TEACHERS’ PREPAREDNESS IN INTEGRATING DIGITAL TECHNOLOGY IN MATHEMATICS TEACHING IN EDO SOUTH SENATORIAL DISTRICT

BY

Ese Francisca ZEKERI-OBASOGIE

APRIL 2023

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A RESEARCH WORK SUBMITTED TO THE DEPARTMENT OF CURRICULUM AND INSTRUCTIONAL TECHNOLOGY, FACULTY OF EDUCATION, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTERS OF SCIENCE IN MATHEMATICS EDUCATION (MSc. [Ed.], MATHEMATICS) OF THE UNIVERSITY OF BENIN

APRIL 2023

CERTIFICATION

We, the undersigned, certify that this project was carried out by**Ese Francisca ZEKERI-OBASOGIE** in the Department of Curriculum and Instructional Technology, Faculty of Education, University of Benin, Benin City, Nigeria.

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Dr. (Mrs.) R. J. Musa **Date**

Head of Department

DEDICATION

To God Almighty whose grace and faithfulness I have attained and for His innumerable mercies and blessings upon me and my entire family.

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First and foremost, praises and thanks to God Almighty for His showers of blessings throughout my research work and to complete it successfully. I would like to express my deep and sincere gratitude to my research supervisor, Dr. F. O. Idehen for his invaluable guidance, insightful suggestions and innovations from the beginning to the end of this work, may God bless him abundantly.

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I am especially indebted to my mother, Mrs. Philomena I. Obasogie. Special thanks go to my brothers and sisters for their encouragement and support they rendered during my study.

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ABSTRACT

This study examined teachers' preparedness in integrating digital technology in Mathematics teaching.Thisaimed to aid Mathematics teachers on how to integrate technology into their Mathematics teaching instructions and to understand the type of technology to use in teaching Mathematics. Ten research questions were raised and five were hypothesized and tested at the 0.05 level of significance.

A correlational survey research design was adopted for the study. The population for the study consisted of one hundred and seventy nine (179) public secondary school Mathematics teachers and seven hundred and eighty (780) private secondary school Mathematics teachers, which gave a total number of nine hundred and fifty nine (959) secondary school Mathematics teachers in Edo South Senatorial District, Edo State. A simple random sampling techniques was used to collect information from in-service public and private secondary school Mathematics teachers which were drawn from the population. A sample of thirty-five (35) public schools and seventy (70) private schools (105 schools) and a sample size of two hundred and ten (210) secondary school Mathematics teachers were used for the study. The instrument for data collection was Mathematics Teachers Questionnaire Instrument (MTQI). Reliability of the instrument was determined using Cronbach Alpha and a value of 0.71 was obtained. Frequency counts, percentage, descriptive statistics (mean and standard deviation), Independent t-test, Pearson correlation statistics and multiple regression analysiswere employed for data analysis.

The findings revealed that majority of Mathematics teachers were not aware of the digital technology tools available to aid in teaching Mathematics; the knowledge of digital technology had been added as a required knowledge of instructions for Mathematics teachers in integrating digital technologies in Mathematics teaching. Sequel to these findings, it was recommended that Mathematics teachers need to undergo training and retraining to meet the standard of Technological Pedagogical Content Knowledge (TPACK) and set up education for the future as well as setting up the students for their future.

CHAPTER ONE

INTRODUCTION

Background of the Study

It is of paramount note that advancement in technology has paved the way to solve human problems, save time and take the world economy to the limelight. The National Policy on Information and Communication Technologies (ICT) in Education, developed by the Federal Ministry of Education (2019) in Nigeria, recognizes the importance of technology in transforming teaching, learning, and educational administration to meet global standards and improve competitiveness. The policy provides guidelines on digital technology integration in education for all stakeholders, with the aim of advancing the education sector in Nigeria. The National Council of Teachers of Mathematics (NCTM, 2000) has also supported the integration of technology in education, stating that technology is essential in teaching and learning Mathematics and that it influences the Mathematics that is taught, enhancing students' learning. The NCTM recognized the importance of preparing Mathematics teachers to meet this standard by providing them with the necessary experiences.

Research findings from various studies have also highlighted the benefits of using technology in the teaching and learning of Mathematics (e.g., Gadanidis& Geiger, 2010; Kastberg&Leatham, 2005;National Policy on ICT in Education, 2019; Roschelle, et al., 2009; Umar and Musa, 2022). Technological tools can support the learning of mathematical procedures and skills, as well as the development of advanced mathematical proficiencies such as problem solving, reasoning, and decision making. The strategic use of technology in Mathematics education can have a positive impact on students' learning outcomes. These findings align with the National Policy on ICT in Education (2019) in Nigeria, which recognizes the potential of technology to solve human problems, save time, and contribute to the growth of the world economy. The integration of digital technology in education, as supported by the National Policy on ICT in Education and the NCTM, has the potential to transform teaching, learning, and educational administration in Nigeria, and enhance students' mathematical proficiencies. It is important for stakeholders in the education sector to embrace and implement this policy to meet global standards and improve the competitiveness of Nigerian education.

In 2003, Microsoft and Nigerian government signed a three year agreement to enable Nigeria to deploy digital technology in order to accelerate a speedy transformation of learning, teaching, research and educational administration; the Federal Ministry of Education (2014) also indicated the significance of technology for promoting the delivery of education in Nigeria with emphasis on developing teachers, capacity and infrastructure. This allows access for teachers and learners to progress at their own pace, learn more effectively and get a richer variety of instructional materials. According to Nsofor and Bello (2015), emerging technological trends have made students digitally literate and created more learning opportunities for them to explore. The use of digital technology in the educational industry in Nigeria has moved the directions and activities of instruction especially in higher institutions from teacher-centered to learner-centered. The means and practice of instructions in the teaching and learning has clearly subjected the teachers to new digital technologies which are unfamiliar to them. This change continued in such a way that technology is now viewed as instructional medium not as content only (Koehler & Mishra, 2006; 2009).

Koehler and Mishra (2005) proposed the concept of TPACK – Technological, Pedagogical and Content Knowledge. They pointed out that good teacher who hoped to effectively apply technology in teaching should have a good understanding of TPACK. TPACK is a framework which teachers need as a way of thinking about the knowledge they can use to understand and integrate technology effectively in their classrooms. Technology knowledge (TK) is the understanding of how to use digital technology in general, but Mathematics teachers need to know how to teach effectively their Mathematics topic to their unique group of students with the integration of digital technologies (Koehler &Mishra, 2006; Niess, Kajder, & Lee, 2008), which is the technological pedagogical and content knowledge (TPACK). This knowledge is the product of synthesizing the subject matter, pedagogy, and digital technologies domains of knowledge and then utilizing this synthesis to identify the affordances and constraints of digital technologies to teach a subject matter such as Mathematics. Consequently, teachers are left with no other choice but to acquire new skills in order to meet up with the demands of this technology integrated environment and to ensure the full integration and implementation of technology in the teaching and learning of Mathematics to the classroom of Nigerian educational system. Hence, Nigeria Mathematics teachers should be prepared and have opportunities to acquire the knowledge, skills and experiences needed to incorporate technology in the context of teaching and learning Mathematics (AMTE, 2006).

The preparedness of Mathematics teachers to integrate technology into Mathematics classroom has been a critical challenge faced with major decisions on how to present the information, what technology resource, which content to teach using technology resource and also how to plan for the standard lesson and time. Some teachers maintain an unwelcoming attitude towards the adaptation of technology as they consider it irrelevant for their use in teaching because of its changing and opaque nature compared to other traditional pedagogical approaches (Ramorola, 2013). It is of the notion that Nigeria as underdeveloped nation faces the challenges to integrate technology into teaching Mathematics due to low capacity-building of teachers in technology, lack of regular review and updating of existing information technology curricula, low capacity of curriculum developers and implementers, educators and teachers are concerned more with efficiency rather than effectiveness, lack of infrastructure in schools, lack of constant power supply and lack of inclusive equitable quality education in the system. There are other reasons for the reluctance of teachers to integrate technology which include computer illiteracy; computer phobia, disinterest, lack of equipment, and lack of time to learn appropriate uses of technology in instruction.

Unlike in developed countries such as US, UK, as technology advances, teachers are eager to explore and integrate technologies as they consistently create new technological oriented ways of pedagogy. The advancement of technology has led to so many researches, development and inquiries on the most beneficial ways technology can be understood and incorporated by teachers, stakeholders, and policy makers towards effective teaching and learning (Abanobi&Abanobi, 2017; Ramorola, 2013; Nsofor& Bello, 2015). Gambari, Shuaibu &Shittu, (2013), believed that technology integration is bringing together or combining technology with teaching and learning strategies in order to meet the curriculum standards and learning outcomes of each lesson, unit, or activity. The questionsare; what knowledge does Mathematics teachers need to integrate technology into teaching Mathematics in the classroom? What technologies are available to aid the preparedness of Nigeria Mathematics teachers in integrating digital technology into teaching Mathematics in the classroom, how to present the information, what technology resource, which content to teach using technology resource and also how to plan for the standard lesson and time? This study is an attempt to discuss on teachers' preparedness in integrating digital technology in Mathematics teaching.

The word technology applies equally to analog and digital as well as new and old technologies. Most traditional pedagogical technologies (such as pencil, microscope, chalkboard, pendulums) are characterized by specificity; they have not changed a great deal over time. These technologies achieve transparency of perception (Bruce and Hogan, 1998); they become commonplace and in most cases are not even considered to be technologies. Digital technologies (such as desktop publishers, computers, handheld devices and software applications) by contrast are protean; they are usable in many ways (Papert, 1980). On an academic level, it is easy to argue that a pencil and a software simulation are both technologies. By their very nature, digital Mathematics technologies (such as geometer's sketchpad, computer algebra system (CAS), Cabri or Tinkerplots, fathom, graphing calculator) are protean, unstable and opaque, presenting new challenges to Mathematics teachers who are struggling to use more technology in their teaching.

Today, technology in education encompasses a vast range of rapidly evolving digital technologies such as Desktop publisher, Notepad, Handheld Computers, Digital Cameras, the Internet, Learning Management System (LMS), Cloud Computing, the World Wide Web, Spreadsheets, multimedia, Simulations, email, Local Area Networking (LAN), Bluetooth, Streaming, DVDs; and applications such as word processors, Virtual

Environment, Simulator, Digital libraries, Computer-Mediated Conferencing, videoconferencing, Emulator etc. Technology allows for the production of digital resources such as digital libraries, where students, teachers, and professionals can access study material and course materials from anywhere at any time. Digital awareness is necessary for Mathematics teachers to use digital technologies to utilize an integrated form of knowledge for effective teaching of Mathematics. Mathematics teachers need to have the responsible use of digital devices (such as software and hardware applications) and online materials. Despite the growth in the use of the internet and digital online tools for various purposes, there is still a lack of awareness among Mathematics teachers.

Digital technologies help students to explore core mathematical concepts, to be interactive and help them to build and investigate mathematical models, objects, figures, diagrams, and graphs (Guerrero, 2010). Also, complicating teaching with technology is an understanding that technologies are neither neutral nor unbiased. Rather, technologies have their own properties, potentials, affordances and constraints that make them more suitable for certain tasks than others (Koehler & Mishra, 2008). Thus, this digital world has invaded the Mathematics teaching world and transformed the capacities of the tools to Mathematics teachers.

There are a number of researchers that have outlined the problems and difficulties in teaching and learning Mathematics in Nigeria schools (e.g., Ali, 2002; Fatade, Mogari and Abayomi, 2013; Omobude, 2014; Obodo, 2007). The poor teaching of Mathematics and poor performance of students in learning Mathematics have generated a lot of heat on the educational system. Several researches have been conducted on the applications and effects of computer based instructional packages in teaching of core science subjects such as Mathematics in Nigeria (e.g.; Ayuba and Timayi,2018; Olabiyi, et al,2013).

It is evidence that the use of technology packages has produced higher achievement than traditional instruction methods. The concept of TPACK framework reveals Mathematics teachers' Technology, Pedagogy, and Content Knowledge (TPACK), which has been described as the body of knowledge Mathematics teachers need for teaching with and about technology through Mathematics contents and grade levels. Koh, Chai, and Tsai (2013) viewed TPACK as a theoretical framework that describes teachers' expertise for information and communication integration. The TPACK framework (Mishra & Koehler, 2006; Niess, 2005) identifies three types of knowledge Mathematics teachers need to combine successfully, these unique set of knowledge are needed to effectively integrate technology into the classroom in conjunction with appropriate pedagogical content knowledge (PCK, as in Ball, Thames& Phelps, 2008; Shulman, 1986). In terms of teacher'sKnowledge, there are various types of knowledge that teachers need to possess in order to develop technological pedagogical and content knowledge(TPACK). It explores the intersections of technological knowledge, pedagogical knowledge, and Mathematics content knowledge, emphasizing the integration of these knowledge domains for effective teaching and learning of Mathematics. It is of important note that the expected knowledge of a teacher forms a body of the subject matter that emanates the structure of the content. Mathematical knowledge for teaching encompasses abilities such as analyzing the students thinking, identifying the mathematical understanding a student does not have, and deciding how to best represent a mathematical idea so that it can be understood by the student. Applying

TPACK into the Nigeria classroom will extend beyond knowledge of how to use technology proficiently and encompass a deeper and transformed knowledge for understanding how Mathematics content, pedagogy and technology are integrated to provide a richer learning experience. This is not only for colleges of education to train teachers on how to teach students technology rather than to train teachers on how to use technology in the classroom. However, how teachers learned their subject matter is not necessarily the way their students will need to be taught in the 21st century. Learning subject matter with technology is different from learning to teach that subject matter (Mathematics) with technology (Niess, 2005). In order words, for Mathematics teachers to integrate technology in ways that are meaningful and productive, they must possess the intersection of technological, pedagogical and content knowledge (Niess, 2009).

Teacher education program should not only be conceptually integrated but also requires authentic experiences. It is obvious that the use of digital technologies in the education system in Nigeria is more prevalent in urban private schools than rural areas. According to Swarts and Wachira (2010), computer use in schools was limited to teaching basic digital technology skills and no integration into the teaching and learning process was observed. Moreover, a study by Mwalongo (2011) on pre-service and in-service teachers' ICT uses in teaching and learning revealed that the majority of teachers were using computers for preparing notes, teaching and learning resources, preparation of school announcements, reports, letters, students' registration and preparation of examinations. Mwalongo added that almost all surveyed schools had computers and television (TV) sets, and teachers also had mobile phones with cameras, but they do not use the computers and the digital cameras from their mobile phones for academic purposes. In some Nigeria schools, the available computers are not used at all. According to Swarts and Wachira (2010), some of the factors hindering the use of technology in teaching are: inadequate training and capacity, resulting in underutilization of ICT facilities; a widespread view of digital technology as a status symbol rather than a tool; and lack of awareness of the multifaceted range of digital technology and how these technologies can be used to address the existing challenges of teaching and learning. Others were lack of common understanding and awareness among stakeholders about the benefits that digital technologies can bring to education and lack of skilled manpower to implement technology-enhanced curriculum.

Teaching experience plays a significant role in the effective integration of technology in the classroom, especially in the context of Mathematics education. However, the gender digital divide poses a challenge in the effective use of digital technology in the classroom, particularly for female teachers. Studies have shown that (e.g., Laegran,2003; miller, 2004) females are more disadvantaged in terms of digital adoption, access to, and use of digital technology compared to males. This gender imbalance in technology skills can further exacerbate the challenges faced by female teachers in integrating technology into their teaching practices, especially in low-cost schools (public and private) and rural areas in Nigeria where educational resources and facilities may be limited. To address this issue, it is crucial to provide adequate training and professional development opportunities for teachers, particularly female teachers, to improve their technical skills and digital technology knowledge. This can be done through workshops, seminars, and training programs that specifically target female teachers and cater to their unique needs and challenges. Furthermore, the TPACK model emphasizes the integration of technology, pedagogy, and content knowledge and provides a framework for teachers to effectively use technology to enhance their teaching and improve student learning outcomes. By providing training and support in the TPACK model, teachers can develop the necessary skills and knowledge to effectively integrate technology in the classroom, regardless of their years of teaching experience or school location.

The research conducted by Ehrenberg, Brewer, and Ferguson (2000) supports the notion that students tend to learn more from teachers with strong academic skills, including higher degrees and subject-specific expertise. When teachers are well-qualified, receive training in professional programs, and attend seminars, it can positively impact their ability to use digital technologies and other innovative teaching methods, which in turn can enhance students' learning abilities and academic achievements, particularly in the subject of Mathematics. Teacher qualification and professional development are important factors that contribute to effective technology integration and overall improvement in student outcomes. Teachers who have Bachelor's or Master's degrees in the subjects they teach, along with relevant experience, are more likely to be effective in facilitating student learning (Ehrenberg, Brewer, and Ferguson, 2000). This is particularly relevant in the context of integrating digital technologies in students' academic achievement, as teacher qualifications play a crucial role in effectively incorporating technology into the teaching and learning process.

It is important for Mathematics teachers to develop a strong understanding of the characteristics of TPACK, which includes their technological, pedagogical, and content knowledge base, to ensure proper and effective use of technology in teaching

Mathematics. Teachers who are knowledgeable in TPACK are better equipped to select appropriate technology tools, integrate them into their instructional strategies, and create meaningful learning experiences for students. This can lead to improved engagement, motivation, and achievement in Mathematics among students.

The integration of technology in teaching Mathematics can face various challenges across different branches of Mathematics. The challenges can include technical challenges, such as limited access to reliable internet, lack of appropriate hardware or software, and technical difficulties in using technology tools. Pedagogical challenges may involve teachers' lack of familiarity with instructional strategies that effectively integrate technology, difficulties in aligning technology use with curriculum standards, and concerns about the appropriateness of technology for different mathematical concepts or levels of student learning. Content-related challenges can include difficulties in finding high-quality digital resources that align with the Mathematics curriculum, ensuring that technology is used to support authentic mathematical thinking and problem-solving and addressing misconceptions or errors that may arise from the use of technology. However, despite these challenges, this study serves as a foundation for further research on initiatives that can motivate Mathematics teachers to creatively and effectively use technology in their classrooms, considering different contexts of Mathematics education.

In conclusion, the successful implementation of TPACK requires teachers to have a deep understanding of the interplay between technology, pedagogy, and content knowledge, and how it applies to their specific subject area, such as Mathematics. Empowering teachers with the necessary knowledge and skills to effectively integrate technology into their instruction can have a positive impact on students' learning outcomes in Mathematics and other subject areas. The Technological Pedagogical Content Knowledge (TPACK) framework can serve as a valuable tool for Mathematics teachers to assess their own knowledge, understand what their students need to know, determine what they teach and how they teach it, and then challenge and support themselves to continuously improve their instructional practices with technology. By leveraging the TPACK framework, Mathematics teachers can integrate technology in their instruction in meaningful and effective ways, aligning with the needs of their students and the requirements of the Mathematics curriculum. Continued research and initiatives, along with the thoughtful application of the TPACK framework, can contribute to the advancement of technology integration in Mathematics education and enhance students' mathematical learning experiences.

Statement of the Problem

Despite the presence of technology such as computer, television, handheld devices, radio, etc. in Nigeria schools do not necessarily imply digital technology integration in education. There are some schools which opt to place computers in laboratories, rather than to use it to enhance students learning. Aside of that, many Nigeria Mathematics teachers are used to the chalk and talk method of instructions; were never taught with digital technology or perhaps have never used digital technologies in their teaching because they received limited training without the use of digital technologies in learning Mathematics. According to Amosun, Falade and Falade (2015), the teacher training program and development in Nigeria is currently facing numerous challenges of which the problem of technology integration is major amongst many.

There is an insufficient supply of trained human resources. However, there is currently no evidence of professionalization of educational technology in Nigeria, which may be attributed to the lack of improvement in the overall educational standard. The challenges can include technical challenges, such as limited access to reliable internet, lack of appropriate hardware or software, and technical difficulties in using technology tools. And lack of awareness of the multifaceted range of digital technology and how these technologies can be used to address the existing challenges of teaching and learning. There seems to be lack of common understanding and awareness among stakeholders about the benefits that digital technologies can bring to education and lack of skilled manpower to implement technology-enhanced curriculum. The absence of technological tools in Mathematics classrooms in Nigeria can hinder students' ability to explore and understand mathematical concepts and limit their access to information and resources that can enhance problem-solving skills. Therefore, there is a growing emphasis on integrating technological, pedagogical, and content knowledge (TPACK) in the field of education. This review aims to provide a framework for developing digital technology integration skills among Mathematics teachers in Nigeria.

The preparedness and knowledge of Mathematics teachers play a vital role in integrating technology in teaching Mathematics in the classroom. However, how teachers learned their subject matter is not necessarily the way their students will need to be taught in the 21st century. Learning Mathematics (subject matter) with technology is different from learning to teach Mathematics with technology (Niess, 2005). In the sense that, the introduction of technology on its own does not enhance teaching and learning, but effective and efficient integration of technology into the classroom environment has the potential of improving academic achievement; this depends on how Mathematics teachers are prepared and knowledgeable to integrate technology into their lesson delivery. The major questions are; what knowledge does Mathematics teachers need to integrate technology in teaching Mathematics in the classroom? What technologies are available to aid the preparedness of Nigeria Mathematics teachers in integrating digital technology in teaching Mathematics in the classroom? This study is an attempt to discuss on teachers' preparedness in integrating digital technology in Mathematics teaching.

Therefore, the specific objectives of this study examined Mathematics teachers' knowledge on how to integrate technology into their Mathematics teaching instructions and to understand the type of technology to use in a particular Mathematics topic.

Research Questions

The following research questions were raised to guide the study:

1. What technologies are available to aid the preparedness of Mathematics teachers in teaching Mathematics?
2. What is the level of teachers' technological knowledge in integrating digital technology in teaching Mathematics?
3. What is the level of teachers' content knowledge in integrating digital technology in teaching Mathematics?

4. What is the level of teachers' pedagogical knowledge in integrating digital technology in teaching Mathematics?
5. What is the level of Mathematics teachers' preparedness in integrating digital technology in teaching Mathematics?
6. What is the difference between male and female Mathematics teacher's technological knowledge in integrating digital technology in teaching Mathematics?
7. What is the difference between pedagogical knowledge of experienced and inexperienced Mathematics teachers in integrating digital technology in teaching Mathematics?
8. What is the difference between the knowledge of public and private school Mathematics teachers in the use of TPACK in integrating digital technology in teaching Mathematics?
9. What is the difference between qualified and unqualified teacher's technological, pedagogical, and content knowledge (TPACK) in integrating digital technology in teaching Mathematics?
10. What is the relationship between the components under technological, pedagogical, and content knowledge(TPACK) framework of teacher's knowledge in integrating digital technology in teaching Mathematics?

Hypotheses

Research questions 6, 7, 8, 9 and 10 were hypothesized and tested at 0.05 levels of significance.

HO_1: There is no significant difference between male and female Mathematics teacher's technological knowledge in integrating digital technology into teaching Mathematics.

HO_2: There is no significant difference between pedagogical knowledge of experienced and inexperienced Mathematics teachers in integrating digital technology into teaching Mathematics.

HO_3: There is no significant difference between the knowledge of public and private school Mathematics teachers in the use of technological, pedagogical, and content knowledge(TPACK) in integrating digital technology in teaching Mathematics.

HO_4: There is no significant difference between qualified and unqualified teacher's technological, pedagogical, and content knowledge (TPACK)in integrating digital technology in teaching Mathematics.

HO_5: There is no significant relationship between the components under technological, pedagogical, and content knowledge (TPACK) framework of teacher's knowledge in integrating digital technology in teaching Mathematics.

Purpose of the Study

This study investigates the teachers' preparedness in integrating digital technology in Mathematics teaching in Edo South senatorial district. This study seeks to help Mathematics teachers integrate, innovate technology into their Mathematics teaching instructions and need to better understand the type of technology to use that can foster technology integration in teaching Mathematics. Specifically, this study sought to find out:

1. The unique set of knowledge needed by Mathematics teachers to effectively integrate digital technologies available to aid their preparedness.
2. The level of Mathematics teachers' technological knowledge in integrating digital technology into teaching Mathematics.

3. The level of Mathematics teachers' pedagogical knowledge in integrating digital technology into teaching Mathematics.
4. The level of Mathematics teachers' content knowledge in integrating digital technology into teaching Mathematics.
5. The level of Mathematics teachers’ preparedness in integrating digital technology into teaching Mathematics.
6. The difference between male and female Mathematics teacher’s technological knowledge.
7. The difference between pedagogical knowledge of experienced and inexperienced Mathematics teachers.
8. Thedifference between the knowledge of public and private school Mathematics teachers.
9. Thedifference between qualified and unqualified Mathematics teacher’s TPACK knowledge.
10. Therelationship between the components under TPACK framework of teacher’s knowledge in integrating digital technology into teaching Mathematics.

Significance of the Study

The findings of this study would be beneficial in several key areas to Mathematics teachers, students, professional development for in-service teachers, educational policy makers and planners such as Ministry of Education and other researchers.

The study acknowledges the importance of equipping future Mathematics teachers with the necessary knowledge, experiences, and skills to effectively integrate technology in teaching Mathematics. As technology continues to advance, it is crucial for Mathematics teacher education programs to prepare teachers with the expertise to integrate digital technologies in their instruction, as well as understanding how technology interacts with pedagogy and content knowledge. The potential of technology integration to provide students with rich learning experiences that bridge the gap between concrete and abstract mathematical concepts. Through explorations and applications, students can develop a deeper understanding of mathematical concepts and problem-solving skills, ultimately enhancing their mathematical proficiency.

The study offers ideas and suggestions for developing and assisting in-service Mathematics teachers in enhancing their TPACK. This can support professional development efforts aimed at helping teachers integrate technology effectively in their classroom practices, promoting innovative and engaging Mathematics instruction that prepares students for the digital age.The findings of this study can inform educational policy makers and planners in the reformation and improvement of strategies to successfully implement digital technologies in Mathematics instruction. This can help shape policies and practices that promote effective technology integration in Mathematics education, ultimately improving the quality of education for students.

Scope and Delimitation of the Study

The scope of this study is on teachers' preparedness in integrating digital technology in Mathematics teaching. It is delimited to some selected public and private school Mathematics teachers in Edo South Senatorial district, Edo state.

One hundred and five (105) schools were used and the schools are from public schools, thirty-five (35) out of one hundred and seventy-nine (179) and private schools seventy (70), out of seven hundred and eighty (780) was used for this study. The schools in Edo South senatorial district are stratified into seven Local Government Areas; Oredo, Egor, Ikpoba-okha, Orhionmwon, Uhunmwonde, Ovia South West and Ovia North East. Two (2) Mathematics teachers from each public school and two (2) Mathematics teachers from each private school which makes seventy (70) total number of public secondary schools Mathematics teachers and one hundred and forty (140) total number of private secondary school Mathematics teachers. A sample size of 210 secondary school Mathematics teachers was used in this study.

Definition of Terms

The following are the definition of terms of this study:

Content knowledge or Subject matter knowledge: The knowledge of the actual subject matter that is to be learned or taught.

Digital technologies: All educational hardware and software educators can use to design, apply, and evaluate their instruction (e.g., computers, Internet, calculators, etc.).

Experienced Teacher: The number of teaching years more than ten years.

Inexperienced Teacher: The number of teaching years less than ten years.

Mathematical Knowledge for Teaching: The Mathematical Knowledge required to teach Mathematics.

Mathematics Teachers' Qualification: A teacher competent having teaching certificate in Mathematics such as NCE, B.Sc. [Ed.], M.Sc. [Ed.].

Pedagogical Knowledge: The knowledge of the teacher about the processes and practices of teaching and students learning, encompassing educational purposes, goals, values, strategies etc.

Teacher's Gender: The physical aspect of a teacher.

Teacher's preparedness: The specific education program which helps teachers in developing quality and effective strategies in the teaching and learning process.

Technology Integration: Involves the infusion of technology as a tool to enhance learning in a content area or multidisciplinary setting.

Technology Knowledge (TK): The knowledge about the various technologies, ranging from low-tech technology such as pencil and paper to digital technology such as the internet, digital video, PowerPoint, multimedia, interactive whiteboards etc.

TPACK Components: These are the seven elements that show how teachers' understanding of technologies and pedagogical content knowledge interact with one another to produce effective teaching with technology.

Unqualified Mathematics Teacher: Having no teaching certificate in Mathematics such as NCE, B.Sc. [Ed.], M.Sc. [Ed.].

CHAPTER TWO

REVIEW OF RELATED LITERATURE

This chapter provides a review of related literature that focuses on teachers' preparedness in terms of the different components of Mathematical technological and pedagogical content knowledge (TPACK). It explores how teachers' technological knowledge, pedagogical strategies, and Mathematics content knowledge contribute to their overall preparedness in integrating technology in Mathematics instruction. This is done along the following sub-themes:

- ❖ Theoretical Framework
- ❖ TPACK and Mathematics
- ❖ Teachers Knowledge and TPACK
- ❖ Digital Technology Knowledge
- ❖ Mathematics Digital Technology Teaching Aids and TPACK
- ❖ Teachers Gender and TPACK
- ❖ School Type, Location and TPACK
- ❖ Teachers experienced and TPACK
- ❖ Teachers’ qualification and TPACK
- ❖ Teachers’ Preparedness and Components of Mathematical TPACK
- ❖ Summary of Review of Related Literature

Theoretical Framework

The reality of education in the society is that most teachers have little knowledge of technology beyond the computer, mobile devices, social networks and media. TPACK has called for different teachers' knowledge on how to efficiently and effectively use technology in the learning and teaching of Mathematics.

The TPACK (formerly TPCK) framework expands on Shulman’s (1986, 1987) conceptualization of pedagogical content knowledge. Shulman (1986), proposed the PCK model consisting of pedagogical knowledge (PK), content knowledge (CK) and pedagogical content knowledge (PCK). The TPACK describes how teachers’ understanding of technologies and pedagogical content knowledge interact with one another to produce effective teaching with technology (Koehler & Mishra, 2008, p. 12). In this model (see Figure 1), pedagogical knowledge (PK), content knowledge (CK) and technology knowledge (TK) intersect at pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogical knowledge (TPK) and technological, pedagogical, content knowledge (TPACK), interact, and influence one another to form and inform not only a teacher’s understanding of content, pedagogy, and technology, but also the combinations of these three knowledge domains. Together, these multiple knowledge domains intersect in the realm of TPACK to represent, the understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face; knowledge of students’ prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge and to develop new epistemologies or strengthen old ones. (Koehler & Mishra, 2008, p. 17–18).

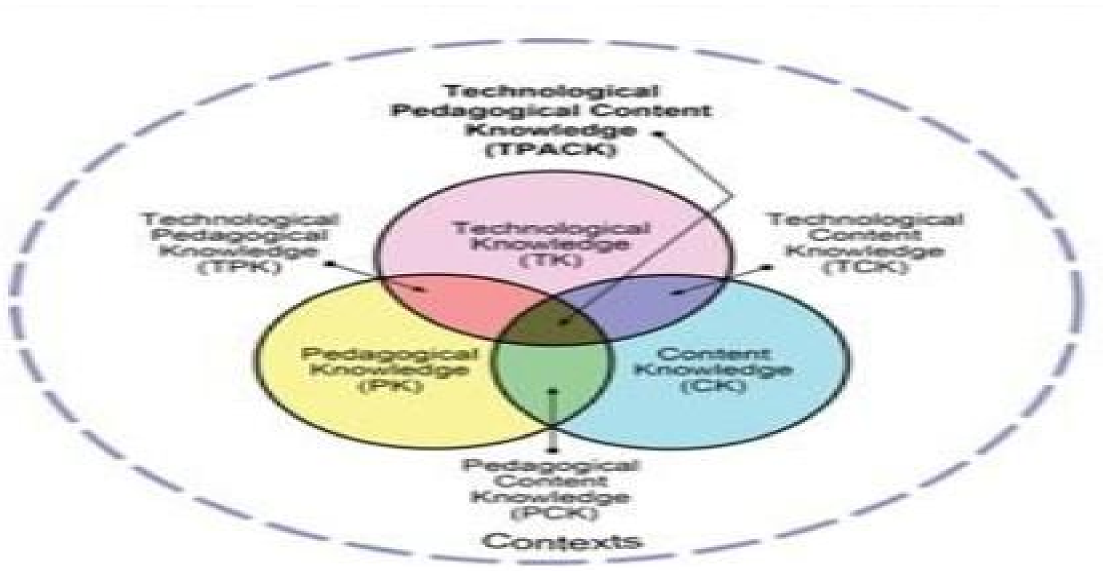

Figure 1: The Framework of TPACK Model
(Source: http://www.TPACK.org)

Koh, Chai, and Tsai (2013) viewed TPACK as a theoretical framework that describes teachers' expertise for information and communication integration. Jang and Tsai (2013) also defined TPACK as a consolidated knowledge system that promotes students learning. Thus, TPACK as one of the significant frameworks of teachers 'knowledge is described as the body of knowledge Mathematics teachers need for teaching with and about technology through Mathematics contents and grade levels. Mishra and Koehler (2006) stated that TPACK is a form of knowledge that is different from the knowledge of a technology expert and also from the general pedagogical knowledge of a teacher. Rather, it is knowledge that helps teachers to understand how to teach a particular topic using a particular type of technology. Guerrero (2010) claimed that TPACK is a rich understanding of how teaching and learning within a specific content area occur and change as a result of authentic, meaningful application of appropriate technologies.

The concept of TPACK framework revealed seven knowledge components that prepared and aid Mathematics teacher to efficiently and effectively integrate technology (Koehler & Mishra, 2009).

- Technological Knowledge (TK) is the knowledge about the various technologies, ranging from low-tech technology such as pencil and paper to digital technology such as the internet, digital video, PowerPoint, multimedia, interactive whiteboards etc. (To use technologies like blackboard, smart board, tablet and Web 2.0 tools (e.g. Wiki, Blogs, Facebook) (Schmidt et al., 2009). Technological knowledge is related to the ability of the teacher to use hardware and software to solve learning problems (Harris, Mishra & Koehler, 2009).
- Content Knowledge (CK) - is the knowledge of the actual subject matter that is to be learned or taught (Mishra & Koehler, 2009). Content knowledge is about the knowledge that a teacher is having on Mathematics subjects which he/she teaches. Shulman (1986) refers to it as the amount and organization of knowledge in the mind of the teacher which including the knowledge of concepts, theories, ideas, organizational frameworks, scientific facts, structures and rules that incorporate those facts and concepts and knowledge of evidence and proof, as well as established practices and approaches towards developing such a knowledge. Teachers must have a broad knowledge base of the subject matter so that they can retrieve and teach contents in logical and organized ways (Jang & Tsai, 2013).
- Pedagogical Knowledge (PK) is the knowledge of the teacher about the processes and practices of teaching and students learning, encompassing educational purposes, goals, values, strategies etc. (Koehler & Mishra, 2009). According to Koehler and

Mishra, pedagogical knowledge encompasses the broad spectrum of teaching approaches, from planning of the lesson to students' assessment. It includes knowledge about techniques or methods used in the classroom, the nature of the learners' needs and preferences, and strategies for assessing student understanding (Harris, Mishra & Koehler, 2009). It also the knowledge about instructional methods and materials, different educational theories, lesson plan development, classroom management and assessment procedures (Chai et al., 2011; Schmidt et al., 2009).

- Pedagogical Content Knowledge (PCK) - This refers to the content knowledge that deals with the teaching process (Shulman 1986). Pedagogical content knowledge blends both content and pedagogy with the goal being to develop better teaching practices in the content area (Schmidt et al., 2009). Koehler & Mishra (2009), adopting the idea of Shulman, describes PCK as the transformation of subject matter for teaching, which occurs when a teacher interprets a subject matter and finds various ways of presenting it, and adapts and tailors the instructional materials to alternative conceptions and students' prior knowledge. It is concerned with pedagogical techniques, knowledge of what makes concepts difficult or easy to learn and theories for specific contexts (Koehler & Mishra, 2009).
- Technological Content Knowledge (TCK) - This is the knowledge of how technology can create new representations for specific content. It is also an understanding of the manner in which technology and content influence and constrain one another. Teachers are advised to master not only the subject matter but also the manner in which the subject matter can be changed by the use of particular technology (Koehler & Mishra, 2009). It is the knowledge about how to use technology in different ways

for example, the knowledge about how to use internet games to show the operations about fractions.

- Technological Pedagogical Knowledge (TPK) - This is about the teachers' understanding of the way teaching and learning can change when particular technologies are used in a particular way (Koehler & Mishra, 2009). It is the knowledge of how various technologies can be used in teaching and understanding that using technology may change the way teachers teach (Schmidt et al., 2009). A teacher should know where and how a particular technology can be used to enhance teaching in a given subject matter (Koehler & Mishra, 2009; Niess, 2005). An example of technological pedagogical knowledge may include the use of interactive whiteboard to engage students in the process of interacting with the materials in the process of learning.
- Technological Pedagogical Content Knowledge (TPACK) - This refers to the knowledge required by teachers for integrating technology into their teaching and content area (Schmidt et al., 2009). Koehler and Mishra (2006, 2009) argue that, by simultaneously integrating knowledge of technology, pedagogy and content, expert teachers bring TPACK into play any time they teach. They also argue that, "there is no single technological solution that applies for every teacher, every course, or every view of teaching. Rather, solutions lie in the ability of a teacher to flexibly navigate the space defined by the three elements of content, pedagogy and technology and the complex interactions among these elements in specific contexts (p. 66)." Schmidt et al. (2009), describe TPACK as a useful framework for thinking about what knowledge teachers must have to integrate technology into teaching and how they

might develop this knowledge. They further argue that, measuring teaching knowledge could potentially have an impact on the type of training and professional development experiences that are designed for both pre-service and in-service teachers. Together with knowledge of technology and awareness of it, teachers are expected to rethink course elements that are difficult to teach in traditional ways, and attempt to transform their instruction into better representations using technologies (Jang & Tsai, 2013).

In recent years, the TPACK model has been employed to investigate teachers' TPACK development according to different learning contexts such as Mathematics (Guerrero, 2009, 2010); Science (Jang & Tsai, 2013). Hence, this model is clearly applicable to the constructivist ideas of students' acquisition of knowledge out of their experiences, which stated that students construct and acquire knowledge on their own and use their intuition, imagination, creativity and search for new information to discover facts correlations and new facts. In other words, teachers should use technology strategically to provide access to mathematics for all students; this promotes learning by doing or active in learning. The TPACK teaching strategies help to create technology learning environment that motivates and influences the learners or students learning process and help students to be creative, to think critically and problem solvers.

Implications of Theoretical Framework to this Study

The implications of the theoretical framework used in this study are as follows:

- Dynamic Framework for Technology Integration: The theoretical framework provides a dynamic approach to integrating digital technology in Mathematics instruction. It recognizes the changing landscape of technology and the need for teachers to adapt their pedagogical approaches accordingly. This framework emphasizes the importance of incorporating technology in teaching Mathematics to enhance student learning experiences.

- Enhancing Student Learning: The theoretical framework is developed to explain a wide range of teaching approaches in a classroom setting, with the goal of enhancing students' learning outcomes. By integrating digital technology effectively, students are provided with additional opportunities to explore and interact with mathematical concepts, leading to increased interest and engagement in learning Mathematics.
- Teacher Preparedness: The theoretical framework emphasizes the importance of teachers' knowledge in integrating technology in Mathematics instruction. It recognizes the need for teachers to possess the right set of knowledge and skills to effectively use technology in their teaching practices. This implies that teacher education programs and professional development efforts need to prioritize the development of teachers' technological pedagogical content knowledge (TPACK) to enhance their preparedness for integrating technology in Mathematics instruction.
- Future-oriented Education: The theoretical framework acknowledges the growing demand for the use of technology in the classroom and sets up education for the future. By incorporating technology in Mathematics instruction, teachers are better equipped to prepare students for the digital age and equip them with the necessary skills for their future success.
- Effective Pedagogical Techniques: The theoretical framework helps teachers make effective use of the TPACK framework by providing them with concepts and strategies to integrate technology in their instructional practices. It guides teachers in

selecting appropriate digital tools, pedagogical techniques, and representations to effectively teach mathematical topics, promoting deeper understanding and reasoning skills among students.

- Individualized Instruction: The theoretical framework recognizes that students come into the classroom with different backgrounds and prior knowledge. By incorporating technology in Mathematics instruction, teachers can tailor their instruction to meet the diverse needs of students, strengthen their prior knowledge, and develop new ways of thinking about mathematical concepts.
- Measurement of Instructor Knowledge: The theoretical framework serves as a measure of teachers' knowledge in integrating technology in Mathematics instruction. It provides a framework for assessing teachers' proficiency in the use of digital technology and instructional strategies, allowing for continuous improvement in their teaching practices.
- Qualified and Experienced Teachers: The theoretical framework emphasizes that experienced and qualified Mathematics teachers should possess the knowledge to make informed decisions about the appropriate use of technology in their instruction. This includes understanding the affordances and limitations of different types of technology, selecting appropriate tools and resources based on instructional goals and student needs, and integrating technology in a way that enhances, rather than detracts from, the learning of Mathematics content.
- Student Benefits: The theoretical framework implies that the use of technology in Mathematics instruction can benefit students. Technology can provide students with new ways of interacting with mathematical concepts, promoting active engagement,

exploration, and discovery. It can also support individualized learning, allowing students to progress at their pace and providing immediate feedback on their performance. Additionally, technology can facilitate communication and collaboration among students, enabling them to work together on problem-solving tasks, share ideas, and learn from each other.

- Contextual Changes: The theoretical framework suggests that the integration of technology in Mathematics instruction can bring about changes in the school environment. This may include changes in instructional practices, classroom management strategies, and student engagement with learning. Technology can create new opportunities for teaching and learning, such as incorporating interactive simulations, multimedia resources, and collaborative tools, which can transform the traditional classroom environment into a more dynamic and engaging learning space.
- Adaptation to Changing Educational Landscape: The theoretical framework suggests that the integration of technology in Mathematics instruction is essential for educators to adapt to the changing educational landscape. As technology continues to advance and become increasingly prevalent in various aspects of modern society, it is crucial for educators to prepare students for the digital age by equipping them with the necessary skills and competencies to effectively use technology for learning and problem-solving. Theoretical frameworks that promote the productive use of technology in Mathematics instruction can help educators stay current with the changing educational landscape and better prepare students for the future.

TPACK and Mathematics

Mathematics evolves as a body of knowledge as technology influences what we know, how we know it, what we teach and how we teach it (Guerrero, 2010). Technology has influenced content development and exploration in all areas of Mathematics by providing novice and expert Mathematicians increased access, understanding, and application of advanced mathematical concepts through concrete modeling, iterative applications, and recursive functioning (Grandgenett, 2008). Guerrero stated that technology allowed us to apply computer-like algorithms to create, analyze, and recursively define fractals, fragmented geometric shapes, objects, or quantities that are reduced size copies (or self-similar structures) of the whole. Fractals have emerged as especially useful applications in defining and measuring geographic and meteoric features and phenomenon. Similarly, technology has influenced Mathematics content development and exploration in areas such as statistics, combinatorics, algebra, probability, geometry, and matrices.

Technology has had considerable impact on how we think about teaching Mathematics in the classroom. For example, dynamic software environments, such as Geometer's Sketchpad, Cabri, Fathom, or Tinkerplots, make the exploration of core mathematical concepts tangible and interactive for students. These type of environments allow students to build and investigate mathematical models, objects, figures, diagrams, and graphs, (Key Curriculum Press, 2008) in ways that bridge the gap between concrete and abstract. Handheld graphing devices allow students, through explorations and applications, to develop a deeper understanding of mathematical concepts and use higher-level approaches to solve mathematical problems.

Handhelds also promote assimilation between mathematical concepts and their multiple representations (e.g., functions and their graphical, tabular, and symbolic representations). Wireless network technologies, such as the TI Navigator, promote, and improve student's engagement, understanding, and performance by allowing for real time tracking of student progress, collaborative lesson engagement, and instant feedback. Virtual learning environments (VLEs) actively involve students in interactive Mathematics instruction. Students are able to manipulate physical objects to visualize relationships and applications, form and test conjectures, and connect abstract concepts to concrete representations. Adeoye and Babatunde (2014), stated that in order to teach well and be relevant in today's classrooms, technological Pedagogical content knowledge is critical for teachers. The Association of Mathematics Teacher Educators (AMTE, 2006) agreed with the NCTM and further stated that technology has become an essential tool for doing Mathematics in today's world, and thus it is essential for the teaching and learning of Mathematics (Guerrero, 2010).

The intent for Mathematics teachers to use digital technology (such as spreadsheet) in the classroom is to enhance and increase students' understandings through investigations, gaining access to Mathematics that might not be available otherwise. The capabilities of the technology would allow exploring graphs, analyzing data, and changing parameters that would be time-consuming and tedious by hand. Students would be able to connect different branches of mathematics through different representations more easily managed through technology. Students would have greater access to tackle real-life problems with complex computations. The technology principle further indicated that student's use of technology should not replace the role of teachers.

In fact the decisions made by teachers play a major role in the effectiveness of the technology use in the classroom. In the ideal classroom every students are expected to have access to technology to enhance his/her mathematics learning through the guidance of a competent teacher (NCTM, 2000).

Moreover, teachers are required to acquire a different knowledge than they were accustomed to and to shift the focus of teaching from basic skills and knowledge for operating technology to learning how to use technology effectively in the Mathematics classroom. With the TPACK standards for Mathematics teachers, the progress of effective integration of technology is slow (Julie, 2011). However, the level of integration of technology, pedagogy and content knowledge is minimal in Nigeria schools. It is of note that teaching is regarded as a complex system and a cultural activity (Hiebert, 1999). Meanwhile, being used to the chalk and talk method of instruction, teachers teach the way they were taught, and to carry out the effective use of integrating technology, they require learning. And learning for teachers, just as for students, requires an opportunity to learn (Hiebert, 2003, p. 18). Thus, UNESCO (2008) presents specific technology competencies that teachers should acquire at the college to be able to integrate technology in teaching in the most appropriate way. Such competencies includes: the ability to manage information, structure problem tasks, and integrate open-ended software tools. Also the ability to integrate subject-specific applications with student-centered teaching methods as well as collaborative projects in support of students' deep understanding of key concepts and their application to solve complex, real-world problems. In regard to the required TPACK Competencies for teachers in the classroom, teachers should be able to use network resources to help students collaborate, access information, and communicate with external experts to analyze and solve their selected problems. Meanwhile, teachers are supposed to be able to use digital technology to create and monitor individual and group student project plans, as well as access experts and collaborate with other teachers and experts in supporting their own professional development. The extent to which teachers will integrate technology in their teaching is the most important. It is obvious that the integration of technology in Mathematics has numerous advantages in students' learning mathematics. The more teachers treat digital technology as an integral part of the students learning in Mathematics is the more the improvement in students' achievements. A research by Keong et al. (2005) reports that, the use of technology in teaching Mathematics improves by increasing collaboration among students and enhancing level of communication and sharing of knowledge. Teachers can also be able to provide a rapid and accurate feedback to students and allow students to focus on strategies and interpretations of answers rather than spending time on tedious computational calculations.

Niess (2005, 2012), postulated four major components of TPACK that can be used as criteria to evaluate teachers' TPACK. They are;

1. An overarching conception about the purposes for incorporating technology in teaching subject matter topics: This requires teachers to have a foundational understanding of what it means to teach a particular subject with technology.
2. Knowledge of students' understanding, thinking, and learning in subject matter topics with technology. This requires teachers to have a comprehensive understanding of students' thinking and learning process with the present of digital technologies in their teaching for a particular subject matter.

3. Knowledge of curriculum and curricular materials that integrate technology in learning and teaching subject matter topics. This requires teachers to have a solid understanding of curriculum and all teaching materials and what affordances and constraints digital technologies will offer to their curriculum objectives.

4. Knowledge of instructional strategies and representations for teaching and learning subject matter topics with technologies. This requires teachers to understand how to build a reciprocal relationship between his or her teaching methods and the best match digital technology that provides the best representation for a specific topic.

For Mathematics, Niess and her colleagues (2009) proposed four TPACK standards and associated them with a five-step process TPACK developmental model in order to meet these standards. The mathematics teacher TPACK standards have some indicators to guide the evaluation of each standard (see Table 1). These TPACK standards were later adopted by the AMTE, combined with ISTE Teacher Standards (NETS•T) (International Society for Technology in Education, 2008) and then published in their version of Mathematics TPACK framework (see Table 2) (AMTE, 2009).

Table 1: Niess Research Group's Proposed Mathematics Teacher TPACK Standards

Proposed Mathematics Teacher TPACK Standards
1. Designing and developing digital-age learning environments and experiences: Teachers design and develop authentic learning environments and experiences incorporating appropriate digital-age tools and resources to maximize mathematical learning in context.
2. Teaching, learning and the mathematics curriculum: Teachers implement curriculum plans that include methods and strategies for applying appropriate technologies to maximize

student learning and creativity in mathematics.

3. Assessment and evaluation: Teachers apply technology to facilitate a variety of effective assessment and evaluation strategies.

4. Productivity and professional practice: Teachers use technology to enhance their productivity and professional practice.

Table 2: Mathematics TPACK Framework

Mathematics TPACK (Technological Pedagogical Content Knowledge) Framework
1. Design and develop technology-enhanced Mathematics learning environments and experiences. Educators use their knowledge of technology, pedagogy, and content to design and develop learning environments and experiences to maximize Mathematics learning.
2. Facilitate Mathematics instruction with technology as an integrated tool. Educators implement curricular plans that integrate appropriate technology to maximize mathematical learning and creativity.
3. Assess and evaluate technology-enriched Mathematics teaching and learning. Educators assess and evaluate Mathematics teaching and learning using appropriate assessment tools and strategies.
4. Engage in ongoing professional development to enhance technological pedagogical content knowledge. Educators seek, identify, and use technology to enhance their knowledge, productivity, and professional practice.

The five levels of TPACK development were inspired by Rogers' five stages of Innovation-Decision Process Model (Rogers, 1995).

Niess, Suharwoto, Lee, and Sadri (2006) defined each level as follows:

1. Recognizing (Knowledge): Teachers at this level can use a specific digital technology and judge its capabilities with a particular subject topic, yet do not integrate the technology in the teaching and learning of Mathematics.

2. Accepting (Persuasion): Teachers at this level develop an attitude open to the integration of digital technology in their teaching but might not understand the potential role of technology in their teaching.

3. Adapting (Decision): Teachers at this level are capable, after an experience of deciding whether to adopt a specific digital technology in their teaching for a particular subject topic.

4. Exploring (Implementation): Teachers at this level start to actively integrate digital technologies in their teaching practices for a particular subject topic.

5. Advancing (Confirmation): Teachers at this level are capable of evaluating the effectiveness of integrating a specific digital technology in their teaching for a particular subject topic.

These TPACK levels provide helpful guidelines for Mathematics teachers, educators and researchers to plan, examine, improve, and evaluate the process of integrating digital technologies in teaching (see Figure 2). They also show the importance of interaction and engagement Mathematics teachers need to have all three domains of knowledge during the integration of digital technologies. In addition, teacher education and professional development programs should be designed, applied, and evaluated according to these TPACK standards and developmental levels.

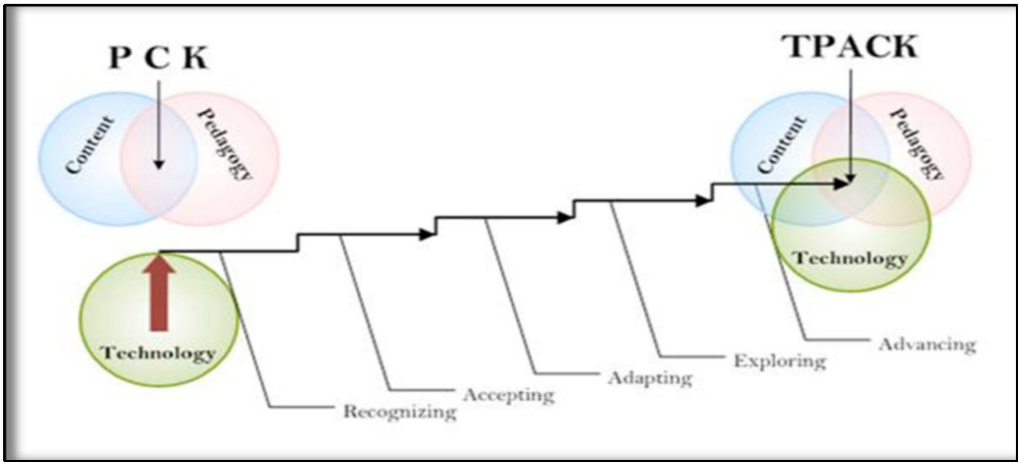

Figure 2: Five Level Model of TPACK Development
source: (Niess et al., 2009)

TPACK as a framework of thinking is wide enough to include three domains of knowledge yet narrow enough to be specific for certain topics, grade level, settings, and students' needs (Niess, 2012).

Those three domains of knowledge should not be taken by Mathematics teachers in isolation of one another but in interactions with each other and within their contexts (Mishra & Koehler, 2006). Therefore, Teacher Knowledge is described in the Comprehensive Framework for Teaching Mathematics (CFTK) with a large circle of interactions between six components (Individual, Environment, Orientation, Discernment, Subject Matter, and Pedagogy) (Ronau et al., 2010). These components of knowledge are engaged in three-dimensional structures, but they also can interact with every other component. The direct interaction between a teacher's knowledge of subject matter and pedagogy forms the first dimension, Field, and this construct produces pedagogical content knowledge but with wide interaction. The second dimension, Mode, consists of the interaction between orientations (knowledge of understanding and managing the impact of personality features on learning process) and Discernment (knowledge of understanding the impact of cognitive domain on learning process).

The interaction of the Mode dimension produces for teachers a dynamic knowledge base to be used for managing multiple internal influences on student learning. The Context dimension has two aspects: individual and environment, both of which represent external factors on the teaching and learning process. The individual component explains the knowledge of individual factors, such as gender, age, socioeconomic status (SES), etc. that influence the learning situation and that teachers must understand and manage in order to effectively teach. The environment aspect describes the knowledge of the environmental impact, such as school climate, classroom climate, and other classroom, school, and community factors, on learning (see Figure 3).The interactions between and among all three dimensions provide a wide picture of the knowledge of teacher with guidelines and explanation of how the National Council of Teachers of Mathematics (NCTM) teacher standards can be met and how digital technologies can be effectively be integrated in teaching Mathematics (Ronau& Rakes, 2012). Mathematics teachers are speculated to reach the advancing level of effective integration of digital technologies TPACK when they have active and effective interactions between all aspects in CFTK model (Ronau et al., 2010).

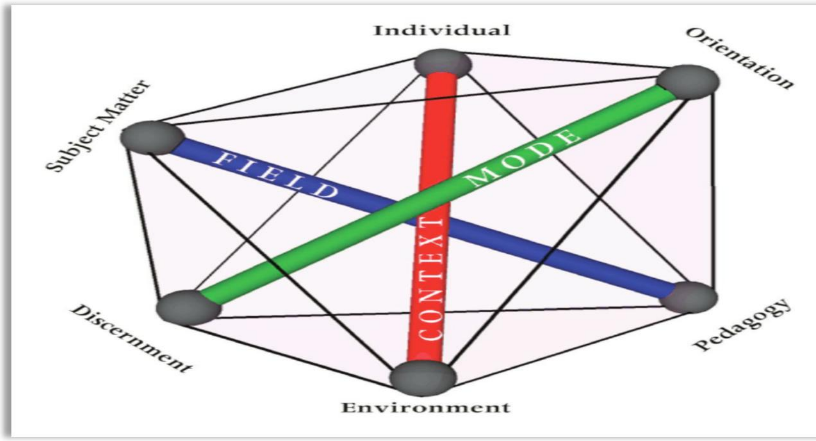

Figure 3: Comprehensive Framework for Teaching Mathematics(CFTK)
Source: (Ronau& Rakes, 2012)

Teachers' Knowledge and TPACK

Teaching as a complex act, requires many kinds of knowledge (Shulman, 1986). Shulman specified what body of knowledge is required for teaching. There are various types of knowledge that teachers need to possess in order to develop technological, pedagogical and content knowledge (TPACK). Thisknowledge explores the intersections of technological knowledge, pedagogical knowledge, and Mathematics content knowledge, emphasizing the integration of these knowledge domains for effective teaching and learning of Mathematics. It is of important note that the expected knowledge of a teacher forms a body of the subject matter that emanates the structure of the content. Mathematical knowledge for teaching encompasses abilities such as analyzing the students thinking, identifying the mathematical understanding a student does not have, and deciding how to best represent a mathematical idea so that it can be understood by the student. When a Mathematics teacher has mastery of the subject of

Mathematics, such a teacher will be able to simplify lessons for his students, thereby making the teaching learning process interesting and fulfilling. Guerrero (2010) believes that the current conceptualizations of teacher knowledge are beginning to reflect the knowledge and skills teachers need to successfully navigate increasingly technologically-rich mathematical classrooms with the addition of knowledge domains such as technological pedagogical and content knowledge (TPACK). He developed four central components of knowledge Mathematics teacher needs, which are;

- Technology specific management;
- Instructional and pedagogical knowledge;
- Increased Mathematics subject-matter knowledge; and
- Knowledge of when and how best to use technology to support Mathematics instruction.

Several areas of knowledge Mathematics teachers are required or recommended to master are Subject matter knowledge (SMK) or content knowledge (CK), Lesson structure knowledge (LSK) and Pedagogy knowledge (PK) are considered to be the foundation for effective teaching (Grossman, 1989, 1991; Shulman, 1986, 1987). According to Leinard and Smith (1985), subject matter knowledge consists of concepts, algorithmic operations, the connections among different algorithmic procedures, the subset of the number systems being drawn upon the understanding of classes of student's errors and curriculum presentation (p. 247). Adediwura and Bada (2007), stated the relationship between perceptions of teachers' knowledge, attitude, teaching skills as predictors of academic performance in Nigeria school, found the teachers' knowledge of SMK were significantly correlated to their effectiveness.

The lesson structure knowledge (LSK) includes planning and running a lesson smoothly and providing clear explanations to the materials covered.

Ball et al., (2008), identified the knowledge of Mathematics (CK) which is theorized to have three sub domains:

- Common Content Knowledge (CCK),
- Specialized Content Knowledge (SCK)
- Horizon Content Knowledge (HCK)

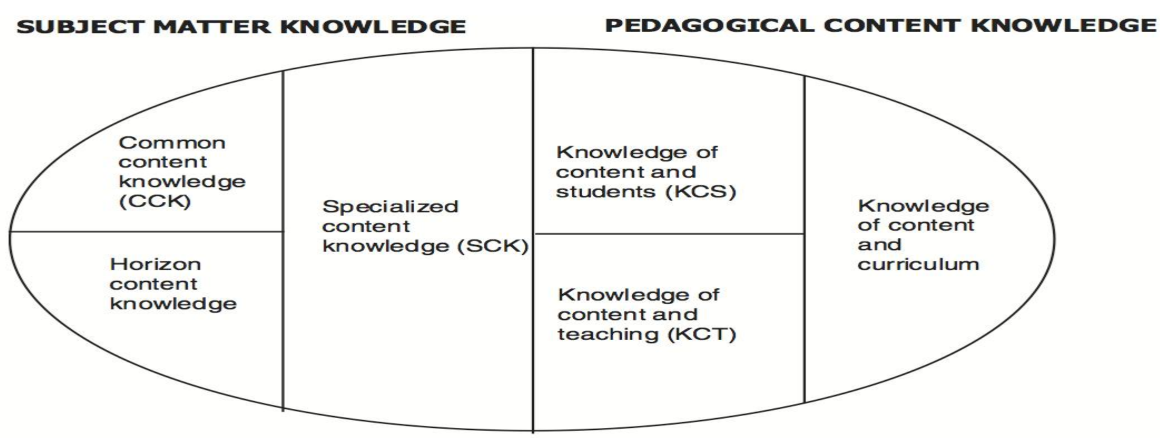

Figure 4: Mathematical Knowledge for Teaching
(Ball et al., 2008, p.403)

Ball, Thames, and Phelps (2008) defined the CCK as the general mathematical knowledge that is needed across all Mathematics-related professions or occupations, and they described the specialized content knowledge as the specific mathematical knowledge that is needed for teaching Mathematics. In addition, they explained the horizon content knowledge (curricular knowledge) as the broad range of mathematical content understanding that enables teachers to make connections between Mathematics topics in a curriculum.

Ma, (1999) described one of the elements of Mathematics knowledge for teaching as the “Profound Understanding of Fundamental Mathematics" (PUFM); as a knowledge that goes beyond conceptual understanding. This element refers to the capacity to see a connection between a given topic and other mathematical concepts and to be able to organize a set of related ideas. The pedagogy knowledge (PK) completes the picture of effective teaching practices; it is defined as the knowledge of methods and strategies of teaching and learning, including the ability to design, implement, and evaluate instructions that respond to students’ needs (Grossman, 1989, 1991; Shulman, 1986, 1987). Researchers speculated that effective teachers, in addition to skillfully navigate the intersection of content and pedagogy knowledge, advance student achievement via the unique understanding of subject matter that allows teachers to design, apply and evaluate the appropriate instructional strategies and representations for particular topics that meet students’ needs (Grossman, 1989, 1991; Shulman, 1986, 1987). This pedagogical content knowledge (PCK) includes; knowledge of content and students (KCS) and knowledge of content and teaching (KCT) (see Figure3). The knowledge of content and students (KCS) is the combined knowledge of mathematical content and students’ learning process matter, and the knowledge of content and teaching (KCT) is the combined knowledge of teaching and Mathematics content, which will assist teachers to understand the subject matter (Ball et al., 2008). Furthermore, the development of teachers’ PCK can be evaluated by Grossman’s (1989, 1991) four criteria:

1. The teacher has a comprehensive understanding of the purpose of teaching a certain subject matter.
2. The teacher has knowledge of instructional strategies and knows how to present particular topics.
3. The teacher has knowledge of students' understanding and misconceptions of the subject matter.
4. The teacher has knowledge of curriculum and curricular materials regarding the subject matter.

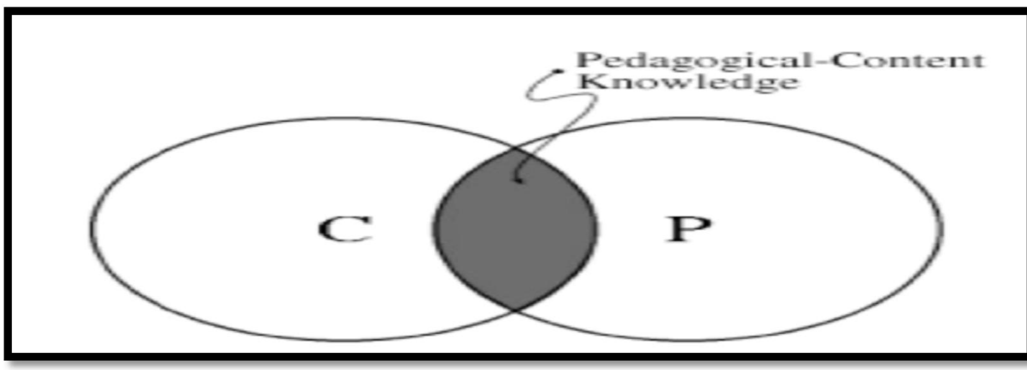

Figure 5: Shulman's Model of Pedagogical Content Knowledge (PCK)
(Mishra & Koehler, 2006, p.1022)

Digital Technology Knowledge and TPACK

The word technology applies equally to analog and digital as well as new and old technologies. Most traditional pedagogical technologies (such as pencil, microscope, chalkboard, pendulums) are characterized by specificity; they have not changed a great deal over time. These technologies achieve transparency of perception (Bruce and Hogan, 1998); they become commonplace and in most cases are not even considered to be technologies. The importance of teachers' digital technology knowledge in relation to TPACK, explores teachers' proficiency in using digital tools and their understanding of how these tools can enhance Mathematics instruction. There is need for teachers to continuously update their digital technology knowledge to stay current with the evolving educational landscape.Digital technologies (such as desktop publishers, computers, handheld devices and software applications) by contrast are protean; they are usable in many ways (Papert, 1980). On an academic level, it is easy to argue that a pencil and a software simulation are both technologies. By their very nature, digital Mathematics technologies (such as geometer's sketchpad, computer algebra system (CAS), Cabri or Tinkerplots, fathom, graphing calculator) are protean, unstable and opaque, presenting new challenges to Mathematics teachers who are struggling to use more technology in their teaching. Today, Technology in education encompasses a vast range of rapidly evolving digital technologies such as Desktop publisher, Notepad, Handheld Computers, Digital Cameras, the Internet, Learning Management System, Cloud Computing, the World Wide Web, Spreadsheets, multimedia, Simulations, email, Local Area Networking, Bluetooth, Streaming, DVDs; and applications such as word processors, Virtual Environment, Simulator, Digital libraries, Computer-Mediated Conferencing, videoconferencing, Emulator etc. Technology allows for the production of digital resources such as digital libraries, where students, teachers, and professionals can access study material and course materials from anywhere at any time. These digital technologies help students to explore in core mathematical concepts, to be interactive and help them to build and investigate mathematical models, objects, figures, diagrams, and graphs (Guerrero, 2010). Also, complicating teaching with technology is an understanding that technologies are neither neutral nor unbiased. Rather, technologies have their own properties, potentials, affordances and constraints that make them more suitable for certain tasks than others (Koehler & Mishra, 2008).

Technology as a broad concept means a lot of different things. In this study, it simply refers to all educational hardware and software educators can use to design, apply, and evaluate their instruction *such* as computers, laptops, iPods, handhelds, interactive whiteboards, software programs, etc. Knowledge of digital technology has been added as a required knowledge domain for integrating digital technologies in teaching.

Mathematics and technology as subject areas have a strong interrelationship, and digital technologies offer Mathematics learners dynamic representations for abstract mathematical concepts. Digital technologies not only support the conceptual and procedural understanding of Mathematics but also help connect these types of understanding. Furthermore, the learning process is facilitated and enhanced by digital technologies through leveraging Lower Order Thinking Skills (LOTS) and Higher Order Thinking Skills (HOTS) with new digital cognitive objectives that are presented and explained in the innovation of Bloom's Digital Taxonomy (see Figure 6) (Churches, 2009). Knowing how to use digital technologies qualifies Mathematics teachers to help their students accomplish these digital cognitive objectives.

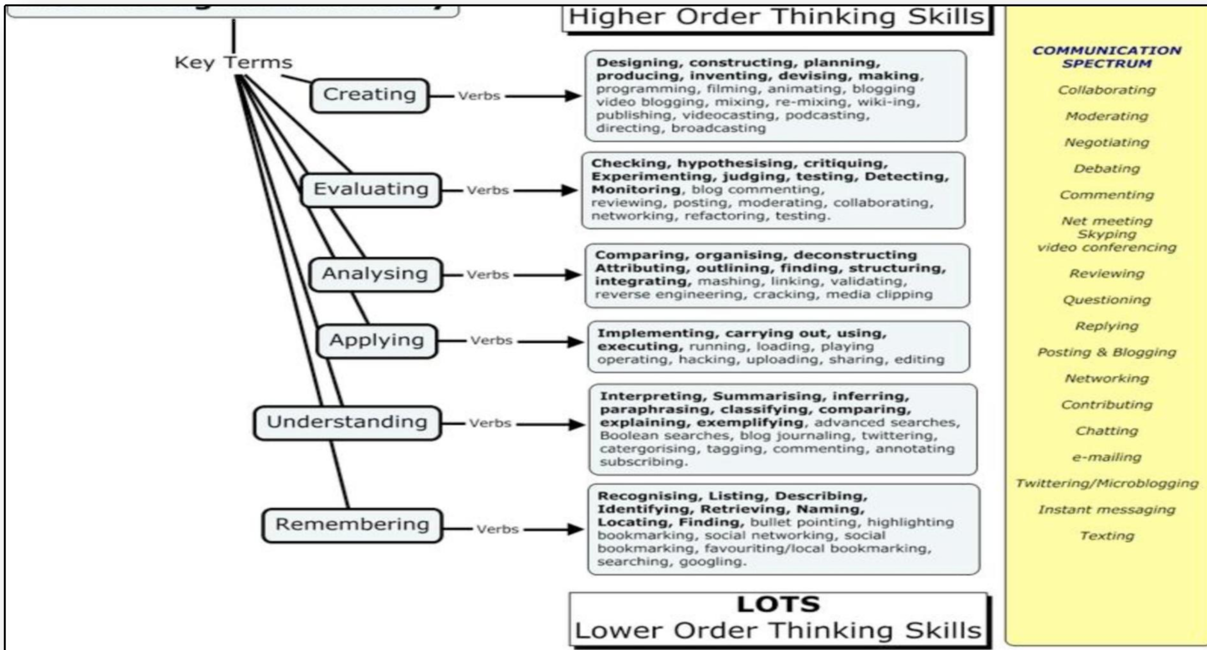

Figure 6: Bloom's Digital Taxonomy
(source:http://edorigami.wikispaces.com/Bloom's+Digital+Taxonomy)

In addition, the affordance of video podcasting technology (e.g., Khan Academy) can digitize teaching methods with new approaches such as "Flip Teaching" or "Flipping the Classroom" (J. W. Baker, 2000) that offer more genuine opportunities for "4Cs" (critical thinking, communication, creativity, and collaboration) (see Figure 7) (Partnership for 21st Century Skills, 2003) than do traditional teaching strategies. In fact, collaboration is even considered more important for the 21st century skills than it has been in the past; therefore, Churches (2009), included it as an additional element in his Bloom's Digital Taxonomy. This interaction between digital technologies and teaching methods indicates that teacher knowledge of digital technologies has to be more than just knowing how to operate them.

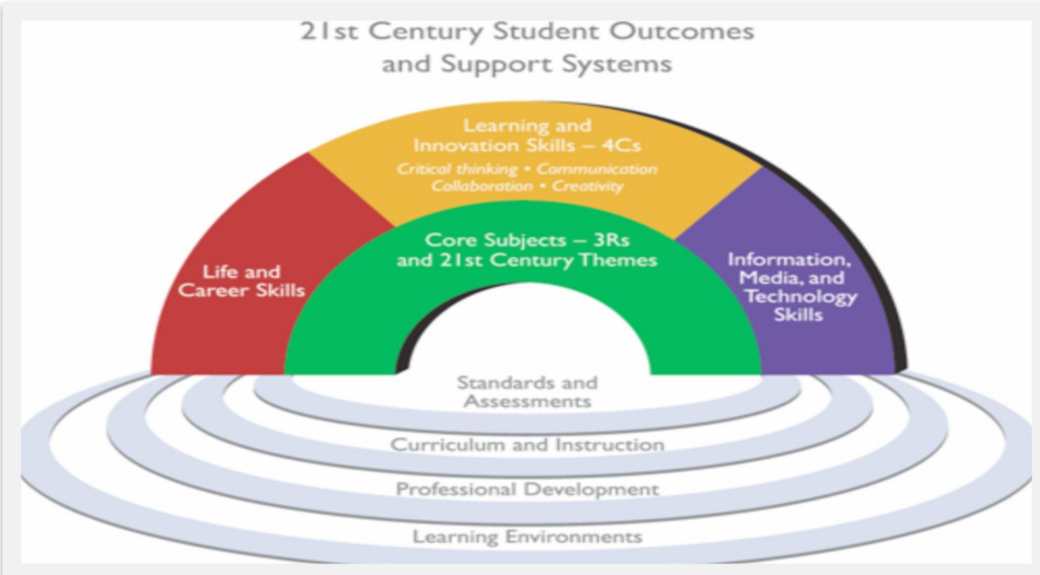

Figure 7: 21st Century Learning Skills
(Source: http://www.p21.org/overview)

In fact, the 21st Century Learning Skills idea, a framework of skills, Knowledge and expertise seen by educators as necessary for students to master to succeed in work and life, has received increased attention and criticism with the growing role of digital technologies in education (Boling & Beatty, 2012). Twenty-first century learning is defined in different and common ways, but Mishra and Kereluik (2011) synthesized ten major educational frameworks of the concept of digital technologies in three categories;

1. Foundational Knowledge, which includes Content, Information Literacy, and Cross-disciplinary Knowledge;
2. Meta Knowledge, which includes Problem Solving/Critical Thinking, Communication/Collaboration and Creativity; and

3. Humanistic Knowledge, which includes Life/Job Skills, Cultural Competence, and Ethical/Emotional Awareness.

However, Mishra and Kereluik (2011), argued that information literacy and cultural competence and awareness are the only skills that can be claimed to be 21st century learning skills. This change in learning objectives as a consequence for the growing role of digital technologies has increased the demand for Mathematics teachers to know how to teach with digital technologies.

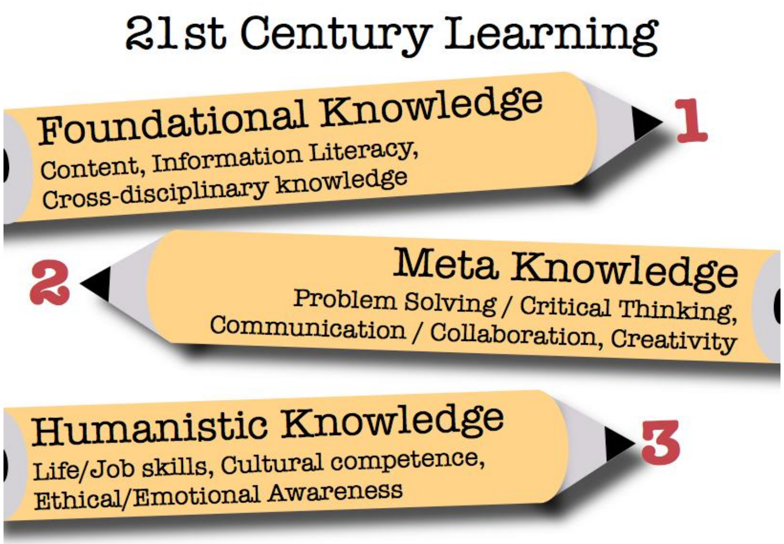

Figure 8: Three Categories of 21st Century Learning Skills
(source:http://punya.educ.msu.edu/presentations/site2011/SITE_2011_21st_Century.pdf)

Digitizing or technologizing learning and teaching are combined with digitized curriculum and environment, and this emphasizes once again the importance for teachers to have a comprehensive understanding of using digital technologies into teaching. Technology knowledge (TK) is the understanding of how to use technology in general, but teachers need to know how to teach effectively their Mathematics topic to their unique group of students with the integration of digital technologies (Mishra & Koehler, 2006; Niess, Kajder, & Lee, 2008), which is the technological pedagogical content knowledge (TPACK). This knowledge is the product of synthesizing the subject matter, pedagogy, and digital technologies domains of knowledge and then utilizing this synthesis to identify the affordances and constraints of digital technologies to teach a subject matter (see Figure 6) (J. Harris et al., 2009; Koehler & Mishra, 2009; Mishra & Koehler, 2006; Niess, 2005). It also can be defined as the further acquisition of technological content knowledge (TCK) or technological pedagogical knowledge (TPK). Technology content knowledge (TCK) is described as the understanding of the reciprocal relationship between technology and content in matters of affordances and constraints (J. Harris et al., 2009). Consequently, a Mathematics teacher would integrate the technology tool that best represents his or her own Mathematics topic. For example, some teaching methods (e.g., collaborative teaching and learning, Mathematics discourse) are enhanced by the integration of digital technologies like Wiki, Web Quest, Skype, and other communication and social networking programs; however, one of them can be better than the others based on its affordances and constraints toward the selected teaching strategy.

This simply illustrates the digital technology tool methods of teaching; in the instance of using Web Quest to teach content on a power point the six major components (the introduction, the task, the process, the resources, the evaluation and the conclusion) must be followed. This method of teaching gives students a task that allows them to use their imagination and problem solving skills and also increase student’s motivation by providing essential questions, real life resources with which to work, and opportunity to work in cooperative groups. Thus, when technology is integrated into mathematics lessons, students are expected to be more interested to the subjects they are studying and be a great benefit to teachers.

Mathematics Digital Technology and TPACK

Teaching aid as an integral component in an ideal classroom, serves as a tool or equipment used by a teacher, a facilitator or a tutor to aid learners to improve learning and instill skills, concepts, facts or ideas and relieve anxiety or boredom which presents lessons more effectively and efficiently in teaching. The Mathematics digital technology embraces all educational hardware and software educators can use to design, apply, and evaluate Mathematics instruction (such as geometer's sketchpad, computer algebra system (CAS), Cabri or Tinkerplots, fathom, graphing calculator) and present their teaching. For a Mathematics teacher to use digital teaching aid (technology), the teacher must bear in mind that the tool should be meaningful and purposeful, be accurate in every aspect, simple to use, be improvised as far as possible, be according to the mental level of the students and motivate them. The characteristics of teaching aid could be classified on Audio-aids (listening skill), Visual-aids (visual senses), Audio-Visual aids (both the listening and viewing faculties), Projected aids (picture/ projection screen) and Non-Projected aids (pictorial materials), (Sawyer, 1969).

Mathematics in general, is considered as a difficult core subject and it is important to incorporate various teaching strategies and methods in the classroom to ensure that students understand the concepts in the best way. Hence, Mathematics is a topic that cannot be learned by sheer memory. According to Sawyer (1969), Mathematics classes have had a traditional aura and the repetition of the use of textbook has been the major source of material that makes students lack understanding in learning Mathematics. Sawyer further stated that a student of Mathematics must minimize memorization and maximize reasoning to find the correct method for a problem. Through the use of digital technology memorization can be minimized and the student's imagination will be challenged. The teacher must decide how to best use technology (if at all) to address the needs of the students, the content, and instruction and then decide which technology best accomplishes all these goals. Mathematics digital technology teaching aids are as essential for Mathematics teachers to present lessons more efficient and effective in teaching Mathematics and lead reality to idea. Consideration in the selection and use of digital technology (teaching aids) to improve learning Mathematics should include; the level of conceptual difficulty and abstraction of the content; instructional time needed; complexity involved in the manipulation of the aid; desirability of each students having the aid; the possibility of using the aid to develop more than one mathematical concept.

Every individual has the tendency to forget. The intent for Mathematics teachers to use TPACK in the classroom is to enhance and increase students' understandings through investigations, gaining access to Mathematics that might not be explained verbally, minimize memorization and maximize reasoning to find the correct method for a problem. Mathematics digital technology teaching aids are usually 3Dmodels, Mathematics puzzles, charts, tables, videos, and likewise. The digital technology Mathematics teachers use for teaching are computers, laptops, iPods, handhelds, interactive whiteboards, Software application such as PowerPoint or prezi, Spreadsheet, Smartboard, Projectors, Desktop publishing software, Computer Algebra System (CAS), Graphing calculator, Cabri or tinkerplot/fathom, flipped classroom, Social media such as; whatsApp, YouTube, Word processing, Virtual Learning Environments (VLEs), Learning Management System (LMS), Television, Blogs, podcast, Dynamic software such as Mathalicious, Geometer's sketchpad, GeoGebra, Video clips, internet facilities, etc.

Difficulties in applying digital technologies and Mathematics content knowledge are related to the weakness of any Mathematics teacher's knowledge of what technology is available and how to use them when learning Mathematics. Mathematics teachers need to take considerable challenges in both Mathematics content and digital technologies teaching aids as well as the pedagogical knowledge. The use of digital technology teaching aids in the Mathematics classroom has primarily held of particular concern to Mathematics educators. By using digital technology teaching aids as a tool for learning, there is need for teachers to maximize the impact of digital technologies teaching aids in Mathematics education (Becta, 2003).

In the use of digital technology (teaching aids) in various areas of Mathematics, which can be in the form of videos, working models, presentations, Mathematics digital technologies teaching aids can be used advantageously in most areas of Mathematics. For examples;

Math Whiteboard is a collaborative tool designed specifically for Mathematics education. It allows the teacher, who shares a link to a collaborative board, to see the work of every student at one time. The teacher can import PDFs for students to work on and annotate, use the included graphing calculator, take advantage of the powerful Computer Algebra System that allows for calculations from arithmetic to calculus, and write or type Mathematics formulas and numbers. The site runs in any browser and so works on any device.

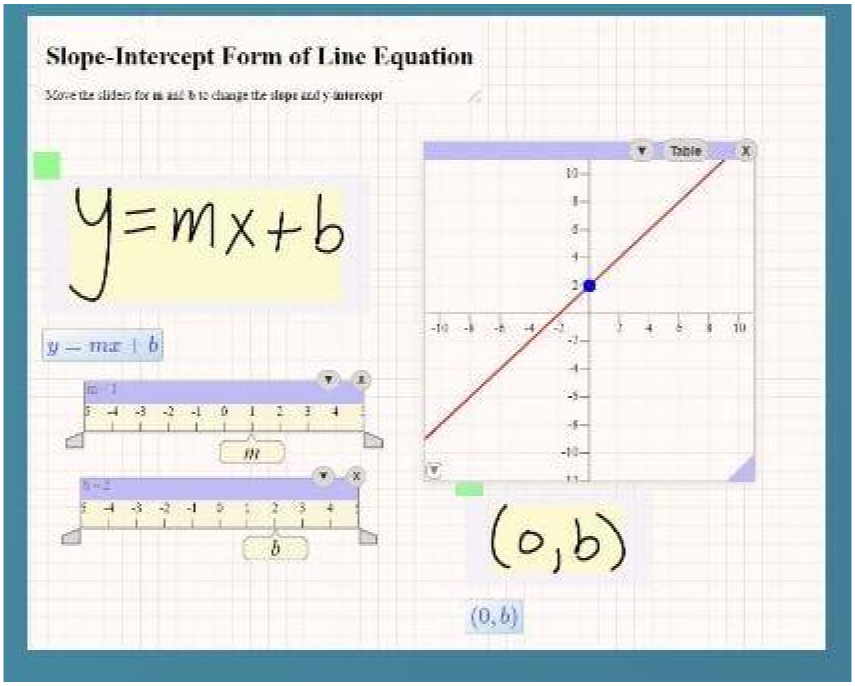

Figure 9: Math Whiteboard
Source: http://www.mathwhiteboard.com

Ge **Gebra**is an interactive geometry, algebra, statistics and calculus application, intended for learning and teaching Mathematics and Science from primary school to university level. GeoGebra is available on multiple platforms, with apps for desktops, tablets and web.

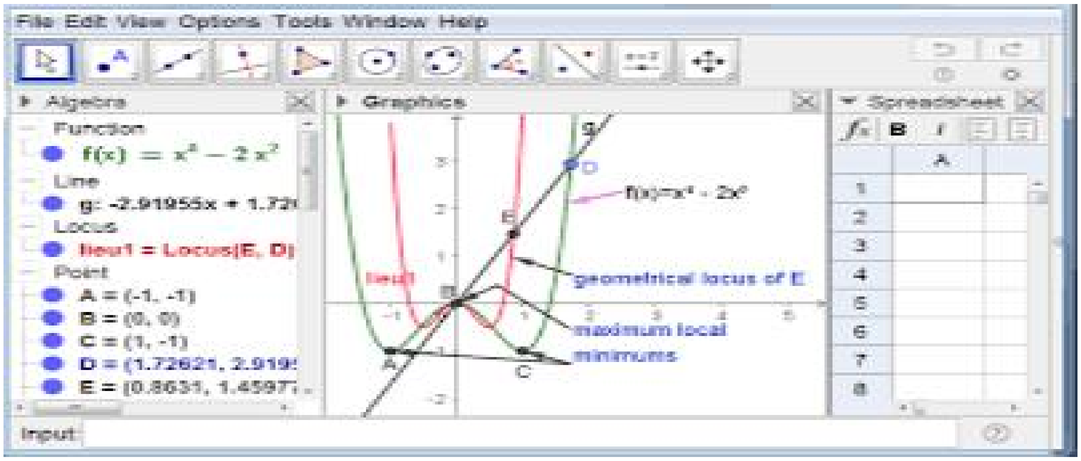

Figure 10: Main areas of GeoGebra software
Developer(s): Markus Hohenwarter et al

Photomathis a mobile computer algebra system with an augmented optical character recognition system designed for use with a smartphone's camera to scan and recognize mathematical equations; the app then displays step-by-step explanations onscreen.

Desmos is an advanced graphing calculator implemented as a web application and a mobile application written in JavaScript. It was founded by Eli Luberoff, Mathematics and physics double major from Yale University, and was launched as a startup at TechCrunch's Disrupt New York conference in 2011.

Learning Management System (LMS) is software that companies, schools, use to develop, deliver, and track training for their employees, clients, and partners. It is a software application for the administration, documentation, tracking, reporting, automation, and delivery of educational courses, training programs, materials or learning and development programs. LMS concept emerged directly from e-Learning and other applications can be imported into the class.

Virtual Learning Environments (VLEs) in educational technology is a web-based platform for the digital aspects of courses of study, usually within educational institutions.

They present resources, activities, and interactions within a course structure and provide for the different stages of assessment.

Graphing Calculator is a handheld computer that is capable of plotting graphs, solving simultaneous equations, quadratic equations like as $X^2+X = 20$ and performing other tasks with variables. It allows students, through explorations and applications, to develop a deeper understanding of mathematical concepts and use higher-level approaches to solve mathematical problems.

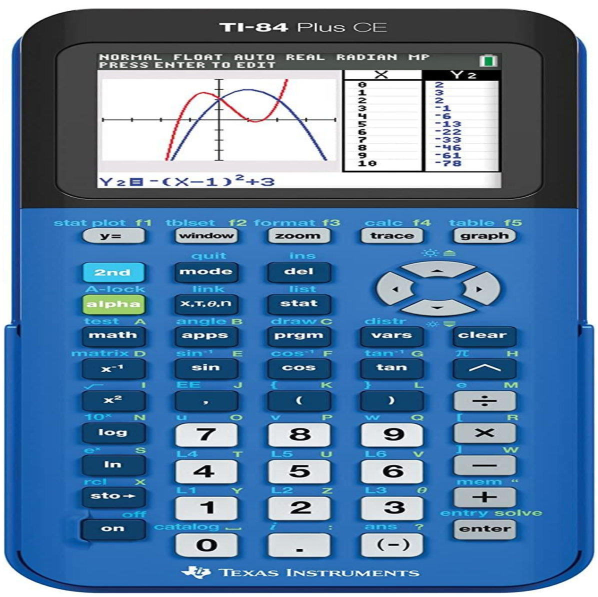

Figure 11: Graphing Calculator
Source http://www.graphingcalculor.com

Geometer's Sketchpad is a commercial interactive geometry software program for exploring Euclidean geometry, algebra, calculus, and other areas of Mathematics. It was created as part of the NSF-funded Visual Geometry Project led by Eugene Klotz and Doris Schattschneider from 1986 to 1991 at Swarthmore College.

Databases – the handling of data is a very important part of a Mathematics lesson. It involves analyzing information collected by the students themselves during a hands-on, practical activity. This can be done with real and relevant data making it an authentic learning experience.

Spreadsheets – these are designed to help work with numbers and formulas. They can be set up as a number of machines that can repeat calculation processes quickly and easily. They can be used to help solve problems where repeating calculations can help find the answer coupled with the use of CAS. Students can be introduced to spreadsheets through the functions they perform. It may be an idea to draw their attention to the formula determining the function and encourage them to experiment with modifying the formula. For instance, to find the volume of a cube, square, cuboid.

Interactive whiteboard (IWB), also known as interactive board or smart board, is a large interactive display board in the form factor of a whiteboard. Encourages Student engagement, Interactive whiteboards with the aid of digital projectors – the combination of these two with the addition of the computer itself will allow us to teach Mathematics using whole-class teaching methods. It can also be used to demonstrate to students various techniques that they need to use during the Mathematics lesson such as spreadsheet skills.

Programmable toys – robotic toys can be used as a catalyst for problem-solving from early childhood to primary education.

Desktop publishing software – this is a great idea for when investigating and designing objects on the screen. They are very useful for studying 2-dimensional objects as they allow creating simple shapes quickly and easily. Some have built-in functions that allow students to rotate and reflect these shapes once created.

Mathalicious - is a supplemental resource great for introduction to Mathematics topics. It creates standard-aligned and quality lessons that explore Mathematical topics through a real-world lens, from sports to shopping to the odds of finding life on other planets. These lessons put teachers and students in a position to have interesting conversations that foster a classroom culture of curiosity and rigorous mathematical thinking. Teacher involvement is necessary, so it is great for in-class work among partners, groups, or individuals rather than as homework. Straightforward lessons guide teachers step by step, but they are not "plug and play." Give lesson guides a thorough review, with attention to scripting, time requirements, and materials. Adjust the lesson for the teaching setting and ensure there is a working Internet connection for slideshows, as they cannot be downloaded.

Figure 12: Mathalicious
Source: http://www.mathalicious.com

Presentation Software (PowerPoint/prezi) - A PowerPoint presentation (PPT) in Mathematics classrooms is one way in which Mathematics teachers can integrate technology into instructional delivery. PPT can be used to reach a lot of audiences by providing slides of concepts using a personal computer and a Liquid Crystal Display (LCD) projecting PowerPoint presentations, into teaching Mathematics provides students in both endowed and less endowed schools with new learning experiences in learning geometry concepts. Some of the experiences derived from using this approach to teaching geometry included: connecting students' immediate environment to the classroom; providing students with real life images of concepts; giving opportunities for students to create their own knowledge and creating opportunities for students to collaborate with each other while attempting the activities on the group computers.

Shanlax,it solves Mathematics problems on different topics that include vectors, calculus, linear programming, algebra, complex numbers, statistics, and more.

SymPy is a Python archive for symbolic Mathematics. It aims to become a full-featured computer algebra system (CAS) while keeping the code as simple as possible to be comprehensible and easily extensible.

YouTube, is a video sharing service where users can watch, like, share, comment and upload their own videos. The video service can be accessed on PCs, laptops, tablets and via mobile phones. It is a visual aid that allows students to physically see what is being taught and helps them understand the course work better. It allows students and teachers to access a broad range of educational video One of the biggest benefits of YouTube for your business is that it allows you to share your content in real times.

Kahoot! Is a game-based learning platform that brings engagement and fun to learners every year at school, at work, and at home.Kahoot! Provides learning through creation of educational games and new understanding through playing them. It is an incredibly engaging student-friendly teaching and learning tool with a mobile and tablet friendly, game-based pedagogy. With a simple and fast drag and drop interface, teachers and students can create and manage 'Kahoot!' in the form of quizzes, surveys or polls. It can be used in many different ways; it encourages learners to look up, creating a trusted learning space which generates discussion, collaboration and motivation around educational content. The game is designed to bring emotion into the learning experience - through game mechanics, music and visual design, creating memorable moments that help learners unlock their potential. Other technology tools such as radio, TV, Internet, computer, laptop, tablets, and many other hardware and software applications can be appropriated in Mathematics teaching-learning process.

In conclusion, the use of Mathematics digital technology teaching aids in education helps in developing critical and scientific thinking among the students and the teachers. It motivates the learner to participate in learning activities at any time and from anywhere. It helps in exchange and shares ideas among teachers for professional growth and improves access and the quality of teacher training. Teachers therefore require 'Technological pedagogical content knowledge' ('TPACK') where the 'content' is the target.D'Ambrosio and Borba (2010) consider trends of development in the use of digital technology in Mathematics education, as a response to problems within the region of inquiry in Mathematics education. It seems that all phases of attempts to introduce digital technology teaching aids have faced problems related to displacing embedded rules of time and space that we were not aware of when we experienced the "paper-and-pencil" classroom. Hence, the use of digital technology in integrating teaching and learning in the classroom is the potential means to drive the Mathematics contents to enhance and arouse learners' interest in learning Mathematics.

Teachers Gender and TPACK

Technology is one of the fundamental way in which gender is expressed in any society. There is a gender digital divide, females are more disadvantaged when it comes to digital adoption, have lower levels of access to and use of digital technology than males and often they are not benefitting from digital technology in the same way as males. Men are more likely to huddle around the computer screen, practice hacking skills, while women develop new communication codes using emotions (Lægran, 2003; Miller, 2004). In the contemporary world, technology is firmly coded for men, having a natural affinity with technology, whereas women have fear or dislike for it. Men actively engage with machines – making, using, tinkering with, and loving them. Women may have to use machines, in the workplace or in the home, but they neither love nor seek to understand them – they are considered passive beneficiaries of the inventive flame. The design of new technologies in the educational sector has posed the problem of technical skills to the effective use of digital technologies in the classroom, especially to female gender. There is a deep gender imbalance in technology techniques in which men can easily adapt.

The knowledge of effective use of technology is crucial, particularly where access to the technology is equated to mathematical development.Rakow (1986), in her classic studies on gender and ICTs, however, points out that technology should not be examined based on the differences in the behavior of men or women towards a technology, but instead to look for the ways in which the technology is used to construct us as women and men through the social practices that put it to use. Rakow further argues that more attention needs to be paid to how communication technologies alter, aid, or construct women's opportunities for interacting with each other and with the wider public domain.

Hence, it is important to note that the difference between male and female Mathematics teachers' technological knowledge in integrating digital technology in teaching Mathematics does not necessarily mean that one gender is inherently better or worse than the other in this area. The difference may be due to a variety of factors, such as differences in educational backgrounds, experiences, and access to technology. It is also important to consider the potential implications of this gender digital divide on teaching and learning, and to work towards promoting equal opportunities for both male and female teachers to develop their technological knowledge and skills.

School Type, Location and TPACK

The advancement of education is greatly linked with the evolution of computing technologies. Technology has really changed the face of how everything is being done in schools. It has become the pen and paper of our time and the lens through which we experience much of our world. Using digital technology in the school sector is all about to deliver a new form of teaching and learning process which has become critical to the classroom of the future. John Dewey's quote, "If we teach today as we taught yesterday, we rob our children of tomorrow. The 21st Century Learning Skills is necessary for students to master to succeed in work and life. There are major challenges in Nigeria schools (both private and public school system).

In Nigeria, from nursery school to university, a child can either attend public or private school. Public schools in this context are schools owned by the government of

Nigeria. Public schools are directly administered and controlled by the Ministry of Education and maintained by its minister. Private schools on the other hand are owned by either individuals or private bodies or groups. In broad terms, private schools do not depend on the Government's Education administration and funding.

A private school is autonomous and generates its own funding through various sources like student tuition, private grants and endowments. A public school is government funded and all students attend free of cost. In Nigeria, there are currently over 80,000 private secondary schools. This is further sub-divided into two. The first which caters to the rich and middle-class – known as the high-cost private schools and the second, which caters to the lower-income earners – known as the low-cost private schools (Fela Bank-Olemoh, The Nation, April 26, 2022).

The low-cost private schools are majorly characterized by poor teacher quality, lack of educational technology inclusion in the curriculum and the academic environment in which some of these facilities are housed – all of which are challenges we must overcome in order to improve the quality of education within these schools. A new report from Cambridge International, based on an online survey of nearly 20,000 teachers and students (ages 12–19) from 100 countries, found that the use of technology in schools worldwide have continued to grow. 48% of students reported that they use a desktop computer in the classroom, 42% use smart phones, 33% use interactive whiteboards and 20% use tablets. Yet, the numbers remain high for more traditional modes as well, such as pen and paper (90%) and whiteboards (73%).

In Finland, the new school Helsinki virtual reality experience launched in 2016 and later featured in Singapore in 2017 presented the new curriculum for elementary and upper comprehensive schools in Finland. The experience introduced a mixed vitality tool that integrates 360° video in a 3D environment and turns static virtual reality into a vivid augmented virtual reality experience. In contrast, findings have shown that primary and secondary schools in Nigeria are generally lagging in the level of application of educational technology in teaching and learning experience. Educational technology facilities are lacking in schools, the capacity for using educational technology by both teachers and students is also very low. Despite the perceived benefits in the use of educational technology in schools, there are a lot of factors inhibiting the successful application of educational technology in primary and secondary schools.

The use of technology which has become an integral and ever-growing part of the education system today, particularly in urban schools, has increased attention and criticism with the growing role of digital technologies in education and has caused alarm both in the urban and rural location. It is believed that teachers in the urban schools are facing challenges on how to utilize digital technologies in integrating the teaching and learning Mathematic in the classroom. The school location in rural areas faces more critical challenges in Nigeria due to so many reasons.

The primary purpose of employing education technology in schools is to enhance students' overall learning experience. A school could be located in urban or rural area. Schools in rural areas are generally inferior to that of urban schools due to poor physical infrastructure, inadequate educational facilities, technical skills, digital technology knowledge, etc. The expected learner's ability to study and perform well in Nigeria school determines the location of the school. Mkpugbe (1998), indicated that the different aspect of school location effects the students' performance and achievement.

She further stated that the individual student’s academy behavior is affected not only by the motivating forces or his home, scholastic ability and academy values but also by the social pressure applied by the participant in the school setting.

It is obvious that most students in urban schools perform better than those in rural areas. Students that lives in urban area will get high performance excel opportunities provided by their location. Urban students have greater access to many resources such as technology and therefore have opportunities that are not easily accessible to rural students.

Therefore, to avoid being left behind as a nation, Nigeria schools must consciously integrate digital technology into all of our schools (be it private, public, urban or rural) by using TPACK model that bridges the technology gap and democratizes it at all levels.

Teachers Experience and TPACK

Teaching experience means the number of years or partial years of experience to the nearest tenth of a year. Teaching experience is the culmination of skills, exposure or training acquired over time that enables one to perform an existing job better or prepare one for a teaching position. Teachers are important providers of educational sustainability. Teachers’ ability to adapt themselves to rapidly developing technologies applicable to learning environments is connected with technology integration. Teachers help students in developing their minds and values, students learn the basic manners, discipline, new concepts, etc. from teachers. The only indicator that is systematically linked to students’ achievement in schools is teacher experience and that such experience positively influences students’ achievement in Mathematics. Teachers gain good knowledge and teaching experience as they teach different students with different mindsets and levels of understanding. Then on the basis of their understanding and experience, they also see good career growth as well as personal growth. Teachers gain good teaching experience when the teachers treat students with patience and kindness. Teachers should have a thorough knowledge of their subject as well as technology to integrate teaching and learning in the classroom and the use of TPACK will also allow teachers to accommodate every learning styles. However, Bos (2011) conducted a mixed method study to investigate the influence of TPACK lesson planning development on Mathematics teachers' TPACK growth and found that Mathematics-teaching experience can support the TPACK development. Experienced Mathematics teachers can create interest for the subject if they use digital technology to present their knowledge in the best possible way or decrease interest if they do not know how to present their knowledge.

A teacher's years of teaching experience determines ten or more years positively influence on students achievement and with years of experience, teachers develop a better understanding of classroom management, which enables them to anticipate issues and to adapt their classroom management practices accordingly. Regarding the research carried out by (OECD, 2009) showed the relation between teaching self-efficacy and experience, the research showed a positive correlation indicating that teachers tend to become more confident over their career. Polly (2011) found in his case study that experienced mathematics teachers had higher confidence in both their content knowledge (CK) and pedagogical content knowledge (PCK) when compared to other knowledge domains. Huberman (1992), calculated what he called a "Coefficient of Mastery" including 18 facets of teaching confidence, such as “dealing effectively with discipline problems” and “motivating uninterested students.” It appears that there is a considerable mastery progression between the first phase in a teaching career (5-10 years of experience) and the last phase (30-39 years of experience). Moreover, with increasing years of experience, the facets rated as “mastered to a large degree” tend to slip into the category of “fully mastered.” Such conclusions have been corroborated by Tschannen-Moran and Woolfolk Hoy (2007), who found that more experienced teachers have a greater sense of efficacy for classroom management than the novice teachers and by Klassen and Chiu (2010), who showed that self-efficacy in classroom management increased from the onset of the career (though a decline was found after 23 years of experience). In support of this, a study conducted by Rockoff (2004), on the impact of individual social studies teachers on student’s achievement in California, found that teaching experience of ten or more years positively influenced student’s achievement in civic activity, social learning andbehaviour. Along the line, he concluded that experienced teachers are more effective in elementary and middle schoolsocial studies. According to Zuzovsky (2008), there is a positive relationship between teacher’s effectiveness and their years of experience on students’ achievement. Inexperienced teachers are less effective than the experienced teachers. Hence, teachers should enhance the teaching and learning of Mathematics through the means of digital technology teaching aids in order to explain the content in simplicity. Teachers that have excellent teaching skills can be great in their teaching career which contributes to positive achievement to students learning.

Teachers Qualification and TPACK

Teacher qualification is the most important factor influencing student's achievement and that of unqualified teachers affect the learning/achievement of the students they teach. Besides, teacher qualification such as having NCE., B.Sc.[Ed.] or an M.Sc.[Ed.] in Mathematics can be enhanced by teacher participation in In-service training program which also can improve teacher's classroom interaction pattern and improve student's achievement level in Mathematics. A qualified Mathematics and technology teacher has the ability to instruct students on crucial mathematical and technological skills that are essential to the learning process in Mathematics classroom.

The different strategies, style and methods employed by qualified teacher helps to improve student's learning and achievements in Mathematics. The pedagogy (methods, styles) and strategies a teacher employ in teaching Mathematics, defines his/herbehaviour and aids students' achievement in Mathematics. The teacher is the core implementer of educational programmes and constitutes critical resources in the provision of quality education to the citizenry. In a study conducted by the Education sector analysis (2005) on selected secondary school teachers in Nigeria by qualification and genders revealed that the bulk of secondary school teachers, (N=69,787) are with first or higher degree where, 43, 073 were male and 26,714 were female revealed that the unqualified teachers proportion affected the quality of teaching and learning delivery of social studies in the sampled schools. Also,Ehrenberg, Brewer and Ferguson (2000) asserted that students learn more from teachers with strong academic skills. According to these researchers, teacher's assignments depend on their qualification on the subject(s). Students learn more from teachers who hold Bachelors or Master's degree in the subjects they teach and from their experience. Kanno and Onyeachia (2009) assumed that teachers teaching behaviour or style have a lot to do with the students' performance if practiced systematically. In line with this, Ugwu (2005) and Adiele (2005) opined that such teaching behaviour as set induction, communication and time management enables teachers and students to exchange ideas with their peers from outside the classroom especially if technological facilities like internet are used. This result corresponds with the views of Rice (2003), who stated that teacher qualification is the most important factor influencing students' achievement.Igwegui(2002), in his view opined that when teachers are well qualified, get training in professional programme, attend seminars, then, the students learning abilities and achievement will improve, and further concluded that there is a relationship between teachers academic qualification and students achievement in the subject matter.Esu et al (2009) also agreed that for effective curriculum implementation, teachers mastery of the subject matter, teacher effectiveness in classroom communication skills and teachers ability to introduce various teaching approaches must be given a priority thought and consideration which shows that teachers teaching behaviour as a characteristics has a vital role to play in effective Mathematics curriculum implementation and student academic achievement in Mathematics.

Teachers' Preparedness and Components of Mathematical TPACK

Generally, the preparedness for teaching profession should be provided with training. Teacher's preparedness is basically the specific education program which helps teachers in developing quality and effective strategies in the teaching and learning process. It is necessary for teachers to acquire the basic knowledge in classroom management skills. Teachers are expected to develop their basic skills to be competence and be successful in their subject areas such as Mathematics. To accomplish this, Mathematics teachers should have a good understanding of TPACK. Teachers' Preparedness is one of the most important factors that a teacher should have to be able to integrate technology in teaching Mathematics in the classroom. For teachers, technology is essential to develop their knowledge both in their areas of expertise (content), in pedagogy and general culture.

According to Guerrero (2010), the knowledge needed to effectively integrate technology as part of Mathematics instruction includes technologyspecificmanagement, instructional, and pedagogical knowledge; increased Mathematics subject-matter knowledge; and knowledge of when and how best to use technology to support Mathematics instruction. TPACK in Mathematics goes beyond knowledge of learning a technology tool and its operation. To operate on technology to improve Mathematics teaching and learning, the basic operational skills in the knowledge of learning and teaching Mathematics embodies the aspects of technology most relevant to its capacity for use in instruction. Also, aids teachers to provide multimedia learning, meet students' needs, gain attention, make abstract contexts more concrete and save time for their teaching. Technology has the potential to change not only what teachers teach but how teachers teach it. Guerrero further argued that TPACK in Mathematics can be characterized by four central components:

- The first component, a teacher's conception and use of technology, relates technology to pedagogical content knowledge by focusing on how the teacher can use technology to make the subject matter more comprehensible and accessible to students.

- The second and third components of TPACK which are Technology-Based Classroom Management and Depth &Breadth ofContent include elements associated with general pedagogical knowledge. These components encompass the general principles of instruction, organization, and classroom management specific to the application of technology in the Mathematics classroom.
- The final component of TPACK, Technology-Based Mathematics Instruction relies on a teachers' subject-matter knowledge and deals with the increased responsibility teachers have to understand their content areas with both breadth and depth as a result of using technology as part of their instruction.

It should be noted that the number of TPACK components should not be thought of as a one-to-one correspondence with the sub domains of knowledge (i.e., PCK, TCK, and TPK) presented in the TPACK model. Rather, it is the result of careful analysis of seminal factors involved in technology-related pedagogy and subject matter specific to the content area under discussion. Consequently, this mathematical TPACK model posits one component related to each of PCK andTCK and two components related to TPK.This is not to say that TPK carries a greater weight or more importance in the development of TPACK in Mathematics, but the issues related to instruction and managementwarranted their own consideration. Other content areas or conceptualizations of TPACK may include greater or fewer components, depending on the roles and interactions of technology, content, and pedagogy in the development of TPACK.As mentioned previously, the way that technology influences both pedagogy and content in

Mathematics is vastly different than the ways it may influence other contentareas, so core components of TPACKmay differ between Mathematics and other content areas.

Summary of Review of Related Literature

The theoretical framework of this study is based on the constructivism theory, is of the belief that learning occurs as learners are actively involved in a process of meaning and knowledge construction. In the constructivist idea, the students are urged to be actively involved in their own process of learning. The teacher functions more as a facilitator who coaches, mediates, prompts and helps students develop and assess their understanding and also emphasizes on collaboration among the students.

Research has revealed that students find it difficult to learn Mathematics effectively as they lack the knowledge of the content and clear understanding of mathematical concepts or ideas, as a result of this study, Mathematics teachers can aid students to learn best through the use of digital technologies. This literature reviewed has identified ways to equip Mathematics teachers with the knowledge, experiences and skills needed to achieve higher quality technology integration in teaching Mathematics; builds the teacher's ability to integrate technological knowledge in classroom teaching into instruction in effective and authentic ways which has a positive impact on the achievement and improvement on students learning Mathematics; provides students the technology type of environments that will allow them to build mathematical proficiencies in such a way that bridge the gap between concrete and abstract, also allow students through explorations and applications to develop deeper understanding of mathematical concepts and use higher-level approaches to solve mathematical problems. Nevertheless, the TPACK will help Mathematics teachers to understand what they know, what students need to know, what they teach and how they teach it and then challenging and supporting them to learn it well.

Empirical studies were reviewed under the following variables; TPACK and Mathematics, teachers knowledge and TPACK, digital technology knowledge, Mathematics digital technology teaching aids and TPACK, teachers gender and TPACK, school type, location and TPACK, teachers experienced and TPACK, teachers qualification and TPACK, and components of Mathematical TPACK. Based on the researcher's initial review of related literature, it was found out that for a successful Mathematics teacher to effectively apply technology in teaching Mathematics in the classroom, the teacher should have a good understanding of TPACK. However, there seem to be limited studies addressing this problem of research.

Therefore, this study tends to cover up the gap by investigating teachers' preparedness on integrating digital technology in Mathematics teaching in Edo South Senatorial District. The results of the study are expected to assist Mathematics teachers to integrate technology in their teaching and also assist in understanding of technologies and pedagogical content knowledge interact with one another to produce effective teaching with technology which has numerous advantages in students' learning Mathematics.

CHAPTER THREE

METHODOLOGY

This chapter provides an overview of the research methodology, procedures, and design used in the study. This includes:

- Design of the Study
- Population of the Study
- Sample and Sampling Techniques
- Instrument for Data Collection
- Validity of Instrument
- Reliability of Instrument
- Administration of Instrument
- Method of Data Analysis

Design of the Study

This study used a correlational survey research design. This was employed to investigate the relationship between the independent and the dependent variables. The independent variables were school location, school type, gender, teacher's qualification and teacher's year of experience. While the dependent variables were scores for TC, CK, PK, TCK, PCK, TPK, TPACK and responses from technologies available to integrate digital technology in teaching Mathematics.

Population of the Study

The population for the study consisted of 179 public secondary school Mathematics teachers and 780 private secondary school Mathematics teachers, which gave a total number of 959 secondary school Mathematics teachers in Edo South Senatorial District in Edo State.

Table 3: Number of Public and Private Secondary School Mathematics Teachers in Edo South Senatorial District

		Total No. of Secondary School Mathematics Teachers		
S/N	**LGA**	**Public**	**Private**	**Total**
1	Oredo	25	136	161
2	Egor	20	201	221
3	Ikpoba-Okha	38	324	362
4	Ovia N/E	27	30	57
5	Ovia S/W	20	26	46
6	Orhionmwon	28	13	41
7	Uhunmwonde	21	50	71
Total		**179**	**780**	**959**

Source: Ministry of Education from the Department of Policy, Planning, Research & Statistics Edo State, 2022.

Sample and Sampling Techniques

A simple random sampling technique was utilized to collect information from in-service public and private secondary school Mathematics teachers which were drawn from the population. A sample of thirty-five (35) public schools and seventy (70) private schools (105 schools) were used for the study. The schools in Edo South senatorial district is stratified into seven Local Government Areas; Oredo, Egor, Ikpoba-okha, Orhionmwon, Uhunmwonde, Ovia South West and Ovia North East. Two (2) Mathematics teachers from each public school and two (2) Mathematics teachers from each private school which makes seventy (70) total number of public secondary schools Mathematics teachers and one hundred and forty (140) total number of private secondary school

Mathematics teachers. A sample size of 210 secondary school Mathematics teacherswas used in this study.

Table 4: Sampled Public and Private Secondary School Mathematics teachers in Edo South Senatorial District, Edo State

S/N	LGA	No. of Sec. Sch. Public	No. of Sec. Sch. Private	No. of Teachers per Sch. Public	No. of Teachers per Sch. Private	Total No. of Sec. Sch. Math Teachers Public	Total No. of Sec. Sch. Math Teachers Private	Total No. of Pub/Pri Math Teachers
1	Oredo	7	10	2	2	14	20	34
2	Egor	3	10	2	2	6	20	26
3	Ikpoba-Okha	7	10	2	2	14	20	34
4	Ovia N/E	3	10	2	2	6	20	26
5	Ovia S/W	5	10	2	2	10	20	30
6	Orhionmwon	5	10	2	2	10	20	30
7	Uhunmwonde	5	10	2	2	10	20	30
	Total	**35**	**70**			**70**	**140**	**210**

Instrument for Data Collection

The instrument used for this study was a 70 item researcher self-structured questionnaire tagged “Mathematics Teachers’ Questionnaire Instrument” (MTQI). The instrument has three parts. The first part elicits participants’ demographic information from one to six (1 – 6). The second part included 22 items to measure the digital technology teaching aids that are available to aid the preparedness of Mathematics teachers in integrating digital technology in teaching Mathematics. The third part measures TPACK knowledge on TK, CK, PK, TCK PCK, TPK, TPACK and level of teacher’s preparedness with 42 items (five items from each except for the level of teacher’s preparedness, seven items), , and all used a five-point Likert-type scale: (5) strongly agree; (4) agree;(3)strongly disagree; (2) disagree and (1) neither agree or disagree.

Validity of Instrument

The instrument was subjected to content validity by the researcher's supervisor and two other lecturers from Department of Curriculum and Instructional Technology (C.I.T.), University of Benin. Their inputs were used to rework the instrument and the project supervisor made the necessary corrections, modification and later considered the achievement test valid before they were administered.

Reliability of Instrument

In order to determine the reliability of the instrument, the questionnaire instruments were administered to twenty (20) Mathematics teachers from schools in the population but are not involved in the study. Therefore the Cronbach Alpha reliability statistics was used to obtain coefficient of 0.71.

Administration of Instrument

The researcher administered the questionnaire instruments to Mathematics teachers which were delivered to each school, the researcher was assisted personally to distribute and collect the completed forms from the teachers after two (2) weeks of administration. The school teachers' cooperation were solicited to aid the process. Two hundred and ten (210)questionnaire forms were administered to Mathematics teachers and 100% retrieval rate were obtained.

Method of Data Analysis

Using quantitative data, the frequency counts and percentage, descriptive statistics (mean and standard deviation), independent t-test, Pearson correlation coefficient, and multiple regression were employed for data analysis to investigate the relationship between the independent and the dependent variables. A scale of 3.0 (the average of the scale)was set as the decision marker. When the mean of the responses to an item is greater than or equal to 3.0 the item is average and vice visa. Hypotheseswere tested at the 0.05 level of significance.

CHAPTER FOUR

PRESENTATION OF RESULTS AND DISCUSSION OF FINDINGS

This study aimed at investigating Teachers' Preparedness in Integrating Digital Technology in Mathematics Teaching. Thus, the results and discussion of findings are on the basis of research questions and hypotheses.

Presentation of Results

Research Question One

RQ 1: What digital technologies are available to aid the preparedness of Mathematics teachers in teaching Mathematics?

Table 5: Teachers' Responses on the Digital Technologies Available to Aid the Preparedness in Teaching Mathematics(N = 210)

S/N	Digital Technologies	Responses Freq. of Yes	Percent (%)	Freq. of No	Percent (%)
1.	Software application such as PowerPoint or prezi	158	75	52	25
2.	Geometer's sketchpad	35	17	175	83
3.	Geogebra	35	17	175	83
4.	Database	88	42	122	58
5.	Spreadsheet	122	58	88	42
6.	Smartboard	52	25	158	75
7.	Interactive whiteboard/Projectors	122	58	88	42
8.	Desktop Publishing Software	52	25	158	75
9.	Computer Algebra System (CAS)	52	25	158	75
10.	Graphing calculator	52	25	158	75
11.	Cabri or Tinkerplot/Fathom	17	8	193	92
12.	Social Media such as; whatsApp	158	75	52	25
13.	YouTube	105	50	105	50
14.	Word Processing	69	33	141	67
15.	Learning Management System (LMS)	69	33	141	67
16.	Virtual Learning Environments (VLEs)	88	42	122	58
17.	Programmable Toys	35	17	175	83
18.	Television (TV)	105	50	105	50
19.	Blogs or Podcast	69	33	141	67
20.	Dynamic software such as: Mathalicious, Sympy, Shanlax	35	17	175	83
21.	Video clips	105	50	105	50
22.	Internet facilities	141	67	69	33

SOURCE: Field Work, 2023

Research question one sought to examine the technologies available to aid the preparedness of Mathematics teachers in teaching Mathematics. The data analyzed in Table 5 revealed that Social Media (such as WhatsApp) and Software applications (such as PowerPoint or Prezi) are widely recognized by 75% of respondents as available technologies to aid in teaching Mathematics. Similarly, 67% of respondents agreed that Internet facilities are available to support Mathematics teachers in their preparedness to teach Mathematics. Other technologies that were perceived to be available to aid the preparedness of Mathematics teachers included Spreadsheet and Interactive Whiteboard/Projectors, which were agreed upon by 58% of respondents. YouTube, Television (TV), and Video clips were also identified by 50% of respondents as available technologies to aid in the teaching of Mathematics. However, there were some digital technologies that had less than 50% agreement among respondents, indicating lower awareness or usage. These technologies included Geometer's Sketchpad, Geogebra, Database, Smartboard, Desktop Publishing Software, Computer Algebra System (CAS), Graphing calculator, Cabri or Tinkerplot/Fathom, Word Processing, Learning Management System (LMS), Virtual Learning Environments (VLEs), Programmable Toys, Blogs, or Podcasts, and Dynamic software such as Mathalicious, Sympy, and Shanlax.

Research Question Two

RQ 2: What is the level of teachers' technological knowledge in integrating digital technology in teaching Mathematics?

Table 6: Mean and Standard Deviation of the level of teachers' technological knowledge in integrating digital technology in teaching Mathematics (N = 210)

S/N	TK (Technology Knowledge)	$\overline{X}$	SD.	Decision
1	I understand a lot of different digital technologies to use to teach specific Mathematics contents.	4.0	0.7	High
2	I can easily learn different new digital technologies in teaching Mathematics.	4.33	0.47	High
3	PowerPoint, geometer sketchpad, Learning Management System and others can explain how to adapt lessons to Improve student learning.	4.08	0.27	High
4	I have the technical skills needed using digital technology in teaching Mathematics.	3.50	1.12	High
5	I have the ability to use hardware and software to solve learning problems in Mathematics.	3.75	0.83	High
	Grand Total	**3.93**	**0.33**	**High**

Significant Score ≥ 3.00

Table 6revealedparticipants' technological knowledge level in integrating digital technology in teaching Mathematics, the respondents agreed ($\overline{X}$= 4.00, SD = 0.70) that a variety of digital technologies can be used to teach specific Mathematics contents, suggesting that they recognize the potential of digital technologies in enhancing their teaching practices. Moreover, the respondents believed ($\overline{X}$ = 4.33, SD = 0.47) that they can easily learn different new digital technologies in teaching Mathematics, indicating a high level of confidence in their ability to adapt to new technologies. The respondents also agreed ($\overline{X}$ = 4.08, SD = 0.27) that PowerPoint, Geometer's Sketchpad, Learning Management System, and other digital technologies can explain how to adapt lessons to improve students' learning, further indicating their positive perception of the instructional potential of these technologies. Although the respondents perceived ($\overline{X}$ = 3.50, SD = 1.12) that they have the technical skills needed to use digital technology in teaching Mathematics, the relatively high standard deviation suggests some variability in their perceptions. Additionally, the respondents believed ($\overline{X}$ = 3.75, SD = 0.83) that they have the ability to use hardware and software to solve learning problems in Mathematics, indicating their confidence in using technology for problem-solving tasks. However, it's worth noting that the grand mean ($\overline{X}$= 3.93) of the participants' technological knowledge level in integrating digital technology in teaching Mathematics ishigh(greater than the significant score).

Research Question Three

RQ 3: What is the level of teachers' content knowledge in integrating digital technology in teaching Mathematics?

Table 7: Mean and Standard Deviation of the level of teachers' content knowledge in integrating digital technology in teaching Mathematics (N = 210)

S/N	CK (Content Knowledge)	$\overline{X}$	SD	Decision
1	I can explain how to use Learning Management System to plan lessons, teach lessons and keep track of students' progress.	3.10	1.41	High
2	GeoGebra can be used to plot graphs such as y = 5x + 3.	3.98	1.08	High
3	I understand how to use Interactive whiteboard/projector to show students the (images) sector, arc, tangent and perpendicular of a circle such as:	3.40	1.30	High
4	Geometer's Sketchpad can aid Mathematics teaching for exploring Euclidean Geometry.	3.88	0.94	High
5	I can solve fractions such as $(4\frac{1}{11} \div (-\frac{3}{4} + \frac{1}{8})$	3.71	1.13	High
	Grand Total	**3.61**	**0.19**	**High**

Significant Score ≥ 3.00

Table 7 showed the level of teachers' content knowledge in integrating digital technology in teaching Mathematics. The result indicated that the respondents($\overline{X}$ = 3.10; SD = 1.41) believed they can explain how to use Learning Management System to plan lessons, teach lessons and keep track of students' progress. They agreed($\overline{X}$ = 3.98; SD = 1.08) thatGeoGebra can be used to plot graphs. The respondents ($\overline{X}$ = 3.40; SD = 1.30) believed that they understood how to use Interactive whiteboard/projector to show students the (images) sector, arc, tangent and perpendicular of a circle and also believed ($\overline{X}$ = 3.88; SD = 0.94) that Geometer's Sketchpad can aid Mathematics teaching for exploring Euclidean Geometry. They further believed ($\overline{X}$ = 3.71; SD = 1.13) that they can solve fractions such as ($4\frac{1}{11} \div (-\frac{3}{4} + \frac{1}{8}$) through the use of PowerPoint or prezi to place text, images, video and audio objects onto an animated sequence of screen shaped slides for display to encourage students learning. Hence, the grand mean ($\overline{X}$ = 3.61) of the participants content knowledge in integrating digital technology in teaching Mathematics is high (greater than the significant score.

Research Question Four

RQ 4: What is the level of teachers' pedagogical knowledge in integrating digital technology in teaching Mathematics?

Table 8: Mean and Standard Deviation of the level of teachers' pedagogical knowledge in integrating digital technology in teaching Mathematics (N = 210)

S/N	PK (Pedagogical Knowledge)	$\bar{X}$	SD	Decision
1	I can assess students' performance in a classroom with digital technology using Collaborative method and others in teaching Mathematics.	3.87	0.88	High
2	I can adapt my teaching styles with digital technology to different learners in teaching Mathematics.	2.89	1.33	Low
3	Collaborative learning, Direct instruction/inquiry learning and Problem solving /project based learning can be used as a wide range of teaching approaches in digital technology classroom setting in teaching Mathematics.	4.19	0.87	High
4	I can explain the use of direct instruction and collaborative methods to enhance students learning by integration of digital technologies.	3.21	0.97	High
5	I understand how to organize and maintain classroom management in teaching Mathematics.	3.97	0.95	High
	Grand Mean	**3.63**	**0.19**	**High**

Significant Score ≥ 3.00

Table 8 revealed that the participants pedagogical knowledge level in integrating digital technology in teaching Mathematics. The result showed that the respondents ($\bar{X}$ = 3.87; SD = 0.88) agreed that they can assess students' performance in a classroom with digital technology using Collaborative method and others in teaching Mathematics. It was deduced from the result that the respondents ($\bar{X}$ = 2.89; SD = 1.33) had a lower mean score for their ability to adapt teaching styles with digital technology to different learners. But they agreed ($\bar{X}$ = 4.19; SD = 0.87) thatCollaborative learning, Direct instruction/inquiry learning and Problem solving /project based learning can be used as a wide range of teaching approaches in digital technology classroom setting in teaching Mathematics. They also believed ($\bar{X}$ = 3.21; SD = 0.97) that direct instruction and collaborative methods can be used to explain and enhance students learning by integration of digital technologies. The respondents ($\bar{X}$ = 3.97; SD = 0.95) believed that they understood how to organize and maintain classroom management in teaching Mathematics. However, the grand mean ($\bar{X}$ = 3.63) of the participants ishigh(greater than the significant score

Research Question Five

RQ 5: What is the level of Mathematics teachers' preparedness in integrating digital technology in teaching Mathematics?

Table 9: Mean and Standard Deviation of the level of Mathematics teachers' preparedness in integrating digital technology in teaching Mathematics (N = 210)

S/N	Items	$\bar{X}$	SD	Decision
1	My teacher education program prepared me to use technology tools for teaching Mathematics.	2.88	1.21	Low
2	I am trained on how to teach Mathematics with digital technologies.	2.74	1.42	Low
3	My teacher education program included courses that are related to technology integration in teaching Mathematics.	2.98	1.26	Low
4	My lecturers appropriately modeled combining content, technologies and teaching approaches in their teaching.	2.85	1.26	Low
5	My teacher education program gave me the opportunity to practice teaching Mathematics with technology.	2.91	1.32	Low
6	My education preparation program introduced me to select appropriate digital technology tools to specific content areas in teaching Mathematics.	2.91	0.88	Low
7	My education preparation program introduced me to design lessons using digital technologies to meet the needs of students learning Mathematics.	2.80	1.11	Low
	Grand Total	**2.87**	**0.17**	**Low**

Significant Score ≥ 3.00

Table 9 showed thelow level of Mathematics teachers' preparedness in integrating digital technology in teaching Mathematics. The result ($\bar{X}$ = 2.88 and SD = 1.21) showed that the participants do not strongly agree that their teacher education program prepared them to use technology tools for teaching Mathematics. They submitted that ($\overline{X}$ = 2.74 and SD = 1.42) they were not trained on how to teach Mathematics with digital technologies, and only slightly ($\overline{X}$= 2.98 and SD = 1.26) agreed that their education programs included courses related to technology integration in teaching Mathematics. The participants ($\overline{X}$= 2.85 and SD = 1.26)also disagreed that their teacher education program appropriately modeled the combination of content, technologies, and teaching approaches in their teaching, and that they($\overline{X}$ = 2.91 and SD = 1.32) were given the opportunity to practice teaching Mathematics with technology.Furthermore, the participants ($\overline{X}$ = 2.91 and SD = 0.88) disagreed that their education preparation programs introduced them to select appropriate digital technology tools to specific content areas in teaching Mathematics, they also ($\overline{X}$ = 2.80 and SD = 1.11) disagreed that their education preparation programs do introduce them to design lessons using digital technologies to meet the needs of students learning Mathematics. However, the grand mean score ($\overline{X}$ = 2.87) of the participants is below the significant score, which indicated that there is low level of Mathematics teachers' preparedness in integrating digital technology in teaching Mathematics.

Hypothesis One

HO_1: There is no significant difference between male and female Mathematics teacher'stechnological knowledge in integrating digital technology in teaching Mathematics.

Table 10: T-test on Male and Female Mathematics Teacher's Technological Knowledge in integrating Digital Technology in Teaching Mathematics

Variable	No. Exp.	$\bar{X}$	SD	t - Cal	Df	Sig. (2-tailed)	Decision
Male	122	19.95	2.59	1.79	208	0.074	HO_1 Accepted
Female	88	19.26	2.96				

P (.074) > .05

Hypothesis one was centred on male and female Mathematics teacher's technological knowledge in integrating digital technology in teaching Mathematics. The data analyzed from table 10 showed that the male Mathematics teachers recorded a higher mean ($\bar{X}$ = 19.95) value as against their female counterparts. The t-test analysis of the difference showed a t-calculated value of 1.79at 208 degree of freedom. The result indicates a significant difference at .05 alpha levels. The null hypothesis is therefore, accepted thus showing that there is no significant difference between male and female Mathematics teacher's technological knowledge in integrating digital technology in teaching Mathematics.

Hypothesis Two

HO_2: There is no significant difference between pedagogical knowledge of experienced and inexperienced Mathematics teachers in integrating digital technology in teaching Mathematics.

Table 11: T-test on pedagogical knowledge of Experienced and Inexperienced Mathematics teachers in integrating digital technology in teaching Mathematics

Variable	No. Exp.	$\bar{X}$	SD	t - Cal	Df	Sig. (2-tailed)	Decision
Experienced	81	17.98	1.51	-0.57	208	0.57	HO_2 Accepted
Inexperienced	129	18.10	1.58				

P (.57) > .05

Table 11presented the result of analysis of data with respect to the pedagogical knowledge of experienced and inexperienced Mathematics teachers in integrating digital technology in teaching Mathematics. These were 81 and 129 sampled from the experienced and inexperienced Mathematics teachers, their mean were found to be 17.98 and 18.10. The t-testanalysis of the difference showed a t-calculated value of -0.57 at 208 degree of freedom while the significant value is 0.57 at0.05 alpha levels of significance; the null hypothesis is therefore accepted. This showed that there is no difference in Mathematics teachers' pedagogical knowledge of experienced to that of inexperienced Mathematics teachers in integrating digital technology in teaching Mathematics.

Hypothesis Three

HO_3: There is no significant difference between the knowledge of public and private school Mathematics teachers in the use of TPACK in integrating digital technology in teaching Mathematics.

Table 12: T-test: on public and private school Mathematics teachers in the use of TPACK in integrating digital technology in teaching Mathematics

Variable	No. Exp.	$\bar{X}$	SD	t - Cal	Df	Sig. (2-tailed)	Decision
Public	70	18.41	5.88	0.49	208	0.63	HO_3 Accepted
Private	140	18.01	5.5				

P (.63) > .05

Table 12 showed that there is no difference in the knowledge of public school Mathematics teachers to that of private school Mathematics teachers in the use of TPACK in integrating digital technology in teaching Mathematics with a higher mean

($\overline{X}$= 18.41) of public school. The t-calculated value is .49 while the significant value is 0.63 at 0.05 alpha levels of significance. The null hypothesis is therefore accepted.

Hypothesis Four

HO_4: There is no significant difference between qualified and unqualified teacher's TPACK knowledge in integrating digital technology in teaching Mathematics.

Table 13: T-test on qualified and unqualified teacher's TPACK knowledge in integrating digital technology in teaching Mathematics

Variable	No. Exp.	$\overline{X}$	SD	t - Cal	Df	Sig. (2-tailed)	Decision
Qualified	84	17.15	3.54	-4.62	208	6.60	HO_4 Accepted
Unqualified	126	18.81	1.55				

P (6.60) > .05

Table 13centred on qualified and unqualified teacher's TPACK knowledge in integrating digital technology in teaching Mathematics. In the data, 84 Mathematics teachers were qualified and 126 Mathematics teachers were unqualified, their respective means were 17.15 and 18.81. The t-test analysis of the difference showed a t-calculated value of -4.62 at 208 degree of freedom while the significant value is 6.60 at 0.05 alpha levels of significance; the null hypothesis is therefore accepted. Thus, there is no significant difference between qualified and unqualified teacher's TPACK knowledge in integrating digital technology in teaching Mathematics.

Hypothesis Five

HO_5: There is no relationship between the components under TPACK framework of teacher's knowledge in integrating digital technology in teaching Mathematics.

Table 14: Correlations among the components under TPACK framework of teacher's knowledge in integrating digital technology in teaching Mathematics(N = 210)

	TK	CK	PK	PCK	TCK	TPK
CK	-0.209					
PK	-0.302	0.829				
PCK	0.103	0.582	0.504			
TCK	0.104	0.639	0.574	0.841		
TPK	-0.131	-0.33	-0.219	-0.328	-0.205	
TPACK	-0.38	0.885	0.883	0.458	0.549	-0.204

*P < .002

Table 14 revealed a positive linear relationship exists between Pedagogical Knowledge (PK) and Content Knowledge (CK), Pedagogical Content Knowledge (PCK) and Pedagogical Knowledge (PK), Technological Content Knowledge (TCK) and Technological Knowledge (TK), Technological Content Knowledge (TCK) and Content Knowledge (CK), Technological Content Knowledge (TCK) and Pedagogical Knowledge (PK), Technological Content Knowledge (TCK) and Pedagogical Content Knowledge (PCK), Technological, Pedagogical, Content and Knowledge (TPACK) and Content Knowledge (CK), Technological, Pedagogical, Content and Knowledge (TPACK) and Pedagogical Knowledge (PK), Technological, Pedagogical, Content and Knowledge (TPACK) and Pedagogical Content Knowledge (PCK), Technological, Pedagogical, Content and Knowledge (TPACK) and Technological Content Knowledge (TCK), Technological, Pedagogical, Content and Knowledge (TPACK) and Technological, Pedagogical Knowledge (TPK).These values indicate that there is a moderate positive relationship between the variables. Meanwhilea negative linear relationship exists between CK and TK, PK and TK, TPK and TK, TPK and CK, TPK and PK, TPK and PCK, TPK and TCK. Using the Bonferroni approach to control for type 1 error across the 21 correlations, a p value of less than .002 (0.05/21) was required for significance. The results of the correlational analysis showed that all the 21 correlations were significantly correlated. Amultiple regression was run to predict TK from CK, PK, PCK, TCK, TPK and TPACK. These variables significantly predicted TK, F (6,203) = 16. 219, P < .OO1, R^2 = 0. 324. All six variables added significantly to the prediction, p < .05.The regression model is a good fit of the data.

Discussion of Findings

The discussion presents the findings of the study as follows:

1. Availability of digital technologies to aid teachers in teaching Mathematics.
2. The level of Mathematics teachers' preparedness, technological, content and pedagogical knowledge in integrating digital technology in teaching Mathematics.
3. Relationship between gender, experience, school type, and teacher qualification in integrating digital technology in teaching Mathematics.

Availability of Digital Technologies to Aid Teachers in Teaching Mathematics

It was found that Majority of Mathematics teachers were not aware of the digital technology tools available to aid in teaching Mathematics.The findings for Research Question 1 indicated that Social Media, Software applications, Internet facilities, Spreadsheet, Interactive Whiteboard/Projectors, TV, Video clips and YouTube were widely recognized by50% and above of respondents as available technologies to aid in the preparedness of Mathematics teachers. However, there are some digital technologies that had less than 50% agreement among respondents, indicating lower awareness or usage. The lower awareness or usage of certain digital technologies highlights the need for increased knowledge and training in this area. The knowledge of digital technology had been added as a required knowledge of instructions for Mathematics teachers to integrate digital technologies in teaching Mathematics effectively. This finding is consistent with Mishra and Koehler's (2009) study, which suggests that technological knowledge is related to a teacher's ability to use hardware and software to solve Mathematics learning problems.

The Level of Mathematics Teachers' Preparedness, Technological, Content and Pedagogical Knowledge in Integrating Digital Technology In Teaching Mathematics

The study found that there were high level of teachers' technological knowledge, content knowledge and pedagogical knowledge except for the preparedness of Mathematics teachers which was low. The findings for Research Question 2 indicated that majority of Mathematics teachers believed that a lot of different digital technologies can be used to teach specific Mathematics contents; Mathematics teachers believed that they can easily learn different new digital technologies in teaching Mathematics if they are trained. Thus, Mathematics teachers need to be trained and be retrained to meet TPACK standard and set up education for the future as well as setting up the students for their future. This aligned with UNESCO (2008) who presented specific technology competencies that teachers should acquire at the college to be able to integrate technology in teaching in the most appropriate way. The findings for Research Question 3 reflected positive mean scores for all the items on the level of teachers' content knowledge in integrating digital technology in teaching Mathematics. In this finding, teachers believed to have the ability and a broad knowledge base of the subject matter range of mathematical content between

Mathematics topics in a curriculum and to teach with digital technologies of a specific Mathematics topic. This inherently supported Jang and Tsai (2013) who reported that teachers should have a broad knowledge base on the subject matter so as to retrieve and teach contents in logical and organized ways. The findings for Research Question 4 in Table 9 revealed that teachers showed pedagogical knowledge in assessing students with digital technology; they expressed dissatisfaction in adapting teaching styles with digital technology for different learners in Mathematics. This underscores the need for more training programs that focus on pedagogical approaches with digital technologies to cater to diverse learners. These findings agreed with Koehler and Mishra (2009) who believed that pedagogical knowledge encompasses the broad spectrum of teaching approaches, from planning of the lesson to students' assessment. The findings for Research Question 5 on Table 10 showed that teachers' preparedness in integrating digital technology in teaching Mathematics was below average, indicating a low level of Mathematics teachers' preparedness, this suggest a need for more training programs specifically focused on Mathematics teachers' education to effectively integrate digital technologies in their teaching practice; this may be caused by lack of training programs that focus on training Mathematics teachers' education program to teach with digital technologies. This finding agreed with Niess and her colleagues (2008) who claimed that Mathematics teachers need to be trained and learn how to teach with digital technologies (TPACK) in order to effectively integrate digital technologies in their teaching practice.

Relationship between gender, experience, school type, and teacher qualification in integrating digital technology in teaching Mathematics

It was found that there were no significant differences between male and female Mathematics teacher's technological knowledge; pedagogical knowledge of experienced and inexperienced; public and private school Mathematics teachers in the use of TPACK; qualified and unqualified teacher's TPACK knowledge. The correlations among the components under TPACK framework of teacher's knowledge in integrating digital technology in teaching Mathematics were significantly corrected. Moreover, findings for Research Hypothesis 1 showed that there was no gender digital divide.. This finding agreed withRakow (1986), who pointed out that technology should not be examined based on the differences in the behavior of men or women towards a technology, but instead to look for the ways in which the technology is used to construct us as women and men through the social practices that put it to use.. Findings for Hypothesis 2 in Table 12 indicated that there was no significant difference of experienced Mathematics teachers to that of inexperienced teachers. This showed that teaching experienced does not influence Mathematics teachers in integrating digital technology in teaching Mathematics. The findings for Research Hypothesis 3 in Table 13 indicated that there was no difference in the knowledge of public and private school Mathematics teachers in integrating digital technology in teaching Mathematics, indicating that types of schools does not influence Mathematics teachers in integrating digital technology in teaching Mathematics. The findings for Research Hypothesis 4 in Table 14 indicated that there was no difference in TPACK knowledge between qualified and unqualified teachers, showed that qualification does not influence Mathematics teachers in integrating digital technology in teaching Mathematics. The findings for Research Hypothesis 5 in Table 15 revealed that the components of TPACK framework were found to be significantly correlated with integrating digital technology in teaching Mathematics, supporting the usefulness of TPACK as a framework for guiding teachers in integrating technology into their teaching practice. The finding supported the earlier result of the study conducted by Schmidt et al. (2009) and Jang & Tsai (2013) who indicated that there were significant increase between the respondents' pre- and posttest means for all seven TPACK subscales, described TPACK as a useful framework for thinking about what knowledge teachers must have to integrate technology into teaching and how they might develop this knowledge.

Finally, the findings of the study highlight the need for increased awareness and training for Mathematics teachers to effectively integrate digital technologies in their teaching. Teachers should receive specific training programs that focus on pedagogical approaches with digital technologies, cater to diverse learners, and enhance their overall preparedness in integrating technology. Additionally, the study indicates that factors like gender, experience, school type, and qualification do not significantly impact teachers' ability to integrate digital technology in their Mathematics teaching.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

This chapter presents the summary, findings, conclusion and recommendations made from the study as presented below:

Summary of the Study

This study examined teachers' preparedness in integrating digital technology in Mathematicsteaching. This aimed to aid Mathematics teachers' knowledge on how to integrate technology into their Mathematics teaching instructions and to understand the type of technology to use in teaching Mathematics. To guide this study, ten research questions were raised, five of which were hypothesized and tested atthe 0.05 level of significance.

A correlational survey research design was adopted for the study. The population for the study consisted of one hundred and seventy nine (179) public secondary school Mathematics teachers and seven hundred and eighty (780) private secondary school Mathematics teachers, which gave a total number of nine hundred and fifty nine (959) secondary school Mathematics teachers in Edo South Senatorial District in Edo State. A simple random sampling technique was used to collect information from in-service public and private secondary school Mathematics teachers which were drawn from the population. A sample of thirty-five (35) public schools and seventy (70) private schools (105 schools) and a sample size of 210 secondary school Mathematics teachers were used for the study, seventy (70) forms were distributed to public schools while one hundred and forty (140) forms were distributed to private schools.

The instrument for data collection was Mathematics Teachers Questionnaire Instrument (MTQI). Reliability of the instrument was determined using Cronbach Alpha and a value of .71 was obtained. The Mathematics teachers' questionnaire instrument was delivered to each school, the researcher was assisted personally by the teachers to distribute and collect the completed forms from the teachers after two (2) weeks of administration. Frequency counts, percentage, descriptive statistics (mean and standard deviation) were used to answer the research questions. The independent t-test statistics was used to test research questions 6 to 9 and Pearson correlation coefficient and multiple regression analysis were used to test hypothesis 10. Hypotheses were tested at the .05 level of significance.

Findings

The findings are based on the research questions raised during the study. The findings obtained from the data analyzed provided answers to the research rose which revealed that:

1. Majority of Mathematics teachers were not aware of the digital technology tools available to aid in teaching Mathematics.
2. There was a high level of Mathematics teachers' technological knowledge in integrating digital technology in teaching Mathematics.
3. There was a high level of Mathematics teachers' content knowledge in integrating digital technology in teaching Mathematics.
4. There was a high level of Mathematics teachers' pedagogical knowledge level in integrating digital technology in teaching Mathematics.

5. There was a low level of Mathematics teachers' preparedness in integrating digital technology in teaching Mathematics.
6. There was no significant difference between male and female Mathematics teacher's technological knowledge in integrating digital technology in teaching Mathematics. This implied that gender does not influence Mathematics teacher's technological knowledge in integrating digital technology in teaching Mathematics.
7. There was no difference in Mathematics teachers' pedagogical knowledge of experienced to that of inexperienced Mathematics teachers in integrating digital technology in teaching Mathematics.
8. There was no difference in the knowledge of public school Mathematics teachers to that of private school Mathematics teachers in the use of TPACK in integrating digital technology in teaching Mathematics.
9. There was no significant difference between qualified and unqualified teacher's TPACK knowledge in integrating digital technology in teaching Mathematics.
10. There was a relationship between the components under TPACK framework of teacher's knowledge in integrating digital technology in teaching Mathematics.

Conclusion

In conclusion, the findings of this research study shed light on the preparedness of Mathematics teachers in integrating digital technology in their teaching. The study revealed that unawareness among teachers regarding the available digital tools; the importance of incorporating them into their instructionand suggested that digital technology need to be added as a required knowledge of instructions for Mathematics teachers to integrate digital technology in Mathematics teaching effectively.

The findings of the study highlightedno differences in technological knowledge between male and female Mathematics teachers, pedagogical knowledge of experienced and inexperienced teachers, public school Mathematics teachers to that of private school Mathematics teachersas well as differences in qualified and unqualified teacher's TPACK knowledge. Furthermore, the findings of this study had significant implications for Mathematics teacher education and professional development programs. To enhance Mathematics teachers' preparedness in integrating digital technology in their teaching, there is a need for comprehensive and ongoing professional development programs that emphasizes the development of TPACK knowledge. Such programs would enable Mathematics teachers to effectively integrate technology into their instruction and improve student learning outcomes in Mathematics.

Recommendations

Based on the findings of the study, the following recommendations are suggested:

1. Mathematics teachers need to undergo training and retraining to meet the standard of Technological Pedagogical Content Knowledge (TPACK) and prepare them for teaching in the future. Professional development programs should focus on enhancing teachers' knowledge and skills in integrating digital technologies in Mathematics teaching.
2. Teacher education programs should incorporate training on how to select appropriate digital technology tools that align with specific content areas in Mathematics

teaching. Teachers should be equipped with the knowledge and skills to effectively integrate digital technologies into their instructional practices in a content-specific manner.

3. Seminars/workshops should be organized to create awareness among Mathematics teachers about the availability of digital technology tools that can aid their instruction in specific Mathematics topics and also should be provided with the opportunities to learn about and experiment with various digital technologies that can enhance their Mathematics teaching practices.
4. Educators can leverage technology to provide professional development opportunities for teachers, such as online courses, webinars, and workshops, to enhance their digital literacy skills, pedagogical strategies, and content knowledge related to integrating technology in Mathematics instruction.
5. Mathematics teachers should be provided with experiences and skills to effectively use technology to teach Mathematics if they are expected to provide such experiences for their future students
6. Further research should be conducted to investigate initiatives that motivate Mathematics teachers to innovatively apply technology in their classrooms in different Mathematics contexts. Identifying effective strategies and best practices for integrating digital technologies in Mathematics teaching can provide valuable insights for teacher education programs and professional development. And also should consider controlling for confounding factors, such as the type of technology environment, which could impact the effectiveness of integrating digital technologies

in Mathematics teaching. This can help in gaining a deeper understanding of how different types of technology environments can influence Mathematics instruction.

7. Educational policymakers and planners should have a clear understanding of the intersection of Technological, Pedagogical, and Content Knowledge (TPACK) in the reformation and improvement of strategies to successfully implement digital technologies in Mathematics teaching. Policy decisions should be informed by research on effective practices for integrating digital technologies in Mathematics education, and resources should be allocated to support professional development programs for Mathematics teachers to enhance their TPACK.

Contribution to Knowledge

The present study makes several important contributions to the field of Mathematics education and the integration of digital technologies in teaching Mathematics:

The study extended the limited research on teachers' preparedness and the available technologies for integrating digital technology in teaching Mathematics, particularly in the context of Nigeria. By applying the Technological Pedagogical Content Knowledge (TPACK) framework, the study goes beyond mere technological proficiency and emphasizes the importance of deeper and transformed knowledge for integrating Mathematics content, pedagogy, and technology to enhance the learning experience.

Second, the concept of TPACK framework revealed Mathematics teachers' Technology, Pedagogy, and Content Knowledge (TPACK), which had been described as the body of knowledge Mathematics teachers needed to achieve higher quality technology integration in teaching Mathematics. By highlighting the interconnectedness of Technological, Pedagogical, and Content Knowledge, the study emphasized the holistic nature of effective technology integration in Mathematics teaching.

Third, no previous study to the best of my course knowledge has empirically explored the effects of teachers' preparedness in integrating digital technology in Mathematics teaching. However, research has shown that the strategic use of technological tools can support both the learning of mathematical procedures and skills as well as the development of advanced mathematical proficiencies; such as problem solving, reasoning and decision making (e.g., Gadanidis& Geiger, 2010; Kastberg&Leatham, 2005; National Policy on ICT in Education, 2019; Roschelle, et al., 2009). There appeared to be a gap in the research on the effects of teachers' preparedness in integrating digital technology in Mathematics teaching. It would be interesting to explore this further, as it could have important implications for teacher training and professional development programs aimed at enhancing the integration of digital technology in Mathematics teaching.

Finally, as technology continues to evolve, it is essential for teachers to stay current with digital tools and platforms in order to provide students with the best possible learning experience. Furthermore, the study's findings on the importance of TPACK (Technological Pedagogical Content Knowledge) aligned with current trends in education. TPACK is a framework that describes the knowledge and skills required for effective technology integration in teaching. It involves not only understanding the technology itself, but also how to use it effectively in teaching specific content areas, such as Mathematics. By prioritizing the development of TPACK, Mathematics teachers can not only enhance their own digital literacy, but also improve student engagement and learning outcomes. This could ultimately lead to a more dynamic and effective Mathematics classroom that leverages the power of technology to promote student success.

Implications for Mathematics Education

The implications of the study are significant for Mathematics teacher education programs, professional development, and educational policies:

1. The findings of the study highlighted the importance of equipping Mathematics teachers with the necessary knowledge, experience, and skills to effectively integrate digital technologies in their instruction. Mathematics teacher education programs can incorporate the TPACK framework to train future teachers in integrating technology in Mathematics teaching. In-service teachers can also benefit from the ideas and suggestions provided by the study, which can assist them in enhancing their instructional practices.
2. The use of technology in Mathematics instruction, guided by the TPACK framework, can provide students with opportunities to build mathematical proficiencies in a way that bridges the gap between concrete and abstract concepts. Through explorations and applications of technology, students can develop a deeper understanding of mathematical concepts and engage in higher-level approaches to problem solving, reasoning, and decision making in Mathematics.
3. The findings of the study can inform educational policies and strategies related to the integration of digital technologies in Mathematics teaching. It can serve as a basis for

reformation and improvement of strategies to ensure successful implementation of digital technologies in Mathematics classrooms. Policy makers can consider incorporating the TPACK framework into teacher education programs and professional development initiatives to enhance teachers' preparedness for integrating technology in Mathematics instruction.

In summary, the implications of the study are wide-ranging and can benefit Mathematics teachers, students, and educational policy makers alike. By providing insights into effective integration of digital technologies in Mathematics teaching and emphasizing the importance of teachers' preparedness and the use of TPACK framework, the study contributes to the advancement of Mathematics education and promotes enhanced learning experiences for students.

Suggestion for Further Studies

Based on the limitations identified in this study, there are several suggestions for further research in the field of Mathematics education and technology integration:

- As digital technologies continue to evolve, there is a need for ongoing research to explore their educational uses in the classroom, particularly in the context of the TPACK framework. Future studies can investigate different types of digital technologies, their effectiveness in supporting Mathematics instruction, and their impact on student learning outcomes.

- While this study utilized a correlational research design, further research can employ experimental or quasi-experimental designs to establish a cause-and-effect relationship between Mathematics teachers' TPACK and their preparedness to integrate technology in their instruction. Experimental studies can provide more robust evidence of the impact of TPACK on teachers' preparedness and instructional practices.

- ❖ This study had a limited sample size, and future research can aim to generalize the findings to a larger population of Mathematics teachers. Conducting studies with larger and more diverse samples can help validate the findings and provide a broader understanding of the relationship between TPACK and teachers' preparedness to integrate technology in Mathematics teaching.

- ❖ Longitudinal studies can provide insights into the changes in Mathematics teachers' TPACK and their preparedness to integrate technology over time. Tracking teachers' TPACK development from pre-service to in-service stages and examining the long-term impact of TPACK on instructional practices and student outcomes can contribute to a deeper understanding of the role of TPACK in Mathematics education.

- ❖ While this study utilized quantitative research methods, future research can employ qualitative research approaches, such as interviews, observations, and case studies, to gain a deeper understanding of teachers' perspectives, beliefs, and experiences related to integrating technology in Mathematics teaching. Qualitative research can provide rich and contextualized insights into the complexities of technology integration in Mathematics education.

In conclusion, further research in the areas of Mathematics education and technology integration, considering the suggestions above, can contribute to the advancement of knowledge and practice in this field, and inform effective strategies for preparing Mathematics teachers to integrate technology in their instruction.

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APPENDICES

APPENDIX A

TEACHERS' PREPAREDNESS ON INTEGRATING DIGITAL TECHNOLOGY IN MATHEMATICS TEACHING IN EDO SOUTH SENATORIAL DISTRICT

MATHEMATICS TEACHERS' QUESTIONNAIRE INSTRUMENT (MTQTI)

DEPARTMENT OF CURRICULUM INSTRUCTIONAL AND TECHNOLOGY (C.I.T.),

FACULTY OF EDUCATION, UNIVERSITY OF BENIN, BENIN CITY

Dear Respondents,

The purpose of this study is to collect data on Teachers' Preparedness in Integrating Digital Technology in Mathematics Teaching in Edo South Senatorial District.

The researcher therefore solicits your cooperation in providing genuine and honest response to the questions. The information so obtained will be kept strictly confidential and will be used for research purposes only.

Thank you.

INSTRUCTION: Please attempt all, (i) fill the gap as appropriate in the space provided
and/or (ii) Tick ( ) as applicable;

SECTION A: DEMOGRAPHIC INFORMATION

This part elicits some demographic information about the teacher.

1. School Location: Urban: ( ) Rural: ( )
2. Type of school: Public ( ); Private ( )
3. Gender: Male ( ) Female ( )
4. Qualifications: TCII ( ); NCE ( ); OND ( ); HND ( ); B.Ed. / B.Sc. ( ); Masters ( ); Ph.D. ( ); Others (Specify) …………………
5. Major: Mathematics ( ); Mathematics Education ( ); physics ( ); chemistry ( ); Biology ( ) Science Education ( ); Others (Specify) …………………
6. Years of Experience: 0 - 3 ( ); 4 - 9 ( ); 10 - 15 ( ); 16 – 21 ( ) and Above ( )

NOTE: Technology is a broad concept that means a lot of different things. For the purpose of this questionnaire, technology is referring to digital technology/technologies. That is, the digital tools Mathematics teachers use for teaching such as Math Whiteboard, Geogebra, Grapging calculator, Geometer's sketchpad, computers, laptops, iPods, handhelds, Smartboard/interactive whiteboards, Software application such as powerpoint or prezi, , Spreadsheet, Projectors, Desktop publishing software, Computer Algebra System (CAS), Cabri or tinkerplot/fathom, Social media such as; whatsApp, YouTube, Word processing, Virtual Learning Environments (VLEs) or Learning Management

System (LMS), Television, Blogs or podcast, Dynamic software such as Mathalicious, Video clips or internet facilities.

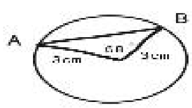
SECTION B: This part measures the technologies that are available to aid the preparedness of Mathematics teachers in integrating digital technology in teaching Mathematics:

Are the following technologies available to aid you integrating digital technology in teaching Mathematics?

S/N	Digital technologies	Yes	No
7.	Software application such as powerpoint or prezi		
8.	Geometer's sketchpad		
9.	Geogebra		
10.	Database		
11.	Spreadsheet		
12.	Smartboard		
13.	Interactive whiteboard/Projectors		
14.	Desktop Publishing Software		
15.	Computer Algebra System (CAS)		
16.	Graphing calculator		
17.	Cabri or Tinkerplot/Fathom		
18.	Social Media such as; whatsApp		
19.	YouTube		
20.	Word Processing		
21.	Learning Management System (LMS)		
22.	Virtual Learning Environments (VLEs)		
23.	Programmable Toys		
24.	Television (TV)		
25.	Blogs or Podcast		
26.	Dynamic software such as: Mathalicious, Sympy, Shanlax		
27.	Video clips		
28.	Internet facilities		

SECTION C: This part measures teacher's Technology, Pedagogy and Content Knowledge:

Keys: SA (Strongly Agree), A (Agree), SD (Strongly Disagree), D (Disagree), NAD (Neither Agree or Disagree)

	SA	A	SD	D	NAD
TK (Technology Knowledge)	**5**	**4**	**3**	**2**	**1**
29. I understand a lot of different digital technologies to use to teach specific Mathematics contents.					
30. I can easily learn different new digital technologies in teaching Mathematics.					
31. PowerPoint, geometer sketchpad, Learning Management System and others can explain how to adapt lessons to Improve student learning.					
32. I have the technical skills needed using digital technology in teaching Mathematics.					
33. I have the ability to use hardware and software to solve learning problems in Mathematics.					
CK (Content Knowledge)	**5**	**4**	**3**	**2**	**1**
34. I can explain how to use Learning Management System to plan lessons, teach lessons and keep track of students' progress.					
35. GeoGebra can be used to plot the graph of y = 5x + 3.					
36. I understand how to use Interactive whiteboard/projector to show students the (images) sector, arc, tangent and perpendicular of a circle such as: 					
37. Geometer's Sketchpad can aid Mathematics teaching for exploring Euclidean Geometry.					
38. I can solve $(4\frac{1}{11} \div (-\frac{3}{4}+\frac{1}{8})$ through the use of PowerPoint or prezi to place text, images, video and audio objects onto an animated sequence of screen shaped slides for display to encourage students learning.					
PK (Pedagogical Knowledge)	**5**	**4**	**3**	**2**	**1**
39. I can assess students' performance in a classroom with digital technology using Collaborative method and others in teaching Mathematics.					
1. I can adapt my teaching styles with digital technology to different learners in teaching Mathematics.					
2. Collaborative learning, Direct instruction/inquiry learning and Problem solving /project based learning can be used as a wide range of teaching approaches in digital technology classroom setting in teaching Mathematics.					
3. I can explain the use of direct instruction and collaborative methods to enhance students learning by integration of digital technologies.					
4. I understand how to organize and maintain classroom management in teaching Mathematics.					

PCK (Pedagogical Content Knowledge)	5	4	3	2	1
5. I can select effective teaching approaches to guide student thinking and learning in Mathematics.					
6. I have a good understanding of instructional strategies that best represent mathematical topics in teaching Mathematics.					
7. I have a good understanding of students' conceptual and practical understanding of mathematical concepts.					
8. I have a good understanding of Mathematics curriculum that meets students' need for learning Mathematics.					
9. I can select effective teaching approaches to guide students thinking and learning in Mathematics.					
TCK (Technological Content Knowledge)	**5**	**4**	**3**	**2**	**1**
10. PowerPoint can be used to enhance students learning when teaching Fractions, Decimals, Percentages, Ratios and Proportions.					
11. GeoGebra can be used to explain Geometry figures, Measurement and Coordinate geometry.					
12. PowerPoint/Word processing can be used to enhance students learning when teaching Algebraic process.					
13. YouTube can be used to enhance students learning to teach Perimeter, area and volume.					
14. Graphing calculator can be used to represent and interpret data in graphs, charts and tables.					
TPK (Technological Pedagogical Knowledge)	**5**	**4**	**3**	**2**	**1**
15. I have the Skills to operate, navigate, and apply the various features of Mathematics-related technology tools in teaching Mathematics.					
16. I have the ability to identify and use digital technologies to enhance the teaching approaches for Mathematics lessons in teaching Mathematics.					
17. The Technological tools I use in instruction help to increase and enhance the teaching approaches for a Mathematics content knowledge in teaching Mathematics.					
18. I can select technologies to use in my Mathematics lessons that enhance the topic in teaching Mathematics.					
19. My Teacher education program has caused me to think more deeply about how technology could influence the teaching approaches I use in my Mathematics classroom.					
TPACK (Technology Pedagogy and Content Knowledge)	**5**	**4**	**3**	**2**	**1**
20. I can teach lessons that appropriately Combine Mathematics digital technologies and teaching approaches in teaching Mathematics.					
21. I can identify Specific topics in the Mathematics curriculum where specific digital technologies are helpful in guiding students' learning in the classroom.					

22. I can use Strategies that combine mathematical content, digital technologies and teaching approaches to support students' understandings and thinking in teaching Mathematics.					
23. I can choose technologies that enhance the content and teaching styles for a Mathematics lesson in teaching Mathematics.					
24. I can use my level of Knowledge of TPACK components to enhance the content for a Mathematics lesson in teaching Mathematics.					
SECTION D: This part measures Mathematics teacher's preparedness for integrating technology in the classroom					
	5	**4**	**3**	**2**	**1**
25. My teacher education program prepared me to use technology tools for teaching Mathematics.					
26. I am trained on how to teach Mathematics with digital technologies.					
27. My teacher education program included courses that are related to technology integration in teaching Mathematics.					
28. My lecturers appropriately modeled combining content, technologies and teaching approaches in their teaching.					
29. My teacher education program gave me the opportunity to practice teaching Mathematics with technology.					
30. My education preparation program introduced me to select appropriate digital technology tools to specific content areas in teaching Mathematics.					
31. My education preparation program introduced me to design lessons using digital technologies to meet the needs of students learning Mathematics.					

Appendix B

Reliability

INTERPRETATION		
CRONBACH'S α	***INTERNAL CONSISTENCY***	
0.9 – Above	*Excellent*	
0.80 – 0.89	*Good*	
0.70 - 0.79	*Acceptable* *	
0.60 – 0.69	*Questionable*	
0.50 – 0.59	*Poor*	
Below 0.50	*Unacceptable*	

Solution

K =	**42**
K – 1=	**41**
$\sum S^2y$ =	**151**
S^2x =	**51.15**
α =	**0.706**

INTERPRETATION: *The Cronbach Alpha is 0.706 denotes an acceptable relationship. Hence the Mathematics teacher's questionnaire has a moderate reliability.*

Appendix C

Data Output

Descriptive Statistics for TK

Q 1		*Q 2*		*Q 3*		*Q 4*		*Q 5*	
Mean	4.004762	Mean	4.333333	Mean	4.080952	Mean	3.495238	Mean	3.747619
Standard Error	0.048442	Standard Error	0.032608	Standard Error	0.018867	Standard Error	0.07704	Standard Error	0.057205
Median	4	Median	4	Median	4	Median	4	Median	4
Mode	4	Mode	4	Mode	4	Mode	4	Mode	4
Standard Deviation	0.701997	Standard Deviation	0.472531	Standard Deviation	0.273414	Standard Deviation	1.116418	Standard Deviation	0.828972
Sample Variance	0.4928	Sample Variance	0.223285	Sample Variance	0.074755	Sample Variance	1.246389	Sample Variance	0.687195
Kurtosis	3.220443	Kurtosis	-1.50721	Kurtosis	7.650402	Kurtosis	-0.07923	Kurtosis	0.803418
Skewness	-1.43089	Skewness	0.712204	Skewness	3.094774	Skewness	-1.07109	Skewness	-1.27945
Range	3	Range	1	Range	1	Range	4	Range	3
Minimum	2	Minimum	4	Minimum	4	Minimum	1	Minimum	2
Maximum	5	Maximum	5	Maximum	5	Maximum	5	Maximum	5
Sum	841	Sum	910	Sum	857	Sum	734	Sum	787
Count	210	Count	210	Count	210	Count	210	Count	210

Descriptive Statistics for PK

Q 11		*Q 12*		*Q 13*		*Q 14*		*Q 15*	
Mean	3.871429	Mean	2.890476	Mean	4.185714	Mean	3.209524	Mean	3.971429
Standard Error	0.060666	Standard Error	0.091876	Standard Error	0.060332	Standard Error	0.066959	Standard Error	0.065765
Median	4	Median	3	Median	4	Median	3	Median	4
Mode	4	Mode	3	Mode	5	Mode	3	Mode	4
Standard Deviation	0.879127	Standard Deviation	1.331404	Standard Deviation	0.874293	Standard Deviation	0.970328	Standard Deviation	0.953032
Sample Variance	0.772864	Sample Variance	1.772636	Sample Variance	0.764388	Sample Variance	0.941536	Sample Variance	0.908271
Kurtosis	0.687203	Kurtosis	-1.11372	Kurtosis	0.484964	Kurtosis	0.396453	Kurtosis	2.428454
Skewness	-1.1109	Skewness	0.042994	Skewness	-1.02175	Skewness	-0.59021	Skewness	-1.38247
Range	3	Range	4	Range	3	Range	4	Range	4
Minimum	2	Minimum	1	Minimum	2	Minimum	1	Minimum	1
Maximum	5	Maximum	5	Maximum	5	Maximum	5	Maximum	5
Sum	813	Sum	607	Sum	879	Sum	674	Sum	834
Count	210	Count	210	Count	210	Count	210	Count	210

Descriptive Statistics for CK

Q 6		*Q 7*		*Q 8*		*Q 9*		*Q 10*	
Mean	3.1	Mean	3.980952	Mean	3.4	Mean	3.87619	Mean	3.714286
Standard Error	0.097462	Standard Error	0.074854	Standard Error	0.089606	Standard Error	0.064533	Standard Error	0.078267
Median	3	Median	4	Median	4	Median	4	Median	4
Mode	5	Mode	4	Mode	4	Mode	4	Mode	4
Standard Deviation	1.412352	Standard Deviation	1.084744	Standard Deviation	1.298509	Standard Deviation	0.935174	Standard Deviation	1.134195
Sample Variance	1.994737	Sample Variance	1.176669	Sample Variance	1.686124	Sample Variance	0.87455	Sample Variance	1.286398
Kurtosis	-1.2748	Kurtosis	1.360528	Kurtosis	-0.88822	Kurtosis	-0.59914	Kurtosis	0.007347
Skewness	-0.06564	Skewness	-1.34714	Skewness	-0.43315	Skewness	-0.49444	Skewness	-0.81002
Range	4	Range	4	Range	4	Range	3	Range	4
Minimum	1	Minimum	1	Minimum	1	Minimum	2	Minimum	1
Maximum	5	Maximum	5	Maximum	5	Maximum	5	Maximum	5
Sum	651	Sum	836	Sum	714	Sum	814	Sum	780
Count	210	Count	210	Count	210	Count	210	Count	210

Descriptive Statistics for Teachers' Preparedness

Q 36		*Q 37*		*Q 38*		*Q 39*		*Q 40*		*Q 41*		*Q 42*	
Mean	2.8762	Mean	2.7429	Mean	2.981	Mean	2.8524	Mean	2.9143	Mean	2.914	Mean	2.8
Standard	0.0833	Standar	0.0978	Standa	0.087	Stand	0.0873	Standar	0.0911	Standar	0.061	Standar	0.0763
Median	3	Median	3	Mediar	3	Medi	3	Mediar	4	Median	3	Median	3
Mode	2	Mode	1	Mode	3	Mode	3	Mode	4	Mode	3	Mode	3
Standard	1.2076	Standar	1.4178	Standa	1.2602	Stand	1.265	Standar	1.3205	Standar	0.882	Standar	1.1059
Sample V	1.4583	Sample	2.0101	Sample	1.5882	Samp	1.6001	Sample	1.7438	Sample	0.777	Sample	1.223
Kurtosis	-0.899	Kurtosis	-1.209	Kurtosi	-0.966	Kurto	-0.901	Kurtosi	-1.598	Kurtosis	0.953	Kurtosis	-0.428
Skewnes	0.3226	Skewne	0.3011	Skewn	0.0216	Skew	0.1093	Skewne	-0.495	Skewne	-0.297	Skewne	0.1252
Range	4	Range	4	Range	4	Range	4	Range	3	Range	4	Range	4
Minimur	1	Minimu	1	Minimu	1	Minin	1	Minimu	1	Minimu	1	Minimu	1
Maximur	5	Maximu	5	Maxim	5	Maxir	5	Maximu	4	Maximu	5	Maximu	5
Sum	604	Sum	576	Sum	626	Sum	599	Sum	612	Sum	612	Sum	588
Count	210	Count	210	Count	210	Count	210	Count	210	Count	210	Count	210

T-TEST

TK

t-Test: Two-Sample Assuming Equal Variances

	Male	*Female*
Mean	19.95081967	19.2613636
Variance	6.708305108	8.74699582
Observations	122	88
Pooled Variance	7.561026704	
Hypothesized Mean Difference	0	
df	208	
t Stat	1.792783292	
P(T<=t) one-tail	0.037230317	
t Critical one-tail	1.652212376	
P(T<=t) two-tail	0.074460635	
t Critical two-tail	1.971434659	

t-Test: Two-Sample Assuming Equal Variances

	Experienced	*Inexperienced*
Mean	17.97530864	18.10077519
Variance	2.274382716	2.481952519
Observations	81	129
Pooled Variance	2.40211798	
Hypothesized Mean Difference	0	
df	208	
t Stat	-0.571029458	
P(T<=t) one-tail	0.284298057	
t Critical one-tail	1.652212376	
P(T<=t) two-tail	0.568596113	
t Critical two-tail	1.971434659	

t-Test: Two-Sample Assuming Equal Variances

	Public	*Private*
Mean	18.41428571	18.01428571
Variance	34.59399586	30.21562179
Observations	70	140
Pooled Variance	31.66806319	
Hypothesized Mean Difference	0	
Df	208	
t Stat	0.485570876	
P(T<=t) one-tail	0.313891266	
t Critical one-tail	1.652212376	
P(T<=t) two-tail	0.627782532	
t Critical two-tail	1.971434659	

t-Test: Two-Sample Assuming Equal Variances

	Qualified	*Unqualified*
Mean	17.1547619	18.80952381
Variance	12.54202524	2.411428571
Observations	84	126
Pooled Variance	6.453926282	
Hypothesized Mean Difference	0	
Df	208	
t Stat	-4.624223135	
P(T<=t) one-tail	3.30006E-06	
t Critical one-tail	1.652212376	
P(T<=t) two-tail	6.60012E-06	
t Critical two-tail	1.971434659	

Multiple Regression Analysis

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.569[a]	.324	.304	.723

a. Predictors: (Constant), TPACK, TPK, PCK, TCK, PK, CK

ANOVA

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	50.873	6	8.479	16.219	<.001[b]
	Residual	106.123	203	.523		
	Total	156.995	209			

a. Dependent Variable: TK

b. Predictors: (Constant), TPACK, TPK, PCK, TCK, PK, CK

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients			95.0% Confidence Interval for B	
		B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1	(Constant)	23.024	2.310		9.969	<.001	18.470	27.578
	CK	.100	.060	.241	1.671	.096	-.018	.218
	PK	-.027	.047	-.074	-.577	.564	-.119	.065
	PCK	-.037	.058	-.072	-.635	.526	-.152	.078
	TCK	.140	.037	.444	3.804	<.001	.068	.213
	TPK	-.224	.092	-.157	-2.436	.016	-.406	-.043
	TPACK	-.117	.024	-.770	-4.911	<.001	-.164	-.070

Dependent Variable: TK