Review Article

Technology Inclusion in Mathematics Classroom;The Extent of incorporationin Ghana's Educational Landscape

Abstract

In the earlystages, humans exhibited apprehension towards interacting with computers, however presently, the majority of individuals possess the ability to effectively utilize computers and their associated functionalities. The incorporation of technology in the field of mathematics extends beyond basic tasks such as typing and printing questions or delivering courses using PowerPoint. Instead, it involves utilizing technology to effectively educate learners on a wide range of mathematical concepts and topics. The incorporation of technology in mathematics education yields beneficial outcomes for both the instruction and acquisition of mathematical concepts. Hence, it is imperative for educators in the field of mathematics to include technology into their instructional practices, while also fostering a culture that promotes the utilization of technology by students for the purpose of enhancing their mathematical learning experiences. This will facilitate enhanced comprehension of the mathematics concept being presented among the students. The use of technology in mathematics education has been increasingly prevalent among younger generations. Consequently, it is imperative to emphasize the utilization of technology among mathematics teachers and students in schools, as it represents a contemporary approach to instructional methods.

Keywords: *Technology, technology integration, information and communication technology, technology for math learning*

Introduction

The human civilization has a cyclic co-dependence on technology; it is impossible to separate technology from human life. Humans utilize and rely on technology in many different ways every day, and our needs and expectations for technology are growing. People can interact, learn, conduct business, and live comfortably due to technology (Karehka, 2012). In order to better

prepare students for the future, it is necessary to examine the topic of integrating technology into mathematics education. This is because the curriculum is changing, and technology usage is increasing. Karehka (2012) found that the advent of technology has made education more distant. He added that the development of internet technology had led to the emergence of a brand-new type of education known as online education. He emphasized once more that students can currently study courses offered in other nearby and faraway nations without running into any negative restrictions. Thus, the globalization of education is a result of technology.

Many academics define technology as the use of tools (machines), abilities, and the application of knowledge to control one's environment. Technology can transform the learning environment from passive (inactive) to active, according to Lowerison, Sclater, Schmidt, and Abrami (2012). Therefore, technology has the potential to put a lesson within the student's control. According to Roblyer (2013), the use of technology may enable the student to participate more actively in math lessons. The use of technology tools and equipment, according to Pramela and Noraza (2007), helped draw students' attention and keep them interested so that they could learn and acquire the necessary skills. They added that the use of ICT had facilitated and improved math instruction. Additionally, Lisa (2005) stressed the value of using media resources as teaching aids to facilitate the instruction of more abstract ideas. This study supports the findings of Krishnasamy, Veloo, and Hooi (2013) who found that mathematics teachers believed schools needed ICT infrastructure to improve math instruction.

Africa, the second-largest continent globally, is notably lacking in terms of information technologies (Odedra, Lawrie, Bennett & Goodman, 2008). According to Odedra et al. (2008), it was found that Africa has the lowest level of computerization compared to other regions. Additionally, the average telephone density in Africa is significantly lower than that of the European community, with more than twenty countries in Africa having a considerably reduced telephone density. Additionally, Intsiful, Okyere, and Osae (2003) have noted that the development of information and communication technology (ICT) in Ghana is still in its nascent phase, despite the fact that the country was the pioneer in accessing internet connectivity in sub-Saharan Africa. Education is widely recognized as a crucial determinant of economic sustainability. Consequently, it is imperative to provide students with training that equips them

with the required skills and competence to thrive in the contemporary information-driven society (Addy & Ofori-Boateng, 2015).

The impact of technology on social and economic transformation in Ghana is of significant importance and should not be underestimated. In the realm of education, the prevailing approach to instruction is typically the traditional method, which relies solely on conventional teaching practices. This is due to the absence of Information Technology tools within the educational sector, which could otherwise facilitate the integration of technology into the teaching process for students. It is widely acknowledged that Information Technology offers a multitude of application software that facilitates the acquisition of mathematical knowledge by rendering it more comprehensible, efficient, and relevant, as opposed to being intricate, time-consuming, and abstract. Some instances of application software that fall under this category include Spreadsheet, Geogebra, Matlab, LaTeX, Octave, and so on. Given the pervasive influence of technology on various facets of human existence, it becomes imperative to reassess the pedagogical approach employed in the teaching of mathematics inside educational institutions. In light of emerging pedagogical paradigms, educators are increasingly tasked with augmenting the educational experience by imbuing it with greater significance for students, rather than only imparting factual information. One approach to facilitating the integration of technology in mathematics education is to provide students with exposure to various technological tools. By doing so, students can develop the necessary skills and knowledge to effectively incorporate technology into their learning experiences.

Despite the emphasis on the importance of using technology in teaching mathematics in schools across the globe, the teaching and learning of mathematics in schools through the use of technology in most African countries including Ghana continues to be a concern. This paper begins by presenting an overview of the study, considering the integral role of technology in mathematics education for Ghanaian students. In the rest of the paper, wediscuss and aim to address the followingquestions: What kind of Technology is available in Ghana? What kind of technologies are available for teaching math? What is the level of mathematics teacher's competence in integrating technology in the classroom? What is the voice of the mathematics curriculum on technology integration? What are the usefulness of technology in developing math concept? What are the challenges of teaching with technology in math classroom? Finally, we

discuss the implications of these issues for improving the teaching and learning of mathematics in Ghanaian schools.

Technologies available in Ghanaian schools

The usage of digital learning resources to facilitate the delivery of lessons is expanding globally (Mereku&Mereku, 2015). Through (i) the digitisation of the school curriculum and (ii) the development of an educational portal/website, the Ghana ICT policy included in its plan the need to enhance effective lesson delivery and accessibility of curriculum materials across the length and breadth of the country (Ministry of Education, 2008). The idea of digitizing educational resources had not yet been widely adopted by the country at the time this report was written, but several individual small-scale enterprises had started digitizing the subject material like mathematics, biology, chemistry, and physics in order to sell it. To support mathematics education and learning, the Ghana Mathematics Society (GMS) has also begun digitizing pre-tertiary mathematics curriculum for tablets, but this has not yet garnered widespread attention.

It was also mentioned that there was a "general absence of rich content that was fit-to-purpose as far as the national school curriculum was concerned" in the recently reviewed ICT in education policy document (Ministry of Education, 2015, p. 11). The Curriculum Research and Development Division, under the Ghana Education Service, needs to regularize the activities of individual small-scale businesses who are digitizing learning materials in order to catch up with nations like The Netherlands, where as of 2014, more than 70% of teachers used digital learning materials in their pedagogical practices (Kennisnet, 2015).

Another crucial issue for successful ICT integration in pre-tertiary education in Ghana is the availability of teaching and learning software. According to the Pan African Research Agenda's Pedagogical Integration of ICT project from 2009, computers at senior high schools across the country only have Microsoft Office, Microsoft Encarta, AutoCard, CorelDraw, and Mavis Beacon installed on them. Only computers in Technical Secondary Schools had access to AutoCard and CorelDraw software (Mereku et al., 2009). Thus, Microsoft Office and Microsoft Encarta were the most widely used instructional programs accessible and available in Ghanaian schools (Ministry of Education, 2009). This suggests that the majority of Ghanaian schools lacked the necessary mathematical software for efficient education. Application software that represents mathematical concepts must be installed on school computers. The nation could start

using open source programs like GeoGebra, Maxima, Maxima, ExtCalc, R, QtiPlot, FreeMat, Octave, Sage, Maple, and Scilas without additional budgetary resources (Wick, 2009).

Many schools in the nation still lack internet connectivity despite the government's promise to enhancing ICT infrastructure in pre-tertiary institutions. According to research by Natia and Al-hassan (2015), there were 335 students for every internet-connected computer in primary schools and 186 students for every computer in junior high schools. In the senior high schools, nothing had changed. Additionally, the cost of internet in the nation is outrageous (Kubis, 2014). Therefore, it is crucial that the government and those involved in education make the internet more accessible and reasonably priced so that teachers and students may make meaningful use of interactive online exercises, video lessons, text files, and courseware.

In conclusion, the availability of technology has emerged as a crucial factor in improving the standard of education and equipping students with the necessary skills to meet the requirements of the contemporary digital era. The presence of technology in educational institutions has been shaped by various variables, such as geographical positioning, discrepancies in funding, and initiatives undertaken by governmental bodies. Commonly found in urban elite schools in Ghana are many types of technologies, including computers with internet connection, smartboards, educational software, e-learning platforms, mobile devices, science and technology labs, and library resources. The presence of these technologies enhances the capabilities of educators to disseminate information and cater to a wide range of learning requirements, hence expanding educational access to remote regions and marginalized populations.

Technologies available for teaching Math in schools

Technology that provides rapid feedback to students' responds, solutions, and techniques is referred to as technology for practicing skills (Bokhove, 2010; Roschelle et al., 2017). Technology's affordances allow teachers to give students formative feedback (Ingram et al., 2016) and let students set their own paces for learning (Heitink, Voogt, Verplanken, van Braak, & Fisser, 2016). For instance, Ingram et al. (2016) provided an example of how teachers used the Show and Tell App to support formative assessment in the mathematics classroom. With the help of the app Show and Tell, you can record writing and speech in real time. The opportunity to gather specific data about students' mathematical thinking and learning was provided to teachers as a result. They could then use the data recorded on the device to address students'

misconceptions through remedial instruction (Ingram et al., 2016). The immediate and detailed feedback students received when using the virtual manipulatives applet (dynamic visual pictures on a computer) was also highlighted by Reimer and Moyer (2005). The specific instances of textual feedback provided to pupils via computers fulfilled the purpose of pointing out their mistakes and increasing their awareness of their own assumptions (Moyer-Packenham & Westenskow, 2013). This input helped the students understand how to appropriately express fractional concepts in words and numbers.

Offering technology-based learning has also been noted as a potential way to increase student retention (Amaral & Shank, 2010; De Freitas, Morgan, & Gibson, 2015; Fozdar& Kumar, 2007; Roschelle et al., 2017). From a cognitive standpoint, Roschelle et al. (2017) suggested that technology has the potential to improve learning and retention since it can create a setting where students can regularly revisit the skills they practiced in earlier sessions. Students might receive immediate feedback from the online platform where they practice math test questions, and they might not have to wait for an instructor to assign the next arithmetic activity or skill. As an illustration, the online tutoring platform Khan Academy provides students with the chance to do exercises, view instructional videos, and has a personalized learning dashboard that enables learners to study at their own speed both at school and at home (Light & Pierson, 2014; Zengin, 2017). Amaral and Shank (2010) discovered that online learning gave their students more time to work on assignments outside of the classroom, which improved their performance and memory of the subject matter.

Recognition is growing for research that examines the connection between technology use and students' affect (such as feelings, involvement, and attitudes) toward mathematics learning (Arroyo et al., 2014; Ingram et al., 2016; Taylor & Galligan, 2006). The impact of multimedia alternatives (video, audio, animations, diaries, interactive examples, and self-assessment) on students' cognitive and affective attitudes toward mathematics was well demonstrated by Taylor and Galligan (2006). According to the authors, these technologies allowed students to (i) feel a part of the group they worked in, (ii) consider their thoughts and views regarding mathematics, (iii) use real-world problem-solving techniques, and (iv) develop their confidence in mathematics through practice and self-evaluation. The authors also stated that when students started utilizing computers to do math, they were able to overcome their fears and feelings of intimidation,

confusion, or terror. Similar to this, Wayang Outpost (a multimedia-based intelligent teaching system) was described by Arroyo et al. (2014) as having the potential to meet the unique requirements, emotions, cognitive states, and metacognitive abilities of students.

The incorporation of technology into the field of education is a widespread occurrence on a global scale, and Ghana is not an exception to this trend. The teaching of mathematics in Ghanaian schools is currently experiencing a significant shift due to the integration of various technological resources. Interactive whiteboards are emerging as a key technological tool being integrated into educational settings in Ghana. The utilization of expansive touch-sensitive displays in conjunction with a computer and projector facilitates the projection of mathematical problems, graphs, and interactive mathematical software onto the board by educators. Educational software and applications have emerged as crucial tools in the context of mathematics education within Ghanaian schools. These tools provide a variety of functionalities, encompassing interactive instructional modules, simulations, assessments, and gamified activities. Additionally, graphing calculators have become indispensable instruments in advanced mathematics courses. These portable gadgets enable students to graph functions, execute intricate calculations, and visually represent mathematical relationships.

In brief, the utilization of technology is swiftly transforming the landscape of mathematics teaching within Ghanaian classrooms, hence enhancing the learning experience through increased engagement, interactivity, and accessibility. A variety of technological tools, such as interactive whiteboards, instructional apps, collaborative platforms, digital textbooks, math games and online math resources, provide students with a wide array of possibilities to investigate and comprehend mathematical topics. Nevertheless, it is imperative to guarantee fair and just access to these technologies and to furnish educators with the requisite training and assistance to proficiently incorporate them into their instructional methodologies for learners' benefit.

Mathematics Teachers competence in Technology integration

The incorporation of technology in the field of education is a prevalent phenomenon worldwide, and Ghana is not an exception to this trend. The integration of technology in Ghanaian classrooms is increasingly influential in the transformation of mathematics instruction and learning. The proficiency of mathematics educators in efficiently incorporating technology is a

vital element of this paradigm shift. The significance of technology in mathematics education is increasingly recognized, yet, the level of proficiency among Ghanaian mathematics teachers in integrating technology exhibits variation. Certain some teachers have enthusiastically adopted technology and skillfully integrate it into their instructional practices, whereas others have difficulties when attempting to leverage digital technologies to augment their pedagogy. In the opinion of Atteh et al (2020b), certain mathematics educators in Ghana have undergone professional development and possess expertise in using technology for instructional purposes in mathematics education. The educators skillfully incorporate various techniques, such as interactive whiteboards, educational software, and web resources, in order to create captivating mathematics lessons.

However, numerous educators possess a rudimentary comprehension of technology, although they may lack complete assurance in harnessing its maximum capabilities. Intermittently, individuals may choose to integrate technology into their classroom practices, often depending on familiar tools such as graphing calculators and digital textbooks. There exists a subset of educators in Ghana that may possess limited familiarity with or formal instruction in the incorporation of technology into their teaching practices. Educators may have challenges in effectively integrating technology into their mathematics lessons, resulting in learning that is less engaging and dynamic.

The existing body of literature suggests that there is still a lack of complete integration of technology in mathematics classrooms in Ghana, as evidenced by studies conducted by Agyei and Voogt (2011), Buabeng-Andoh (2012), and Mereku and Mereku (2015). According to Agyei and Voogt (2011), it has been observed that teachers in Ghana lack adequate knowledge regarding the effective integration of technology into their instructional practices. Additionally, they demonstrate a lack of proficiency in utilizing specific mathematical software during lessons. Furthermore, the availability of professional development opportunities for enhancing technology integration in mathematics teaching appears to be limited for Ghanaian teachers. The study conducted by Buabeng-Andoh (2012) revealed a discrepancy between the beliefs and attitudes of Ghanaian teachers and their utilization of technology within the educational setting. The findings of this study are consistent with the research conducted by Agyei and Voogt (2011), which revealed a minimal association between the attitudes of Ghanaian teachers towards

computers (including enjoyment, absence of anxiety, instructional productivity, professional development, interaction, and understanding of the benefits of technology) and their utilization of technology in the educational setting.

Moreover, the Ministry of Education's (2015) recent review revealed that there is a lack of teachers who possess the necessary expertise to effectively incorporate information and communication technology (ICT) into their subjects or projects in a manner that is contextually relevant and capable of generating sustained interest among learners. Therefore, there is a substantial body of evidence suggesting that mathematics educators in Ghana lack the necessary professional expertise, encompassing knowledge, beliefs, and attitudes, to effectively use technology into the teaching and learning of mathematics. The incorporation of technology in pedagogical decisions within the classroom is contingent upon the type of professional development that teachers receive during the course of their job (Bennison & Goos, 2010). Hence, it is imperative to furnish educators with the utmost indispensable and pivotal professional development required to facilitate proficient technology integration within Ghanaian educational settings.

Mathematics Curriculum and Technology

In the words of Bos (2009), the utilization of technology, in conjunction with suitable pedagogical approaches, can effectively facilitate students in attaining satisfactory levels of mathematical proficiency. According to Loveless (1995), technology possesses the capacity to not only provide assistanceto the existing curriculum, but also to augment the overall experience and comprehension of this curriculum, and even facilitate novel avenues for thinking and learning (p. 6). In the opinion of the National Council of Teachers of Mathematics (NCTM, 2003), technology has been recognized as a crucial instrument for enhancing the learning of mathematics. This recognition stems from its ability to optimize students' comprehension, foster their engagement, and enhance their proficiency in the subject. These factors are probably what prompted several nations to use technology as an educational tool in their mathematics curricula (Lawless & Pellegrino, 2007; Levin &Wadmany, 2005). As an illustration, the mathematics curriculum in Ghana mandates the use of technological tools, such as calculators, spreadsheets and mobile Apps, by educators to augment comprehension of numerical computation and facilitate the resolution of practical, real-world problems. Furthermore, as outlined by the

Ministry of Education, Science and Sports (2007), the curriculum mandates that educators employ a pedagogical method that facilitates students' ability to (i) articulate verbal responses to inquiries pertaining to mathematics, (ii) engage in discourse regarding mathematical concepts and perform mental calculations, (iii) partake in hands-on and investigative mathematical tasks, and (iv) collaborate with peers and cultivate a passion for mathematics.

Like numerous other nations, the mathematics curriculum in Ghana incorporates significant elements of Vygotsky's work. This framework emphasizes the acquisition of mathematical knowledge within a sociocultural context and through interactive environments (Herbel-Eisenmann, Meanney, Bishop &Metzuyanim, 2017; Vygotsky, 1978). When controlling for other variables such as school leadership, political will, learners' demographic background, and parental support are held constant, the instructional methods employed by teachers have a substantial impact on the diversity of learning outcomes (Agyei & Voogt, 2011; Ertmer, 1999; Larbi-Apau& Moseley, 2012; Levin &Wadmany, 2005; Mereku&Mereku, 2015). According to Marks (2000), the implementation of effective pedagogy in the mathematics classroom not only facilitates students' acquisition of knowledge, but also plays a significant role in fostering their cognitive and social growth. In order to facilitate effective mathematics instruction, it is crucial for educators to strategically identify the fundamental practices of mathematics instruction that have the potential to enhance teaching and learning within a specific group of students (Jacobs & Spangler, 2017).

In accordance with the assertion made by Mishra and Koehler (2006) regarding the implementation of effective pedagogy, particularly in relation to technology, it is argued that teachers must possess a comprehensive understanding of the integration of technology, pedagogy, and content in order to successfully achieve this objective. According to Hechter, Phyfe, and Vermette (2012), it is important to consider the broader contexts of school environments, individual teachers' previous experiences, and epistemological beliefs about teaching and learning when examining the application of technological, pedagogical, and content knowledge principles. The viewpoint expressed regarding the integration of technology aligns with the perspective put forth by Davis (1986) in the Technology Acceptance Model. The Technology Acceptance Model is a regression model that examines the causal relationship between external variables, perceived utility, perceived ease of use, attitude towards the use, and

an individual's behavioral intention to use a specific technology (King & He, 2006). The integration of technology in mathematics education necessitates educators to possess the necessary expertise to establish an instructional setting that fosters collaborative student engagement in the construction of mathematical concepts (Bai & Ertmer, 2008; Ertmer & Ottenbreit-Leftwich, 2010; Hew & Brush, 2007; Ma, Lu, Turner, & Wan, 2008; Palak & Walls, 2009).

Usefulness of Technology in developing Mathematical concept

The utilization of technology in the context of idea formation pertains to the establishment of an educational setting that stimulates a particular cognitive process and facilitates the cultivation of mathematical reasoning abilities among students (Jupri et al., 2015). Extensive scholarly inquiry has been conducted to investigate the efficacy of technological tools in facilitating the acquisition and comprehension of mathematical concepts. For instance, Saha et al. (2010) and Akkaya et al. (2011) conducted studies that demonstrated the positive effects of utilizing the GeoGebra environment on students' academic performance. This was attributed to the provision of numerous visual representations, enabling students to effectively comprehend mathematical ideas. The intervention resulted in an enhancement of students' spatial abilities in terms of their capacity to investigate the interconnections between geometric objects and algebraic formulas. In the words of Akkaya et al. (2011), an instructional technique utilizing GeoGebra has the potential to facilitate learners in internalizing the fundamental logic of a mathematical subject matter.

Previous research has shown that spreadsheets can be beneficial in enhancing students' mathematical learning results (Benning & Agyei, 2015; Dettori, Garuti, &Lemut, 2001; Jones, 2005; Neurath & Stephens, 2006; Niess, 2005; Niess, Sadri, & Lee, 2007). The study conducted by Neurath and Stephens (2006) provided empirical evidence supporting the notion that including Excel spreadsheets into high school algebra instruction can enhance the engagement of students who previously held negative attitudes towards learning algebra. Niess (2005) asserts that spreadsheets provide dynamic modelling characteristics, which have resulted in its adoption as a mathematical problem-solving tool. These features enable students to engage in higher order thinking skills and encourage exploration beyond initial solutions.

Research suggests that the integration of digital technology in classrooms has the capacity to enhance students' interactive learning experiences (Attard & Curry, 2012; Calder et al., 2006; Geiger et al., 2012; Ingram et al., 2016). The study conducted by Ingram et al. (2016) investigated the efficacy of the Show and Tell application in enhancing students' involvement in problem-solving activities. The researchers discovered that the application facilitated students' ability to engage in both independently and collaborative problem-solving activities. In the opinion of Calder et al. (2006), digital technologies like spreadsheet have the potential to facilitate mathematical dialogue among students by enabling them to promptly generate output and engage in interactive reasoning and iterative formulation of arguments related to mathematical concepts. Consequently, the software programs' interactive features provided students with the chance to establish connections between different concepts (Funnell, Marsh, & Thomas, 1995), so enhancing the visibility of their mathematical reasoning (Ingram et al., 2016).

Based on the preceding discourse, it can be inferred that technology offers a viable educational methodology that aligns with the principles espoused by developmental cognitive theorist Piaget (1926) and socio-cognitive theorist Vygotsky (1978). According to the proponents of these theories, the implementation of small group learning has been found to enhance academic performance. This is attributed to the fact that small group learning provides students with valuable opportunities to engage in discussions, debates, and presentations, thereby facilitating the exchange of individual perspectives. As a result, cognitive conflicts may arise during these interactions, leading to the identification of inadequate reasoning and the emergence of a more comprehensive understanding of the subject matter (Springer, Stanne, & Donovan, 1999, p. 25).

The use of mobile technology applications in mathematics education not only enhances students' active participation and self-assurance in the learning process, but also fosters their intrinsic motivation and cultivates a sense of personal responsibility and independence in their academic development (Bray & Tangney, 2015). As stated by Harper and Milman (2016), the integration of laptops in middle school classrooms brought about significant transformations in the character of classroom activities. These devices were utilized to facilitate small group work, thereby fostering collaboration and promoting effective communication among students. A similar study by Atteh et al (2020a) indicated that, the utilization of technology facilitates the ability of students to engage in numerous swift computations. Furthermore, learners possess the capability

to conveniently and precisely evaluate mathematical calculations, so enabling them to authenticate and investigate the accuracy of their hypotheses. The computer application additionally provides expedited and precise feedback that is impartial and unbiased.

Challenges of Teaching with Technology

The use and effectiveness of technology in classrooms are significantly influenced by the attitudes and beliefs of teachers. The attitudes and beliefs about educational technology and pedagogy at large have a significant impact on instructors' utilization of technology in their instructional practices. Numerous contemporary educators grew up in an era devoid of technological advancements such as personal computers and the internet. Conversely, present-day learners are immersed in an atmosphere characterized by pervasive computer technology. Teachers, particularly those with limited computer proficiency, may feel intimidated by these individuals known as "digital natives." When educators perceive a lack of proficiency in utilizing technology, it can result in a diminished sense of classroom management, less use of technology, and a reluctance to include innovative technological approaches into instructional design (Hughes, 2005; Rakes & Casey, 2002). Teachers who adhere to conventional teaching methods may experience a sense of authority within the classroom and avoid the need to adapt to the demands of instructing technologically savvy students in a digital learning environment.

According to a study conducted by Wozney, Venkatesh, and Abrami (2006), a survey including 764 teachers revealed that confidence in attaining instructional goals using technology emerged as one of the two most influential factors in predicting teachers' utilization of technology. Educators who perceive a deficiency in their training have the option to either engage with technology within the confines of their existing skill set or defer its utilization until they deem themselves adequately proficient (Ertmer, 1999). In order to enhance teachers' knowledge to a satisfactory level and instill trust in the educational process, it is imperative to provide them with enough training and assistance from educational administrators.

One frequently cited rationale provided by educators for their limited adoption of emerging technology is their contentment with existing instructional strategies. The motivation for a

teacher to modify their lesson plans is minimal if the existing plans adequately cater to the learning demands of their learners. This desire stems from the instructor's commitment to facilitating effective learning in the classroom. Educators dedicate considerable amounts of time to the development of lesson plans that are designed to captivate students' attention and foster an engaging learning environment. The process of modifying lesson plans entails a significant amount of supplementary effort on the part of the educator, which poses a challenge due to an already rigorous timetable and therefore teachers do not feel comfortable to integrate technology in their lessons.

Educators encounter the challenge referred to as the "double innovation" dilemma in the realm of adopting novel classroom tools, as identified by Cleaver (2014) in online sources. Double innovation introduces an additional level of preparation that educators are required to navigate. Prior to determining how to incorporate technology into classroom objectives and curriculum, it is imperative for the teacher to acquire a proficient understanding of the technology and its use within an educational environment. Although the accessibility of educational tools is increasing, the issue of double innovation continues to necessitate more time for preparation. According to Ertmer et al. (2012), the data obtained from interviews with teachers indicated that time emerged as the sixth most significant obstacle to the successful integration of new classroom tools. The value of a teacher's time is significant, and it is unsurprising that time is frequently identified as a major obstacle to the incorporation of new technologies in educational settings.

Professional educators must possess not just expertise in their respective fields, but also a comprehensive understanding of how to adaptively leverage the advantages provided by various teaching methodologies to suit certain subject matters. In recent decades, the emergence of various innovative technologies has provided educators with a wide range of tools to enhance the effectiveness of their teaching methodologies. While the potential advantages are evident, the vast array of potential combinations of technologies and pedagogical approaches for various tasks and students can be somewhat daunting.

Summary of the Review

The integration of technology in the field of education has had a profound impact, presenting novel opportunities to enrich the pedagogical practices and educational experiences in several disciplines, such as mathematics. In the Ghanaian setting, where the emphasis is placed on

providing high-quality education, it is of great importance to examine the existing integration of technology in mathematics instruction and the consequential ramifications. The present status of integrating technology into mathematics education holds promise in offering interactive and captivating learning experiences, hence increasing accessibility to mathematics and enhancing learning chances. Moreover, technology integration can play a crucial role in advancing STEM education in Ghana.

The integration of technology in mathematics education in Ghana shows promise, yet encounters various challenges. One such challenge pertains to the availability of resources. While urban schools have made significant progress in incorporating technology, utilizing interactive whiteboards, educational software, and internet access, rural and underserved areas often lack these resources, resulting in a digital divide. Teachers' proficiency in technology use is a significant obstacle in the same vein. This is due to the fact that numerous educators lack expertise in technology and necessitate further training to proficiently utilize digital tools for mathematics instruction. This implies that teachers require sufficient training and opportunity for professional development in order to proficiently incorporate technology into their mathematics instruction, as the mathematics curriculum at all levels is designed to be properly utilized alongside technological tools.

In conclusion, it can be argued that the utilization of technology holds the capacity to bring about a transformative impact on the field of mathematics education in Ghana, hence enhancing its accessibility, engagement, and efficacy should be a great concern to stakeholders in education to tackle the obstacles related to resource availability, teacher training, and curriculum alignment in order to fully harness its capabilities.

Conclusion and Recommendation

Advancing the integration of technology in mathematics education in Ghana necessitates a comprehensive strategy that entails the cooperation of government agencies, educational institutions, educators, and other relevant stakeholders. The following proposed approach offers a potential path for progress:

- It is imperative for stakeholders to allocate resources towards the development of technology infrastructure, with a specific focus on rural and neglected regions. It is

imperative to guarantee that educational institutions are equipped with dependable access to electricity and internet connectivity. Engage in collaborative efforts with telecommunications firms to enhance network coverage in geographically isolated areas.

- It is imperative for stakeholders to actively promote the fair distribution of funds and allocation of resources to educational institutions. In order to guarantee equitable access to digital tools, it is imperative to allocate dedicated funding for the purpose of technology-enhanced math education.
- Education stakeholders should prioritize the development of comprehensive teacher training programs that specifically emphasize the integration of technology into mathematics instruction. Provide continuous professional development programs, workshops, and certifications to educators in order to ensure their knowledge and skills remain current with the latest technological breakthroughs.
- Education stakeholders should collaborate to provide comprehensive rules and optimal strategies for the incorporation of technology in mathematics teaching. The standards should encompass various areas, including the selection of suitable software, hardware, and educational methodologies.
- It is imperative for stakeholders to actively promote the advancement of math content and applications that are specifically tailored to the local context. Collaborate with indigenous developers and educators to establish digital educational materials that are in accordance with the curriculum and cultural framework of Ghana.
- Education stakeholders should periodically initiate STEM-focused programs that utilize technology to motivate and instruct students in the fields of science, technology, engineering, and mathematics. Advocate for the promotion and endorsement of STEM competitions, clubs, and mentorship programs.

Through the implementation of these strategies, Ghana has the potential to establish a mathematics education system that is characterized by inclusivity, effectiveness, and technological advancement. This system would effectively equip students with the necessary skills to thrive in the digital era, while simultaneously addressing the digital divide and promoting equitable access to high-quality education for all individuals.

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