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Technology Use Among Senior High School Mathematics Teachers and the Factors That Influence It

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Abstract: The study's objectives were to examine the usage of technology among Ghanaian senior high school mathematics instructors and to identify the factors that affect this use. The study used a descriptive survey (cross-sectional survey) approach and blended quantitative and qualitative data. All SHS mathematics teachers in the Sissala-East District of the Upper West area made up the study's population. Among rural, peri-urban, and urban schools in the district, 60 SHS mathematics teachers were chosen using a stratified sample technique. The results showed that the district's Senior High School level utilised less technology in the teaching of mathematics (2.048.85388). The study identified the usage of technology in mathematics instruction by SHS teachers. Manipulative, digital/computer-based, and audio-visual technologies were all combined into one category. The findings showed that the majority of teachers (3.120 ± 1.063) used manipulatives when teaching mathematics. The survey found that protractors were more frequently utilised with manipulatives than graph boards and cardboards, which were used the least by mathematics teachers in the district. However, the data also revealed that the district's mathematics teachers never employed digital/computer-based tools such virtual protractors, mobile phones, calculators, geometry pads, stepping stones 2.0 comprehensive mathematics, or computer game programmes like Globaloria, etc. Similarly, evidence from the study adds that audio-visual technologies including television, pie chart assignment to students based on TV program and other audio-visual devices were never in use by mathematics teachers in the district ($1.416 \pm .712$). The study identified a number of variables that affect how technology is used by mathematics teachers. The results revealed that teachers' use of technology in teaching mathematics was significantly influenced by gender ($t = 22.684$, $p < .001$), age ($t = 15.444$, $p < .001$), experience in teaching ($t = 16.093$, $p < .001$), and location of the school ($t = 16.019$, $p < .001$). Also, despite the fact that there are many factors that may have an impact on the usage of various technologies in mathematics education, respondents cited ease of understanding as their primary motivation for doing so. The study proposed that the Ghana Education Service (GES), the Ministry of Education (MoE), the Government of Ghana (GoG), and NGOs help schools with infrastructure like computers and other visual and audio equipment as well as financial support. So, it is advised that mathematics teachers make an effort to employ these technologies in order to improve junior high school pupils' visual grasp of mathematics.

Keywords: Technology, Ghanaian, Mathematics, Teachers, Factors and Influence

1. Introduction

The needs of contemporary civilizations have also been impacted by the technology's quick progress, which has brought about notable changes in the 21st century. Education stakeholders and authorities in many nations throughout the world are very concerned about the push to integrate technology in education [1]. The majority of the teaching materials that were available to instructors up until recently were found in libraries. According to Campoy [14], technology offers a better technique to teach mathematics. Technology levels the playing pitch for all people; it is the greater equaliser. No of the student's academic level, using technology to teach and learn propels both high achievers and low achievers to previously unimaginable heights. Six guiding principles were provided by the National Council of Teachers of Mathematics [68] to help and direct instructors in enhancing the content and delivery of mathematics instruction. Equity, curriculum, teaching, learning, assessment, and technology were the six guiding concepts. Technology, one of these six principles, will be the subject of this study. Students have the ability to concentrate more on the applications of mathematics and less on its computational components thanks to the use of technology in mathematics education. According to Rojano [77], kids can learn more and at a deeper level of mathematics with the proper use of technology. According to him, the true learning in mathematics can start once the computational components are taken out. He insisted that employing technology helped students study mathematics more thoroughly. Technology relieves the load of computation on the pupils, allowing them the luxury of concentrating on the subjects being taught. Additionally, technology gives kids the chance to master the mathematics they are learning by giving them more time to model and conceptualise the concepts [68]. Students can produce multiple representations of solutions by using technology. Also, according to Furinas & Marinas [32], computers are an integral part of everyone's lives and children should learn how to utilise them as they grow into adults in order to better prepare them for the future. Also, they claimed that mathematics instructors use practical manipulatives to help their students' grasp of the transition from concrete to abstract.

According to several researches, technology is crucial to both the teaching and learning of mathematics. For instance, Becta. [11] claimed that the use of technology in maths enables pupils to concentrate on tactics and response interpretation rather than allotting time to laborious computer calculations. According to Tall & Ramos [85], the use of ICT in mathematics training helps students visualise the process and the concept role of symbols, which reaches its highest point in calculus. According to Ittigson & Zewe [39], technology boosts students' knowledge of fundamental concepts and improves the way mathematics should be taught. Once more, incorporating Information and Communication Technology (ICT) tools into mathematics instruction, such as computers and scientific calculators, has the potential to drastically alter pedagogical approaches and improve individual student learning outcomes by changing the social practises in the classroom [31]. Therefore, it is crucial that junior high school mathematics teachers include ICT into their lessons and encourage their students to do the same. The students will be able to comprehend the taught mathematical concepts more fully as a result. As more technologies have been available, so has the amount of technology used in the classroom. The use of electronic tools in the classroom increases student accomplishment [27], performance [54], and engagement [54, 81]. The use of new and sophisticated technologies has started to develop as a system that plays a beneficial function in students' learning as a result of the advancement of computer technology [36]. Nevertheless, according to Cuban [22], very few teachers utilise computers in the classroom on a regular basis). According to Waite [87], although instructors are very interested in and motivated to learn about the potential of technology, in reality, technology use is rather limited and is concentrated on a small number of applications, with word processing being the most common one. Several studies have focused on how teachers utilise technology to teach mathematics and the variables that affect this use. According to Keong, Horani & Daniel [41], mathematics teachers employ less technology in their lessons. Furthermore, Lau & Sim [47] research on Malaysian mathematics and science teachers shows that they regularly use the internet for surfing (53%), but less frequently for peer communication (26%), and personal development (12%). Their research also showed that teachers' frequent use of word processing (71%), presentation tools (50%) and courseware (63%), as well as their preparation and delivery of classes, may be related to their computer proficiency. A similar study by Yildirim [90] found that teachers mostly utilise technology to create handouts and assessments rather than to enhance students' higher order cognitive capabilities and promote critical thinking.

However, according to Becker [10], rather than involving students in learning that requires higher order thinking, teachers typically employed computer technology to support their current methods (providing practise exercises, demonstrations) and communicate (such as through the use of email). According to (Mereku, Yidana, Hodzi, Tete-Mensah & Williams) [56], although technology is utilised to type exam questions in all institutions and, in certain circumstances, to process students' exam results, relatively few Ghanaian professors actually use it to teach their pupils. Agyemang & Mereku [1] also stated that mathematics teachers frequently utilise technology for regular computer applications such researching information online for teaching, connecting with coworkers and students, sending emails, attaching files to emails, and creating lesson plans. Unfortunately, Ghana has relatively little utilisation of technology by these teachers when it comes to teaching mathematics.

Also, a number of studies have emphasised the elements that affect mathematics instructors' use of technology in the classroom. According to a study by (Mereku, Yidana, Hodzi, Tete-Mensah & Williams) [56], teachers' use of technology in the classroom is influenced by the availability of ICT textbooks and manual computers as well as computer labs that can be used sometimes. According to (Cassim & Eyono) [16], instructors' perceptions of the use of technology for the instruction of word problems are greatly influenced by their teaching experience, computer access, internet connection, and school location. In addition, Lau & Sim,[48] discovered that men teachers used computers more frequently and with greater assurance than female teachers. According to a study by [51], computer use is a male-dominated activity, and men are more likely than women to see technology favorably. Additionally, Samah Shaffril Hassan & D' Silva [79] assert that instructors' perceptions of the perceived ease of using ICT were significantly influenced by their own levels of self-efficacy. Also, a study by Agyemang & Mereku [1] found that gender and self-perceived technological efficacy have a statistically significant impact on how much technology is used in the classroom by Mathematics teachers. Statistics show that the use of technology in teaching by mathematics teachers is not statistically influenced by their age, teaching experience, school location, or access to technology resources.

Ghana's education stakeholders have expressed worry about how instructors and students utilise computers in the classroom and how their use promotes learning since the early 1990s [13]. As a result, Ghana launched the World Links for Development (WorLD) programme in 1997. This programme was created to employ technology to give teachers and students access to a world of learning. The program's objectives include helping teachers and students incorporate technology into their curricula, facilitating teacher-student collaboration on projects and distance learning, supporting students' use of computers and the internet as communication and research tools, and creating local educational content for the internet [46]. Incorporating technology into classroom instruction, according to the Ministry of Education, Youth and Sports (MOEYS) and Ghana Education Service (GES) (2002), ensures greater motivation, boosts self-esteem and confidence, improves good questioning skills, encourages initiative and independent learning, enhances presentation of information/outputs, fosters problem-solving abilities, encourages better information handling skills, lengthens focus time on task, and improves so many other factors. According to the Mathematical Syllabus for Senior High School (2012), the syllabus is made to assist students in using a calculator and a computer to solve problems and research real-world scenarios; students can also change learning materials to better comprehend concepts and abilities. The teaching syllabus for introductory ICT (SHS), published in 2012, is also intended to encourage students to use ICT in other subject areas.

In Ghana's Upper West region is the Sissala-East District. It is an area with some residents working in trading, while only a handful take on teaching or other white-collar jobs (Population and Housing Census, 2020). According to a report by the district public relations officer, the district is well-known for being underprivileged and has maintained a low rating in the Upper West region since 2008 due to low student achievement in both the Basic Education Certificate Examination (BECE) and WASCE, which are administered by the West Africa Examination Council (WAEC) (PRO). The majority of schools are located in the capital, with only a small number maybe located in peri-urban or urban areas. In order to support the district education system, the government and other non-governmental organisations (NGO's) have built computer laboratories with computers, provided laptops, built libraries with contemporary books, and provided teaching and learning resources like cardboards, drawing boards, mathematical sets, and ICT tools.

Additionally, the government and NGO's placed a high priority on the organisation of seminars, workshops, and conferences for teachers on how to incorporate technology in teaching and learning in order to upgrade the teachers, students, and education officers to meet national educational standards in Ghana and the rest of the world. In light of this, the Global Education Partnership Grant (GPEG), also known as the Ghana Partnership for Education Grant, was introduced in the Sissala-East District in 2011/2012 to cover the following expenses: raising awareness of education in the communities; buying teaching and learning materials (TLMs); buying a set of football jerseys; and arranging in-service training (INSET) for teachers on the use of contemporary technology in the classroom. The Global Education Partnership Grant (GPEG) is a fund established by the Ministry of Education (MoE) and Ghana Education Service (GES), according to the Ghana Partnership for Education Grant Project Implementation Manual (2013: 4), to improve planning, monitoring, and delivery of basic education services in 57 underprivileged districts of Ghana. The $75.5 million grant was given, among other things, to ensure that the four key components of access, quality, closing the gender gap, and management of education are met. Through the creation of strategic plans and school performance improvement plans (SPIP), which were created in tandem with annual performance work plans of the institutions to enhance programme management, monitoring, and evaluation, education directorates and schools, were able to access a US$4.58 million grant provided by the MoE and GES. Teachers in Senior high schools in the Sissala-East District have benefited from a number of in-service education and training programmes as a result of the GPEG. In order to determine whether mathematics teachers in the district are utilising the skills and information acquired from this in-service education and training programmes in terms of technology use, the researcher must first determine whether they are. The use of minimum standards as an assessment tool has helped identify various weaknesses in the performances of both students and teachers in some Ghanaian Senior high schools, according to a study by Mills & Mereku [58] about students' performance on the national minimum standards for Senior high school mathematics in the country. The results of the studies showed that around half of the SHS students had not met the minimal standards required by the mathematics curriculum. This demonstrated that despite appearing to have acquired mathematics from SHS1 to SHS2, the students had not actually mastered the fundamental concepts needed to meet the mathematics requirements of daily life. This forced the government to guarantee the availability of top-notch mathematics education. In an effort to integrate information and communication technologies into Ghanaian education at the basic and secondary school levels, education authorities there started a number of programmes at the turn of the millennium. For instance, the ICT for Accelerated Development (ICT4AD) policy aimed to establish a framework for the use of information and communication technologies to transform the educational sector and enable all Ghanaians to pursue quality opportunities for lifelong learning regardless of where they lived [75]. In addition to Ghana's recent educational reform, the National Council for Curriculum and Assessment (NaCCA), which was established in September 2019, has placed a strong emphasis on integrating ICT throughout all subject areas [60].

Also, there are now more computer labs at all levels of the educational system, which is evidence of the effectiveness of using computer technology in the delivery of education [89]. Moreover, ICT is now a required subject for all JHS students in Ghana. Additionally, the GPEG has helped the Sissala-East District since 2011/2012 with the use of technology in education through workshops, seminars, and the provision of ICT tools and updated teaching and learning materials. This is the case because, according to the rationale stated in the Ministry of Education [60], Mathematics Curriculum for B7-B10, "...mathematics is also concerned with the development of attitudes and therefore it is important for all citizens to be mathematically and technologically literate for sustainable development," the mathematics curriculum specifically emphasises the integration of technology in instruction. Also, the point 10 of the Instructional Expectations [60] and Mathematics Curriculum for B7-B10 stressed how to assist students in using appropriate technologies to address issues that are ingrained in their culture and the larger society. In the Upper West Region, the Sissala-East District has persistently maintained a low ranking for student accomplishment in the West African Examination Council Certificate Examination (WAEC). Consequently, incorporating technology into mathematics instruction and learning may be a suitable tactic to raise students' performance in the subject. The MOE anticipates that mathematics instructors will set the groundwork for classroom technology integration. Hence, it is necessary to evaluate how technology is used by mathematics teachers at the SHS level and identify the aspects that affect it. So, the goal of the current investigation was to determine the degree to which SHS Mathematics teachers in the Sissala-East District use technology in the classroom as well as the variables that affect this use.

1.1. Purpose and Objectives of the Study

The purpose of this study is to investigate the extent to which Ghanaian Senior High School (SHS) mathematics teachers use technology in teaching and also to uncover the factors that influence it.

1.2. Research Questions

This study will answer the following questions;

1) To what extent do SHS Mathematics teachers use technology in teaching of mathematics'?
2) What are the SHS mathematics teachers' views and perception of the influence of technology on mathematics' teaching?

1.3. Significance of the Study

The results will increase our grasp of the underlying mathematical theories. The Ministry of Education will benefit from giving Senior high school mathematics teachers access to technology resources. It will help parents and mathematics teachers rethink how they feel about using technology in the classroom to teach mathematics. According to the researcher, the data from the study will be utilised to enhance the professional abilities of mathematics teachers in integrating technology into their classes. The research will add to the wealth of literature connected to the entire global community.

2. Review of Related Literature

2.1. Theoretical Framework

The theoretical framework of the study was rooted in technological pedagogical content knowledge (TPCK).

2.1.1. Technological Pedagogical Content Knowledge (TPCK)

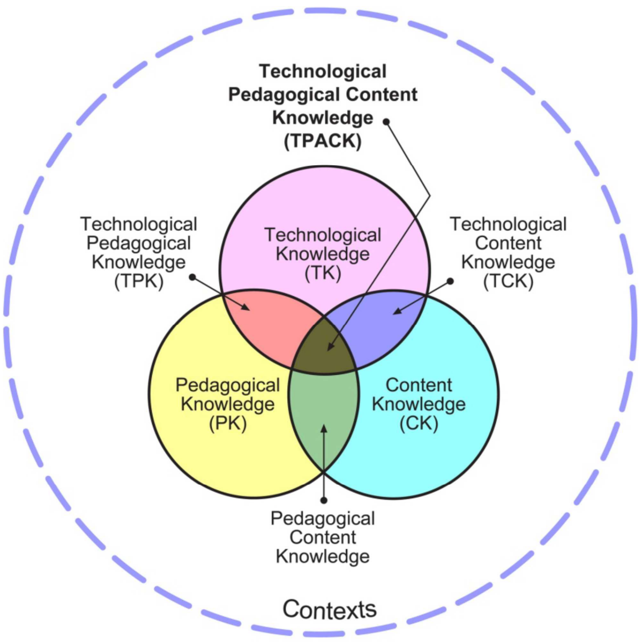

Figure 1. *The TPACK framework and its knowledge components.*

The design and operation of integration programmes depend on both technology and a theoretical framework [23]. In order to enable technology integration in learning-teaching contexts, Shulman (1986) developed the notion of pedagogical content Knowledge (PCK). Technological pedagogical content knowledge (TPCK) is a theoretical framework that was acquired by integrating the technology component to PCK. This theory explains how instructors' knowledge of educational technologies and PCK interact to provide efficient technology-enhanced instruction. To explain how teachers' knowledge of educational technologies and PCK interact with one another to produce effective teaching with technology, the TPACK framework relies on Shulman [82, 83] descriptions of PCK. Similar concepts have been presented by other authors, though frequently with different labeling schemes. The idea for TPACK discussed here has evolved over time and through a number of publications; the most thorough explanations of the framework may be found in Mishra & Koehler [59] and Koehler & Mishra [43]. Content, pedagogy, and technology make up the three key parts of this model (Figure 1) of instructors' expertise. The interconnections between and among these bodies of knowledge, represented by PCK, TCK (technological content knowledge), TPK (technological pedagogical knowledge), and TPACK, are equally significant to the model.

2.1.2. Content Knowledge

Teachers' subject-specific knowledge is referred to as their content knowledge (CK). The material that must be presented in middle school science or history is distinct from the material that must be covered in a doctoral seminar on astrophysics or an undergraduate course on art appreciation. Teacher content knowledge is crucially important. This knowledge would comprise understanding of concepts, theories, ideas, organisational frameworks, understanding of evidence and proof, as well as understanding of established processes and methods for acquiring such information, as mentioned by Shulman [83]. Teachers should be aware of the deeper knowledge principles of the disciplines they teach because knowledge and the nature of enquiry vary widely between fields. For instance, knowledge of scientific facts and ideas, the scientific method, and evidence-based reasoning would fall under this category in the context of science. Knowledge of art history, well-known paintings, sculptures, artists, and their historical contexts, as well as familiarity with aesthetic and psychological evaluation theories, would all fall under the category of knowledge relevant to art appreciation. Lack of a solid foundation in subject knowledge can be expensive; for instance, pupils may be given wrong information and create erroneous beliefs about the subject [68, 73]. Content knowledge is an unstructured field, however, and as the culture wars, debates over the Great Books [7, 15, 50], and legal disputes over the teaching of evolution [71] have shown, curriculum-related topics can give rise to a lot of contention and disagreement.

2.1.3. Pedagogical Knowledge

Teachers that possess strong pedagogical knowledge (PK) are knowledgeable about the procedures, techniques, and approaches used in teaching and learning. They cover a variety of topics, including general educational ideals, values, and purposes. This type of general knowledge is applicable to lesson design, student assessment, and general classroom management techniques. It comprises information about instructional strategies or procedures, the makeup of the intended audience, and techniques for gauging students' comprehension. A teacher with extensive pedagogical expertise knows how pupils build information and abilities, how they form mental habits, and how they form favorable attitudes towards learning. As a result, comprehension of cognitive, social, and developmental theories of learning and how they relate to students in the classroom is a prerequisite for pedagogical knowledge.

2.1.4. Pedagogical Content Knowledge

PCK is in line with and comparable to Shulman's concept of pedagogical knowledge that is suitable to the teaching of particular material. The idea of subject matter transformation for instruction is crucial to Shulman's understanding of PCK. According to Shulman [83], in particular, this transition takes place as the instructor interprets the information, discovers various ways to convey it, and adapts and customises the instructional materials to alternate perspectives and students' existing knowledge. The basic activities of teaching, learning, curriculum, assessment, and reporting are all covered by PCK, including factors that encourage learning and connections between pedagogy, assessment, and curriculum. Effective teaching requires an understanding of common misconceptions and approaches to addressing them, the significance of creating connections between various content-based ideas, students' prior knowledge, alternative teaching strategies, and the flexibility that comes from exploring different angles on the same idea or issue.

2.1.5. Technology Knowledge

More than the other two basic knowledge categories in the TPACK architecture, technology knowledge (TK) is always changing (pedagogy and content). As a result, defining it is famously challenging. By the time this material is written, any definition of technological knowledge may be out of date. Yet, not all technology tools and resources require the same approaches to thinking about and using them. The Committee of Information Technology Literacy of the National Research Council's recommended Fluency of Information Technology (FITness) is similar to the definition of TK utilised in the TPACK framework [67]. They contend that FITness goes beyond conventional ideas of computer literacy to demand that people have a thorough understanding of information technology to apply it effectively in their daily lives and at work, to recognise when information technology can help or hinder the achievement of a goal, and to continuously adapt to changes in information technology. So, unlike the conventional notion of computer literacy, FITness necessitates a deeper, more fundamental grasp and command of information technology for information processing, communication, and problem solving. By acquiring TK in this way, one can use information technology to carry out a range of jobs and create new methods for carrying out a certain work. Instead of positing a "final state," this conception of TK considers it to be a progressive process that develops during a lifetime of creative, open-ended interaction with technology.

2.1.6. Technological Content Knowledge

Technology and content knowledge have a long-standing link; advancements in subjects as disparate as physics, medicine, history, and archaeology have all been accompanied by the emergence of new technologies that enable the representation and productive use of data. Think about how the development of X-rays by Roentgen or the use of carbon-14 dating has affected the study of medicine and archaeology. Think about how the development of the digital computer altered physics and mathematics and increased the importance of simulation in the study of phenomena. New metaphors for comprehending the world have also emerged as a result of technological advancements. Technologies have opened up new avenues for comprehending phenomena, such as seeing the brain as an information processing system or the heart as a pump. These conceptual and representational linkages go deeper than they appear. These frequently resulted in profound alterations to the disciplines' natures.

Creating the right technical tools for educational purposes requires an understanding of how technology affects the practices and knowledge of a particular field. The varieties of content concepts that can be taught are both facilitated and constrained by the technology choices made. Similar to how certain content choices can restrict the technology that can be used. Technology might limit the types of representations that are feasible, but it can also make it possible to create newer and more diversified representations. Moreover, technical tools may offer additional flexibility while exploring these representations. TCK is thus knowledge of the ways in which content and technology interact and impact one another. More than just the subject matter they teach, teachers need to have a thorough awareness of how the subject matter (or the types of representations that can be created) can be altered by the use of specific technologies. Instructors need to be aware of the precise technologies that are most effective for addressing subject-matter learning in their fields, as well as the ways that either the technology or the content is dictated by or even altered by the other.

2.1.7. Technological Pedagogical Knowledge

TPK is the study of how specific technologies utilised in specific ways can alter teaching and learning. Knowing the pedagogical benefits and limitations of a variety of technological tools in relation to discipline- and developmentally appropriate educational designs and tactics is part of this. A greater comprehension of the limitations and affordances of technologies as well as the disciplinary settings in which they operate is required to construct TPK. Take the use of whiteboards in classrooms, for instance. It is assumed that a whiteboard will be used in classrooms because it is often stationary, widely visible, and simple to alter. As a result, the teacher typically uses the whiteboard, which is situated at the front of the classroom. Since students frequently can only use it when the teacher calls on them, this area imposes a specific physical order on the classroom by dictating the positioning of tables and chairs and structuring the type of student-teacher interaction.

It would be false, nevertheless, to claim that there is only one application for whiteboards. To illustrate a very different application of this technology, compare it to the use of a whiteboard in a brainstorming session held in a setting of an advertising agency. The whiteboard in this situation is not under the control of one person. Anybody in the group is free to utilise it, and it becomes the centre around which conversation and the negotiation/construction of meaning takes place. Understanding technology affordances and how they might be used differently depending on context and purposes changes is a crucial component of TPK. Because the majority of widely used software packages are not made for educational objectives, TPK becomes especially crucial. Typically, business environments are the target audience for software packages like the Microsoft Office Suite (Word, PowerPoint, Excel, Entourage, and MSN Messenger). Blogs and podcasts are examples of web-based technologies that are intended for social networking, communication, and entertainment. Instructors must reject functional fixity [26] and acquire the knowledge and abilities to see beyond the most typical applications of technologies, reconfiguring them for specific instructional goals. Hence, TPK demands a future-focused, imaginative, and open-minded approach to using technology, not for its own sake but in order to advance student learning and understanding.

2.1.8. Technology, Pedagogy, and Content Knowledge

There is an emerging body of knowledge known as TPACK that goes beyond the three "core" elements (content, pedagogy, and technology). An understanding that results from interactions between content, pedagogy, and technological knowledge is known as technological pedagogical content knowledge. TPACK is distinct from individual understanding of any of the three principles, and it underpins highly relevant and profoundly skillful teaching with technology. Instead, TPACK is the cornerstone of effective teaching with technology, necessitating an understanding of the representation of concepts using technologies, pedagogical techniques that use technologies in constructive ways to teach content, knowledge of what makes concepts difficult or easy to learn and how technology can help solve some of the issues that students face, knowledge of students' prior knowledge and theories of epistemology, and knowledge of how technologies can be used to enhance learning.

Expert teachers use TPACK whenever they teach by combining their knowledge of technology, pedagogy, and material at the same time. There is no one technical solution that works for all teachers, all courses, or all points of view on teaching because each circumstance that is offered to teachers is a special combination of these three elements. The ability of a teacher to nimbly negotiate the spaces established by the three aspects of material, pedagogy, and technology as well as the intricate interactions between these elements in particular circumstances is where the solutions reside.

Oversimplified solutions or failure might result from ignoring the complexity included in each knowledge component or the complexity of the relationships between the components. So, in order to create efficient solutions, teachers must become fluent and cognitively flexible in not only each of the three major domains (T, P, and C), but also in the way that these domains and contextual elements interact. This kind of comprehensive, adaptable, practical, and nuanced knowledge of teaching using technology was taken into account when TPACK was being considered as a professional knowledge construct.

It is not easy to see technology, pedagogy, and content as three interconnected knowledge bases. As previously said, disentangling the three elements (material, pedagogy, and technology) requires analysis, which is challenging to do in actual teaching situations. These elements actually exist in a condition of dynamic equilibrium, or as the philosopher [44] put it, in a state of "essential tension." It does a serious disservice to good teaching to consider any of these elements in isolation from the others. The three elements of our framework for teaching and learning with technology are in a dynamic transactional connection; any change to one of the aspects must be "paid" for by modifications to the other two [8, 24, 78]. This compensation is particularly noticeable when utilising new educational technology unexpectedly compels teachers to address fundamental educational challenges and rebuild the dynamic equilibrium between all three elements [59], (p. 1029). This viewpoint challenges the widespread belief that instructional objectives and technological frameworks are drawn from subject-matter curricula. Rarely are things that easy, especially when using more recent technologies. One instance of the arrival of a technology that forced educators to consider fundamental pedagogical issues is the introduction of the Internet, particularly the rise of online learning. These issues include how to represent content on the Web and how to connect students with subject matter and with one another [72].

Technology-based instruction is challenging to master. According to the TPACK framework, teaching/learning environments, pedagogy, technology, and content all have responsibilities to play both individually and together. In order to properly teach with technology, a dynamic equilibrium must be constantly established, maintained, and restored. It is important to keep in mind that a variety of variables affect how this balance is established.

2.1.9. Technologies for Mathematics Instruction

Mathematical terminology is essential to comprehending mathematics, according to the study authors. An alphabetical lexicon of thousands of mathematics vocabulary words may be found on the excellent learning site Study Geek. A variety of educational movies are also available, covering topics like algebra and geometry. The purpose of the game is to evaluate students' recollection of mathematics vocabulary, and they will enjoy playing the game while learning. Nayak Vidyalaya William & Kolkata [69] claim that a range of technological platforms are presently used in conventional classrooms. Radio, television, audio and video tapes, slide projectors, and overhead projectors are examples of passive learning when there is little interaction from the learner.

Computer in the classroom: Each teacher can benefit from having a computer in the classroom. Teachers can showcase a new lesson, offer new information, demonstrate how to use new programmes, and show new websites when there is a computer in the classroom.

Wikis and class blogs are two examples of the Web 2.0 tools that are currently being used in the classroom. With the help of blogs, students may keep an ongoing conversation going about their thoughts, ideas, and assignments while also allowing for student feedback and reflection. Wikis are more geared towards groups so that numerous group members can edit a single document and produce a truly collaborative and meticulously edited final product.

Wireless classroom microphones: Teachers can be heard more clearly by pupils in noisy classrooms thanks to the use of microphones. When the teacher is heard clearly, the students learn more effectively.

Mobile gadgets: By giving lecturers the chance to receive feedback, mobile devices like clickers or smart phones can improve the experience in the classroom.

Interactive Whiteboards: A touchscreen interactive whiteboard that allows users to engage with computer programmes. They enrich the learning environment by displaying anything that can be displayed on a computer screen. The students can draw, write, or alter images on the interactive whiteboard thanks to this, which not only supports visual learning.

Digital video-on-demand: By avoiding the use of the open Internet, digital video eliminates the requirement for in-classroom hardware (players) and enables teachers and students to instantly access video clips.

Online media: Websites that stream videos can be used to improve lessons in the classroom. Online study tools: Resources that encourage learning by making it more enjoyable or personalised for the user.

Digital Games: Over the past few years, the market for instructional and serious games has seen substantial growth. The use of digital games in the classroom has received a lot of good feedback, including an increase in student motivation. Several additional tools are used, depending on the funding options and the local school board. They could be LCD projectors, document cameras, interactive whiteboard tools, digital cameras, or video cameras.

2.1.10. Softwares Used for Teaching and Learning Mathematics

1) Graphic Calculators
2) Dynamic graphing tools (Geo gebra)
3) Dynamic geometry tools
4) Microsoft Excel / spreadsheet
5) Microsoft Mathematics
6) Geo Gebra
7) Auto shape
8) Mat lab

In conclusion, these programmes encourage students to become more self-aware and help them understand how mathematics is a crucial component of their everyday lives. Students can take charge of their academic success and develop a positive relationship with the subject that they previously felt ambivalent about by using these technologies.

2.2. Impact of Technology Use in Mathematics Instruction

A recent OECD research, Drijvers [25], raises the issue of what proof there is that employing digital technology in mathematics instruction is beneficial. We revisit the most important recent review papers in this field and concentrate on experimental and quantitative investigations to evaluate this. The findings indicate that, while having only modest effect sizes, the usage of digital technology has a positive impact on students' academic performance. An appeal is made for replication research and studies that pinpoint critical variables by combining a methodologically sound design with a theoretical underpinning of domain-specific ideas from mathematics didactics.

The impacts of educational technology applications on mathematics achievement in K–12 schools were reviewed by Cheung & Slavin [18]. In contrast to earlier evaluations, this one uses uniform inclusion criteria and concentrates on research that adhered to strict methodological criteria. The relationship between educational technology applications and study features is also studied, along with the methodological and substantive aspects of the investigations. With a total sample size of 56,886 K–12 students, 74 qualified studies with 45 elementary studies (N = 31,555) and 29 secondary studies (N = 25,331) were included in our final analysis. The results imply that educational technology applications generally provided a favorable, albeit modest, effect (ES = +0.15) in comparison to conventional techniques, which is consistent with the more recent reviews. By instructional technology type, the results could, however, differ. Supplemental CAI had the biggest impact of the three categories of educational technology applications, with an effect size of +0.18. The effect sizes of the other two interventions, comprehensive programmes and computer-management learning, were substantially less, at +0.08 and +0.07, respectively. Discussion is also had regarding the varying effects of various study elements and methodological aspects.

The effect of technology on elementary children' ability to learn was the subject of a meta-analysis by Chauhan [17] in India. According to the research currently available, technology can be a potent instrument for elementary children' successful learning provided it is fully included into pedagogy. The quantitative data from 122 peer-reviewed scholarly studies measuring the effect of technology on primary kids' learning effectiveness were combined in this study's meta-analysis. The findings showed that technology had a moderate impact on elementary pupils' ability to learn. The effect sizes of moderating factors such domain subject, application kind, intervention length, and learning environment were also examined in this study. After discussing the impact of technology at various levels of moderating variables, the consequences for theory and practice are given.

The use of technology in secondary mathematics classrooms: the instance of one school district at Lamar County School District in Southern Mississippi was the subject of a study done by Watson [88]. The research study surveyed 31 teachers of students in grades 6 through 12 in the Lamar County School District in southern Mississippi about the availability, utilisation, and requirements for professional development related to technology use. In this survey research study, the utilisation of the available technologies in mathematics teaching and learning as well as the needs of mathematics instructors for technological professional development were evaluated.

A convenience sample was used by the researcher. Not only is this school district nearby the researcher, but only the caretaker replied when the researcher asked if she may interview the secondary Mathematics teachers there. Although this sample is not a true representation of Mississippi mathematics teachers, the researcher found it to be the most practical to draw from it.

Teachers of mathematics for grades 6 through 12 from the Lamar County School District (LCSD) in Mississippi were the participants. Thirteen of the 62 instructors in the LCSD teach grades 6–8 and seventeen teach years 9–12. There are 62 teachers, of which 8 are men and 54 women. The purpose of this survey was to evaluate teachers' use of technology in the classroom as well as their professional development experiences related to that use. The survey's opening three questions asked about the participants' demographics. The researcher was interested in the participants' genders, experience levels, and mathematics courses they had taught. The next question from the researcher was if the respondents thought technology was an essential tool for teaching and learning mathematics. The researcher did not want the participants' comments to be restricted because new technologies are continually being developed. They made the question open-ended, allowing teachers to list any tools they employ.

A study on the impact of performance evaluation using a graphic calculator on mathematics achievement in Malaysia was done by Idris & Meng [38]. In that study, the impact of performance evaluation, which included the use of a graphic calculator, on secondary pupils' achievement in mathematics was to be investigated. This study used a non-equivalent quasi-experimental control group design for its investigation. Eleven public secondary schools were chosen at random from from those in Malaysia's six states of Malacca, Selangor, Pahang, Terengganu, Johor, and the Federal Territory of Kuala Lumpur. These states represent various geographic regions as well as various economic, social, and cultural backgrounds of the nation's student body. Eight of the eleven schools included for the study are found in state capitals, thus the students there, particularly those attending the three city schools in Kuala Lumpur, come from more urban areas.

However, the kids at the Pahang School came from a more rural background, and their parents were mostly engaged in farming and fishing. The schools that were selected had to have at least two Form Four courses being taught by qualified Mathematics teachers. One class served as the experimental group and the other class served as the control group for each school. The Form Four pupils made up the sample. The kids were 16 years old on average. They represented the three main ethnic groups in the nation: Malays, Chinese, and Indians. These pupils successfully completed three years of lower secondary school, culminating in the Lower Secondary School Assessment (Penilaian Menengah Rendah or PMR) at the conclusion of Form Three, when they entered Form Four. These children had to pass seven PMR subjects, including Malay Language, English Language, Mathematics, Science, History, Geography, and Living Skills, in order to advance to Form Four. As a supplementary topic, some students may choose to pursue Tamil, Chinese, or Islamic Studies. There were 844 total students in the sample, 423 of whom were in the experimental group and 421 in the control group. Pre- and posttests were used to gather quantitative information about the mathematics proficiency of secondary pupils before and after the intervention. The outcomes demonstrated that following the intervention, the experimental groups in each of the eleven schools outperformed the control groups on the mathematics achievement exam, demonstrating the efficacy of performance assessment using graphic calculators to raise secondary students' mathematics scores.

Technology use in classrooms is thought to have a good effect on students' success and attitudes towards lessons in the modern world, according to Eyyam & Yaratan [28] study, Effect of use of technology in Mathematics Lessons on Student Attitudes and Achievement. This study looked at how students felt about using technology in the classroom and whether it helped them perform better in school. We employed a quasi-experimental research design, assigning 3 groups—3 experimental groups (n = 41) and 2 control groups—2 control groups (n = 41) to the study. The chosen subject to study was mathematics. A pretest and a posttest were completed by all groups. Lessons for the control groups were taught using conventional teaching techniques, whereas lessons for the experimental groups were created utilising a variety of technological tools. The experimental groups filled out a scale at the conclusion of the study to look into the preferences and attitudes of the students about technology-based instruction.

The posttest results for the groups who received instruction without the use of technology were significantly lower than the posttest results for the groups who received instruction with it. This was determined by utilising a one-way ANCOVA to analyse the differences in posttest results. The findings indicated that pupils' attitudes on using technology were favourable. The ramifications for teachers and curriculum designers are highlighted. Also, the survey participants' sentiments towards the usage of instructional technology were largely favourable. The usage of educational technology has a good impact on students' performance, according to an analysis of the mean results of their performance, and the results of the students' advancement show this impact.

2.3. Factors That Influence the Use of Technology in Mathematics Instruction

[1] conducted research on the use of technology by Ghanaian senior high school mathematics instructors in order to better understand the factors that affect their usage of technology. For the study, both quantitative and qualitative data were collected using a cross-sectional survey approach. All Math teachers in the Ashanti region made up the study's population. In the Ashanti area, 80 Mathematics instructors from both rural and urban districts were chosen using a stratified sample technique. The results showed that very little technology was used in the classroom by SHS mathematics teachers. The Independent samples t-test showed that instructors with high perceived efficacy (Mean = 2.94, SD = 1.10) used more technology than teachers with low perceived efficacy (Mean = 1.63, SD = 0.51), and that male mathematics teachers used more technology than female teachers (Mean = 1.51, SD = 0.47). The study showed that the differences in self-perceived efficacy in technology use and the mean amount of technology use by male and female teachers were statistically significant (t = -2.44, p =0.02) and (t = -4.23, p =0.00), respectively.

A study on the use of ICT in the teaching and learning of mathematics was undertaken in 2016 by Asiedu-Addo, Apawu, and Owusu-Ansah, with a tracer study of mathematics educators. The study's goal was to do a follow-up on the use of ICTs in mathematics teaching and learning among in-service mathematics educators. The descriptive survey design was used for the investigation. 48 people were conveniently and consciously chosen as a sample. A questionnaire served as the data collection tool. Both quantitative and qualitative data analysis was done. According to the findings, 41.7% of participants were already integrating ICTs into the teaching and learning of mathematics, and 95.8% of participants were aware that such integration was taking place. The results also showed that MS Excel, MS PowerPoint, and MS Word were the three programmes that in-service mathematics educators most frequently used to create their lesson plans. The participants listed a few challenges they have when attempting to incorporate ICTs into their teaching and learning of mathematics as the lack of software, the absence of computers and other ICT devices, certain software being difficult to use, and pricey software. Statistics and probability are among the Mathematics curriculum areas where ICTs have been primarily incorporated. The majority of educators concurs or strongly concurs that using ICTs helps pupils learn. In order for in-service mathematics educators in Ghana who seek to integrate ICTs into the teaching and learning of mathematics to be able to do so without any obstacles, schools must be fully resourced with ICT hardware, software, etc.

In their 2016 study, Students and Teachers Views of ICT

Usage in Classroom: Pakistani Classrooms, Khokhar and Javaid found that the use of information and communication technology (ICT) has significantly contributed to the global transformation of education. In Pakistan, ICT usage has expanded during the past ten years. ICT use in classrooms is emphasised in the Government of Pakistan's most recent educational policy. The curriculum materials have also advised teachers to incorporate ICT into the teaching and learning procedures in their classrooms. This study is limited to Pakistan's four largest cities and focuses on the use of ICT in schools there. The study looks into how teachers and students use ICT in daily life.

The study investigates how students perceive their teachers' use of ICT for instruction, learning, and evaluation in the classroom. Data from secondary school students (classes 7, 8, 9, 10, and 11) and teachers of secondary classes were gathered using survey questionnaires. To take part in this study, schools were recruited. According to the survey, both students and teachers have access to computers both at school and at home, and they utilise them for a variety of activities including communication, education, and enjoyment. The study also reveals discrepancies between teachers' and students' views on how and what technology should be used in the classroom. Two opposing viewpoints are found by the study. While students disagree with their teacher's idea of integrating ICT in the classroom, teachers contend that they use it efficiently.

In their 2011 study, Cassim and Eyono Obono investigated the variables influencing the adoption of ICT for the instruction of word problems. The quantitative analysis of data gathered from a questionnaire-based survey of 102 foundation phase instructors, conducted within the theoretical framework of the Technological Acceptance Model (TAM), allowed for the accomplishment of this goal (grades 2, 3, & 4). These educators were chosen from 36 schools in the South African region of Kwa-Zulu Natal. According to the statistical and descriptive analysis of the survey data, teachers' adoption of ICT for the teaching of word problems was typically low despite their moderate awareness of ICT, attitude towards ICT, and perceptions of its utility and usability.

The Republic of Kenya's Nyandarua and Nairobi counties' secondary mathematics teachers' embrace of technology was the subject of a study by Kamau [40]. To further understand the statistical findings from the quantitative survey of 135 teachers, I used a sequential explanatory mixed methods technique to collect qualitative data from interviews and classroom observations of six instructors. I also drew on Rogers [76] diffusion of innovations theory. Using multiple regression analysis, I found six explanatory variables for technology adoption in the initial quantitative phase. The resulting R square was 61.2%, and the corrected R square was 59.3%. These six variables are as follows, along with their standardised regression coefficients (Beta): teacher age (-.321), school type (.267), Internet use at home and at school (.245), general educational technology (.301), in-service training (.527), and technology talks (.161). In the qualitative phase, the participants discussed the factors that influenced their choices on the use of technology in their classrooms, including demographics, technological training, and technology resources. Overall, the results showed that secondary Mathematics teachers in Kenya lacked technology skills and received little technology training. The Internet aided early adopters in self-training, access to learning resources, and teacher collaboration, but late adopters' opinions of technology in learning environments hindered technology adoption. Where technology was available, the teachers did not use it. Gender, education level, time, laptop ownership, and computer lab were a few of the non-significant variables. In fact, qualitative data showed that teachers' decisions to incorporate technology in the teaching of mathematics were hampered by the need for time to finish the curriculum and prepare technology-enhanced classes. Through this study, I have come to the conclusion that in-service training, rather than the availability of technology resources, is the most important factor in the technology adoption process. However, the relationship between the type of school and the teacher's age on the technology adoption score of a mathematics teacher is not well understood.

In their 2007 study, Li and Kirkup looked into gender disparities in this cross-cultural setting as well as differences in how Chinese and British students used the Internet and generally viewed computers. Responses to a self-report survey form from 245 British and 280 Chinese students are discussed. Between Chinese and British students, there were clear disparities in their views towards, use of, and confidence with regard to the Internet. Chinese students were more self-assured about their sophisticated computer skills, but British students were more willing to use computers for academic purposes. In both national groupings, there were also notable gender differences. In both nations, men were more likely than women to utilise chat rooms or email. Chinese men were the most avid gamers, with men playing more video games overall than women. Males were more self-assured about their computer skills than women in both nations, and men were also more inclined to believe that using computers was a man's hobby. The British group had more gender disparities than the Chinese group. The current study demonstrates how gender continues to play a significant role in how students perceive and use computers in various cultural situations. Researchers [3] examined the variables affecting the uptake and utilisation of internet services in Saudi Arabia. The study examined factors that affect the acceptance and consumption of e-services, particularly in Saudi Arabia, and was based on the diffusion of innovations (DOI) theory applied to the online world. Using survey questionnaire data from 651 participants, factors were empirically examined. In order to gather information for the study, a survey was carried out in 2008 in Saudi Arabia. The effectiveness of the Internet and its comparative advantage had a significant impact on Saudi Arabia's usage and acceptance of e-services. Participants' gender played a crucial impact in the adoption of e-services, and it was discovered that Saudi women are more likely than

Saudi men to do so. In 2005, Keong, Horani, and Daniel did research on the use of ICT in Malaysian mathematics instruction. According to early observations, teachers are not completely utilising these resources in their instruction. In order to understand the obstacles preventing the adoption and integration of information and communication technology (ICT) in the teaching of mathematics, a survey was undertaken. The study used a survey methodology to look into the use of ICT and the difficulties in incorporating it into mathematics instruction. The poll was done as part of a State Education Department in-service course on mathematics. The respondents received a briefing on the survey's objectives before to the survey's start.

2.4. Research Design

According to Creswell (2007, p. 3), "research designs are plans and procedures for research that span the decisions from broad assumptions to detailed methods of data collection and analysis,"

The study used a descriptive approach. Given that the events or conditions are already there, descriptive research examines relationships among non-manipulative factors [12]. Descriptive research, according to (Grimes & Schulz) [35] (p. 145), "is concerned with and designed merely to characterise the existing distribution of variables, without attention to causation or hypotheses." Descriptive study design, according to [4], concentrated on how to ascertain the state of a specific population with regard to particular factors. The researcher was particularly interested in the types of technology used in junior high school mathematics instruction, the factors that influence junior high school mathematics teachers' use of technology in instruction, and the impact of junior high school mathematics teachers' use of technology on students' learning outcomes and mathematical performance.

Fraenkel & Wallen [29] added that conducting descriptive research entailed posing the same kinds of inquiries, frequently in the form of questionnaires. The researcher employed a descriptive study design and a quantitative method to gather data. According to me, the quantitative methods of data collection allowed for significant generalisation in terms of the numerical connections that were present in the data and which represented the characteristics of the entire population. The choice of this design was made to enable the researcher to study disparities in the use of technology in the teaching and learning of mathematics by mathematics instructors at the SHS level based on sex, age, teaching experience, and school location. This study's design was crucial since it enabled the researcher to accurately and impartially characterise the phenomenon under investigation. Descriptive research gave the researcher the chance to assess the situation as it actually was. Despite the fact that the descriptive research approach is prone to information distortion due to bias, the researcher took special care to protect the data from the influence of bias from the researcher or the respondents. The researcher realised that the descriptive design was most appropriate for this research topic even though this design has some flaws, such as the challenge of getting respondents to answer questions thoughtfully and honestly. Instead of reporting on experimental and control groups, this study reported on the use of technology by SHS Mathematics teachers.

2.5. Population

In research, a population is defined as "a group of elements or cases, whether humans, things, or events, that conform to particular criteria and to which we wish to generalise the outcomes of the investigation," according to MacBride & Scshumacher [55] (p. 85). According to Fraenkel & Wallen [30], the population is the group that the researcher is interested in, or the group to whom the researcher hopes to generalise the findings of the study. Populations are therefore sums of all the people on which the researcher will base his or her conclusions. 78 public Senior High School Mathematics instructors from the Sissala-East District in the Upper West of the Republic of Ghana made up the study's population. There are twelve (15) circuits that make up the district.

2.6. Sample and Sampling Technique

A sample is a group of people chosen from a population who are typically intended to represent the population in a research study, according to (Gravetter & Forzano) [34], (p. 117).

The sample was chosen using probability sampling. By giving the population equal chances, a sample is chosen via probability sampling. From the 15 circuits in the district, 110 teachers were chosen using the stratified sampling technique. Once more, a proportional allocation method was used to choose five mathematics teachers from each of the district's 15 circuits using a simple random selection procedure. In the Sissala-East District, there are more than five mathematics teachers in each circuit. The teachers were handed a piece of paper with numbers 1 through 5, and those who chose those numbers were chosen for the study.

2.7. Questionnaire

A questionnaire is "a self-report data-collection instrument that each research participant fills out as part of a research project," according to Johnson and Christensen [37], (p. 162). According to (Sidhu) [80] (p. 131), among the data-gathering tools, this one is arguably the most used and abused. Moreover, it is thought to be the most adaptable technique for gathering both qualitative and quantitative data. The questionnaire was chosen over other tools because it was thought to be the quickest way to get a lot of data from the respondents. The questionnaire was also thought to ensure respondents' privacy and anonymity because it was typically self-reporting and so able to elicit more accurate answers. Also, using a questionnaire is less expensive than using other data collection methods like interviews and observation. The appendix A questionnaire featured an introduction section with questions about the respondents' backgrounds and a guarantee of secrecy and anonymity tied to the respondents' responses. The questionnaire's part B, which inquires about the types of technologies used in mathematics instruction, was answered using a 5-point Likert scale with the following labels: Not at all, Nearly Never, Sometimes, most of the time, and Almost Often. Section C of the questionnaire has the following response options: strongly disagree, disagree, disagree, uncertain, agree, and highly agree. Section D of the questionnaire offers questions on the variables that affect the use of technology in the teaching and learning of mathematics. There were open-ended and closed-ended questions on the survey for responders.

2.8. Validity of the Study

Validity is the ability of an instrument to measure what it is intended to measure and to do so in a proper or relevant manner. The researcher consulted with the Dean to get permission to have two senior lecturers at the School of education and lifelong learning at the S. D. Dombo University of Business and integrated development studies, who are experts in educational technology and mathematics, evaluate the questionnaire for content and construct as well as face validity.

Reliability of the Study

Similar to this, a pilot test was conducted on 20 teachers from each of the district's 15 circuits, where the majority of the schools are located in rural areas with a smaller number in peri-urban and metropolitan areas. According to [49], piloting or pilot studies are a chance to determine if the respondents understand the researcher's instructions. A pilot study does not, however, test a hypothesis; rather, it allows the researcher to assess and test for the larger-scale study's viability [49]. Before data collection started, the researcher's supervisor reviewed and piloted the questionnaire. The instrument was put through a trial-and-error process to ascertain its dependability and address questionnaire flaws. A survey questionnaire pilot test is a process where a researcher modifies an instrument based on feedback from the few people who complete and evaluate the instrument [20].

2.9. Data Collection Technique

Two weeks before to the scheduled date, the researcher requested authorization from the Sissala-East District Head Teachers to distribute the questionnaire to the Senior High School Mathematics Teachers. The study's goal was explained to the respondents, and they were urged to read all instructions thoroughly before responding to the questions. They received a guarantee of anonymity because research ethics required it. After giving them out, the Senior high school mathematics teachers filled them out and gave them back. It took two weeks to administer the surveys to the fifteen (15) circuits of chosen Senior high school mathematics teachers, most of them are located in rural areas with a small number in peri-urban and urban areas in the Sissala-East District. In total, 100 respondents were used for the study, including 57 men and 43 women. Because the researcher sought to guarantee excellent accessibility and a high response rate, the questionnaire was individually delivered by the researcher to the respondents.

Data Analysis

The researcher used descriptive statistics such as percentage, frequency, mean and standard deviation and, inferential statistics such as independent t-test and one-way Analysis of Variance (ANOVA) to test the null hypothesis using Statistical Package for Social Sciences (SPSS) version 16.0.

3. Results

3.1. SHS Mathematics Teachers' Use of Technology in Teaching of Mathematics

This section presents an analyses information on the specific kinds of technologies that are used by teachers in teaching mathematics. To achieve this, respondents rated the frequency to which they used various technologies in teaching, ranging from 1 = not at all, 2 = almost never, 3 = occasionally, 4 = most of the time, to 5 = almost always. The results were recoded as 1 & 2 = never, 3 = rarely, 4 & 5 = often, and used to present the summary of results on the mathematics teachers' use of basic technology in teaching.

The basic technologies used in teaching mathematics were categorised into manipulatives, digital/computer-based technology and audio-visual technology. Table 1 present the mathematics teachers' ratings of their frequency of using manipulatives in teaching.

Table 1. *Frequency and descriptive statistics of 'use of manipulatives in teaching of mathematics with technology'.*

Item	Never		Occasionally		Often		Mean	Std. Dev.
	N	%	N	%	N	%		
Protractor	20	16.67	45	37.5	55	45.83	4.2667	.79972
Graph board	40	33.33	70	58.33	10	8.33	2.4167	1.19734
Cardboards	36	30.0	66	55	18	15	2.8500	1.19071

Source: Field Data, 2020

The study determined whether mathematics teachers at the senior high level used various basic technologies in teaching mathematics as shown in Table 1 above. The results indicate that 45 (37.5%) of the respondents rarely used protractors in teaching mathematics compared to 55 (45.83%) who stated that they use protractors in teaching mathematics. This means that majority of the teachers who teach at the junior high level in the district used protractors in teaching mathematics. With regards to the use of graph board, it was found that 40 (33.33%) of the respondents affirmed that they never use graph boards in teaching mathematics compared to the remaining 70 (58.33%), and 10 (8.33%) who indicated that they rarely and often use graph boards in teaching mathematics respectively. This suggests that most mathematics teachers in the district do not use graph boards in teaching mathematics at the senior high level. Results of the study further revealed that while 36 (30.0%) of the respondent stated that they never use cardboards in teaching mathematics, 66 (55%) of the respondents and 18 (15%) of the respondents stated that they rarely use, and often use cardboards in teaching mathematics. The implication of this results is that majority of the teachers in the district who teach mathematics at the senior high level do not use cardboards. Based on the mean scores, the results revealed that the most used manipulatives in teaching Mathematics was protractor (4.266 ±.799) whilst the least used manipulatives in teaching Mathematics was found to be graph board (2.416 ± 1.197).

Table 2: presents the mathematics teachers' ratings of their frequency of using digital/computer-based technology in teaching.

Table 2. *Proportion of Mathematics Teachers' Use of Digital/Computer-based Technology in Teaching.*

Item	Never	Rarely	Often	Mean	Std. Dev.
	N	N	N		
Mobile phones	42	6	12	1.50	.81
Virtual protractor	39	6	15	1.60	.87
Stepping stones 2.0 comprehensive Mathematics	52	8	-	1.13	.34
Geometry Pad	51	6	3	1.20	.51
Computer game programs (eg. Globaloria, GetTheMath, etc.)	58	2	-	1.03	.18
Calculator	48	7	5	1.28	.61

Source: Field Data, 2023

The usage of several digital/computer-based technologies in relation to the teaching of mathematics was examined, as indicated in Table 2 According to the findings, only a small number of respondents, 6 (10.0%) and 12 (20.0%), admitted to ever using mobile phones in their mathematics classes, whereas 42 (70.0%) of respondents said they never do. This finding strongly shows that district mathematics teachers used their mobile phones for very little of their senior high mathematics instruction. Since 39 (65.0%), 6 (10.0%), and 15 (25.0%) of the respondents said they had never, seldom, or frequently utilised virtual protractors in teaching mathematics, it was determined that the use of virtual protractors by teachers was relatively low. As a result, few teachers in the district use virtual protractors when teaching mathematics. In a same vein, the majority of respondents to the poll (52, or 86.7%) said they had never used stepping stones 2.0 comprehensive mathematics, while only 8 (13.3%) said they had very occasionally used it. As a result, the vast majority of teachers in the district confirmed that they teach mathematics using stepping stones 2.0 comprehensive mathematics. In a similar line, 51 (85.0%) of the study participants who responded to the survey said they never used geometry pads when teaching mathematics. The remaining 6 (10.0%) and 3 (5.0%) respondents confirmed that they utilise geometry pads in their mathematics lessons both occasionally and frequently. This indicates that the majority of senior high mathematics instructors in the district do not use geometry pads in their lessons.

Also, it was observed that the majority of respondents (58, 96.7%) said they had never used computer game applications (such as Globaloria, GetTheMath, etc.) to teach arithmetic, despite the fact that only two respondents (3.3%) said they did. This demonstrates that teachers in the district did not employ computer game programmes (such as Globaloria, GetTheMath, etc.) as a type of digital or computer-based technology in their instruction of mathematics. In addition, 48 (80.0%) of the respondents said they had never used calculators when teaching mathematics, as opposed to the remaining 7 (11.7%) and 5 (8.3%) respondents who said they did so both frequently and infrequently. The findings imply that teachers of mathematics in the district's senior high schools do not utilise calculators when instructing students in the subject.

According to the findings in Table 2, the virtual protractor was the digital/computer-based teaching tool that senior high school students used the most (1,600.867) and computer gaming applications were the least (1,033.181) when it came to teaching mathematics.

Table 3 presents mathematics teachers’ use of audio-visual technology in teaching.

Table 3. *Proportion of Mathematics Teachers' Use of Audio-visual Technology in Teaching.*

Item	Never		Rarely		Often		Mean	Std. Dev.
	N	%	N	%	N	%		
Television	56	93.3	4	6.7	-	-	1.0667	.25155
Audio-Visual devices	52	86.7	8	13.3	-	-	1.1333	.34280
Pie chart assignment to students based on (TV) program (rainfall in Ghana)	48	80.0	7	11.7	5	8.3	1.2833	.61318

Source: Field Data, 2023

The outcomes depicted in Table 3 above also hint at the teachers' use of audio-visual tools when instructing maths. According to the survey, 56 (93.3%) of the respondents said they had never taught mathematics using television. Nonetheless, 4 (6.7%) of them stated that they hardly ever utilise television to teach maths. This demonstrates unequivocally that district mathematics teachers do not use the televisions provided in their classrooms and district libraries for teaching mathematics. Once more, statistics from the findings demonstrate that audio-visual aids are not employed in mathematics instruction. This is due to the fact that, compared to the few, 8 respondents (13.3%), who confirmed their infrequent use of audio-visual aids in mathematics instruction, 52 respondents (86.7%) said they had never used them. This indicates that the district's maths teachers don't use audio-visual aids at all to teach their subjects. Additionally, it was determined from the results that, while 5 (8.3%) and 7 (11.7%) of the respondents claimed to have given students pie chart assignments based on television programmes about Ghana's rainfall, the majority (48, 80.0%) of them said they had never done so. This finding implies that the majority of the district's mathematics teachers do not give students pie chart assignments (rainfall in Ghana). It was possible to draw the conclusion that instructors in the district used a variety of basic tools when teaching mathematics based on the results mentioned above. On the other hand, teachers in the district did not use audio-visual or digital/computer-based technology to teach mathematics. Additional investigation, as shown in Table 3 above, revealed that the assignment of pie charts to students based on (TV) programmes about rainfall in Ghana was the most commonly used audio-visual teaching tool, whereas television was the least frequently utilised (1.066.251). The outcomes of teachers' overall technology utilisation in teaching mathematics are shown in Table 4. It was discovered that the district's senior high school level mathematics instructors used very little technology to teach their subjects (2.048.85388).

Table 4. *SHS mathematics teachers' overall use of technology in teaching of mathematics'.*

	N	Min	Max	Mean	Std. Dev.
Use of manipulatives	60	1.50	5.00	3.1208	1.06315
Use of digital/computer tools	60	1.00	3.86	1.6214	.84036
Use of audio-visual tools	60	1.00	3.33	1.4167	.71208
Overall use of technology in teaching of mathematics'	60	1.15	4.08	2.0487	.85388

Source: Field Data, 2023

The overall usage of technology in maths instruction was given in Table 4 above. The findings showed that manipulatives were frequently employed by instructors when teaching mathematics (3.120 1.063). The teachers of mathematics at the junior high school level, however, were found to never employ digital/computer tools or audio-visual aids (1.621.840; 1.416.712).

3.2. Reasons for the Use of Technologies, and Other Technologies Used, in Mathematics Instruction

Reasons for the use of various technologies in mathematics instruction by mathematics teachers are presented in Table 5.

Table 5. *Respondents' Reasons for the Use of various Technologies in Mathematics Instruction.*

Reasons	Frequency	Percentage (%)
Makes learning simple and easier/easy understanding	39	70.9
Helps to improve pupils' learning/identification of pupils' learning abilities	32	58.2
Ensures the participation of pupils in learning process	16	29.1
For easy calculations (of areas of plane shapes, and complex mathematical problems)	27	49.1
Help students to get a pictorial representation of mathematical pupils	18	32.7
Ensures child-centeredness in teaching	18	32.7
Reduces too much talking in lesson delivery	19	34.5
Lack of electricity/teaching equipment	6	10.9
Inadequate lesson times for subject	3	5.5

Source: Field Data, 2023 *Total does not add up to 100% due to multiple responses

The justifications for utilising technology in mathematics instruction were examined, as can be seen in Table 5 above. It was discovered that the benefits of using technology in mathematics instruction included making learning simple and easier and improving understanding (39, 70.9%), assisting in improving students' learning and identifying students' learning abilities (32, 58.2%), ensuring students' participation in the learning process (16, 29.1%), and making it easier for students to calculate the areas of plane shapes and solve complex mathematical problems (27, 49.1%). However, it was discovered that the usage of various cutting-edge technologies, such as digital/computer-based and audio-visual technologies, was limited because of a lack of electricity and instructional materials (6, 10.9%) and insufficient class lengths (3, 5.5%). Although though several justifications for adopting various technologies in math instruction have been identified, respondents' top justification for doing so was to make learning straightforward and simple to grasp. In other words, the desire to make mathematics learning straightforward and simpler to comprehend motivates teachers to use a variety of technology into their mathematics lessons. Table 6 lists additional technology that math teachers employ in the classroom along with their justifications.

Table 6. *Other technologies Used by Respondents in Teaching Mathematics.*

Technology	Reasons
Abacus	Aid in the teaching of the concept of place value
Geoboard	Making the teaching of plane shapes such as rectangles and squares
Wall clock	Bring wall clock to the classroom for pupils to observe as it is a real material that can enhance the understanding of lesson such as bearing
Compass	For teaching construction
MS Encarta	Has been my technological tool used to learn or study on my own and I have introduced learners who have personal computers to use to learn mathematics. And it is helping those learners.
Smartphones	To search for information and some mathematics games to teach the learners
	Have been using the internet through mathematics sites mostly www.mathefun.com. I get access to all mathematical topics at all levels of teaching.

Source: Field Data, 2023

In addition to the technologies listed in Table 3 above, respondents were asked to list any additional technologies they employed in the classroom to teach mathematics, along with the justifications for doing so. The findings showed that the following respondents used the extra technologies listed below in teaching mathematics for the goals listed in Table 6 above. It was discovered that the abacus, wall clock, compass, MS Encarta, and smartphones were among the additional technology used by respondents in teaching mathematics.

4. Discussion of Results

The usage of technology and the elements that affect it in the teaching of mathematics have been recognised. According to the survey, most math teachers in the district typically employ manipulatives, particularly protractors, to teach their students. The teaching of mathematics did not make use of other technologies, such as digital/computer-based or audio-visual ones. The results of the current study revealed that digital/computer-based technologies, including stepping stones 2.0 comprehensive Mathematics, geometry Pad, charts, and other geometric features, computer game programmes such as Globaloria, GetTheMath, etc., and use of digital/computer-based technologies, differ from those of (Lynch & Ghergulescu) [53] who identified the use of numerous technologies such as the use of charts, stepping stones 2.0 comprehensive mathematics, and more.

Once more, the report shows that teachers did not employ audio-visual aids when teaching mathematics. This might be the result of the relatively high cost of such technology, which limited their use in junior high schools. This outcome was in contrast to that of Nayak, Vidyalaya, William & Kolkata) [69] who found that the traditional classroom made use of a variety of audio-visual media, including radio, television, audio cassette, and others. Yet, it was noted that maths teachers had never used these technologies. This is in contrast to (Agyemang & Mereku) [1] findings, which showed that instructors of mathematics in particular schools in Ghana's Ashanti area employed technology in their instruction. The usage of the aforementioned technologies was determined to be necessary in order to make mathematics both simple for students to learn and understand. These initiatives to make mathematics simpler to learn might be motivated mostly by students' subpar maths performance. Making sure it is simple to understand could therefore improve pupils' maths proficiency. Also, the study found characteristics that strongly influence junior high school mathematics teachers' use of technology in teaching. The findings of this study confirmed that the gender of mathematics teachers influences their use of technology, which is consistent with previous research by (Agyemang & Mereku) [1], who discovered that male mathematics teachers use technology more frequently than female teachers in the United Arab Emirates (UAE). Given that teaching mathematics is a profession predominately held by men, it is possible that male teachers are more likely than female teachers to employ technology in the classroom. The use of technology in the teaching of mathematics has also been shown to be significantly influenced by the teaching experience of the instructors. This is in line with the findings of (Drijvers) [25], who found that a mathematics teacher's experiences have a big impact on how they use technology to teach mathematics. This may imply that teachers with more classroom experience will have a better understanding of their pupils and how to best adapt technology to their needs. For instructors with less teaching experience, the reverse may be true.

It was also revealed that the district's senior high school mathematics teachers' usage of technology is significantly influenced by the school's location. This finding suggests that schools in the district's urban districts are more likely to have an advantage over those in its peri-urban and rural areas. Encouraging, as opposed to other areas, the use of technology in mathematical education. This is in contrast to the findings of (Agyemang & Mereku) [1], who found that the school's location had little to no impact on the utilisation of mathematics teachers in instruction. Additionally, research showing that teachers' ages influence how they use technology to teach mathematics teachers also supports earlier research showing that teachers' ages influence how they use technology to teach. This implies that young, tech-savvy teachers are more likely than older, less tech-savvy teachers to employ technology in the classroom to teach mathematics. Additionally, it has been discovered that incorporating technology into maths instruction has a number of advantageous implications on both teaching and learning results. The main benefit was that it inspired pupils and encouraged them to adopt favourable attitudes about arithmetic teaching and learning. This is in line with the findings of researchers like [25, 18, 28], and [84] who found that using technology in the classroom had a favourable impact on students' performance and outcomes. The results also showed that there was little total technology use in mathematics instruction by instructors. The results are in line with those of (Agyemang & Mereku) [1], who discovered that the general use of technology by maths teachers in the classroom is low.

4.1. Summary of Findings

This section gives a summary of the study's findings, which were arranged in accordance with its goals. They covered the variables influencing teachers' use of technology, the attitudes and perceptions of SHS mathematics teachers on the use of technology on mathematics teaching and learning, and the usage of technology in teaching mathematics by SHS mathematics teachers;

4.2. SHS Mathematics Teachers' Use of Technology in Teaching of Mathematics'

The study identified the usage of technology in mathematics instruction by SHS teachers. Manipulative, digital/computer-based, and audio-visual technologies were all combined into one category. The survey found that protractors were more frequently utilised with manipulatives than graph boards and cardboards, which were used the least by mathematics teachers in the district. Contrarily, the findings also demonstrated that the district's mathematics teachers never made use of digital/computer-based tools such virtual protractors, mobile phones, calculators, geometry pads, stepping stones 2.0 comprehensive mathematics, and computer game programmes like Globaloria, etc. Also, the study's findings show that mathematics teachers in the district never used audio-visual technologies like television, pie charts assigned to students based on TV programmes, or other audio-visual gadgets. The findings suggest that while digital/computer-based and audio-visual technologies are not used in senior high mathematics instruction, manipulatives are. As teachers evaluated their usage of technology as never, it may be deduced from the results that there was very little technology utilised in mathematics instruction. Despite multiple factors that have been shown to affect the usage of various technologies in mathematics education, respondents' top justification for doing so was to make learning straightforward and simple to grasp. In other words, the desire to make mathematics learning straightforward and simpler to comprehend motivates teachers to use a variety of technology into their maths lessons.

4.3. SHS Mathematics Teachers' Views on and Perception of Technology Use on Mathematics Teaching and Learning

Also, opinions on how technology is used in mathematics instruction were looked at. The majority of the teachers believed that using technology to teach mathematics has an impact on the teaching and learning outcomes, while those who disagreed did so by claiming that the school does not have access to such technologies. Likewise, the majority of respondents believed that the usage of technology had a beneficial impact on teaching and learning results. Understanding the impact of technology on the practises and knowledge of a given discipline is critical to developing appropriate technological tools for educational purposes. These views on technology use were established to include content dictates or perhaps even change the technology or vice versa, constrain the types of content ideas that can be taught, constrains the types of possible representations, and provides a greater degree of flexibility in navigating across these. While the most and least negative effects of technology use in teaching mathematics were encouraging students to adopt positive attitudes towards mathematics teaching and learning as well as limiting the kinds of representations that can be used, respectively. Regarding other effects of technology use on mathematics instruction, it was observed that most teachers affirmed to a positive effect, specifically including encouraging the development of a culture of effective teaching by teachers where teachers are encouraged to broaden curriculum objectives, use more problem-solving examples, and use an inquiry approach to learning, makes mathematics instruction in the teaching and learning simple, and aids students.

5. Conclusion

The purpose of the study was to determine the extent to which Ghanaian Senior High School (SHS) mathematics teachers used technology in the classroom and the variables that affected their use. According to the study's findings, protractors were the manipulatives that teachers utilised the most when instructing students in mathematics. The primary motivation behind the usage of this technology is the goal to simplify and improve the understanding of mathematical education. The study comes to the additional conclusion that the location of the school, the gender, age, and teaching experience of the teacher all has a major impact on how much technology is used to teach mathematics. Also, the study came to the conclusion that technology use had an impact on arithmetic instruction. These outcomes were mostly favourable for the students, especially in terms of motivating them and encouraging them to adopt good attitudes about mathematics instruction and learning.

6. Recommendations

Based on the study's findings, the following suggestions were put forth; the study discovered that senior high mathematics classes employed manipulatives. Yet, there was little technological utility in mathematics instruction. This was mostly caused by the lack of such technology in the classroom. As a result, it is advised that NGOs, the Ghana Education Service (GES), the Ministry of Education (MoE), and the Government of Ghana (GoG) help schools with infrastructure like computers and other visual and audio tools as well as financial support. Also, based on observation, it appears that the district's libraries all have TVs and other audio-visual equipment for use in teaching and learning. Yet, mathematics professors did not make use of this technology. Therefore, it is advised that mathematics teachers make an effort to employ these technologies in order to improve junior high school pupils' visual grasp of mathematics. Additionally, since each kid has different learning needs, technology must be adjusted to meet those needs. This will guarantee that pupils' results are excellent and favourable. Finally, there is a need for additional national research to be done. This is because the results of these studies will offer a sufficient and comprehensive understanding of how technology is used in mathematics instruction throughout the nation. This will help to better inform educational technology policies. Moreover, more research utilising a qualitative methodology should be done in order to provide flexibility and a thorough understanding of technology use in mathematics instruction.

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