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Preservice Mathematics Teachers' Perception and Utilization of Digital Literacy at the University of Cape Coast, Ghana

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Abstract
This study explored the digital literacy of pre-service mathematics teachers. A descriptive research design was adopted by employing a quantitative approach. A simple random sampling technique was used to select a sample of 80 out of a population of 105. The instrument used for the data collection was a set of questionnaires made up of closed-ended and open-ended statements. Descriptive statistics (means, standard deviation, frequency counts, and percentages) were used to analyse and answer the research questions. By self-report, the pre-service teachers defined digital literacy as the ability to access and assess information using appropriate digital resources and having knowledge of the types of digital tools. An average percentage of the teachers reported using different digital tools to augment classroom learning activities. The most reported digital resources these teachers used to support teaching and learning were graphics, animations, quizzes, and games. The teachers were described as proficient in using word processing applications and cloud computing, video and audio conferences for online discussions, good skills in connecting devices to the internet, and the use of appropriate search engines. The digital domains that defined the digital literacy of the teachers were engaging in effective data collection activities, data evaluation, management, and processing using appropriate digital resources, being socially responsible, and interacting effectively with team members with digital tools. Generally, the study informed us that there is a favourable perception of digital literacy among pre-service mathematics teachers as supporting learning processes. The implications of the pre-service teacher's knowledge of digital literacy, the digital resources they use to support learning, their proficiencies in using digital resources, and the digital domains that define their digital literacy are discussed in this paper.

Keywords: Digital Literacy, Digital Resources, Digital Proficiency, Digital Domains, Teachers' Perception

Introduction

The COVID-19 crisis substantially shifted education from a face-to-face interaction to an online process and caused Higher Education Institutions in Ghana to use ICT in their teaching to an unprecedented degree. Both lecturers and students were not prepared to use e-learning platforms for online instruction. Notwithstanding, the progression of globalisation cannot be overlooked, particularly in the 21st century with the quick advancement of innovation, which is currently entering a period of modern upheaval. In the period of computerised transformation, everything connected to data and information can be accessed progressively and rapidly, any place and whenever. One's powerful contribution globally greatly depends on one's computerised abilities, which in turn depend on one's instructional level (Peromingo & Pieterson, 2018). Both instruction and working environment prerequisites involve material and tangible innovative information. Workers are continually needed to utilise significant innovation and update their computerised abilities (Peromingo & Pieterson, 2018).

Digital literacy, a concept introduced in the 1990s and popularised by Gilster, refers to the capacity to comprehend and utilise information from various sources in different formats. Julien (2018) described digital literacy as a collection of skills, attitudes, and knowledge necessary for successfully, efficiently, and ethically accessing digital information. Digital literacy encompasses the proficient and analytical use of a wide variety of digital technology for information, communication, and fundamental problem-solving in all areas of life (UNESCO, 2021). Digital tools are essential for communication, creating meaning, and evaluating digital content (Neumann et al., 2017). Digital literacy and competency present both novel opportunities and challenges to instructors because of the skills, educational

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frameworks, and teaching environments they demand. Teachers must provide pupils with topic knowledge and also develop the skills needed for success in the digital world of the 21st century (Gilster, 1997). Research on digital literacy indicates that teachers are increasingly emphasising the importance of ICT skills. It highlights the official and informal usage of ICT to improve students' ability to apply these skills in a technology-driven society (Lau & Yuen, 2014).

Literacy is the capacity to read and write. Digital literacy refers to the skills and technology knowledge needed for individuals to engage in continuous learning activities and make valuable contributions to society (Çam & Kiyici, 2017). Digital literacy is a crucial ability in modern schooling, encompassing information literacy, computer literacy, media literacy, communication literacy, visual literacy, and technology literacy (Çam & Kiyici, 2017). Young individuals can leverage digital literacy to access information sources related to digital technology and equip themselves to tackle contemporary technological difficulties (Çam & Kiyici, 2017). Digital literacy in mathematics learning allows for engagement, access to many reading sources, diversified material references, communication, and problem-solving opportunities (Swan et al., 2009). Enhancing digital literacy among students can facilitate their comprehension of mathematics, transform it into a practical activity, and foster a culture of competitiveness and practice (Yaw et al., 2012). Digital literacy among pre-service teachers in Ghana is still inadequate, as indicated by Yaw et al. (2012). Generally, students who attend classes continue to use traditional methods of learning, such as textbooks (Brown, 1998). This provides kids with a restricted amount of knowledge and educational chances. Current pre-service teachers are well-versed in digital technology and possess the skills to get, generate, and distribute digital content (Ting, 2015). According to Greene et al. (2014), being digitally literate requires the ability to seek, handle, scrutinise, and integrate digital information. While today's pre-service teachers are often seen as proficient with technology, many struggle to use it successfully

Ghana is a highly developed and economically stable country in the West African sub-region. Ghana's burgeoning economy and stable democratic political system have elevated the country to a significant regional economic power. Ghana is among the African countries where the importance of digital literacy is becoming increasingly apparent. Digital literacy's impact on Ghanaian society is evident in the field of education (Gaisie-Nketia, 2008). Over the last twenty years, the Ghanaian government has made significant investments in ICT education to prepare students with the necessary skills for digital literacy in the modern economy. In 2008, the government of Ghana allocated approximately US$3 million to enhance ICT in basic education. Additionally, it distributed more than 450,000 laptops to schools, particularly those in disadvantaged regions of Ghana. According to the survey, 87% of the second-cycle schools had computer laboratories, and 94.7% had ICT teachers (Gaisie-Nketia, 2008). There are no statistics available regarding the number of computers in colleges of education and teacher education-centred universities in the pre-service teacher education context. However, evidence indicates that every college of education or teacher education-centred university in Ghana has at least one ICT laboratory. Most institutions are connected to the Internet, according to Owusu et al. (2010).

However, a study conducted by Lim and Toh (2020) discovered that although ICT is widely available in schools, particularly in metropolitan areas, teachers are not using this technology for educational objectives. Significant funds have been allocated towards hardware, software, and infrastructure including computer labs, internet access, and science resource centres with advanced ICT tools to enhance science and mathematics education (Yaw et al., 2012). Despite significant investments in ICT infrastructure, equipment, and professional development to enhance education in Ghana, the full potential of ICT to revolutionise teaching methods and student learning has not been achieved according to Yaw et al. (2012). The report highlighted teachers' unfavourable attitudes regarding using technology for instructional purposes. The success of students' learning with ICT and acquiring digital literacy in Ghanaian classrooms depends on pre-service teachers' attitude towards and acceptance of integrating ICT and digital literacy, as highlighted by Yaw et al. (2012), Lim and Toh (2020), and Teo and Milutinovic (2015). Understanding pre-service teachers' attitudes and responses to digital literacy is crucial for the successful implementation of ICT in education, especially during a period of significant government spending in Ghana.

Researchers have debated pre-service teachers' perceptions of ICT usage, particularly in the classroom, as a crucial factor influencing the acceptance and integration of technology in education systems globally. This study aims to investigate how pre-service mathematics teachers in Ghana perceive and utilise digital literacy in education. The article introduces a novel digital literacy assessment called the Seven Domains of Digital Literacy and evaluates the

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competence of pre-service teachers in utilising digital tools for educational purposes. Understanding pre-service teachers' perceptions of ICT can provide crucial insights for educational programme developers aiming to support this new advancement in creating strategies for integrating ICT into the educational system.

Digital Literacy

The purpose of formal education is to increasingly recognise digital literacy, which is the combination of the words digital and literacy. Digital information is a symbolic representation of data, and literacy is the capacity to think critically about written language, write coherently, and read for information (Gomathy, 2018). To fully engage in a knowledge society, one must possess a set of competencies known as digital literacy. It encompasses behaviours, knowledge, and abilities related to using digital devices—like smartphones, tablets, laptops, and desktop computers—effectively for advocacy, communication, expression, teamwork, and cooperation (Gomathy, 2018). The traditional definition of literacy, which was the capacity to read and write in order to satisfy the demands and expectations of society (McArthur et al., 2018), is no longer relevant. Individuals with strong digital literacy are adept at switching between different media quickly. They have developed the ability to deliver information in a way that will be most understandable to their audience because they are aware of which forms of expression are appropriate for which types of knowledge. The ability to fit the medium we use to the type of information we are presenting and the audience we are presenting it to is made possible by digital literacy. Digital literacy was defined by Gilster and Gilster as the capacity to comprehend and apply knowledge in a range of formats from various sources when it is delivered through computers, especially the Internet (Gilster & Gilster, 1997).

The ability to use compelling new media requires digital literacy, and our understanding of the Internet will be shaped by our ability to grasp its fundamental concepts. Gilster distinguished four essential skills for digital literacy: assembling knowledge, assessing the quality of information, conducting web searches, and navigating hypertext. "The ability to read and interpret media (text, sound, and images), to reproduce data and images through digital manipulation, and to evaluate and apply new knowledge gained from digital environments" is the precise definition of digital literacy (Shopova, 2014). Understanding technology and how to use it to communicate and operate more efficiently are both parts of digital literacy.

According to the literature, students' academic performance may be significantly correlated with certain digital literacy skills, such as their capacity to use digital tools to find information, evaluate it critically, and apply it to further their personal and professional objectives (Gilster, 1997). Because evaluating digital literacy skills is a complicated phenomenon, according to research, investigations instead gauge participants' perceptions of their digital literacy. For example, Shopova's (2014) study on students' self-perceived digital skills revealed that 76% of them had high skills and the capacity to use computers to evaluate information. Amiri (2009) also demonstrated how digital literacy improves pupils' academic achievement. Similarly, Brown (2009) investigated the connection between students' achievement and digital literacy and found that there was a favourable correlation. In general, studies have shown that better surroundings and simple access to ICT and digital literacy benefit students' performance. This illustrates how students' competencies in their educational experiences and future professions will be impacted by digital knowledge.

Digital Resources Used by Pre-Service Teachers

With the rapid breakthroughs in science and technology, media, especially television, the internet, and online communication, have a rising influence on society, including education. In contrast to twenty years ago, students now have different expectations, interests, priorities, and attitudes towards education. According to Janssen et al. (2013), students want an innovative and captivating education that is akin to the digital graphics they see on television or websites. To improve the process of teaching and learning, digital technologies are essential. Digital tools aid in the achievement of educational goals, the presentation and transmission of mathematical material by pre-service instructors, and the support of students' learning and development of diverse skills and values (Koç, 2005). When used properly, digital learning resources can greatly improve student experiences and the quality of education (Koç, 2005; Akaadom, 2020). Digital tools like simulations, models, graphics, animations, quizzes, games, e-books, and e-notes have been found in the study literature to be useful in augmenting pre-service teachers' learning experiences.

Simulations and Models

The advancement of technology has led to the integration of computer simulations and other digital instructional technology into mathematics classrooms. According to Bell et al. (2008), computer simulations are dynamic models

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produced by computers that provide theoretical or condensed representations of elements, phenomena, or processes found in the real world. Simulations offer significant benefits in educational settings by representing abstract and complex ideas that are hard to see directly in the actual world (Scalise et al., 2011). According to Weller (2018), computer simulations are software applications that let users engage with a digital depiction of a theoretical system or a model of the real or natural world. According to Windschitl and Andre (1998), simulation offers student-centred environments where students can investigate systems, change variables, and test theories. With the help of this programme, teachers and students can examine phenomena that are not easily accessible in everyday contexts. Animations, visualisations, and interactive lab experiences can all be included in simulations. Simulations enhance comprehension of mathematical ideas by doing experiments that are unfeasible in traditional classroom environments. Variables in simulations can be readily modified in reaction to students' inquiries, a capability sometimes lacking in real equipment (Bell & Trundle, 2008). Students can use simulations at home to review or expand on classroom activities for further understanding. Comparative studies suggest that traditional learning can be enhanced by including simulations.

E-books and E-Notes

The name "Electronic Book," or E-Book, was coined by Van Dam of Brown University in the 1960s and is widely used today. An electronic book, or e-book, is a self-contained digital text that resembles traditional books and is read on an electronic display or device (Matthew et al., 2009). E-books have become widely accepted in academic settings, offering convenience and accessibility to students, which are the primary reasons for their popularity as learning resources. According to Walton (2014), students tend to utilise e-books more when they find them convenient and when printed books are not available. E-books are portable and easily accessible according to Ennis (2018) and Mizrachi (2015). E-books have searchable information based on keywords and offer advanced navigation features in a digital setting, including linkages to other digital material and the capability to directly copy and paste text chunks. Technological advancements have significantly improved perceptions of e-book usage, leading to exponential growth in its adoption (Mizrachi, 2015).

Animation and Graphics

Bell and Trundle (2008) describe animation as a sequence of images that transition throughout time and/or space. Chen et al. (2011) define graphics as visual representations like pictures, illustrations, diagrams, charts, tables, and maps, used alongside written text to enhance comprehension. Multimedia refers to any presentation that includes both text and images (Mayer & Clark, 2002).

Graphics have been essential components of mathematical textbooks for millennia (Brooks et al., 2002). They have been utilised to pique students' attention and enhance their engagement with educational objectives. A significant amount of study has been conducted on the process of acquiring knowledge through text and images, as noted by Brooks et al. (2002). It is well-accepted that combining images with related text content is good for readers (Morrison et al., 2002). Graphics are an excellent means of visual communication and can convey textual messages efficiently (Brooks et al., 2002). Graphics attract the learner's attention by organising the elements spatially (Morrison et al., 2002). Instructional material typically includes written texts and visual aids including maps, charts, graphs, and diagrams (Morrison et al., 2002). Graphical displays in the text have a functional purpose rather than being used as mere decorations to attract readers. Graphics are utilised to visually represent abstract ideas, structure intricate information sets, incorporate new knowledge into existing structures, enhance information retention, and promote thinking and problem-solving processes, serving as valuable tools for learning (Morrison et al., 2002). Utilising images to comprehend abstract concepts aids in elucidating the spatial links outlined in the text (Mizrachi, 2015). Graphics can fulfil multiple roles such as illustrating data, elucidating intricate connections, structuring information, enhancing retention of facts, and impacting problem-solving. These functions do not originate from visuals themselves, but rather from how these graphics are cognitively processed (Mayer & Clark, 2002). Integrating printed text, static images, charts, maps, dynamic visuals, and animations into instructional material may raise costs, but these components can enhance the learning experience (Mayer & Clark, 2002).

Games and Quizzes

In the 1980s, the emphasis on using games for teaching and learning was mostly on their efficacy in the classroom. Game-based learning has been proven to enhance learners' learning processes and understanding of different curricular subjects. Game-based learning in education has recently gained significant interest due to its potential to enhance

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learners' academic achievement. Game-based learning comprehension has significantly risen over time, highlighting the ability of games to reinforce educational concepts. Studies have shown that learners engage more actively in the classroom when games and quizzes are incorporated (Belova & Zowada, 2020). Educational games and quizzes are seen as a valuable supplement to traditional teaching methods, helping educators motivate students to study, cultivate a passion for learning, and make the learning process enjoyable (Belova & Zowada, 2020). These duties are frequently overlooked in maths education due to the difficulty of engaging pupils and motivating them during lectures, as highlighted in several researches (Hilliard & Kargbo, 2017). Students are more eager to study when the learning process is entertaining and interactive (Mizrachi, 2015). Educational games are an engaging method that enhances active learning, and motivation, and fosters teamwork (Belova & Zowada, 2020). Games and quizzes play a crucial role in facilitating active learning by incorporating interactive and unique components (Selby et al., 2007). They enhance learning by making it more engaging, promoting students' participation in class, and shaping their attitudes towards learning (Jones et al., 2015). Furthermore, students who are motivated and engaged in the teaching approach are likely to achieve a more successful learning outcome, resulting in a lasting reservoir of knowledge that may be retrieved later (Selby et al., 2007). Teachers can utilise games and quizzes for goals like solidifying previously covered material, introducing new ideas, and encouraging student engagement. Educational games are suitable for both the commencement and conclusion of a lesson. Therefore, teachers can cultivate students' interest and motivation in lessons, as well as review, strengthen, and evaluate the topics acquired. Educational games and quizzes encourage pupils to actively engage in lessons, facilitating their learning (Üldur, 2016).

Proficiency of Teachers' Use of Digital Resources

Digital resources will play significant roles in the learning experiences of students if teachers have the requisite proficiencies to effectively use them to support their instructional approaches. Research on the digital proficiencies of teachers is reviewed with respect to Word Processing, Cloud computing, and Digital Devices.

Word Processing

Mastery of word processing is crucial for improving academic performance in the classroom. Many teachers are unable to operate the word processor due to a lack of necessary training. Inadequate teacher training directly affects students' utilisation of computers in the classroom (Bingimlas, 2009). Without proper training in technology and a lack of comfort with word processing, a teacher will fail to demonstrate to students the value of using word processing. Teachers require sufficient preparatory time to acquire and impart word-processing skills through regular practical training. Utilising word processing as a tool for learning can enhance the effectiveness of ICT in mathematics education (Bingimlas, 2009). The teacher's stance on word processing can impact the student's views on utilising a word processor. It is crucial for teachers intending to have their students use word processors to undergo adequate training and have sufficient time to enhance their word-processing skills before teaching the topics (Üldur, 2016). According to Riahi (2015), teachers' integration of word processing and digital tools in the classroom may enhance students' capacity to create refined reports, newsletters, and publications for authentic audiences.

Cloud Computing

Cloud Computing arose as a versatile service provider in response to the advancement of Internet technology and the growing need for computer applications. It facilitates the sharing of information, software, and resources within an Internet-based setting. Cloud computing has been defined in several ways due to its early stage of development (Geelan, 2009). The National Institute of Standards and Technology (NIST) has introduced a fundamental cloud computing notion that has gained widespread acceptance among the public (Mell & Grance, 2011). Cloud computing is a model that enables the sharing of multiple computing resources as services to different clients. Students benefit more from cloud-based e-learning. Students can enrol in online courses, complete online assessments, receive course feedback from instructors, and submit their projects and assignments electronically to their lecturers (Maskare & Sulke, 2014). Teachers benefit from utilising cloud-based e-learning. Teachers can create online assessments, organise lecture timetables, assess students' tests, assignments, and activities, provide feedback, and communicate with students via online forums (Riahi, 2015).

Cloud computing offers advantages such as cost-effectiveness, network availability, innovation capabilities, scalability, user-friendly operation, and environmental sustainability (Linthicum, 2009). Deelman et al. (2008) asserted that cloud computing is a cost-efficient method for managing data. E-learning users do not require sophisticated computers to operate the e-learning programmes. Students can easily access their applications from the

cloud using their desktops, mobile phones, or tablet PCs with little setup and internet connection because the data is stored and retrieved in the cloud. Deelman et al. (2008). Cloud computing also presents certain concerns. The primary possible concerns comprise security vulnerabilities, limited controllability, financial strain, poor transparency, absence of auditing capabilities, and challenges connected to service agreements (Linthicum, 2009).

Digital Devices

Digital technology utilisation and accessibility are seen as crucial elements according to Maher et al. (2012). Ghana recorded almost 41.7 million mobile connections, an increase from 39.97 million in the same month of the previous year. Each person in Ghana had an average of 1.328 mobile connections, considering that individuals may use more than one network (Maher et al., 2012). Digital gadgets are crucial for improving the quality of education. Ackerman and Goldsmith (2011) and other researchers have shown that educational material presented on mobile handheld digital devices can significantly influence collaborative, inquiry-based, and self-directed student learning. In this instance, students also discovered that mobile learning was more gratifying than traditional approaches. Ackerman and Goldsmith (2011) stated that digital gadgets, especially smartphones, enabled instructors and teachers to obtain greater involvement levels compared to traditional training and restricted personal computing resources. Mobile devices allow for concurrent, simultaneous engagement in classrooms.

Digital Competence of Pre-Service Mathematics Teachers

According to Tondeur et al. (2017), educators should incorporate technology into their lesson plans due to its growing significance in the workplace and labour market. Digital technology must be used by teachers to enhance their methods of instruction and learning (Aesaert & Van Braak, 2015); also, teachers must teach students how to use digital technologies (Tondeur et al., 2017). According to Maderick et al. (2016), one essential component of a top-tier education in the twenty-first century is digital competence. Digital skill proficiency is becoming more and more important in contemporary economies and society (Fraile et al., 2018). According to Aesaert and Van Braak (2015), digital competence encompasses a variety of skills such as technical proficiency with digital technologies, navigation of digital information environments, communication and teamwork, creation of digital content, comprehension of digital media, assurance of safety, problem-solving, employment, community involvement, and confident acquisition of knowledge about digital technology to improve critical and creative thinking abilities. Digital competence, according to Fraile et al. (2018), is the culmination of technical proficiency, the application of technology in both personal and professional contexts, critical evaluation of digital tools, and engagement with digital culture. Using digital technologies' benefits while minimising their drawbacks is what it means to be digitally competent (Fraile et al., 2018).

Past research on digital competencies has demonstrated how teachers' attitudes towards technology have a significant impact on their professional development (Tondeur et al., 2017). According to Tondeur et al. (2017), attitudes like "usefulness" and "attitudes towards ICT in education" might have a significant impact on digital skills. Studies have indicated that the attitudes instructors have towards technology have an impact on their inclination to use it and incorporate it into their lessons. According to Kreijns et al. (2013), pre-service teachers' perceptions of the practicality and use of digital devices have a major impact on their propensity to employ them in the classroom. According to Hoy and Spero (2005), teachers develop opinions about teaching throughout their time in school and assess other teachers as "good" or "bad" depending on these opinions. First impressions could be problematic since strongly held beliefs can be resistant to modification over time (Hoy & Spero, 2005). Laying a strong foundation for future teaching requires examining pre-service teachers' beliefs and attitudes about incorporating ICT in the classroom. This is because these beliefs will influence their behaviour and have an impact on their pupils. The study looked at pre-service teachers' perceptions of their own digital literacy, skills, and readiness to use digital resources in the classroom during their teacher preparation.

Domains of Digital Literacy

The seven facets of digital literacy are the main topic of this study. Seven digital literacy categories have an impact on teachers' digital competency, which is characterised as their ability to use digital resources to enhance instruction. Kurtz and Peled (2016) looked at seven aspects of digital literacy: obtaining information, assessing it, organising it, manipulating it, working with others, being aware of ethics, and having a civic responsibility. According to Kurtz and Peled (2016), these areas are essential for a person's ability and preparedness to operate in complex digital environments (Horrigan, 2016). A synopsis of the seven dimensions of digital literacy is provided in the report.

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Information Collection

One of the most important skills for modern literacy is the ability to find and search for information on digital platforms (Kurtz & Peled, 2016). This critical ability involves determining what level of expertise and understanding is required to use digital platforms. Kurtz and Peled (2016) emphasise that before beginning a search, it is important to acknowledge and articulate the demand for information. Janssen et al. (2013) emphasise that selecting appropriate digital tools for research requires thoughtful decision-making. The ability to identify and retrieve information in an electronic environment utilising digital tools with proficiency and success is known as digital competency in information retrieval. The ability to locate, get, interpret, and use critical information from online resources, professional databases, and search engines is known as information literacy (Nelson et al., 2011; Lau & Yuen, 2014).

Information Evaluation

Evaluating information is a crucial component of digital learning that might be more psychologically demanding than collecting, retrieving, and managing information. Kurtz and Peled (2016) support the ability to evaluate a source's credibility and determine if the information meets the specific needs of an assignment. Key talents encompass critical thinking, thoughtful contemplation, and problem-solving capabilities. Digital literacy requires the ability to assess, evaluate, interpret, and reflect on a task, together with the knowledge needed to meet the relevant criteria (Janssen et al., 2013). Information evaluation is the process of assessing the usefulness of gathered data. The ability to evaluate the quality, reliability, significance, timeliness, comprehensiveness, credibility, usefulness, and effectiveness of digital materials (Lau & Yuen 2014; Nelson et al. 2011).

Information Management

Kurtz and Peled (2016) look at the fundamentals of information management, focusing on digital file organisation. Similar to learning and having access to information, this ability is necessary for many new literacies. Building on this basic idea, Rusitoru et al. (2016) and Janssen et al. (2013) stressed the importance of a person's self-efficacy in navigating a digital world and understanding the information presented in various formats. Those who are digitally literate must be able to learn and use digital technology skills, as these are becoming increasingly important given the speed at which modern technologies are developing. Data structuring and archiving for later use are key components of information management. Proficiency with digital information retrieval, storage, and organisation while being aware of plagiarism and copyright issues (Nelson et al., 2011). According to Lau and Yuen (2014) and Nelson et al. (2011), it refers to the capacity to safeguard private information and data against threats such as unauthorised access, deletion, identity theft, impersonation, illegal data manipulation, and fictional creation.

Information processing

Content creation and knowledge compilation are necessary for organising, managing, and presenting information (Son et al., 2017). According to Son et al. (2017), engaging in digital literacy exercises encourages a proactive approach to the meaning-making process. Beyond the fundamentals of representation, digital literacy entails the creative use of a variety of digital media. According to Janssen et al. (2013), there is a direct link between creative expression and digital technology and information processing. Text, audio, and picture data are just a few of the formats that information processing generates and arranges. The aptitude to generate new knowledge from existing data through the application of information and communication technology (Lau & Yuen, 2014).

Teamwork

Team-based learning is connected to the necessity for individuals to collaborate in a participatory culture, similar to social responsibility. Kurtz and Peled (2016) examined team members' understanding of their individual responsibilities, the roles of their teammates, and how well their individual roles matched the group's work. The literature highlights collaborative involvement, constructing social groups, and sharing individual opinions with group members as crucial abilities of digital literacy. Teamwork involves multiple individuals working together in the learning process by exchanging knowledge, interacting, and engaging in assessments to learn, collaborate, and create a shared outcome. Put simply, it refers to the capacity to collaborate and cooperate with others, such as instructors and peers, in order to achieve a shared learning objective through discussion and teamwork (Nelson et al., 2011).

Integrity Awareness

Following copyright laws, being aware of the ethical and legal ramifications of using digital media, understanding Creative Commons licences, and knowing how to properly attribute sources are all necessary for understanding digital integrity (Hobbs, 2010; Kurtz & Peled, 2016). According to Janssen et al. (2013), legal and ethical considerations, privacy, and security are all crucial elements of digital literacy. A person who is digitally competent can protect personal information, put security measures in place, behave morally and responsibly online, and demonstrate knowledge of the ethical and legal ramifications of ICT and digital content (Janssen et al., 2013). Son et al.'s (2017) study on digital literacy and security focuses on virus detection, hacking, scams, and password protection as well as internet and mobile security. Integrity awareness is the ability to search for, gather, and create knowledge in an ethical manner while using information with honesty, fairness, and integrity.

Social responsibility

In the participatory culture of the fourth industrial revolution, driven by the digital economy, social responsibility is crucial for survival. According to Kurtz and Peled (2016), social responsibility is understanding actions that have an impact on society and being aware of such threats. Son et al. (2017) emphasised the importance of taking individual rights and responsibilities into account as well as societal awareness. For all social gatherings, including virtual ones, social etiquette is crucial. It is recognised as a code of conduct and is comparable to Hobbs' view on the significance of making moral decisions in interpersonal relationships. In a more comprehensive examination of digital talents in 2010, Hobbs made a distinction between digital emotional intelligence and digital literacy. She talks about the value of empathy for other people, self-control, and emotional awareness. By being aware of and understanding the role of ICT in society, people may balance their ideas and behaviours with it (Janssen et al., 2013). Social responsibility includes acting with moral rectitude and dependability as well as acceptable behaviour in the digital sphere. It entails understanding the effects and results of using digital resources in social and ethical contexts. A person's level of proficiency with the SDDLs reflects their level of readiness for many facets of digital literacy. The research objectives of this study are theoretically influenced by the digital literacy domains. The domains aid in examining pre-service teachers' digital domain features, their proficiency with digital tools, their comprehension of digital literacy, and the kinds of digital tools they employ.

Statement of the Problem

Teachers need to be digitally literate adults so that their students can be equipped with the digital skills and knowledge needed to be successful in a workplace dominated by technology (Garner & Gillingham, 1998; Eynon, 2021; Nurhayati, et al., 2020). Studies indicate that technology fosters change in the classroom (Myers et al., 1998); Pianfetti, 2001; Roschelle et al., 2000). Despite the assertion by the Ghanaian Ministry of Education that the majority of senior high schools in Ghana are equipped with ICT equipment, statistics show that teachers of mathematics in Ghana do not integrate technology into their day-to-day classroom activities (Mereku et al., 2009). In support of this, it was seen that during off-campus teaching practice, most mathematics pre-service teachers abstained from integrating technology into their teaching. As a result, Computer Applications as a Course in Mathematics Education was developed to prepare pre-service mathematics teachers to use technologies to support their teaching. Even though the pre-service teachers undergo such course training, reports suggest few teachers are realising the importance of incorporating technology into the teaching and learning activities of mathematics (Mereku et al., 2009). If the perceptions of teachers towards digital literacy have a great bearing on the application of such literacy in the classroom, then it is necessary to ask: What are the teachers' perceptions towards digital literacy? And how proficient are the pre-service teachers in digital literacy? It is against this background that the researchers seek to conduct an empirical study to investigate pre-service teachers' perception and utilisation of digital literacy at the University of Cape Coast, Ghana. Therefore, the following questions were proposed to guide the research work: (1) What is pre-service teachers' understanding of digital literacy?

(2) What digital resources did pre-service teachers use during teaching practice?

(3) How proficient are pre-service teachers in using digital resources? and

(4) What domain(s) of digital literacy are the pre-service teachers' digital literacy most conversant with?

The conceptual and empirical review of digital literacy among pre-service mathematics teachers entailed the need for digital literacy among pre-service teachers, the pre-service teachers' understanding of digital literacy, the digital resources used, their perceived proficiencies in using digital resources, and the impact of digital literacy on pre-service mathematics teachers. Also, the theoretical framework reviewed to underpin the study is the seven domains of digital literacy.

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Materials and Methods

This study utilised a descriptive survey research approach. Descriptive research involves collecting participant data without altering the environment. This study utilised the descriptive survey research method to investigate the perception and utilisation of digital literacy among pre-service mathematics instructors. The descriptive research approach was considered suitable for providing fundamental information about variables in a dataset, which may be examined to identify potential links between them. The study focused on final-year pre-service mathematics teachers as the available population. There were 153 Bachelor of Education (Mathematics) students in the population. 80 pre-service mathematics teachers were selected using simple random sampling. An algorithm based on probability was utilised to randomly choose the 80 individuals from the population. Of the 80 respondents, 81.25% were male and 18.75% were female, showing a male-dominated survey. 18.8% of respondents were 20 years old or younger, 60.0% were between 21 and 25 years old, 18.8% were between 26 and 31 years old, and 2.5% were beyond 31 years old.

A questionnaire was utilised as a tool for gathering data. Questionnaires are a cost-effective and efficient way to measure the behaviour, attitudes, preferences, views, and intentions of a big group of individuals compared to other methods. The questionnaire consisted of four sections: demographic information, pre-service teachers' understanding of digital literacy, competence in using digital tools, and areas of digital literacy expertise among pre-service teachers. 80 mathematics pre-service teachers were given questionnaires, and all of them were completed and returned, resulting in a 100% return rate. The participants took around 20 minutes to complete the questionnaire. The Cronbach's Alpha reliability coefficients for the subscales measuring competency in the use of digital resources and the preservice teachers' areas of digital literacy were 0.87 and 0.94, respectively. Each participant had to answer all the questions on the survey by indicating their level of agreement using a five-point Likert scale or by choosing digital literacy statements that reflect their knowledge of digital literacy. They also had to select digital tools or resources they used in previous maths lessons. Descriptive statistics were utilised to provide a broad summary of the acquired data. The findings for study questions one and two were displayed as frequency counts and percentages. Means and standard deviations were utilised to display the findings of research questions three and four.

Results

The perceptions of the pre-service mathematics teachers' digital literacy are reported in this section. The findings of the reported digital literacies are also discussed

Results

The results of this study are systematically presented in this section based on the research questions. Results on the level of digital literacy, types of digital resources used, proficiency in the use of digital resources, and the digital domains of pre-service teachers are systematically presented.

What is pre-service teachers' understanding of digital literacy?

This objective aimed to determine how pre-service mathematics teachers understand the concept of digital literacy. Possible definitions of the concept of digital literacy were provided, and participants expressed their understanding by choosing a definition that best explains the meaning of digital literacy. The frequency counts of each definition of digital literacy are displayed in Table 1.

Table 1: Pre-service Teachers' *Definition of Digital Literacy*

Variables	Frequency	Percent (%)
Ability to read and write	2	2.5
Assessing information	30	37.5
Knowledge of types of computers	8	10.0
Finding information	12	15.0
Using information properly	7	8.8
Handling digital tools	15	18.8
Internet Safety	3	3.8
Sharing information	1	1.3
Creating new information	1	1.3
Owning a digital device	1	1.3
Total	**80**	**100**

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The frequency counts in Table 1 appear to suggest that pre-service mathematics teachers define digital literacy as the capacity of "assessing information, handling digital tools, finding information using digital tools, and having knowledge of types of computers". This indicates that a digitally literate pre-service mathematics teacher is one who has the ability to effectively assess information through the appropriate use of digital tools. It extends to their ability to have knowledge of the requisite types of digital tools, appropriately handle the digital tools, and use them effectively to find required information in the course of training as pre-service teachers.

What digital resources did pre-service teachers use during teaching practice?

Table 2 shows a list of possible digital resources that pre-service teachers could use in their teaching practice lessons. The results show the types of digital tools they often use in their teaching and practice activities. The frequency counts revealed the resources most commonly used to enhance teaching and learning activities.

Table 2: *Digital resources pre-service teachers used during teaching practice*

Variables	Frequency	Percent (%)
Simulation and Models	5	6.25
Graphics and Animation	13	16.25
Quizzes and Games	13	16.25
E-books and E-notes	11	13.75
None	38	47.50
Total	**80**	**100.00**

From Table 2, 47.50% representing none suggests the majority of the pre-service mathematics teachers did not use any digital tools to augment their teaching practice and learning activities. This aligns with the conventional characteristics of the Ghanaian mathematics classroom, where many in-service teachers avoid integrating technology into their instructional activities. The pre-service teachers associated their low usage of digital resources for instructional activities with factors such as time constraints, a lack of digital tools and infrastructural facilities in schools, teachers' inadequate knowledge of using digital tools to teach, and students; difficulties in understanding lessons taught using digital tools. A reported 16.5% suggests the pre-service teachers used 'graphics and animations', and 'quizzes and games' to support their teaching and learning activities. Also, a 13.75% record on e-books and E-notes' suggests a good rate of use of electronic materials to support learning. Thus, it can be stated that an average percentage of the pre-service teachers used one digital tool or another to support their instructional activities. The most reported digital resources pre-service mathematics teachers used to support teaching and learning were graphics, animations, quizzes, and games.

How proficient are pre-service teachers in using digital resources?

This objective assessed pre-service teachers' self-reported competence and proficiency with digital resources. A 4-point Likert scale (ranging from 1-4) was used. For the interpretation of the means, the following cut-off points were used: 1–1.5 = Strongly Disagree, 1.6–2.0 = Disagree, 2.1–2.5 = Undecided, 2.6–3.5 = Agree, and 3.6–4.0 = Strongly agree. Table 3 presents the results.

Table 3 – *Proficiency in Use of Digital Resources*

Statement	Mean	SD
I am able to efficiently use word-processing applications	3.68	1.13
I can efficiently engage in audio and or video conferences for online discussion	3.64	1.04
I have workable knowledge of cloud computing		
I have a digital device that is connected to the internet	3.15	1.26
I know how to use search engines to find information	3.73	1.24
Mean of means	3.86	1.09
	3.61	**0.93**

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Table 3 shows that, generally, the pre-service teachers have expressed their desire to be digitally literate and proficient in the use of digital resources. The overall mean (mean = 3.61, SD = 0.93) of digital proficiency among the pre-service was high. The item-by-item means are all above 3.0, indicating that the pre-service teachers have high proficiency capacities to use digital tools to support their classroom teaching activities. It is noted that the pre-service mathematics teachers are proficient in using word processing applications; they can engage their students in video or audio conferences for online discussions; they have good skills in connecting devices to the internet; they use appropriate search engines; and they have a workable knowledge of cloud computing. This suggests trainee teachers have the requisite proficiency to use variant digital resources to support their instructional strategies.

What domains of digital literacy define pre-service teachers' digital literacy?

The pre-service teachers' agreement to their proficiency in data collection, evaluation of data, data management, data processing, teamwork, integrity awareness, and social responsibility would collectively define their digital literacy. The collective domains that define the pre-service teachers' digital literacy were determined using a five-point Likert scale ranging from 1 to 5. A mean score of 3.0 and above indicated the teachers' agreement with a domain that defines their digital literacy, while a mean score below 3.0 indicated the teachers' disagreement with a domain that defines their digital literacy. Table 4 presents the results of the domains that define the digital literacy of the pre-service mathematics teachers.

Table 4 – *Pre-service Teachers' Domains of Digital Literacy*

The domain of digital literacy	Mean	SD
Data collection	4.08	1.27
Evaluation of data	3.89	0.80
Data management	4.15	0.94
Data processing	3.87	0.85
Teamwork	4.11	0.79
Integrity Awareness	4.04	0.71
Social responsibility	3.94	0.84
Total	**4.05**	**0.74**

Table 4 shows that generally, the pre-service mathematics teachers agreed (Mean =4.05; SD = 0.74) to possessing the ability to engage in effective data collection activities, data evaluation, management, and processing using appropriate digital resources, maintaining digital integrity awareness, being socially responsible, and interacting effectively with teammates using digital tools. A total mean score of (Mean = 4.08, SD =1.27) for data collection proficiency suggests that an element of the teachers' digital literacy is defined by their data collection ability. Thus, data collection is a domain of digital literacy for pre-service mathematics teachers. The pre-service teachers expressed that they are capable of collecting data from the web, databases, and specific web pages. The teachers revealed their ability to identify information needed for teaching specific content and their skills to search effectively for such information. This indicates that the pre-service teachers have the requisite knowledge of data collection, and hence data collection is an integral part of their digital literacy.

The teachers' digital ability to assess and evaluate the data collected for an intended purpose also revealed a high mean score (Man = 3.89, SD = 0.80). Thus, the pre-service teachers possess data evaluation abilities as a domain of their digital literacy. The report indicated that the teachers can determine the usefulness of a data set, assess the credibility of the data obtained, determine to what extent a given data set is accurate and practical, and compare data from diverse sources. Therefore, pre-service mathematics teachers' digital literacy includes their ability to appropriately evaluate data obtained from different sources. Another element that forms part of the teachers' digital literacy is their data management skills. A high reported mean of (Mean = 4.15, SD = 0.94) was realised, indicating that the teachers agree to have the digital ability to manage digital data effectively. The teachers' responses suggest they have the digital competence to save files in a specific required location, retrieve saved files when needed, store files with defined names, relocate them, and are capable of grouping files under specified categories. Data management skills are therefore a component of pre-service teachers' digital literacy.

Data processing as a digital literacy domain recorded a high mean (Mean = 3.87, SD = 0.85). The pre-service teachers reported having the digital skills to process data obtained for effective instruction. The responses revealed that the teachers can interpret data from variant sources, create new data from existing information, and represent it in a variety

of ways, such as PowerPoint, websites, audio, and podcasts. It was also stated that teachers can differentiate between written, graphical, and video representations as well as analyse information for educational purposes. The preservice teachers have equally demonstrated their confidence to work collaboratively with their students and with other mathematics educators using digital tools. Thus, teamwork as a domain of digital literacy is reported to have a high mean (Mean = 4.11, SD = 0.79), indicating that the pre-service teachers have the necessary teamwork digital skills to support their instructional processes. The responses revealed that the pre-service teachers can cooperate with team members in finding information, share their thoughts and information with team members, communicate with others by sharing knowledge digitally, and are aware of what they can offer during team activities.

Finally, the pre-service teachers' digital integrity awareness and social responsibility as domains of digital literacy were determined. Results from the table show that integrity awareness has a high mean (Mean = 4.04, SD = 071). It was reported that pre-service math teachers were aware of password security issues, copyright issues, and the importance of citing sources. They are also very aware of the fact that there are consequences when one uses technology irresponsibly. The results in Table 4 show that the teachers are aware of their digital social responsibilities. A high mean (Mean = 3.94, SD = 0.84) was reported, which indicates that digital social responsibility is a confirmed element of the teachers' digital literacy. The reports informed us that the pre-service teachers can make responsible choices with collected information; they are self-aware of being reliable individuals in the digital space; they know how to respect the privacy of others in the digital space; they are aware of being accountable in the digital space; and they can reliably use another person's information confidentially.

Discussion

This is a self-reported survey that sought to obtain the perception of mathematics pre-service teachers regarding their digital literacy. The study aimed to determine pre-service teachers' understanding of digital literacy, the types of digital resources they use and how proficiently they use them, and the domains of digital literacy that define their digital literacy. The results showed that the pre-service teachers appear to define digital literacy as the ability to handle digital tools, use the tools to find digital information, assess digital information, and have knowledge of variant computer types. Digital literacy is also perceived by teachers as the process of a teacher effectively assessing digital data through the evaluation and application of new knowledge obtained from digital environments. A digitally literate pre-service mathematics teacher should have the ability to handle digital tools well and use them appropriately to obtain desired information for instructional activities.

The meaning of digital literacy perceived by the pre-service teachers aligns with Lanham's (1995) preposition that to be digitally literate involves being skilled at deciphering complex images and sounds and moving from one digital medium to another. These teachers are seen as proficient at knowing what kind of expression fits what knowledge and skilled at representing information in a medium that their audience easily understands (McArthur et al., 2018). The results defined the preservice teacher's digital literacy as their ability to understand and use digital data in multiple formats from a variety of sources to meet the learning needs of their students. This is confirmed by Gilster and Gilster (1997), who popularised the term digital literacy and posited that it involves digital skills such as information search, knowledge assembly, navigating hyperlinks, and evaluating the content of digital information. The pre-service teachers are thereby said to have demonstrated understanding and knowledge of digital literacy, as the results defined their digital literacy as the ability to access and assess information, handle digital tools, find necessary information, and exhibit knowledge of computers or digital tools.

The digital resources used by the pre-service teachers during teaching practice were also determined. The results indicated that the trainee teachers were more characterised by not using digital resources in their teaching practice lessons. The majority (47.5%) of pre-service teachers associated their practice of not using digital tools for instruction with reasons including time constraints to design and implement technology-motivated lessons, inadequate digital resources and infrastructures in the respective schools, the teachers' inadequate knowledge and skills to teach with digital resources, and some students inability to understand lessons taught with digital tools. This result extensively informs us that the Ghanaian mathematics teacher is still not skilled at integrating appropriate digital resources into the teaching and learning activities of mathematics. On the other hand, a proportionate number of the trainees reportedly used some digital resources, such as graphics and animations, quizzes and games, E-books and E-notes, and simulations and models. Janssen et al. (2013) confirmed that appropriate digital tools commonly used by teachers to support instruction include simulations, graphics and animations, quizzes and games, and E-books and E-notes.

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These digital tools are stated to add considerable value to the quality of instructional processes and provide learners with realistic experiences (Akpan, 2001). Additionally, Bell and Trundle (2008) posited that digital tools such as simulations enhance the visualisation and interactive experiences of students through laboratory experiments.

The results indicated that trainee teachers averagely used E-notes and E-books to support their teaching practices. Electronic notes and books are described as the key learning resources that meet the learning convenience of students. Chen et al. (2011) expressed that electronic learning materials are readily available, keyword searchable, and often described as portable. These features may have caused the extent of the usage of electronic books and notes by the pre-service teachers during their teaching practice activities. Graphics and animations were also used to some extent by the trainee teachers. The results indicate that the students perceived that the use of graphics and animations augments mathematics learning and contributes extensively to positive learning experiences. The teachers stated that graphics and animations are capable of offering visual representations that can enhance the spatial capacities of their students. The literature contains similar positions on how animations are used to stimulate students' interest in learning and increase their involvement during instruction (Brooks et al., 2002). Graphics are stated to be a good source of visual communication capable of delivering textual content effectively due to their ability to capture the attention of learners through spatial arrangements of the contents, which in turn develop the perception of human visual systems and spatial configurations (Morrison et al., 2002). These potentials could explain the pre-service teachers' perceptions of using graphics in data representation, organising information, and explaining complex relationships to improve memory of facts and problem-solving skills.

Educational games and quizzes are equally effective alternatives that consolidate teaching and learning and support the traditional method, especially by improving the role of the teacher by making learning interactive and stimulating (Udoewa et al., 2016). Thus, the pre-service teachers listed games and quizzes among the digital resources they used to support their teaching activities. The pre-service teachers perceived games and quizzes as providing an active and interactive learning platform that encourages teamwork, motivates student class participation, and fosters positive learning attitudes (Udoewa et al., 2016). Educational researchers agree that learning with games and quizzes reinforces learned concepts, fosters interest and motivation towards lessons, and motivates students to participate in learning activities (Selby et al., 2007). The effective adoption of digital tools in the mathematics classroom depends largely on the proficiency of teachers in using these digital resources. Despite the low level of technology integration into mathematics instruction by the pre-service teachers, the report on their proficiency in using digital tools was high. The pre-service teachers' responses revealed that the teachers can efficiently use word-processing applications and engage students in audio and video conferences for online discussions. Proficiency in the use of word applications is confirmed to be key in enhancing teaching practises and therefore causing good academic output on the part of students (Bingimlas, 2009). It is emphasised that the use of such tools significantly motivates and fosters students' interests, and thus, teachers must be effectively trained to teach with word applications through consistent hands-on experiences. It is through the integration of such tools that teachers maximise the impact of ICT in mathematics education (Bingimlas, 2009).

The results also confirmed that the teachers have a workable knowledge of cloud computing and know how to use appropriate search engines to obtain the needed information for instruction. Some pre-service teachers reported how successfully students responded to online assignments and projects. Such findings agree with Riahi (2015), who stated that with cloud computing, teachers can conduct online lessons, conduct and evaluate tests and homework, and provide almost immediate feedback on students' learning progress. It is thereby indicative that the pre-service teachers are proficient in using digital resources to augment their teaching practises. The proficiency of a teacher's use of technology for instruction defines their digital literacy based on the domains of digital literacy. The results confirmed that the digital literacy of the pre-service teachers was defined based on their proficiency in data collection, data evaluation, data management, data processing, teamwork, and digital social responsibility. Therefore, the pre-service teachers are digitally literate based on the domains of data collection, evaluation, management, processing, teamwork, and social responsibility. The perceived digital domains of the teachers confirm that they have the potential to obtain information from diverse web pages. Also, they suggest possessing data management, evaluation, and processing skills such as retrieving saved files, representing data in various forms, and analysing information for instructional purposes. It is equally noted that the teachers have demonstrated proficiencies in working collaboratively with other teachers using digital tools, have shown digital integrity and social responsibility through responsible choices of data collection and representation, and also know how to respect the digital privacies of others.

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The digital domains of the pre-service teachers suggest they have the requisite digital skills to integrate technology into mathematics instruction. However, the reported digital tools the pre-service teachers used during teaching practice were relatively below average. The percentage of pre-service teachers who supported their teaching practice lessons with technology activities was also below 50% of the sample. Notwithstanding, the pre-service teachers demonstrated a significant degree of proficiency in using digital resources to support the teaching and learning activities of mathematics. Therefore, the digital characteristics of the pre-service teachers inform the faculty of the teacher training institutions to work towards developing variables that would improve teacher perception, attitude, acceptance, and use (integration) of digital resources into their professional practises. If the pre-service mathematics teacher is to be motivated to adapt teaching with technology, an adequate course should be provided as well as appropriate practice opportunities to help them perceive the usefulness and ease of use of digital tools. The self-reported proficiencies of the pre-service teacher indicate that they can adapt to learning and teaching with multiple digital tools when given the right exposure and support. Thus, teacher education institutions could develop these interests by providing training opportunities for trainee teachers to gain in-depth experience harnessing the potential of technological tools for teaching and learning activities. It is not until teachers express confidence and success in using technology for instruction through effective course training that their positive attitudes will be developed, which thus motivates their intention to employ digital resources in mathematics instruction.

The participant characteristics of this paper were limited to pre-service mathematics teachers. Thus, their reported digital literacy may be with respect to only the integration of mathematics education. It is thereby recommended that extensive replication of the variables measured be conducted in other fields of educational studies to ascertain the comprehensive digital literacy framework of pre-service teachers. Also, the self-efficacy, attitudes, and competence of integrating technology into instruction between pre-service and in-service teachers may vary. Pre-service teachers describe their technology adoption based on their beliefs about instructional practices, while in-service teachers report their proficiencies based on their experiences. The inclusion of in-service teachers is recommended to provide a holistic digital literacy framework for teachers. The digital literacy of the pre-service teachers was profiled using the seven domains of digital literacy. It is also recommended that other digital literacy profile frameworks be used to determine the digital literacy of pre-service and in-service teachers in diverse fields of education. This would have a wide range of implications for teacher education curriculum design and development.

Conclusion

Based on the perception of the mathematics pre-service teachers, digital literacy for a teacher is the ability to handle digital tools, use them to obtain information, and assess the information for effective classroom instruction. Despite 47.5% of the teacher trainees not using digital resources, it is noted that digital resources such as graphics and animations, quizzes and games, E-books and E-notes, and simulations and models are some of the digital tools the pre-service teachers used. The need to develop the digital skills and proficiencies of pre-service teachers is therefore recommended in order to realise its high classroom adoption for mathematics instruction. This is necessary due to the high potential for using digital tools by Ghanaian teachers for mathematics instruction. The degree of the teachers' proficiency in using variant digital tools was noted to be high in the use of word processing applications, online video and audio discussions, cloud computing, and appropriate search engines to obtain information. Finally, the digital literacy of the pre-service teachers was defined based on digital literacy domains. The digital literacy domains of the pre-service teachers encompass their capabilities in data collection, data evaluation, data management, data processing, teamwork, and social responsibility. The study has revealed that there is a favourable attitude among pre-service mathematics teachers towards digital literacy. It is concluded that pre-service mathematics teachers at the University of Cape Coast are generally digitally literate.

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Data Availability Statement

The datasets generated during and/or analysed during the current study are available from the authors at reasonable request. Nevertheless, data can only be released after the quantitative aspect of the study has been published.

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