an essay describing how I would use technology in my mathematics classroom.	0.660
Integrated apps	**0.732**	create a newsletter with graphics and text in 3 columns.	0.791
		use a spreadsheet to create a pie chart.	0.617
		save documents in formats so that others can read them if they have different word processing programs (e.g., saving Word or text).	0.573

Source: Fieldwork (2019)

Teacher Proficiency Self-Assessment for the 21st Century (TPSA-C21) – Teaching Style and Confidence in Skill

The last section of Teacher Proficiency Self-Assessment for the 21st century (TPSA-C21) involving 14 items measured confidence and teaching style. Three (3) subscales were obtained: *Internet use* (send and receive messages, download and stream video, e-books and save to cloud-based environment), *Technology learning support* (incorporate ICT such as devices and software in instruction and collaborative learning) *and Emerging themes* (online interactive tools such as google classroom, ZOOM, WhatsApp group and blogs). The reliability coefficient observed for the scales were: Internet use (α = 0.913), technology learning support (α = 0.877), and Emerging themes (α = 0.764). Table 4 displays the internal consistency reliability of the TPSA-C21.

Table 4: Internal Consistency Reliability for Three Sub-Scales of the TPSA- C21

Subscales	Cronbach's Alpha	Items (N=92)	Factor Loadings
Internet use	**0.913**	download and view streaming mathematics video clips.	0.891
		download and read mathematics e-books.	0.862
		send and receive text messages.	0.834
		download and listen to mathematics podcasts/audiobooks.	0.815
		save and retrieve files in a cloud-based environment.	0.742
		transfer photos or other data via a smartphone.	0.658
Technology learning support	**0.877**	find a way to use a smartphone in my classroom for student responses.	0.821
		use social media tools for instruction in the classroom (e.g. WhatsApp, etc.).	0.794
		integrate mobile technologies into my mathematics instructions.	0.757
		teach in a one-to-one environment in which the students have their own device.	0.743
		use mobile devices to have my students' access to learning activities.	0.730
Emerging themes	**0.764**	create a wiki or blog to have my students collaborate.	0.829
		use online tools to teach my students from a distance.	0.773
		use mobile devices to connect to others for my professional development.	0.604

Source: Fieldwork (2019)

Access to ICT tools

Access to ICT tools had 7 items, of which 4 items were selected due to reliability. The access to ICT tools items were not adequate for EFA because it did not meet the assumption of the Positive Definiteness, Kaiser-Meyer-Olkin

Measure of Sampling Adequacy (KMO) and Bartlett's Test of Sphericity. Table 5 presents the reliability of access to ICT tools.

Table 5: Reliability of the Access of ICT Tools

Subscales	Cronbach's alpha	Items (N= 92)
Access to ICT tools	**0.744**	access to a computer at home
		internet connectivity
		access to a computer at school
		Personal Computer

Source: Fieldwork (2019)

Results obtained were used to analyse research question one (1), two (2), and three (3). Research question one was answered using descriptive statistics mainly by analysing the subscales to find mathematics teachers perceived attitudes (will), competencies' (skill), access to ICT tools (tool) and teaching style and confidence in skill (pedagogy) in teaching are high, moderate or low.

The second research question was analysed using descriptive statistics and Pearson's correlation. The descriptive was employed to determine teachers' perceived level of ICT usage. The correlation is the appropriate test statistics for assessing the relationship between mathematics teachers' attitudes (will), competencies (skill), access to ICT tools (tool) and teaching style and confidence in skill (pedagogy) and the use of ICT. Thus, the final research question was carried out using structural equation modelling (SEM) procedure to determine if the data collected fit to be used to estimate parameters in the structural model of the WSTP model in STMA senior high schools.

CHAPTER FOUR

RESULTS AND DISCUSSION

This chapter presents and discusses the results of the survey data generated for the study. The study aimed at investigating senior high school mathematics teachers' integration of Information and Communication Technology (ICT) in the teaching and learning of mathematics. Teachers ICT integration was premised on four areas: 1) Teachers attitudes towards technology (will); 2) their competencies in the use of ICT (skill); 3) Teachers access to ICT tools (tool) and teaching style as well as confidence in skill (pedagogy) that affect ICT integration in their mathematics instruction. The analysis and interpretation of data were done based on the results of the research questions, and were directly linked to the study. The chapter is made up of two strands. The first part focuses on the demographic characteristics of the respondents while the second deals with the presentation and discussion of the study findings in accordance with the research questions and the theoretical framework which underpins the study.

Demographic Characteristics of the Respondents

This section dealt with information collected on the background of the respondents. The characteristics of the respondent discussed in this section included, gender, age, professional qualification as well as the subject taught by respondents. Tables 6 to 8 give an account of teachers' gender and age, professional qualification and subject taught.

Gender Distribution of Respondents

This section presents information on respondents' gender which is presented in Table 6 below. The aim was to ascertain and understand the category of the respondents and the group which dominate the teaching and learning of mathematics in the senior high schools in the study area (S.T.M.A).

Table 6: Gender Distribution of Respondents

Gender	Frequency (N)	Percentage (%)
Male	81	88.0
Female	11	12.0
Total	92	100.0

Source: Fieldwork (2019)

Table 6 shows that a total of 92 participants were involved in the study. Out of this number, the majority (81) representing eighty-eight percent (88.0%) of the respondents were males with eleven (11) being females representing 12.0%. This result gives credence to the findings of Trujillo and Hadfield (1999) that mathematics teachers are dominated by males than females.

Age Distribution of Respondents

In ICT-related studies, age becomes relevant, as it may prevent the use or understanding of technology. Extant literature has shown that younger people tend to use ICT more than older ones. For instance, Colley and Comber (2003) argued that younger people are optimistic and use computers more than older persons. Table 7 below therefore shows the age range of respondents in the study.

Table 7: Age Distribution of Respondents

Age	Frequency(N)	Percentage (%)
20 - 30	25	27.2
31 - 40	44	47.8
41 - 50	17	18.5
51 - 60	6	6.5
Total	92	100.0

Source: Fieldwork (2019)

Table 7 displays the age of mathematics teachers involved in the study. From the result, it can be seen that 44 (47.8%) of the respondents were between the ages of 31 – 40 years and forms the majority. Twenty-five 25 (27.2%) of them were between the ages 20 – 30 years, 17(18.5%) were between 41 – 50 years old whereas 6 (6.5%) which forms the minority were between the ages 51 – 60 years. Findings suggest that a vast percentage of the respondents were aged between 20 – 40 years, totaling 69 (75.0%) out of 92 respondents. The average age of the respondent was found as 36.

Professional Qualification of Teachers

Data on professional qualifications shows the different professional levels of respondents were involved in the study. These include diploma, first and second degrees as well a as doctorate degree. This allows researchers to know which professional level uses ICTs more and vice versa. Information for professional qualification is thus illustrated in Table 8.

Table 8: Professional Qualification of Respondents

Professional qualification	Frequency(N)	Percentage (%)
Diploma	2	2.2
Degree	77	83.7
Masters	12	13.0
PhD	1	1.1
Total	92	100.0

Source: Fieldwork (2019)

Table 8 above shows that out of the 92 respondents, close to three-quarters (83.70%) of the respondents were degree holders while approximately only 1% of them was a doctorate degree holder. Few of the respondents (2.17%) were diploma holders whilst, three out of every twenty-five (13.04%) of the respondents indicated that they had attained their master's degree indicating that the study's respondents were highly educated.

Mathematics Subjects Taught and Nature of Employment of Respondents

Again Table 9 presents a summary of the teachers' responses on the type of mathematics subject they teach and the nature of employment to show the category of permanent and temporal teachers.

Table 9: Mathematics Subjects Taught and the Nature of Employment of Respondents

Subjects taught	Frequency(N)	Percentage (%)
Core mathematics	14	15.2
Elective mathematics	9	9.8
Both	69	75.0
Total	92	100.0
Nature of Employment	Frequency(N)	Percentage (%)
Part-time	89	96.7
Full time	3	3.3
Total	92	100.0

Source: Fieldwork (2019)

Table 9 shows that sixty-nine of the participating teachers, which represents seventy-five percent (75%) indicated that they teach both elective mathematics and core mathematics. Also, fourteen teachers (15.2%) stated they teach core mathematics only whiles nine point eight percent (9 teachers) indicated they handle only elective mathematics.

It can also be observed from Table 9 that almost all (96.7%) of the respondents reported that they were full-time mathematics teachers' whiles 3.3% of them indicating they were part-time mathematics teachers. On the average, nearly all mathematics teachers in Sekondi-Takoradi Metropolis are full-time teachers.

Rank of Respondents

In this study teachers' rank was considered as their position in the hierarchy in the teaching service. The information was deemed important because it gives insight into the number of years individual teachers have been in the teaching service. Details of teachers' ranks are presented in Table 10.

Table 10: Rank of Respondents

Rank	Frequency(N)	Percentage (%)
Senior Superintendent	2	2.2
Principal Superintendent	49	53.3
Assistant Director II	29	31.5
Assistant Director I	12	13.0
Total	92	100.0

Source: Fieldwork (2019)

From Table 10, it can be observed that the majority of the teachers (49) representing fifty-three percent (53.3%) were in the principal superintendent rank, 29(31.5%) were at the rank of assistant director II. Twelve (13%) of the participants were in the assistant director I rank while two of the teachers representing two point two percent (2.2%) were in the senior superintendent rank.

Presentation and Discussion of Findings

This section presents analyses and discussion of the study results. The presentation is done according to the three research questions which guided the study. The results are presented in tables and figures with corresponding interpretations and literature support.

Research Question 1(RQ 1): What are mathematics teachers' perceived attitudes (will), competencies' (skill), access to ICT tools (tool) and teaching style and confidence in skill (pedagogy) in the use of ICT in teaching?

Research question one was framed to investigate participating mathematics teachers' attitude, competencies, access to ICT tools, teaching style and confidence in skill as far as their utilisation of ICT in the teaching of mathematics is concerned.

To answer this (RQ 1), the researcher computed the means and standard deviations for each of the four constructs i.e. teachers perceived attitudes (will), competencies' (skill), access to ICT tools (tool) and teaching style and confidence in skill (pedagogy). The sub-scales extracted from teachers' attitudes towards computer questionnaire (Christensen & Knezek, 2008) were measured on a five-point Likert scale (1 =strongly disagree, and 5 = strongly agree). The scores were interpreted as 1 the lowest score, which represents a very strong negative attitude, whilst 5 is the highest possible score which represents a very strong positive attitude (See chapter 3 Table 2). Table 11 shows the means and standard deviations of the subscales under which attitudes of teachers towards computer were measured.

From the results as shown in Table 11, it is evident that the SHS mathematics teachers who participated in the study from the different SHS perceived their attitude towards computer to be positive in terms of the four subscales; lack of anxiety, usefulness, benefit, enjoyment.

Table 11: Attitude Based on TAC Scores of Mathematics Teachers

Subscales	Mean	SD
Lack of Anxiety	4.32	0.696
Usefulness	4.27	0.585
Benefit	4.18	0.635
Enjoyment	3.99	0.588
Overall attitudes	4.23	0.508

Source: Fieldwork (2019)

The overall attitudes (Mean = 4.23, SD = 0.51) seems to suggest positive attitudes of the teachers towards computers. Teachers showed they were less anxious working with computers (Mean = 4.32, SD = 0.70); they also perceived high usefulness (Mean =4.27, SD = 0.59); the teachers are aware of the benefit (Mean = 4.18, SD = 0.64) of using computers; and they enjoy using computers (Mean = 3.99, SD = 0.59). The results indicate a high level of computer attitudes among SHS mathematics teachers in the Sekondi-Takoradi Metropolis and they are expected to integrate ICT in their teaching of mathematics.

The study also reported on the competencies of the teachers with regards to ICT integration in teaching. Teachers' competence was investigated using the first part of TPSA-C21 questionnaire (Appendix A) which measures teachers' competencies in using computer. This was categorized into three scales: Basic skills (send documents, texts, messages over the internet), Instructional use (software for teaching and learning), Integrated apps (newsletters, spreadsheet, pdf). Details of how these scales were developed as well as a discussion about their reliability can be found in (Chapter Three). The mean scores and standard deviations of these subscales forming teachers' competencies are presented in Table 12.

Table 12: Competences Based on TPSA Scores of Mathematics Teachers

Subscales	Mean	SD
Basic skills	4.04	0.668
Instructional use (software for teaching and learning),	3.52	0.781
Integrated apps (newsletters, spreadsheet, pdf)	3.66	0.763
Overall competences	3.74	0.616

Source: Fieldwork (2019)

The overall teachers' competence score (Mean = 3.74, SD = 0.737) is high. Specifically, the results indicated that teachers are perceived to be using the internet to do basic skills (send documents, texts, messages over the internet) (Mean = 4.04, SD = 0.67); they are also competent in using ICT for instructional purposes (Mean = 3.52, SD = 0.78); and integrated apps (Mean = 3.66, SD = 0.76).

As part of RQ1, the study reported mathematics teachers teaching style and confidence in skill. They were asked what kinds of teaching activities were carried out in their mathematics classes. Responses to the second part of the TPSA-C21 questionnaire (Appendix A) which measures participants teaching style and confidence in skill were used to provide indicators for respondents' confidence and their pedagogical strategies in using ICT tools. Three subscales were computed: Internet use, ICT learning support (incorporate ICT such as devices and software in instructions and collaborative learning) and teaching with Emerging apps (online interactive tools and courses). Table 13 shows teachers' perceived Teaching style and Confidence in skill levels.

Table 13: Teaching Style and Confidence in Skill Based on TPSA- C21 Scores of Mathematics Teachers

Subscales	Mean	SD
Internet use	4.09	0.722
ICT learning support (incorporate ICT such as devices and software in instructions and collaborative learning)	3.45	0.845
Emerging apps (online interactive tools and courses)	3.47	0.811
Overall teaching style and confidence in skill	3.67	0.655

Source: Fieldwork (2019)

The overall teaching style and confidence in skill score (Mean = 3.7, SD = 0.7) is high. The subscale which was perceived to be most positive by SHS mathematics teachers was internet use (Mean = 4.1, SD = 0.7) with the least perceived subscale being ICT learning support (Mean = 3.2, SD = 0.6).

The study also explored teachers' ICT access levels in their various institutions. Teachers' access to ICT tools has been identified as one of the factors to ICT integration in the mathematics classroom. Mathematics teachers rated their level of accessibility to ICT tools and the mean and standard deviation rating of the responses is presented in Table 14.

Table 14: Mathematics Teachers' Access to ICT Tools

Items	Mean	SD
Personal Computer	3.99	1.094
Internet Connectivity	3.42	1.030
access to a computer at school	2.46	1.063
access to a computer at home	4.01	1.104
Overall access to ICT tools	3.47	0.810

Source: Fieldwork (2019)

Table 14 provides a breakdown of the level of access to ICT tools among math teachers. It is clear that ICT tools are available to teachers (Mean = 3.47, SD = 0.81). Teachers have high access to personal computers (Mean = 3.99, SD= 1.09) and teacher access to computer at home (Mean = 4.01, SD = 1.10). They agreed that their computers were often connected to the internet (Mean = 3.42, SD = 1.03). The teachers also had access to a computer at school (Mean = 2.46, SD = 1.06), and access to computers at home (Mean = 4.01, SD = 1.10).

In conclusion, the results suggest that senior high school mathematics teachers perceived attitudes, competence, access to ICT tools and teaching style and confidence in skill were high.

Research Question 2(RQ 2). How do mathematics teacher's attitudes towards technology (will), competence in the use of technology (skill), access to technology (tool), teaching style and confidence in skill (pedagogy) relate to their perceived use of ICT?

In order to determine whether there was any relationship between Mathematics teachers attitudes towards technology (will), competencies in the use of ICT (skill), access to ICT tools (tool), teaching style and confidence in skill (pedagogy) and their ICT Integration in their classroom instruction, first the researcher reported on the teachers' perceived levels of ICT use in their current teaching practices. Teachers' ICT Integration level was measured using stages of adoption (Christensen & Knezek, 2008). Figure 2 displays the ICT Integration profile for S.H.S. mathematics teachers.

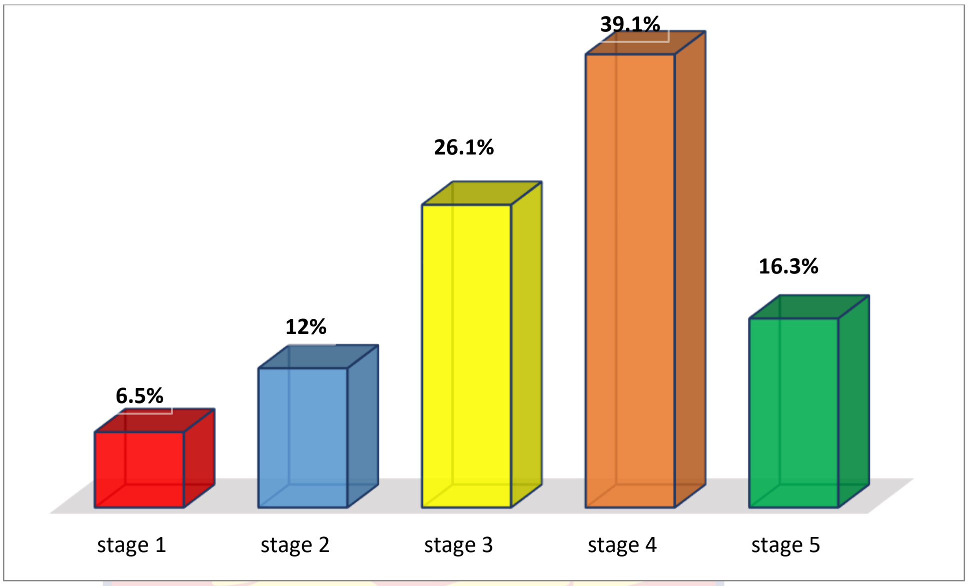

Figure 2: ICT integration profile for S.H.S. mathematics teachers

Source: Fieldwork (2019)

Figure 2 shows a self-reported use of ICT in the mathematics classroom. The findings revealed that most mathematics teachers' (39.1%) were at stage 4 (adaptation to other contexts) while approximately 6.5 % of them were at stage 1(awareness). Eleven respondents (12%) were at stage 2 (learning the process) whilst, twenty-four respondents (26.1%) indicated they were self-efficient in using computer (stage 3). Fifteen participants (16.3%) were at stage 5(creative application to new contexts) implying that most of the study's respondents were applying technology in other contexts (stage 4). An inference from the above is that the majority (about 81.5 %) of the respondents were in stage 3 and above.

The study proceeded to determine the relationship between the four independent latent constructs (attitude, competencies, access to ICT tools, teaching style and confidence in skill) and their ICT integration as the core focus of RQ2. A simple correlation test using Pearson's rank correlation coefficient was used to find the relationship between each construct and ICT integration. This was done to ensure whether the obtained correlations affect their ICT integration levels. The results of the correlation for each independent construct (attitude, competencies, access to ICT tools, teaching style and confidence in skill) and stages of adoption are presented in Tables 15, 16, 17 and 18.

The relationship between mathematics Teachers' attitudes towards technology (will) and stages of adoption are presented in Table 15.

Table 15: Relationship between Mathematics Teachers' Attitudes towards Technology (Will) and Stages of Adoption (N=92)

Variables		Attitudes, (r = 0.26, p = 0.01)			
		Lack of Anxiety	Usefulness	Benefit	Enjoyment
Stages of adoption	Pearson Correlation	**0.251***	0.133	**0.224***	**0.256***
	P-value	0.016	0.207	0.032	0.014

Source: Fieldwork (2019)

A Pearson product-moment correlation was calculated between the various attributes of attitude towards computer use and stages of adoption. Correlations were significant for "lack of anxiety" (r = 0.25, p = 0.16) "Benefit" (r = 0.22, p = 0.03) and "enjoyment" (r = 0.26, p = 0.01) at 0.05 levels of significance. However, the product-moment correlation between the overall computer attitudes and the stages of adoption (r = 0.26, p = 0.01) was found to be weak. This seems to suggest that the overall attitudes of the respondents had a weak correlation with stages of adoption.

The relationship between mathematics teachers' competencies in the use of ICT (skill) and stages of adoption are presented in table 16.

Table 16: Relationship between Competences in the Use of ICT (Skill) and Stages of Adoption (N=92)

Variables		Competence (r = 0.30, p=0.00)		
		Basic skills	Instructional use	Integrated apps
Stages of adoption	Pearson Correlation	**0.291****	0.147	**0.319****
	P-value	0.005	0.161	0.002

**p < .01 (2-tailed)

Source: Fieldwork (2019)

A significant association (r = 0.30, p < 0.01) was found between overall ICT competencies and stages of adoption of these teachers. Correlations were significant for "Basic skills" (r = 0.29, p = 0.05) and "Integrated apps" (r = 0.32, p = 0.02) at 0.01 levels of significance but not for "Instructional use" (r = 0.15, p = 0.16). This means that the respondents' competence in Basic skills and Integrated apps tended to relate positively to their stages of adoption.

The relationship between mathematics teachers' teaching style and confidence in skill (pedagogy) and stages of adoption are presented in Table 17.

Table 17: Relationship between Teaching Style and Confidence in Skill (Pedagogy) and Stages of Adoption (N=92)

Variables		Teaching style and Confidence in skill, (r = 0.25, p = 0.02)		
		Internet use	ICT learning support	Emerging apps
Stages of adoption	Pearson Correlation	**0.314****	0.149	0.179
	P-value	0.002	0.156	0.088

Source: Fieldwork (2019)

Based on Table 17, the relationship between teaching style and confidence in skill and stages of adoption of these teachers showed a low positive correlation (r = 0.25, p < 0.01). From the table, it was observed that SoA weakly positively correlated with the use of internet (r = 0.31, p = 0.002). Examining the relationship between the SoA and the other subscales ICT learning support (r = 0.18, p = 0.16) and teaching with emerging apps (r = 0.15, p = 0.09) of teaching style and confidence in skill showed insignificant relationships.

The relationship between teachers' access to ICT tools (Tool) and stages of adoption are presented in table 18.

Table 18: Relationship between Teachers' Access to ICT Tools (Tool) and Stages of Adoption (N=92)

Variables		Teachers' access to ICT tools, (r = 0.36, p = 0.00)			
		Personal computer	Access computer school	to Internet at connectivity	Access to computer at home
stages of adoption	Pearson Correlation	**0.353****	**0.275****	**0.288****	**0.284****
	P-value	0.001	0.008	0.005	0.006

Source: Fieldwork (2019)

From Table 18, there seems to be a weak and linear relationship between the teachers' access to ICT tools and stage of adoption, the correlation (r = 0.36, P< 0.01) was significant at the 0.01 level of significance. It was observed that stage of adoption was weakly positively correlated with teachers' access to personal computer (r = 0.35, p = 0.001), access to internet connectivity (r = 0.29, p = 0.005) access to computer at home (r = 0.28, p = 0.006), access to computer at home (r = 0.28, p = 0.008). On the whole, all variables were significant, giving us enough evidence to model a relationship for the population.

Research Question 3(RQ3): To what extent do attitudes (will), competencies (skill), access to ICT tools (tool), and teaching style and confidence in skill (pedagogy) of the mathematics teachers predict their ICT integration levels.

To predict their ICT integration levels, a relationship between each predictor variable and ICT integration was proposed. Based on this, four hypotheses were postulated:

H1a. Will positively and significantly influences ICT integration.

H1b. Skill positively and significantly influences ICT integration.

H1c. Tool positively and significantly influences ICT integration.

H1d. Pedagogy positively and significantly influences ICT integration.

Structural equation modeling was conducted to determine variables that predict ICT integration in the mathematics classroom. Initial correlation analysis in RQ2 showed low correlations among the predictors (attitude, competencies, access to ICT tools, teaching style and confidence in skill) and dependent variable (ICT integration). The analysis was conducted in two phases that involved separate assessments of the measurement and structural models. The measurement model explores the relationship between the indicators and the constructs while the structural model explores the relationship between the constructs in the model. Smart PLS 3.0 (Ringle, Wende, & Becker, 2015) was used to assess the measurement and structural model.

Assessing the Measurement Model

The measurement model was evaluated by assessing validity and reliability. This assessment consists of examining i.e. (1) Reliability; (2) convergent validity; and, (3) discriminant validity (Hair, Hult, Ringe, &

Sarstedt, 2017; Imam & Hengky, 2015). The following sections present the results for all analyses to evaluate the validity and reliability of the measurement model.

Reliability, Convergent and Discriminant Validity

Reliability on the measurement model determines whether the items that measure a construct has similar scores. Cronbach's alpha (CA) and Composite Reliability (CR) were used to determine the reliability of a construct. On the contrary, convergent validity of the construct was also assessed, using the Average Variance Extracted (AVE) criterion. The AVE parameter implies that a set of indicators represent a single underlying group due to its unidimensionality (Henseler, Ringle, & Sarstedt, 2015) as all of them must be 0.7, 0.7, and 0.5 respectively or higher.

The discriminant validity of the construct was assessed, using the Fornell-Larcker criterion. This determines the extent a construct is different from the others. Using the data from an AVE according to the Fornell-Larcker criterion, the square root of the AVE of each construct is greater than its correlation values with other constructs (Henseler, Hubona, & Ray, 2016). The values pertaining to internal consistency reliability, convergent validity and discriminant validity for each construct are reported in Table 19.

Table 19: Reliability, Convergent and Discriminant Validity

Variables	Cronbach's Alpha	Composite reliability	AVE	Will	Skill	Tool	Pedagogy	ICT Integration

Will	0.803	0.869	0.623	**0.789**				
Skill	0.783	0.868	0.688	0.486	**0.829**			
Tool	0.744	0.844	0.583	0.315	0.373	**0.763**		
Pedagogy	0.764	0.854	0.663	0.513	0.626	0.294	**0.814**	
ICT Integration	1.000	1.000	1.000	0.289	0.325	0.399	0.286	**1.000**

Source: Fieldwork (2019)

Table 19 shows that the Cronbach's alpha (CA) and Composite reliability (CR) value for each construct falls between 0.744 and 1.000. The threshold value for CA and CR should be higher than 0.70. All factors showed a CA and CR around 0.8 (good reliability) and all constructs have an AVE ranging from 0.583 to 1.000 suggesting the measurement model exhibits an adequate convergent validity.

As can be seen in Table 19, the bolded elements represent the square roots of the AVE and non-bolded values represent the inter-correlation value between constructs. All off-diagonal elements are less than the square roots of AVE confirming that Fornell and Larker's criterion is met.

Overall, the reliability and validity tests conducted on the measurement model are satisfactory, suggesting that items used to measure constructs in this study are valid and fit to be used to estimate parameters in the structural model.

Assessment of the Structural Model

With the reliability and validity of our constructs confirmed, the next step assessed the relationships between the constructs of our structural model. This involves exploring the predictive capabilities and relationships between the constructs of the model. For assessing the structural model, criteria checked were Multi-collinearity assessment, T-statistic value and Path coefficient (β value). A systematic approach was adopted in evaluating the structural model (Hair, Sarstedt, Hopkins, & Kuppelwiesr, 2014).

First, the structural model was assessed for collinearity among its predictor constructs. The results of collinearity for using Will, Skill, Tool and Pedagogy as predictors of ICT integration show the Variance Inflation Factors (VIF) to be below the recommended threshold of 5. Table 20 presents a multi-collinearity of constructs.

Table 20: Independent Variables and their Variance Inflation Factors

Independent variables	VIF
Will	1.476
Skill	1.837
Tool	1.196
Pedagogy	1.819

Source: Fieldwork (2019)

On the other hand, a VIF value above five (5) indicates possible multicollinearity problems (Hair, Ringle, & Sarstedt, 2011). Table 20 indicates that the VIF for the independent variables are all down to satisfactory values hence no multicollinearity is present. Thus, the values indicate some correlation, but not enough to warrant further corrective measures.

Path Diagram

The study also explored the relationship between the predictor and the dependent variables. Based on the proposed hypotheses, the Partial least Square (PLS) path is assessed by reporting predictive capability (R^2), path coefficients beside the significance level, t-value, and p-value. Figure 3 is concerned with the factors that influence mathematics teachers' use of ICT in SHS and the results of testing the proposed hypothesis are illustrated in Table 21 with the path significances and R^2 of the relevant constructs.

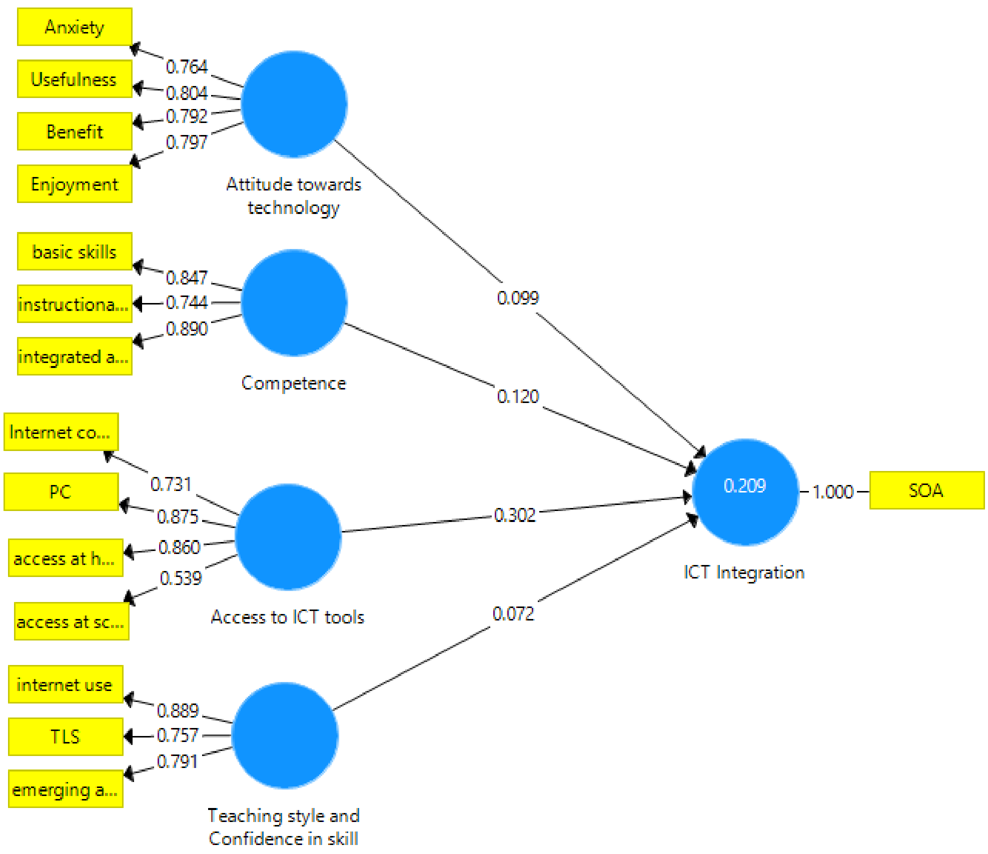

Figure 3: PLS-SEM path model for the relationship between attitudes, competencies, access to ICT tools, and teaching style and confidence in skill and stage of adoption

Source: Fieldwork (2019)

In Figure 3, we hypothesize attitudes, competencies, access to ICT tools, and teaching style and confidence in skill to have a direct relationship on stages of adoption. The diagram indicates that the path coefficients of the structural model were positive in attitudes, competencies, access to ICT tools, and teaching style and confidence in skill.

Coefficient of Determination, R^2 and Structural Model Hypothesized Relationships

The confirmation of the proposed hypothesized relationships shows how each construct is contributing to the integration of ICT in mathematics instruction. Table 21 presents the coefficient of determination, R^2 as well as the path coefficients, t-statistics, and significance level for all hypothesized relationships.

Table 21: Coefficient of Determination, R^2 and Hypothesized Relationships Results

No.	Hypothesis	Coefficient (ß)	SD	*t-value*	*p-value*	Result
H1a	Will → ICT Int.	0.099	0.111	0.888	0.375	Not-Significant
H1b	Skill → ICT Int.	0.120	0.120	1.000	0.318	Not-Significant
H1c	Tool → ICT Int.	0.302	0.102	2.959	0.003	Significant
H1d	Pedagogy →ICT Int.	0.072	0.112	0.644	0.520	Not-Significant

Source: Fieldwork (2019) **R^2=21%**

However, as shown in Table 21 the coefficient of determination, R^2 is 0.209 for the endogenous latent variable. Hence, the model could explain 20.9% of the variance associated with ICT integration in the mathematics classroom ($R^2 = 21\%$).

Mathematics teachers' attitudes had a weak positive influence (beta = 0.10, t=0.888, $p < 0.05$) on stages of adoption, indicating teachers' attitudes have no significant influence on stages of adoption. Their competence in the use of technology had a non-significant (beta = 0.12, t= 1.000, $p < 0.05$) influence on stages of adoption. The positive influence of access to ICT tools on stages of adoption (beta = 0.30, t=2.959, $p < 0.05$) was statistically significant. Therefore, there is a significant relationship between teachers' access to ICT tools and stages of adoption to use ICT in class.

The results indicate that teachers' access to ICT tools increases the stages of adoption of the teachers ICT usage for teaching in SHS. Their teaching style and confidence in skill had a weak influence (beta = 0.07, t= 0.644, $p < 0.05$) on stages of adoption. Hence, hypotheses H1a, H1b, and H1d are rejected, whereas the hypothesis (H1c) is supported at a 5% significance level and the path coefficient will be significant if the T-statistics is greater than 1.96.

Discussions of Results

The pivot of the study was to gain an in-depth understanding of SHS mathematics teachers' computer attitudes, competencies, access to ICT tools, teaching style and confidence and ICT integration in Ghanaian SHS. The theoretical approach to these questions used the will (attitudes towards technology), skill (ICT competency), tool (access to ICT tools) and pedagogy (teaching style and confidence in skill) WSTP model, a model that incorporates four factors (i.e. will, skill, tool, and pedagogy) to a successful integration of ICT in the classroom. The WSTP model suggests that a teacher must possess these four attributes to integrate ICT in his/her mathematics instructions effectively.

The study focused on three research questions that guided the study. This section discusses the key findings in accordance with the research questions as well as the literature review in Chapter 2 of this study.

The purpose of RQ1 was to determine mathematics teachers perceived attitudes (will), competencies' (skill), access to ICT tools (tool), teaching style and confidence in skill (pedagogy) in the use of ICT in teaching. From the analysis, the high means recorded in Table 6,7,8,9, by SHS mathematics teachers revealed high attitudes, competency, access to ICT tools, teaching style and confidence in skill in using ICT in teaching.

A study conducted by Keengwe and Onchwari (2008) suggests that teachers' positive attitudes influence the successful adoption and integration of ICT into teaching while the study show teachers willingness to use ICT tools, the findings of the current study bolster those findings by providing evidence from table 6 that teachers hold positive attitudes (mean=4.23, SD=0.70) towards computer usage.

However, Christensen and Knezek (2008) noted that a positive attitude towards ICT tools alone does not predict the integration of ICT in the classroom. It is ineffectual if mathematics teachers' willingness to use technology is not supported by the necessary skill to use it. Mumtaz (2000) states that the ability to easily use ICT tools influence teachers' attitude towards technology use in school. This study's conclusion is echoed in the responses of the current study where their high positive attitudes are in line with their ability to use ICT tools. Most teachers of the current study perceived themselves as very competent (mean=3.74, SD=0.62) in the use of ICT. The finding is also consistent with

Usluel and Aşkar (2015) who point out that teachers perceived themselves as very competent and proficient in using ICT.

Successful ICT integration also depends on external factors that provide the teacher with the necessary resources in terms of the available ICT tools, training and support (Rogers, 1999). The study showed that the teachers had a high level of access to ICT tools (mean=3.47, SD=0.81). The results contradict Mwalongo (2011) in Tanzania that ICT infrastructure was unavailable to most teachers.

If teachers are to integrate technology into their teaching, they must consider themselves qualified to teach with it and be comfortable using it. The findings also revealed that respondents exhibited a high level of teaching style and confidence in skill (mean=3.67, SD=0.66) in teaching. This finding refutes Butzin's (2004) study that teachers felt more comfortable, using the traditional method of teaching rather than using ICT but supports Sa'ari, Wong, and Roslan (2005) that once the teachers showed a high level of ICT skill, their confidence level also improves thus reducing anxiety and averse to using it.

In conclusion, the study found out that most teachers in SHS in STMA were less anxious, resulting in high attitudes, ICT competency and self-efficient in the use of ICT tools in their classroom instructions. The finding of the current study is supported by Kadel (2005) who found that regardless of the quantity and quality of technology available in the classroom, the key to ICT integration is the teacher; therefore, teachers must have the essential factors for implementation.

The answer to the first research question was reiterated in the findings of the second research question. The second research question wanted to find out if mathematics teacher's attitudes towards technology (will), competencies in the use of technology (skill), access to ICT tools (tool), teaching style and confidence in skill (pedagogy) relate to their perceived use of ICT.

From Tables 15, 16, 17 and 18, the study also indicated that the correlation between overall teachers' attitude, competencies, access to ICT tools, teaching style and confidence in skills and stages of adoption shows that all variables have a positive significant low relationship. This finding suggests that mathematics teachers with high attitudes, competencies, access to ICT tools, teaching style and confidence in skill are likely to have high stages of adoption in ICT integration. Thus, teachers' ICT integration increases as a result of an increased attitude, competencies, access to ICT tools, teaching style and confidence in skill in using ICT to teach. This conclusion is congruent with the findings of Buabeng-Andoh (2012); Morales (2006) who found a significant relationship between teachers' stages of adoption with their attitudes toward computers, self-efficacy and level of computer usage but contrary to Agyei and Voogt (2011) who reported an insignificant relationship between teachers attitudes and stages of adoption.

Although mathematics teachers reported high levels of ICT integration in the teaching and learning of mathematics, the weak correlation between attitude, competencies, access to ICT tools, teaching style and confidence in skill and ICT integration did not reflect their high levels of ICT integration. A low correlation coefficient means low integration therefore respondents may have overrated their ability to integrate ICT in mathematics instruction as they reported.

Finally, the findings of the last research question in the study sought to establish the extent the parameters will, skill, tool and pedagogy contribute to predicting teachers' classroom ICT integration.

Research question 3 investigated the causal relationship among the four constructs namely, *will, skill, tool, pedagogy* and their *ICT integration.* Structural equation modelling technique was used to investigate the factors influencing ICT integration in mathematics classroom instruction. The model used for the current study implies an equal predictor status for the four variables.

The 'will, skill, tool, pedagogy' model showed a relatively low (R^2= 0.21) explanatory power in relation to ICT usage in the classroom, which debunks the assertion that the model predicts beyond 90% (Knezek & Christensen, 2015).

A second conclusion that emerges from the results found the four predictors (will, skill, tool and pedagogy) having a positive influence on ICT integration. However, this causal relationship is only statistically significant for *Tool*. Specifically, Tool factor has the strongest positive influence on ICT integration (beta = 0.30). This finding implies that in this context, *Tool* in Table 21 was the strongest predictor whiles Agyei and Voogt (2011) study reported 'skill' to be the strongest predictor in the same local context.

It is interesting to note that the influence of Will (0.888), Skill (1.000), and Pedagogy (0.644) factors is not significant at a 5% significance level. Therefore, ICT integration can be enhanced by factors beyond teachers' access to ICT tools. Such enhancement of simply having ICT tools in the school does not necessarily mean that the use of ICT will follow automatically. The finding that Tool (teachers' access to ICT tools) has the strongest positive influence on

ICT integration is in line with the results from Morales (2006) who found that ICT integration variance was explained by the variable tool could mean an access problem which needed to be overcome, for the teachers to reach a more advanced stage of ICT integration.

Also, the study highlights Knezek and Christensen's (2015) findings that "the area in which the local environment has the greatest variability" becomes the strongest predictor confirms Agyei and Voogt (2011); Morales (2006) and the current study findings revealing the strongest predictor varying from context to context. This leads to this conclusion: finding the strongest predictor is dependent on the context in which the study was conducted.

Chapter Summary

The chapter focused on data analysis and findings of the study. It noted that senior high school mathematics teachers reported high attitude, competencies, access to ICT tools and teaching style and confidence in skill in the teaching and learning of mathematics. Teachers also reported a weak positive relationship between attitude, competences, access to ICT tools and teaching style and confidence in skill and ICT integration which was a mismatch to their perceived high levels of ICT integration.

Finally, to determine the best predictor of ICT integration, the current study also revealed that access to ICT tools was the major predictor of effective ICT use while teachers' attitudes, competencies and teaching style and confidence in skill have no significant effect on ICT usage.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This study explored the determinants of ICT integration in mathematics classroom instruction in selected senior high schools in the Western region of Ghana. Specifically, it focused on the underlining factors: Mathematics teachers' attitudes, their competencies, access to ICT tools as well as their teaching styles and confidence in skill in predicting teachers' usage of ICT in the senior high schools.

Purposive sampling technique was used to select ten (10) senior high schools to participate in the study and census survey was used to select ninety-two mathematics teachers from ten (10) SHS in Sekondi-Takoradi Metropolitan Assembly for involvement in the study. 5-point Likert Scale questionnaires were the instruments for data collection. Responses from the questionnaire were analysed, using SPSS and SmartPLS software. Descriptive statistics such as means and standard deviations were used to describe the determinants will, skill, tool, pedagogy and classroom ICT integration levels for these teachers.

Pearson's correlation was used to determine the relationship between teachers' attitudes, their competencies, access to ICT tools as well as their teaching styles and confidence and ICT integration. Structural equation modelling was used to determine the strongest predictor of ICT integration in mathematics instruction. This chapter presents the summary of findings resulting from the analysis of data, the conclusions drawn from the analysis and recommendations for future research work.

Summary

The study revealed that the sample obtained in senior high schools in the Sekondi-Takoradi Metropolis regarding mathematics teaching and learning was dominated by males.

Senior high school mathematics teachers reported high positive attitudes, competencies, access to ICT tools and teaching style and confidence in skill the usage of ICT.

The study also found that respondents exhibited high ICT integration levels.

With regard to the relationship between teachers' attitudes, competencies, access to ICT tools, teaching style and confidence in skill and ICT integration, it was observed that all construct scores were weakly and positively correlated with ICT integration, revealing significant relationships.

Also, the study revealed low correlations that did not depict their high levels of ICT integration.

The explanatory power of the will, skill, tool, pedagogy model was relatively weak (0.21).

Among the four predictors, the current study also revealed that access to ICT tools was the strongest predictor for effective ICT use at the senior high school level, there is, therefore, a positive and significant influence between access to ICT tools and ICT integration. Thus, teachers who have high access to ICT tools are most likely to report high ICT integration.

Reflection on the WSTP Framework used in the Study

Christensen and Knezek found that the WST framework helped researchers make assumptions about teacher ICT integration in the classroom context. In terms of the integration process, the new version of the model

(WSTP) prescribes that increased will, skill, tool and pedagogy will result in higher ICT integration in the mathematics classrooms.

From the adopted WSTP model, I studied the teachers' perceived attitudes, competencies, access to ICT tools and teaching style and confidence in skill and ICT integration in mathematics instruction. The reflections took into consideration conducting a survey to gather data on teachers' attitudes, competence, access to ICT tools and teaching style and confidence in skill and ICT usage in their mathematics instruction. The WSTP framework enabled the researcher to analyse and evaluate data collected and describe mathematics teachers' dispositions related to the use of ICT in teaching to enhance our deeper understanding.

The results of the study indicated that the participants exhibited high attitudes, competence, access to ICT tools and teaching style and confidence in skill yet the extent of ICT integration in mathematics teaching and learning in senior high schools were low. The findings also suggest that increasing mathematics teachers' access to ICT tools should be a focus of senior high schools. It is deemed that such intervention will improve or promote higher ICT integration levels in the senior high schools' mathematics instruction.

Conclusions

Major challenges exist in moving towards promoting ICT pedagogical integration. The study reports on the modification and adoption of some measures: mathematics teachers' attitudes, competencies, access to ICT tools, teaching style and confidence in skill as predicting factors of ICT integration. From the findings, it was established that teacers perceived their attitudes, competencies, access to ICT tools and teaching style and their confidence levels to be high.

Although the findings of this research showed that the levels of the constructs WSTP (attitudes, competencies, access to ICT tools, teaching style and their confidence in skill) and ICT integration were at high levels, the relationship between WSTP and ICT integration in the senior high schools were low implying, a low ICT integration in their mathematics instruction.

Finally, teachers' access to ICT tools is reported to be the strongest predictor of ICT usage in the teaching and learning of mathematics.

Recommendations

Based on the conclusion, the following recommendations are made;

i. The results of this research indicate that easy access to ICT tools would undoubtedly lead to the use of computers by teachers in schools. The government of Ghana and other stakeholders such as the Parent Association, administrators, teachers and so on must prioritise the provision of school ICT resources (e.g. mathematics labs, internet connectivity, appropriate mathematical software, computers, and projectors) to promote and improve the access of teachers.

ii. The findings of this study also suggest that policymakers together with the Curriculum Research Development Division (CRDD) of the Ghana Education Services and related agencies in the Ministry of Education will have to take the initiative to carry out research to review the mathematics curriculum and revise the existing syllabus to include teachers and students to have access to their device in school and at home.

iii. Most of the respondents were men, indicating that teaching institutions should aim to make the requisite provisions in their pre-service education for more women to pursue mathematics and also train them to improve ICT skills to incorporate them into their teaching.

iv. The heads of the various SHS and heads of departments may be tasked to organise regular in-service training in professional development courses geared towards teachers' ICT usage in mathematics instruction.

Suggestions for Further Research

Similar studies should be carried out in other regions of Ghana and that the findings should be compared to the current study.

Also, as a follow-up to the present quantitative analysis, a qualitative approach can be carried out to explore the WSTP factors to find out if there will be consistency in results.

Future research can use the control variables (age, gender, experience) as a moderator variable in the model to explore the moderating effects or not in the relationship between the predictors and dependent variables.

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APPENDICES

APPENDIX A

DATA COLLECTION INSTRUMENT

Questionnaire for Senior High School Mathematics Teachers

The questionnaire intended to collect information on the use of ICT in mathematics instructions in Senior High Schools. Kindly assist by completing this questionnaire for academic purposes. The information you provide will only be used for the purposes of this study and will be treated with utmost confidentiality.

Instruction: Please tick [√] the box or circle the number that correspond with your choice of response concerning the question, or write your response in the space provided.

Section A

Background Information

1. Age:

i. 20-30[ ]

ii. 31-40[ ]

iii. 41-50[ ]

iv. 51-60[ ]

2. Sex:

i. Male [ ]

ii. Female [ ]

3. School: ....

4. Professional Qualification:

i. Diploma ( )

ii. Degree ( )

iii. Masters ( )

iv. Others ( )

5. Subject taught:

i. Core Mathematics [ ]

ii. Elective Mathematics [ ]

iii. Both [ ]

6. Rank:

i. Senior Superintendent [ ]

ii. Principal Superintendent [ ]

iii. Assistant Director II [ ]

iv. Assistant Director I [ ]

v. Deputy Director [ ]

7. Nature of employment:

i. full time [ ]

ii. part time [ ]

Section B

1. The following table shows various perceptions of use of computers and varying responses. Read each statement and then circle the number which best shows how you feel.

SD = Strongly Disagree, D = Disagree, U = Undecided, A = Agree, SA = Strongly Agree

SD= 1, D= 2, U= 3, A= 4, SA= 5

Items	SD	D	U	A	SA
1. I enjoy working with computers.	1	2	3	4	5
2. I want to learn a lot about computers.	1	2	3	4	5
3. The challenge of learning about computers is exciting.	1	2	3	4	5
4. I like learning on a computer.	1	2	3	4	5
5. I can learn many things when I use a computer.	1	2	3	4	5
6. I get a sinking feeling when I think of trying to use a computer.	1	2	3	4	5
7. Working with a computer makes me feel tense and uncomfortable.	1	2	3	4	5
8. Working with a computer makes me nervous.	1	2	3	4	5
9. Computers intimidate me.	1	2	3	4	5
10. Using a computer is very frustrating.	1	2	3	4	5
11. If I had a computer at my disposal, I would try to get rid of it.	1	2	3	4	5
12. Studying about computers is a waste of time.	1	2	3	4	5
13. I can't think of any way that I will use computers in my career.	1	2	3	4	5
14. I will probably never learn to use a computer.	1	2	3	4	5
15. I see the computer as something I will rarely use in my daily life.	1	2	3	4	5
16. The use of electronic mail (E-mail) makes the student feel more involved in mathematics instructions.	1	2	3	4	5
17. The use of E-mail helps provide a better learning experience.	1	2	3	4	5
18. The use of E-mail makes mathematics class more interesting.	1	2	3	4	5
19. The use of E-mail helps the student learn more in mathematics instructions.	1	2	3	4	5

20. The use of E-mail increases motivation for mathematics class.	1	2	3	4	5
21. Computers are changing the world too rapidly.	1	2	3	4	5
22. I am afraid that if I begin to use computers I will become dependent upon them.	1	2	3	4	5
23. Computers dehumanize society by treating everyone as a number.	1	2	3	4	5
24. Our country relies too much on computers.	1	2	3	4	5
25. Computers isolate people by inhibiting normal social interactions among users.	1	2	3	4	5
26. Use of computers in mathematics education always reduces the personal treatment of students.	1	2	3	4	5
27. Computers have the potential to control our lives.	1	2	3	4	5
28. Working with computers makes me feel isolated from other people.	1	2	3	4	5
29. Computers could increase my productivity.	1	2	3	4	5
30. Computers can help me learn.	1	2	3	4	5
31. Computers are necessary tools in both educational and work settings.	1	2	3	4	5
32. Computers can be useful instructional aids in the teaching and learning of mathematics.	1	2	3	4	5
33. Computers improve the overall quality of life.	1	2	3	4	5
34. If there was a computer in my mathematics classroom it would help me to be a better teacher.	1	2	3	4	5
35. Computers could enhance mathematics remedial instruction.	1	2	3	4	5
36. Computers will improve mathematics education.	1	2	3	4	5
37. I like to talk to others about computers.	1	2	3	4	5
38. It is fun to figure out how computers work.	1	2	3	4	5
39. If a problem is left unsolved in a mathematics class, I continue to think about it afterward.	1	2	3	4	5
40. I like reading about computers.	1	2	3	4	5
41. The challenge of solving problems in mathematics with computers does not appeal to me.	1	2	3	4	5
42. When there is a problem with a computer that I can't immediately solve, I stick with it until I have the answer.	1	2	3	4	5
43. It is important for students to learn about computers in order to be informed citizens.	1	2	3	4	5
44. All students should have an opportunity to learn about computers at school.	1	2	3	4	5

45. Students should understand the role computers play in society.	1	2	3	4	5
46. Having computer skills helps one get better jobs.	1	2	3	4	5
47. Computers could stimulate creativity in students.	1	2	3	4	5

Section C

2. To what extent are you confident in accomplishing the following?

SD = Strongly Disagree, D = Disagree, U = Undecided, A = Agree, SA = Strongly Agree

SD= 1, D= 2, U= 3, A= 4, SA= 5

Items	**SD**	**D**	**U**	**A**	**SA**
I feel confident I could					
1. send e-mail to a friend.	1	2	3	4	5
2. subscribe to a discussion list.	1	2	3	4	5
3. create a “nickname” or an “alias” to send e-mail to several people at once.	1	2	3	4	5
4. send a document as an attachment to an e-mail message.	1	2	3	4	5
5. keep copies of outgoing messages that I send to others.	1	2	3	4	5
6. use an Internet search engine (e.g., Google or Yahoo) to find Web pages related to mathematics.	1	2	3	4	5
7. search for and find the Smithsonian Institution Web site.	1	2	3	4	5
8. create my own World Wide Web home page.	1	2	3	4	5
9. Keep track of Web sites I have visited so that I can return to them later. (An example is using bookmarks.)	1	2	3	4	5

10. find primary sources of information on the Internet that I can use in my mathematics teaching.	1	2	3	4	5
11. use a spreadsheet to create a pie chart.	1	2	3	4	5
12. create a newsletter with graphics and text in 3 columns.	1	2	3	4	5
13. save documents in formats so that others can read them if they have different word processing programs (e.g., saving Word, ClarisWorks, RTF, or text).	1	2	3	4	5
14. use the computer to create a slideshow presentation.	1	2	3	4	5
15. create a database of information about important authors in mathematics.	1	2	3	4	5
16. write an essay describing how I would use technology in my mathematics classroom.	1	2	3	4	5
17. create a lesson or unit that incorporates mathematical software as an integral part.	1	2	3	4	5
18. use technology to collaborate with other interns, teachers, or students who are distant from my mathematics classroom.	1	2	3	4	5
19. describe 5 mathematical software programs that I would use in my teaching.	1	2	3	4	5
20. write a plan with a budget to buy technology for my mathematics classroom.	1	2	3	4	5

Section D

3. To what extent are you confident participating in any of the following professional development activities?

SD = Strongly Disagree, D = Disagree, U = Undecided, A = Agree, SA = Strongly Agree

SD= 1, D= 2, U= 3, A= 4, SA= 5

Items	**SD**	**D**	**U**	**A**	**SA**
I feel confident that I could					
1. download and read mathematics e- books.	1	2	3	4	5
2. download and view streaming mathematics video clips..	1	2	3	4	5
3. send and receive text messages.	1	2	3	4	5
4. download and listen to mathematics podcasts/audio books.	1	2	3	4	5
5. save and retrieve files in a cloud-based environment.	1	2	3	4	5
6. create a wiki or blog to have my students collaborate.	1	2	3	4	5
7. use online tools to teach my students from a distance.	1	2	3	4	5
8. use mobile devices to connect to others for my professional development.	1	2	3	4	5

4. To what extent are you confident using Emerging Technologies for Students?

SD = Strongly Disagree, D = Disagree, U = Undecided, A = Agree, SA = Strongly Agree

SD= 1, D= 2, U= 3, A= 4, SA= 5

Items	**SD**	**D**	**U**	**A**	**SA**
I feel confident that I could					
1. use social media tools for instruction in the classroom (e.g. whatsapp, etc.).	1	2	3	4	5
2. teach in a one-to-one environment in which the students have their own device.	1	2	3	4	5
3. integrate mobile technologies into my mathematics instructions.	1	2	3	4	5
4. find a way to use a smartphone in my classroom for student responses.	1	2	3	4	5
5. use mobile devices to have my students' access learning activities.	1	2	3	4	5
6. transfer photos or other data via a smartphone.	1	2	3	4	5

Section E

5. Does mathematics teachers in the school have access to the following ICT facilities? (Please mark only one choice in each row)

Items	Extremely	Very	Moderately	Slightly	Not At All
Personal Computer					
Computer Laboratory					
Computers in the Library					
Computers in the Staff Common Room					
Internet connectivity					
Access to PC at school					
Access to PC at home					

Section F

7. Please read the descriptions of each of the six stages related to adoption of Information and Communication Technology and write down the number of the stage that best describes where you are in the adoption of ICT.

Stage 1: Awareness

I am aware that information and communication technology exists but has not used it - perhaps I'm even avoiding it.

Stage 2: Learning the process

I am currently trying to learn the basics. I am often frustrated using computers. I lack confidence when using computers.

Stage 3: Computer self-efficacy

I understand the process of using technology and have gained a sense of confidence in using the computer for mathematics tasks. I am starting to feel comfortable using the computer.

Stage 4: Adaptation to other contexts

I think about the computer as a tool to help me and I'm no longer concerned about it as technology. I can use it in many applications and as an instructional aid.

Stage 5: Creative application to new contexts

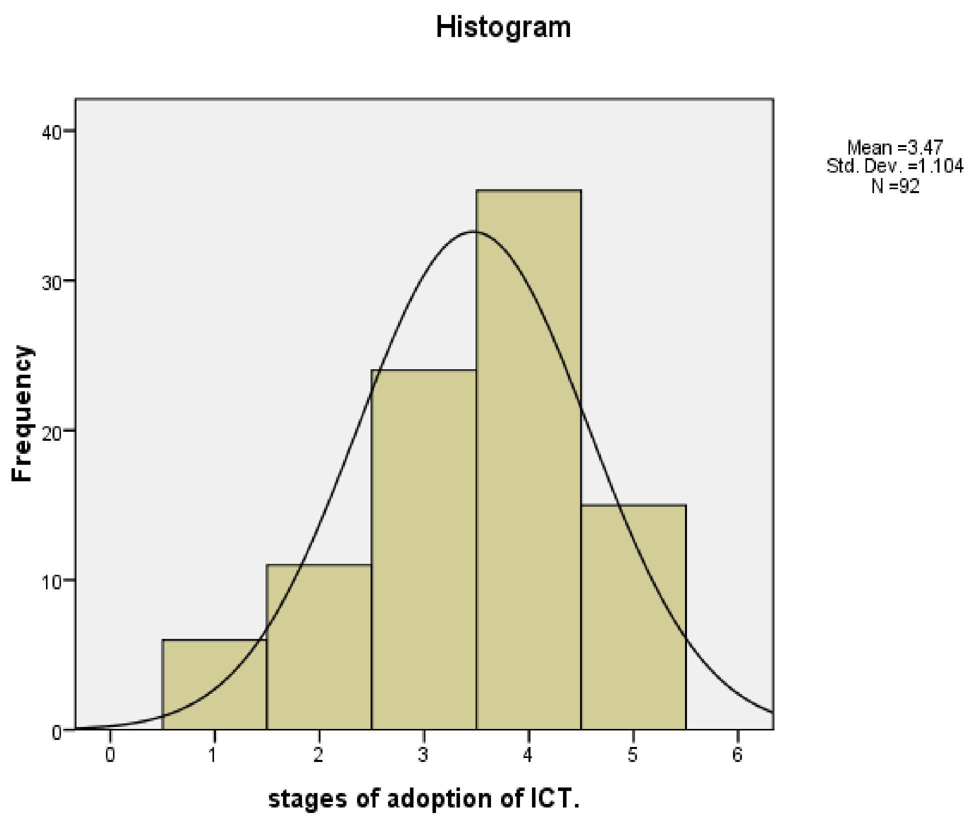
I can apply what I know about technology in the mathematics classroom. I am able to use it as an instructional tool and integrate it into the mathematics curriculum.

The stage that best describes where I am now is number _________.

APPENDIX B

SPSS ANALYSIS OUTPUT

Normality Assumption of Data



Exploratory Factor Analysis

WILL

Determinant = 1.51E-007

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.884
Bartlett's Test of sphericity	Approx. Chi-Square	1.304E3
	df	253
	Sig.	.000

Rotated Component Matrix[a]

	Component			
	1	2	3	4
Working with a computer makes me feel tense and uncomfortable.	.823			
Computers intimidate me.	.808			
Using a computer is very frustrating.	.806			
Working with a computer makes me nervous.	.793			
If I had a computer at my disposal, I would try to get rid of it.	.745			
Studying about computers is a waste of time.	.693			
I get a sinking feeling when I think of trying to use a computer.	.589			
I can't think of any way that I will use computers in my career.	.588			
If a problem is left unsolved in a mathematics class, I continue to think about it afterward.		.752		
Computers will improve mathematics education.		.710		
It is important for students to learn about computers in order to be informed citizens.		.702		
Computers can be useful instructional aids in the teaching and learning of mathematics.		.680		
Having computer skills helps one get better jobs.		.655		
All students should have an opportunity to learn about computers at school.		.638		
Students should understand the role computers play in society.		.615		
Computers are necessary tools in both educational and work settings.		.537		
If there was a computer in my mathematics classroom it would help me to be a better teacher.			.848	
Computers improve the overall quality of life.			.676	
Computers could enhance mathematics remedial instruction.			.609	
Computers can help me learn.			.532	
I like reading about computers.				.748
I like to talk to others about computers.				.613
I enjoy working with computers.				.545

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 8 iterations.

SKILL

Determinant = 2.24E-006

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.858
Bartlett's Test of Sphericity	Approx. Chi-Square	1.090E3
	df	171
	Sig.	.000

Rotated Component Matrix[a]

	Component		
	1	2	3
use an Internet search engine (e.g., Google or Yahoo) to find Web pages related to mathematics.	.812		
keep copies of outgoing messages that I send to others.	.788		
send a document as an attachment to an e-mail message.	.776		
Keep track of Web sites I have visited so that I can return to them later. (An example is using bookmarks.)	.723		
find primary sources of information on the Internet that I can use in my mathematics teaching.	.704		
subscribe to a discussion list.	.672		
use the computer to create a slideshow presentation.	.672		
send e-mail to a friend.	.668		
create a “nickname” or an “alias” to send e-mail to several people at once.	.553		
create a lesson or unit that incorporates mathematical software as an integral part.		.866	
use technology to collaborate with other interns, teachers, or students who are distant from my mathematics classroom.		.793	
create a database of information about important authors in mathematics.		.776	
describe 5 mathematical software programs that I would use in my teaching.		.696	
write a plan with a budget to buy technology for my mathematics classroom.		.682	
write an essay describing how I would use technology in my mathematics classroom.		.660	
create a newsletter with graphics and text in 3 columns.			.791
use a spreadsheet to create a pie chart.			.617
save documents in formats so that others can read them if they have different word processing programs (e.g., saving Word, ClarisWorks, RTF, or text).			.573

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 5 iterations.

PEDAGOGY

Determinant = 8.25E-005

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.873
Bartlett's Test of Sphericity	Approx. Chi-Square	803.929
	df	91
	Sig.	.000

Rotated Component Matrix[a]

	Component		
	1	2	3
download and view streaming mathematics video clips..	.891		
download and read mathematics e- books.	.862		
send and receive text messages.	.834		
download and listen to mathematics podcasts/audio books.	.815		
save and retrieve files in a cloud-based environment.	.742		
transfer photos or other data via a smartphone.	.658		
find a way to use a smartphone in my classroom for student responses.		.821	
use social media tools for instruction in the classroom (e.g. whatsapp, etc.).		.794	
integrate mobile technologies into my mathematics instructions.		.757	
teach in a one-to-one environment in which the students have their own device.		.743	
use mobile devices to have my students' access learning activities.		.730	
create a wiki or blog to have my students collaborate.			.829
use online tools to teach my students from a distance.			.773
use mobile devices to connect to others for my professional development.			.604

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 5 iterations.