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Teachers' knowledge, attitudes, and practices of digital skills in science, technology, engineering, and mathematics in Lagos State secondary schools

Oladiran Stephen Olabiyi[1], Racheal O. Okunuga[2], Omolabake T. Ojo[3] & Adeneye O. A. Awofala[4]
[1] Department of Technology and Vocational Education, University of Lagos, Akoka, Nigeria.
Orcid: https://orcid.org/0000-0002-1319-265X
[2,3,4] Department of Science Education, University of Lagos, Akoka, Nigeria, Orcid Ids: [2] https://orcid.org/0000-0001-9654-558X, [3] https://orcid.org/0000-0002-8744-3490, [4] https://orcid.org/0000-0003-0808-1784.
*Corresponding author: solabiy@unilag.edu.ng

Abstract
The study investigated STEM teachers' knowledge, attitudes, and practices vis-à-vis digital skills in Lagos State secondary schools. Also, the influence of the STEM teachers' gender was determined. The research method used in the study was a descriptive correlational survey. The design was appropriate for determining the relationship between the research variables. The respondents for the study consisted of two hundred and eighty-two (282) STEM teachers. The study was guided by four objectives. A structured questionnaire was used to collect data. The reliability coefficient of the instrument yields 0.89 using Cronbach's alpha. The statistical tools used for data analysis were an independent samples t-test, multiple regression analysis, and Pearson's moment correlation. The study found that there was a weighty influence of gender on STEM teachers' attitudes and knowledge; however, gender did not have a significant influence on digital skills among STEM teachers. Significant relationship exists within practice, attitude, and knowledge regarding digital skills. Attitude and knowledge were substantial predictors of digital skills. Consequently, the study recommended that digital skills training be provided to improve STEM teachers' digital skills. To better predict STEM teachers' knowledge and attitudes towards digital skills. To succeed in school and future workplaces, STEM students need to learn how to be digital citizens, conduct research, and become information-fluent. Utilizing effective instructional methods helps prepare students for the digital environment they currently navigate and will encounter in the future.

Keywords: Attitudes, Digital Skills, Knowledge, Practice, STEM education, and STEM teachers

Introduction
As we advance into the digital age, the importance of digital skills has become increasingly evident across various sectors. In today's rapidly evolving technological landscape, possessing robust digital skills is not merely an advantage but a requirement for workforce participation and success. Various establishments are experiencing digital transformations, which require that workforces acclimatize to new technologies and processes. (Olabiyi, 2020). This change is pushing the request for people prepared with the necessary digital competencies. In various organisations, employers are in search of a workforce with expertise in areas such as cybersecurity, social media management, and data analysis. Digital skills improve in securing employment, opportunities for career advancement that were previously restricted. Also, inaccessible work becomes more usual, digital communication tools and platforms have occupied the utmost importance, making it indispensable for experts to use them proficiently. Technological developments have introduced a significant shift in Science, Technology, Engineering, and Mathematics (STEM) education, demanding the integration of innovative digital technologies to improve learning outcomes. In the contemporary world, developing digital skills has become important for the workforce, especially STEM educators (Olabiyi & Awofala, 2021). These skills are needed for active communication within the international community, effecting managerial or educational tasks, and fostering creativity and innovation.

Possessing digital skills has become essential for the workforce, irrespective of their academic background. Digital skills are key for the flow of information nationally and internationally, while carrying out administrative or STEM tasks, and developing creativity and innovation in STEM students (Osterman, 2012). Digital skills denote the capabilities and knowledge required to use digital tools, technologies, and platforms effectively. These skills range from basic tasks like using a touchscreen or sending emails to advanced capabilities such as data analysis, digital marketing, and artificial intelligence. They are essential for personal and professional growth, enhancing productivity, creativity, and adaptability in a rapidly evolving technological landscape (Preston, 2024). Digital skills also encompass proficiency in computer software, applications, digital devices, and other technology hardware (Sánchez, 2024). These skills involve a range of tasks that utilize digital literacy and computing methods to fulfill essential responsibilities for both internal operations and customer-facing activities. Put succinctly, digital skills are skills and knowledge that allow for the appropriate use of technological tools, both in the personal and professional spheres. These skills enable STEM

trainees to enhance their employability, productivity, creativity, and professional resilience.
The importance of digital skills is now increasingly noticeable. The World Economic Forum (WEF, 2024) predicts that 42% of tasks will be automated by 2027 due to the implementation of AI and other emerging technologies. Such changes, according to Sánchez (2024), necessitate that STEM educators have adequate talent capable of adapting to these new technologies, as well as possessing the necessary digital skills to get the most out of them. In STEM education, developing digital skills aligned with STEM goals significantly enhances STEM educators' ability to perform job responsibilities effectively. A solid understanding of technological systems is particularly vital for STEM educators, enabling them to swiftly adapt to emerging technologies and integrate digital workflows into their teaching practices. In the present global world, digital tools vary from smart devices to sophisticated software, their usage is requisite across industries. As a result, expertise in these digital tools is vital for STEM educators to remain competitive in the modern workforce. (Deyana & Kosta, 2021).

STEM education, in the opinion of Deyana and Kosta (2021), denotes teaching and learning in the fields of science, technology, engineering, and mathematics. This method reduces the traditional barriers between these subjects, integrating the four themes into a unified learning experience. The engineering section emphases the procedures and the proposal of solutions rather than merely the products, inspiring learners to get involved in discovery, investigation, and problem-solving. This provides students with the opportunity to understand mathematics and science within personalized, real-world contexts, developing critical thinking skills that can be applied across academic and professional domains. The technology aspect assists in serving as a bridge, increasing understanding of the other STEM subjects, and permitting ground-breaking approaches to problem-solving. Concerning digital tools in STEM education, it simplifies the teaching and learning of scientific concepts by using technology to increase understanding. Integrating digital tools into STEM classrooms has the latent ability to meaningfully improve student learning outcomes, making the educational experience more engaging and effective.

UNESCO (2022) explains the importance of digital skills for teachers, particularly in STEM disciplines. This stresses the growing application of technology tools in teaching and learning environments. Expertise in digital skills equips educators to use digital tools effectively, design engaging and interactive lessons, and prepare students with the abilities required to succeed in a technology-driven world. Within the STEM framework, digital skills are particularly important as digital skills foster innovation, adaptability, and problem-solving capabilities, which are important features for steering the ever-changing industrial landscape and solving real-world challenges. MacDonald, Nink, and Duggan (2010) underscored that the market-driven training requires the integration of digital skills to effectively appraise educational and training needs. This strategy is designed to address skill demands and develop targeted approaches to enhance the employability of STEM graduates in Nigeria. As technology continues to evolve and new competencies emerge, employees must remain adaptable to keep pace with these advancements. A forward-thinking STEM education system should proactively conduct surveys to identify the critical digital competencies needed by STEM graduates. Recognising and integrating these skills is essential for improving their employability and ensuring alignment with the demands of an ever-changing technological landscape.

Among the factors that influence the successful use of technology in teaching are teachers' beliefs and attitudes toward digital tools (Buabeng-Andoh, 2012; Khan, Hasan, and Clement, 2012; Oldfield, 2010). Picken (2005) defined an attitude as a mental or neural state of readiness, organized through experience, exerting a direct or dynamic influence on the individual's response to all objects and situations to which it is related. Attitudes toward digital technology are thought to influence not only the acceptance of digital tools but also future behaviour, such as using digital tools as a professional tool or introducing computer technology applications into the classroom (Woodrow, 1991).

Conceptual Framework

Knowledge, Attitude, and Practice (KAP) is a framework often employed in research to assess and understand people's behaviors and beliefs. This can also be used to examine the behavior and attitude of STEM educators about digital skills. Knowledge represents what STEM teachers or administrators recognize or understand about digital tools in teaching STEM subjects, which includes facts, information, or awareness that could shape their decisions or behavior. Attitude is an individual's feelings, beliefs, or insights of STEM educators about digital tools. (Olabiyi, 2021; Adediwura & Bada, 2007). Attitudes, either positive, neutral, or negative, impact how people respond to their knowledge. on the other hand, practice emphasises the way STEM educators apply the acquired knowledge and attitudes in real-life activities or behaviors. Fundamentally, it relates to what individuals do based on their knowledge about digital technologies and how such feel about using these tools. Within the framework of STEM education, the practice of digital skills is an important element. Practice involves applying tools, technologies, and computational thinking to improve learning and problem-solving. e.g., students might be involved in data analysis, 3D modeling, coding, or using digital platforms for collaborative assignments. Also, STEM educators could use digital tools such as simulations, virtual labs, or online resources to make teaching STEM subjects interactive and accessible. (Isabella & Sofia, 2024). This not only improves understanding but also equips students with the skills required for the digital-driven world.

Digital Technology in STEM Education

As schools progressively integrate technology into teaching and learning activities, determined to prepare students for success beyond, nurturing digital skills has become more essential than ever. Fidalgo, Santos, and Hill (2016) observed that skill in digital technologies is a 21st-century skill necessary to equip students for life and work after school. Similarly, Ascione (2015) highlighted that digital skills empower students to locate and effectively use information, while the absence of these skills leaves them vulnerable, particularly when discerning trustworthy websites. For instance, students who cannot identify an author or assess their credentials risk misunderstanding the biases present in online content (Ascione, 2015). Apart from identifying bias, students must also develop the skills to assess the accuracy and credibility of the information they need. Ascione (2015) explained further that in an age where the Internet is a primary source of information for many aspects of life, critical digital literacy is indispensable. These skills enable students to verify that the information they rely on is written by credible and reliable sources. Jean, Greene Taylor, Kodama, and Subramaniam (2017) emphasized the urgency of this issue, stressing that students increasingly turn to the Internet for health-related information.

Without digital skills, students may find it difficult to identify and assess relevant and credible online health resources. Thus, equipping students with robust digital skills is not just a requirement for academic achievement but also an essential prerequisite for their overall well-being and informed decision-making in the digital age. Research highlights the importance of digital skills, emphasizing the need for specific instruction to ensure students develop a solid foundation of understanding. Additionally, students must possess the ability to transfer their knowledge, attitudes, and practices in digital literacy to diverse real-world experiences (Mattson & Lindsey, 2021). Pratolo and Solikhati (2021) advocate for teachers to acquire both technical and pedagogical skills as a prerequisite for effectively teaching digital literacy to their students.

However, sometimes when schools fail to provide curriculum materials, teachers are often required to seek resources on their own or, worse, ignore digital instruction altogether. Gerben (2017) admits that while STEM educators have a collective responsibility to teach students the way to navigate and act responsibly in a digital world, students often lack suitable assistance on the way to using digital skills effectively. Moreover, Mattson and Lindsey (2021) observed that teachers occasionally are not clear about the concept of digital citizenship, compounded by the scarcity of high-quality materials available to prepare educators to teach these principles across all grade levels. To address these challenges, it is imperative to equip STEM teachers with curriculum resources that both engage students and support educators in successfully implementing digital literacy lessons. Doing so increases the likelihood that these vital skills are integrated into classroom learning, ultimately empowering students to navigate the complexities of the digital world with confidence and discernment. Saxby (2018) emphasized the importance of teaching digital skills within the context of STEM subjects to help students understand their relevance and value.

As technology continues to play a pivotal role in society, students of all abilities are expected to engage with it, both as learners and as productive members of the workforce. Cihak, Wright, Smith, McMahon, and Kraiss (2015) further demonstrated that teaching digital literacy is crucial, as all students, regardless of intellectual abilities, can acquire and maintain functional digital skills. To promote equity in education, it is essential to provide teachers with high-quality, standards-aligned curriculum materials designed to effectively address digital skills. These resources support educators in delivering comprehensive instruction, ensuring that all students have access to valuable learning opportunities. As digital skills are increasingly recognized not only as essential 21st-century competencies but also as critical learning and life skills (Pratolo & Solikhati, 2021), both teachers and students must actively develop the ability to navigate and contribute meaningfully within the digital landscape.

Attitude in STEM Education and Digital Technologies

The rational model of promoting technology tools posits that increased knowledge fosters a positive mindset, leading to constructive behavior. Attitude encompasses various characteristics, including strength, magnitude or intensity, importance, salience or centrality, complexity, and flexibility. However, attitude measurements commonly focus on the dimension of magnitude and its direction. This refers to the degree of favourableness or unfavourableness an individual express toward a psychological object. A psychological object can be defined as a person, group, idea, symbol, or any entity that elicits positive or negative feelings from individuals. This concept aligns with the broader understanding of attitudes, emphasizing their role as evaluative predispositions influenced by one’s experiences and perspectives (Eagly & Chaiken, 1993; Adediwura & Bada, 2007). In this context, teachers' attitudes towards digital technologies play a pivotal role in STEM education. A positive attitude towards these tools can encourage their consistent use and deeper understanding, ultimately enhancing the integration of digital skills into teaching practices.

Attitude can be understood as an emotional or neural state of preparedness, shaped by experience, which influences an individual's reaction to objects or situations. It reflects a person’s disposition or perception of circumstances (Wu, 1999). In this study, attitude is defined as the perceptions and dispositions of STEM educators or administrators towards using digital tools in teaching STEM subjects. It encompasses their feelings, beliefs, and inclination to act in specific ways. In essence, the attitudes of STEM teachers, shaped by their feelings, beliefs, and predispositions, significantly influence how they manage and implement digital technology in classrooms or laboratories. Attitudes are acquired tendencies to respond consistently, whether positively or negatively, towards specific objects or situations. The attitudes of STEM educators toward digital skills display a remarkable diversity, influenced by factors such as personal experiences, beliefs, and familiarity with digital technologies. While many STEM teachers enthusiastically embrace digital tools as innovative resources that enrich teaching and learning, others may view them with hesitation, questioning their impact on the quality of education. This spectrum of attitudes reflects differences in individual comfort levels with technology, the extent of professional training, and the unique demands of the educational settings in which teachers work. (Olabiyi, 2021).

The attitudes of STEM teachers toward digital skills can vary significantly based on their individual experiences, beliefs, and exposure to digital technologies. While some educators may wholeheartedly embrace digital tools as valuable resources that enhance teaching and learning, others might approach them with skepticism or apprehension, concerned about their potential impact on the quality of education. This diversity of attitudes is shaped by numerous factors, including personal comfort with technology, training received, and the specific educational context in which they operate. As society continues to evolve, there is a renewed emphasis on identifying the particular skills and competencies deemed essential for navigating our increasingly digital world. Mattson and Lindsey (2021) emphasise that today's children must be equipped with the knowledge and skills necessary to perform tasks that machines cannot accomplish. The authors further explain that digital citizenship skill development helps students to develop into “safe, well-rounded, literate and participatory” citizens. This perspective underscores the significance of 21st-century skills, which include creativity, critical thinking, problem-solving, and collaboration. These skills are not just supplementary; they are increasingly considered fundamental to thriving in the contemporary landscape of education and the workforce (Akgunduz, 2015). Thus, fostering a positive attitude toward digital skills among STEM teachers is crucial for preparing students to meet the challenges of the modern world.

Knowledge in STEM Education and Digital Technologies

Knowledge encompasses the understanding and expertise required to seamlessly integrate digital tools and resources into teaching practices. Background knowledge, structured as mental schemas, significantly affects perception and subsequent learning processes. Research supports this, highlighting that background knowledge, derived from experience, strongly influences the development of digital skills (Glover et al., 1990). In the context of STEM education, knowledge is the synergy of understanding and skills gained through both experience and education. A robust foundation in digital technologies not only enhances STEM teacher effectiveness but also provides opportunities for personalized learning experiences. This is critical in preparing students to thrive in the digital age by equipping them with relevant skills and competencies. By embedding digital tools into the STEM curriculum, educators can cultivate a positive attitude toward their use, enabling students to develop key aptitudes such as data analysis, programming, problem-solving, and other digital competencies essential for the modern job market. As Hughes and Ferret (2008) suggest, the integration of digital knowledge in STEM education fosters critical thinking, innovation, and adaptability—qualities that are paramount for success in the 21st century.

In the context of STEM education, knowledge refers to the skills and information that educators must possess to prepare students not only for existing job roles but also to empower them to thrive across various industries. This includes fostering innovation, embracing emerging job opportunities, and nurturing entrepreneurship. Knowledge enables STEM educators to leverage digital technology as a transformative tool, enriching teaching practices while providing meaningful learning experiences for students. Eggen and Kauchak (2001) categorize teachers’ knowledge into three key areas: content knowledge, pedagogical content knowledge, and general pedagogical knowledge. Pedagogical knowledge is an understanding of how to design and implement technology-enhanced teaching strategies to engage students and foster problem-solving, critical thinking, and collaboration. Content knowledge refers to in-depth mastery of STEM subjects to seamlessly connect digital technologies to core concepts and curriculum standards.

The pedagogical content knowledge of digital tools in STEM education refers to the specialized understanding that educators need to effectively integrate digital technologies such as simulation programs, coding environments, and interactive learning platforms into their teaching while addressing the unique requirements of STEM subjects. Pedagogical content knowledge of digital tools means STEM educators not only know how to use technology but also understand how to align these tools with STEM content to enhance teaching and learning, such as using digital simulations to teach complex scientific phenomena, leveraging coding platforms to develop programming skills, and employing data analysis software to help students interpret mathematical patterns. STEM educators with strong pedagogical content knowledge of digital tools can create learning environments that are interactive, personalized, and aligned with real-world applications. This prepares students to master STEM concepts while developing critical digital competencies for their future careers.

In the digital age, effective teaching demands more than just subject-matter expertise; it requires educators to cultivate comprehensive knowledge that integrates pedagogical strategies and technological competence (Jeschke, Kuhn, Heinze, Zlatkin-Troitschanskaia, Saas & Lindmeier, 2021). This multifaceted understanding allows them to design engaging and impactful lessons that leverage digital tools to enhance learning. Without familiarity with the subject matter and digital technologies, teacher effectiveness is diminished, an issue further evidenced by research showing that teacher effectiveness is highly subject-specific. For STEM educators, embracing digital technologies as part of their teaching toolkit equips them to instil key skills such as critical thinking, problem-solving, data analysis, and programming in their students. These competencies are essential for success in the 21st-century workforce, making the educator’s depth of knowledge pivotal to achieving transformative outcomes. (Levin-Goldberg, 2012)

For STEM teachers, it is crucial to thoroughly understand the content of the digital skills they teach. A teacher with a deep and comprehensive understanding of a topic demonstrates clearer communication, develops more coherent discourse, and provides better explanations compared to those with weaker foundational knowledge. The level of expertise that STEM teachers possess in digital technologies has a significant influence on their teaching performance and overall effectiveness. Pedagogical content knowledge relies on a strong understanding of specific topics and the ability to explain them in ways that resonate with students. It encompasses the design and implementation of technology-enhanced teaching strategies that actively engage students and promote critical competencies such as problem-solving, critical thinking, and collaboration.

Pedagogical content knowledge also involves an awareness of how best to represent complex concepts in ways that make them accessible and meaningful to learners, as well as an understanding of the challenge's students may face when learning specific topics. Eggen and Kauchak (2001) underscore the consequences of inadequate pedagogical content knowledge, stating that teachers who lack this vital understanding often resort to paraphrasing textbook information or offering abstract explanations, which fail to connect with students meaningfully. This underscores the necessity of deep subject-matter expertise as a cornerstone of effective teaching. Evidence from the literature consistently highlights the critical role of teachers' knowledge of digital technologies in fostering meaningful and impactful instruction in STEM education. By combining subject-matter expertise, pedagogical strategies, and technological competence, STEM teachers can create transformative learning experiences that equip students with essential skills for the digital age.

Practice in STEM Education and Digital Technologies

Digital skills practice in STEM education focuses on the way STEM educators and their students efficiently use their knowledge and attitudes regarding digital tools in actual teaching and learning contexts.

Practice involves the actual use of knowledge and attitudes within the classroom and laboratory. Effective STEM teaching incorporates digital tools into lesson design, enabling hands-on activities for problem-solving and data analysis. It fosters teamwork through collaborative digital projects and emphasizes continuous reflection to refine strategies based on feedback and outcomes (Olabiyi, 2021). Stressing practical learning, practice ensures that both teachers and students actively engage in using digital tools to improve their competencies. For example, the teacher may employ a coding platform to teach programming concepts or employ data visualization software to assist students in interpreting scientific data.

The use of digital technologies in STEM education involves different types of tools and platforms designed to ease both teaching and learning experiences. This method comprises different activities planned to increase student engagement, develop understanding, and empower learners for future tasks (Mattson & Lindsey, 2021) An important application of this integration is specific software used for simulations, modelling, and data analysis, according to Becker (2018) allows students to test with and picture complex concepts in a controlled setting, thereby develop a hands-on and immersive learning experience. Collaboration platforms such as Google Classroom and Microsoft Teams further promote effective teamwork on STEM projects, enabling resource sharing, communication, and collaboration irrespective of physical setting. Moreover, interactive technologies, like instructive games and augmented reality (AR), offer attractive opportunities for teaching STEM subjects, helping to increase retention and spark interest. Also, digital tools, like sensors and mobile apps, empower students to collect real-world data for their work. This data can then be interpreted using software tools, allowing students to draw meaningful inferences that support their results.

Digital platforms perform a major role in assessment, using tools like Kahoot! and Quizizz making quizzes interactive and providing instant feedback on student learning outcomes. This actual assessment helps teachers supervise understanding and adjust instruction accordingly. The flipped classroom model is another innovative approach in STEM education, allowing students to explore new content through digital videos and resources at home, which frees up class time for interactive activities. This encourages active learning and greater student engagement (Aslan, 2021). Additionally, digital technologies enhance project-based learning, enabling students to create presentations, build prototypes, or develop apps to solve real-world problems. Online platforms offer access to a wealth of resources, including research articles, e-books, and tutorials, fostering independent learning and deeper understanding. By incorporating these digital practices into STEM education, educators can create an engaging learning environment that equips students with both essential STEM skills and necessary digital competencies for the future. STEM educators must effectively use digital tools in the teaching and learning environment to help solidify learning for STEM students (Aslan, 2021)

Influence of Gender on STEM Education and Digital Technologies

Gender plays a crucial role in shaping STEM education and digital technologies, affecting access, participation, and innovation within these fields. Despite advances in gender equity and increased interest over the past decade in computer science, engineering, math, and statistics among various genders, the underrepresentation of women in STEM education persists. According to the National Science Foundation (2023), the gender gap in STEM remains substantial, with women comprising only twenty-eight percent of the workforce. This inequality is troubling, as it results in a lack of diversity and inclusion, ultimately limiting the potential of the STEM industry (Wang & Degol, 2017). Addressing the ongoing underrepresentation is essential as the world grapples with economic, environmental, geopolitical, societal, and technological challenges. Reducing the gender gap will not only enhance sustainable tech-enabled growth and innovation but is also considered an economic necessity (World Economic Forum, 2023).

Gender inequalities in STEM and digital technology, along with the knowledge, attitudes, and practices of STEM education educators, show that females are consistently underrepresented in STEM-related employment. According to OECD surveys, there are nearly four times as many males as females working in engineering (OECD, 2015). Differences in mathematics aptitude, technical drawing skills, attitudes, self-concepts, interests, and occupational and lifestyle values and preferences have all been suggested as factors contributing to female underrepresentation in STEM education, particularly in technology-related fields (Eccles, 2009). Male students demonstrated higher levels of mathematics self-efficacy and preferred STEM education-related jobs significantly more often than their female counterparts (Ketenci et al., 2020). Similarly, gender stereotypes were prevalent in educational settings, where girls performed poorly in mathematics (Riegle-Crumb & Peng, 2021). Despite the recent increase in female participation and accomplishment in mathematics and science, negative attitudes toward their abilities in technology education persist.

According to Zhang, Min Chia, and Chen (2022) and Wang and Degol (2017), females' learning experiences have influenced their decision to pursue STEM education-related employment. For instance, gender differences have been identified among Nigerian technical college students (Chan & Cheung, 2018; Olabiyi, Awofala & Akinlabi, 2025). Female students in STEM education were less likely than male students to complete their degrees and enter the labor force. Furthermore, among those who completed STEM courses, female students were less likely than male students to pursue technology and engineering courses in higher education and employment in technology/engineering-related fields. Christensen, Knezek, and Tyler-Wood (2014) found that female students in eleventh and twelfth grades in the United States were more likely than their male counterparts to seek careers in STEM. The risks encountered in the workplace and the strategies needed to mitigate them can differ by gender. This is due to variations in job nature, working conditions, societal expectations, and gender-based treatment. Therefore, when addressing gender disparities in STEM education and digital technologies, it is essential to foster diversity, innovation, and equal opportunities in STEM and digital fields.

Statement of The Problem

Students today are often referred to as digital natives due to their early exposure to technology. While they are acquainted with various devices and digital platforms, this familiarity does not necessarily translate into the essential digital skills required to succeed as competent and productive members of a digital society. Yamila and El-Khayat (2016) emphasize that being tech-savvy does not guarantee that students possess the skills necessary for success in both their academic pursuits and the future workforce. Raish and Rimland (2016) argue that developing technology skills is crucial for workforce readiness as employers increasingly demand these competencies. Bali (2016) further elaborates on this viewpoint, suggesting that the emphasis on digital skills should extend beyond merely understanding technology; it should also focus on effectively applying these skills in practical contexts. Walters, Gee, and Mohammed (2019) stressed that digital skills include not only the understanding of technology's purposes, however, it involves the ability to apply knowledge and skills in different circumstances, vis-a-vis empowering students to make use of knowledge they obtain, STEM educators play a crucial role in preparing their students to transfer their digital knowledge and skills to future experiences. This training prepares students to acclimatize with evolving digital environments and provide solutions to challenges in STEM education, work, and elsewhere. Though there is general consensus on the relevance of digital skills and the formulation of state, national, and international standards, differences in teaching and prospects pose significant barriers to attaining reasonable access to the important competencies (Leavy, Dick, Meletiou-Mavrotheris, Paparistodemou, & Stylianou, 2023).

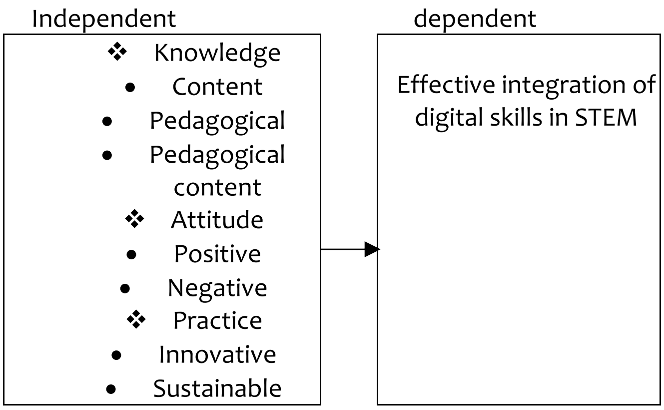
Irrespective of the different technology tools used, many educators display low self-esteem and struggle to totally use digital tools. A significant number of educators are not clear about their competencies, resulting in intermittent and remote usage of digital resources in their teaching practices. Moreover, teachers are often constrained in their choices vis-à-vis digital acceptance, which reduces their comfort with technology. Several teachers are obligated to depend solely on resources acquired through institutional agreements, starting a technology arrangement process that demands new adjustments for some. Which can be both unsatisfying and time-consuming, mostly for individuals who are already experts and confident in using specific technologies that successfully meet their teaching desires. Therefore, they discovered that they are unable to use pedagogical opportunities at their usual pace. While inclusivity and reliability are essential, even when adopting licensed digital extensions from textbooks, preparing relevant resources for classroom use can prove to be a daunting task. Unfortunately, teachers do not always receive the training and support needed for implementing the curriculum materials with their student population. Addressing these gaps requires a more cohesive and inclusive approach to digital literacy education, ensuring that all students are equipped with the skills needed to succeed in an increasingly digitized world. Consequently, the gap that this study fills is critical. Knowledge, attitude, and practice of STEM educators are the most important variables in STEM education. Significantly, Landasan (2017) recommended that teachers' knowledge, attitude, and practice must be given appropriate measures to further enhance the understanding of digital tools, their attitudes toward using these tools in the classroom, and their actual implementation of digital skills in their teaching practices.

Purpose of The Study

1) To investigate gender differences in STEM teachers' knowledge, attitudes, and practices in using digital tools.
2) Is there a significant relationship between STEM teachers' knowledge, attitudes, and practices regarding digital skills in STEM education?
3) To determine STEM teachers' knowledge, attitudes, and practices regarding the implementation of digital skills in their teaching.
4) What is the predictive influence of attitude and knowledge on the variance in STEM teachers' practices of using digital tools?

Method

The researchers employed descriptive correlational survey methods of research, with the questionnaire as the primary tool for data gathering. The knowledge, attitude, and practices (KAP) of digital skills in STEM education were determined and analysed in this study. The descriptive survey independent variables were knowledge, attitudes, and practice, while the dependent variable was the effective utilisation of digital skills in STEM. The study's participants were STEM teachers. STEM teachers currently teaching in Lagos State secondary schools provided accurate and trustworthy responses regarding the mission of the institutions, their understanding of digital tools, their attitudes toward using these tools in the classroom, and their actual implementation of digital skills in their teaching practices. This study included 282 respondents, all of whom were teachers. The total population was used in the study. The researchers used his judgment and a suitable strategy in selecting respondents who comprised the sample and who best met the study's objectives. This sampling technique relied on the researcher's discretion to pick a sample that provided the required data. Individuals with special qualifications or who are considered representative based on previous evidence comprised the total population sample. A survey questionnaire adapted from Mthetwa (2008) was used as the research instrument, and it is divided into two parts; the first is the profile of the teacher, and the second part includes statements that find out the teachers' knowledge, attitude, and practice regarding digital skills. The reliability coefficient of the instrument was 0.89 as computed using Cronbach's alpha. Independent samples t-test, Pearson's moment correlation coefficient, and multiple regression analysis were used to analyse the data collected.



Results and Discussion

Research Question 1: What are the gender differences in STEM teachers' knowledge, attitudes, and practice in using digital tools?

Table 1. Gender differences in STEM teachers' knowledge, attitudes, and practice in using digital tools

Vari	Gen	N	Mean	SD	T	Df	Sig
Knowle	M	166	62.40	3.70	-2.877	280	.004
	F	116	60.81	4.50			
Attitude	M	166	57.90	4.00	-3.284	280	.001
	F	116	56.10	4.96			
Practice	M	166	55.70	5.20	.313	280	.754
	F	116	54.50	5.40			

Table 1 displays a summary of the mean responses of respondents on the gender differences in STEM teachers' knowledge, attitude, and practice regarding use of digital skills in teaching STEM subjects. Generally, the male respondents had more knowledge and practice and a helpful attitude concerning digital skills. Based on the collected data, it showed that the male teachers were more inclined toward use of digital tools than the female teachers. With regard to attitude, male teachers had a mean of 57.90 with a standard deviation of 4.00, while female respondents had a mean of 56.10 with a standard deviation of 4.96. Concerning knowledge, male respondents had a mean value of 62.40 with a standard deviation of 3.70, while female respondents had a mean of 60.81 and a standard deviation of 4.50. With regards to practice, male respondents had a mean value of 55.70, slightly higher than female respondents of 54.50.

Furthermore, as shown in Table 1, there was a significant influence of gender on technology STEM's attitude (t=-3.284) and knowledge (2.877) of digital skills. However, gender did not have a significant influence on STEM teachers' practice of digital skills (t=0.313).

Research Question 2: Is there a significant relationship between STEM teachers' knowledge, attitudes, and practices regarding digital skills in STEM education?

Table 2. Significant relationship between STEM teachers' knowledge, attitude, and practice regarding digital skills in STEM education?

Variable	P	A	K
Practice (P)	1		
Attitude (A)	.173**	1	
Knowledge (K)	.481**	.916**	1
Mean	55.65	56.83	61.51
SD	5.28	4.68	4.27
N	282	282	282

Table 2 showed the connection between STEM educators' understanding and perspectives and using digital tools in STEM education. There was a weighty relationship among knowledge, attitude, and practice regarding digital skills. In line with the Pearson correlation analysis (Table 2), Furthermore, there were significant correlation for digital skills between attitude and practice ($r = -481$, $p<0.05$) attitude and practice ($r = 0.173$, $p<0.05$), knowledge and attitude ($r=.916$, $p<0.05$) relationship between attitude and knowledge were statistically significant. The knowledge, attitude, and practice of STEM teachers on digital skills were thus significantly correlated.

Research Question 3. What are the STEM teachers' knowledge, attitudes, and practices regarding the actual implementation of digital skills in their teaching?

Table 3. STEM teachers' knowledge, attitudes, and practices regarding the implementation of digital skills in their teaching.

Variable	N	Mean	SD	t	Df	Sig
Attitude	282	57.90	4.00	-3.284	274	.001
Knowledge	282	62.37	3.71	-2.877	274	.004
Practice	282	55.73	5.19	.313	274	.754

Table 3 shows a summary of the mean responses of respondents on STEM teachers' knowledge, attitudes, and practices on the actual implementation of digital skills in teaching STEM subjects. Generally, the respondents had more knowledge than the attitude and practice concerning digital skills in Nigeria. Based on the collected data about attitude, STEM teachers had a mean value of 57.90 (t=-3.284). Concerning knowledge, respondents had a mean value of 62.40 (2.877), and about practice, respondents had a mean value of 55.70 (t=0.313).

Research Question 4: What is the predictive influence of attitude and knowledge on the variance in STEM teachers' practices of using digital tools?

Table 4 showed the predictive influence of attitude and knowledge towards the explanation of variance in technology teachers' practices of work-related safety and health. The ANOVA regression analysis (Table 4) revealed a significant impact of attitude and knowledge on STEM teachers' practice on digital skills ($F_{(2,273)} = 289.21$, p=0.000). The two factors (knowledge and attitude) investigated contributed as much as 67.9% variance to practice regarding digital skills.

Table 4. The predictive influence of attitude and knowledge on the variance in STEM teachers' practices of using digital tools.

R =.824					
R^2 =.679					
Adjs R^2=.677					
SEE=3.001					
F=289.21 (2,273)					
P < 0.001					
Variable	Unstandardized B	Coefficient Std. Error	Standardized coeff. Beta	T	Sig.
Constant	9.585	2.659		3.610	.000
Attitude	-1.896	.097	-1.679	-19.53	.000
Knowledge	2.500	-.106	2.02	23.51	.000

As seen in Table 4, knowledge had the highest beta (β) value (2.02), followed by attitude (β = -1.679). The regression analysis equation is as follows: digital skills $_{\text{predicted}}$ = 9.585 - 1.896 attitude + 2.500 knowledge. According to the equation, a one-unit increase in attitude results in a -1.896 decrease in digital skills practice. A one-unit increase in knowledge of digital skills will result in a 2.500 rise in practice using digital tools.

The study investigated gender differences in STEM teachers' knowledge, attitudes, and practices regarding digital tools. It also examined how attitudes and knowledge predict variations in STEM teachers' practices with digital skills. Knowledge, attitude, and practice (KAP) must be given appropriate measures for increasing STEM educators' awareness and effective use of digital tools. The primary objective of this study was to comprehensively investigate the relationship between KAP and digital skills in STEM education within the Nigerian context. Gender emerged as a critical factor in STEM-related work programmes, with an analysis of records and scientific literature underscoring a growing emphasis on gender-specific strategies. The study results indicated that male respondents demonstrated greater knowledge, more practice, and a positive attitude toward digital skills compared to their female counterparts. The collected data highlighted that male teachers showed a higher inclination to use digital skills than female teachers. Table 1 presents the independent variables (attitudes, knowledge, and practices) and their respective predictive power for digital skills. Among these, attitudes emerged as the strongest predictor (t = -3.284), followed by knowledge (t = -2.877) and practice (t = 0.313). Gender-specific analysis revealed that, for both male and female respondents, knowledge was the most significant variable influencing digital skills. The findings of this study align with previous research, emphasizing the importance of digital skills in enhancing STEM learning processes. These skills are especially crucial for supporting students who face challenges with concentration in the classroom. For teachers, the ability to navigate websites effectively is fundamental as it enables them to access relevant resources that enhance students' understanding of instructional content.

This study corroborates the findings of Sadaf and Johnson (2017), which highlighted the application of digital skills in teaching practices. Such skills not only alleviate the stress of teaching and learning but also foster a more engaging, motivating, and enjoyable experience for students. Furthermore, digital tools empower STEM educators to meet the diverse needs of learners in a digitally connected environment. In alignment with addressing students' needs, Aslan (2021) emphasized the importance of teachers incorporating digital skills to connect with students, acknowledging the integral role these tools play in their lives outside the classroom. The effective use of digital tools by teachers enhances learning and promotes engagement for all students. However, findings vary across studies. Ongoren (2021) resolved that STEM teachers show no significant gender differences in their digital skills for classroom use. Conversely, Rizal, Rusdiana, Setiawan, Siahaan, and Ridwan (2021) found that males possessed higher digital skills than females. Additionally, Fernandez-Batanero (2022) reported that female teachers exhibited higher levels of digital competence compared to their male counterparts. The outcomes of this study offer valuable insights into the diverse perspectives on digital skills in STEM education and underscore their crucial role in fostering effective teaching practices.

Nkechinyere, Amos, and Chiedu (2022) report that girls perform better than boys in digital knowledge and skills, with gender differences in attitudes to technology explaining these differences. These contradictions in the literature could be attributed to environmental factors that limit the exposure of either boys or girls to digital skills. Rashid (2016) supports the idea that digital inequalities emanates from social inequalities across the five nations, Bangladesh, Brazil, Chile, Ghana, and the Philippines studied, a clear gender gap in technology access was observed. Key variables such as skills, user attitudes, access to computers, and the Internet were used to examine this gap. The study emphasized that females in Bangladesh, compared to other countries, experience the most significant digital segregation. Another related study carried out by Buabeng-Andoh and Yidana (2014) in Ghana showed male dominance in attitudes toward technology when compared to females. Hatlevik and Christophersen (2013) in providing solution to this emphasized the importance of integrating digital skills into STEM education programmes to ensure the digital inclusion of both girls and boys. Educators and schools must remain mindful of gender-based differences in digital skills and actively work to remove challenges. This could be done through involving both genders in designing technology-based learning experiences, STEM teachers need to ensure that learning experiences meet different learners' needs, reflect their digital realities, and foster positive attitudes toward technology (Tyers-Chowdhury & Binder, 2021; Kennedy & Odell, 2014). Furthermore, new technological advancements, such as artificial intelligence and machine learning, can be applied to create personalized learning experiences. These innovations can address the diverse needs of STEM students and promote positive attitudes about digital tools (Bhutoria, 2022). Achieving digital equity necessitates a multifaceted approach to link both the first and second-gender digital divides (Isabella & Sofia, 2024). One important phase is providing equal opportunity to digital tools, which is essential for achieving digital gender equity. In South Asian and African economies, according to Tyers-Chowdhury and Binder (2021), girls are 23 percent and 13 percent less likely, respectively, to own a mobile phone compared to boys within the same household. This inequality significantly limits students' ability to contribute wholly in the digital world (Tyers-Chowdhury & Binder, 2021). Access to digital tools is essential for creating opportunities that permit students to develop positive attitudes toward technology (Erdogdu & Erdogdu, 2022) and acquire the digital skills necessary to succeed in contemporary economies (Hurwitz & Schmitt, 2020). To reduce these disparities, countries with developing economies must prioritize investments in technology infrastructure and create equitable opportunities for all students to access and engage with technologies tools (Deyana & Kosta, 2021).

Implication of The Study

The implication of this study offers both practical and academic contributions to the knowledge and practice of digital skills through STEM teachers in assisting their students. Digital skills are important for easing relationship between teachers and their students, having opportunities to instructional content available on the net, and nurturing interface irrespective of environmental location. The findings emphasize the relevance of preparing STEM teachers with digital skills to successfully sustenance their students in teaching and learning STEM programmes. Digital skills offer important benefits for STEM educators by improving student engagement and interaction. Again, the study has implication for STEM teachers that are lacking proficiency in particular aspects of digital skills, which are relevance for sustaining meaningful interactions and supporting student engagement both within and outside the classroom environment. Without understanding of essential digital skills, the achievement of STEM education objectives may be mired. The study further makes a distinguished theoretical contribution by supporting the principles of Siemens' connectivism theory, which promotes the use of digital technologies in education. Connectivism stresses the transformative role digital tools play in enabling STEM educators to meet the diverse needs of their students in a technology-driven learning environment.

Conclusions

Digital skills have been identified as essential for students to thrive in a digital society. The study aimed to assess the digital skills, knowledge, attitudes, and practices of secondary school STEM teachers in Lagos State. The exploratory study employed a descriptive correlational survey method of research. Gender (male and female) differences and similarities in knowledge, attitudes, and practices of digital skills. The findings show a significant relationship between knowledge, attitudes, and practices about digital skills, with both knowledge and attitude identified as significant predictors of the actual practice of digital skills. Therefore, the study recommended that providing training in use of technology tools to improve STEM teachers' attitudes and knowledge, which would subsequently improve their practical application of digital skills. Also, school administrators should prioritize promoting practices related to digital skills through ensuring that both teachers and students have opportunity to use required technology tools and a supportive digital environment. Effective procedures and corrective measures should be instituted in STEM education to further develop teachers' knowledge, attitudes, and practices (KAP), thus enhancing their perceptions of the use of digital skills. To succeed in school and future workplaces, STEM students need to learn how to be digital citizens, conduct research, and become information-fluent. Using effective teaching methods helps in preparing students for the digital environment they currently steer and will meet in the future.

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