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Nigerian preservice computer science teachers' digital competence In the era of digital education

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Abstract

Digital competence is fast becoming an attribute teachers must possess regardless of their disciplines. This is because digital technologies in education are pervasive and only teachers who are competent in digital skills can integrate them into education. This study investigated 372 Nigerian senior preservice computer science teachers' digital competence, through a research philosophy of positivism within the blueprint of quantitative approach of a cross-sectional survey model. Two research questions were stated and answered in the study. Results showed that preservice computer science teachers had high level of digital competence (Mean=120.30, Std Dev.=14.97, score range: 72.00-146.00, and 95%CI= 118.77–121.82). In addition, gender had no evidentiary influence on preservice computer science teachers' digital competence (t_{370} = 0.36, p=0.72) and even at the sub-scale of problem-solving (t_{370} = 0.73, p=0.46), safety and security (t_{370} = 0.23, p=0.82), digital content creation (t_{370} = 0.16, p=0.87), communication and collaboration (t_{370} = 0.35, p=0.72), and information and data literacy (t_{370} = 0.31, p=0.76). The study highlights the need for all-inclusive policy reforms, infrastructural upgrades, and professional development programmes to deepen the digital competence of Nigerian preservice computer science teachers. Implications for educational policy, curriculum design, and teacher education, are expatiated.

Keywords: Computer science, Preservice teacher, Digital competence, Digital education, Nigerian

Introduction

Presently, digital technologies have appeared as auspicious and compelling tools with transmutable potency in the education field, allowing the accomplishment of novel instructional aims, goals, and objectives. Arguably, teachers have been compelled to replace traditional pedagogical practices with technology-enhanced instructional tools, since the adoption of educational technology tools is potentially fruitful (Rachmadtullah, Setiawan, Wasesa, & Wicaksono, 2023; Rahim, Widodo, Suhandi & Ha, 2023; Washington, Penny, & Jones, 2020). Technology-assisted education enhances learners' anticipation for more impulsive educational experiences and adaptability since learning can occur anywhere, anytime, and everywhere. Thus, the incorporation of information, communication and technology (ICT) into education should be a welcome notion that should not be taken with levity. Evidence suggests that not all teachers are used to digital technology (Daniels et al., 2020; Nicol et al., 2018) thereby causing them to have some issues and challenges regarding digital technology adoption and integration into instructional systems. A lot of teachers do not possess the relevant skills to efficiently and effectively transform the classroom pedagogical milieus using digital technologies (Awofala et al., 2022; Awofala et al., 2021; Lawal & Awofala, 2020). This condition has highlighted the necessity of a befitting professional development and training to enhance teachers' integration of digital technology into teaching to promote learning efficacy for the students. Digital competence is described as the ability to efficiently utilise digital media, tools, and technologies to attain professional, social, and personal goals. It is the ability to utilise software and hardware, skill in choosing and integrating relevant technologies for attaining learning objectives, and the capability to solve and troubleshoot minor technical challenges (Bravo, Chalezquer, & Serrano-Puche, 2021; Yang, 2020). Digital competence is the capacity to creatively, critically, collaboratively, and confidently navigate the utilisation of digital technologies in achieving optimal learning-dependent goals (Blau, Shamir-Inbal, & Avdiel, 2020; Rahim, Suherman, & Muttaqiin, 2020).

In relation to education, digital competence is defined as the capacity of institutions, students, and educators to creatively, critically, collaboratively, and confidently navigate the utilisation of digital technologies, media and tools in enhancing assessment, learning and teaching for optimal education-dependent goals. Digital competence in education

consists of the ability to engage in online safety and security during instruction, digital content creation, information and data literacy, technical digital skill, and pedagogical digital skill. These skills are needed for creating inclusive, effective, and innovative instructional environments where teaching, learning and assessment are maximised. In this era of digital education, teachers must be prepared to efficiently use digital technologies in pedagogical contexts and be digitally competent to meet students' learning goals. This becomes necessary since today's teachers are dealing with millennial generation students who are digital natives (Asih, Yudiana, & Ujianti, 2021). The successes recorded in the creation of digital technologies have revolutionalised education, turning pedagogical spaces into SMART classrooms where students are actively engaged in the affairs of the society, collaborating with one another, and acquiring knowledge, attitudes, and skills for societal integration. Thus, teachers who are effective and efficient in integrating digital technologies into the classroom will be able to cater for the learning preferences and needs of the ICT driven coevals by providing them with applicable, piquant, and customized contents for improved learning experiences.

Clearly, teachers who are digitally competent will be able to manoeuver the upheavals and harness the possibilities inherent in the digital world to promote effective and efficient delivery of relevant, practical, comprehensive, and innovative education to today's digital natives (Abiodun, Asanre & Awofala, 2023; Manuaba, 2017). Adequate attention must be given to preservice teachers in their professional development to acquire relevant, applicable, and adequate knowledge, skills and attitudes to integrate digital technologies into education. Preservice teachers should be equipped with the skills to effectively apply instructional design principles in digital contexts, use applicable software and hardware, and promote their comprehension of digital learning platforms and tools for effective pedagogical delivery when they become teachers. Preservice teachers must be served with the opportunity to learn about online safety and digital ethics and promote their efficacy in managing digital resources via appropriate selection and integration.

The curriculum of teacher education programmes should be technology-driven and provides the preservice teachers the opportunity to be taught and trained using technology in their quest for professional growth and evolution (Radia & Aulia, 2021; Falloon, 2020). Adequate attention should be given to preservice teachers in their professional training so that they become agents of change in education (Rahim, Widodo, Suhandi & Ha, 2023), capable of harvesting the goods of digital technologies to create inspiring, applicable, and progressive learning experiences for their students who are digital natives. Preservice teachers who are digitally competent will find it easy to empower their who be students to become effective problem solvers, critical thinkers, and active learners in the affairs of the society. Based on their expertise in technology integration in the classroom, preservice teachers can promote digital literacy, collaboration, creativity, and critical thinking among students. As change agents, preservice teachers have the ability to metamorphose the conventional teaching spaces into interactive and dynamic learning environments that equip students with the skills to face the challenges and harness the opportunities inherent in the digital age.

Moreover, for preservice computer science teachers, digital competence is a valuable construct in the teaching milieu as they strive to connect computer science education with educational technology. There is a strong connection between computer science education and digital competence, as computer science literacy supports digital skills and technology improves computer science learning outcomes. Digital competence in computer science education could have a lot of benefits for the preservice teachers including enhanced problem-solving and critical thinking (Ajao & Awofala, 2024a, 2024b; Ajao & Awofala, 2022), improved understanding through visualisation (Ajao & Awofala, 2024a), increased engagement and motivation (Ajao, Akinoso & Awofala, 2023; Awofala, Olaguro, Fatade & Arigbabu, 2024; Awofala & Akinoso, 2024; Awofala, Lawani & Adeyemi, 2020), personalised learning experiences (Arigbabu & Awofala, 2023; Akinsola & Awofala, 2009) and better preparation for STEM careers (Awofala & Lawani, 2020). With high digital competence, preservice computer science teachers can use various digital media, tools, devices and technologies to audio-visually elucidate computer science concepts and engage relevant interactive pedagogies that are technology-driven during instructional discourse in the classrooms (Abiodun, Asanre & Awofala, 2023; Ojaleye & Awofala, 2018). Through the integration of digital technologies into teaching, preservice computer science teachers can leverage the technologies to create engaging and dynamic learning experiences that promote problem-solving skills, critical thinking and reasoning and scientific inquiry (Okunuga, Awofala, & Osarenren, 2021; Awofala & Lawal, 2022; Awofala, Ojo, Okunuga, Babajide, Olabiyi, & Adenle, 2019; Sarkingobir, Egbebi, & Awofala, 2023).

In today's world, the digitization of education is irreversible and students are expected to be digitally competent to meet social requirements. So, the topic of digital competence of preservice computer science teachers is in line with the discussion on higher education and media pedagogy. Therefore, the present study investigated preservice computer science teachers' digital competence in the era of digital education in Nigeria. Presently, studies on preservice teachers' digital competence are outside the shores of Nigeria. Thus, studies on digital competence of preservice computer science teachers in Nigeria are scarce.

Research Questions

Two research questions were answered in this study and they included:

1) What is the level of digital competence of the preservice computer science teachers?
2) Do preservice computer science teachers' digital competence vary according to gender?

Literature Review

Literature search has shown that investigations into preservice teachers' digital competence are limited (Alnasib, 2023; Niyazova, Chistyakov, Volosova, Krokhina, Sokolova, & Chirkina, 2023; Rahim, Widodo, Suhandi & Ha, 2023). In the investigation carried out, Alnasib (2023) determined the level of digital competence of 140 preservice teachers in a Saudi Arabia public university via online survey. Results showed that there was a high level of digital competence among the preservice teachers. Rahim, Widodo, Suhandi and Ha (2023) investigated the digital competence of 248 preservice and graduate physics teachers in Indonesia and found that the level of digital competence of the participants was high. The study by Niyazova, Chistyakov, Volosova, Krokhina, Sokolova and Chirkina (2023) evaluated the digital skills and ICT competence of 620 pre-service teachers in Russia and Kazakhstan within the context of the demands of the 21st century. The results showed that creation of digital content, communication of digital content, and use of digital tools had significant influence on ICT competence among the preservice teachers whereas digital empathy, digital security, and management of digital content did not reach a statistical significant effect. The study by Çebi and Reisoğlu (2020) examined the digital competence of 518 preservice teachers in Turkey through a cross-sectional survey model. The results showed that the preservice teachers' digital competence was moderate and varied significantly based on perceived level of digital competence, branch, and gender.

Tomczyk, Fedeli, Włoch, Limone, Frania, Guarini, Szyszka, Mascia, and Falkowska (2023) investigated the digital competences of 1209 pre-service teachers in Italy and Poland and found that presentation creation tools and word processors were the most used software and that the preservice teachers were not using software to edit video, create visual materials, and create web pages. More so, the preservice teachers were good at using multimedia presentations. The Italian preservice teachers were more digitally competent than the Polish preservice teachers. Ata and Yıldırım (2019) examined the perceptions of digital citizenship in education programs among 291 Turkish pre-service teachers within the blueprint of convergent mixed methods research design. Results revealed that gender had a significant influence on digital citizenship of preservice teachers in favour of the males. However, there was no significant influence of department on preservice teachers' digital citizenship. The respondents revealed that their parents were more instrumental to their high level of competences in digital participation and digital communication. Benaoui and Kassimi (2021) investigated 291 Moroccan preservice teachers' perceptions of digital competence and also determined the influence of age, type of bachelor's degree, and gender on their digital competence. Results showed that the level of the preservice teachers' digital competence was low or weak and that the age, gender, and type of the bachelor's degree had significant roles in shaping different perceptions on the preservice teachers' digital competence.

Akayoğlu, Satar, Dikilitaş, Cirit and Korkmazgil (2020) examined the practices of digital literacy among 113 Turkish senior preservice EFL teachers through a qualitative approach. Results showed that preservice teachers' conceptualisation of digital literacy involved collaborative use, creative and critical use, and knowledge to use technologies with university professors playing significant roles in the growth of digital literacy levels of the preservice teachers. More so, preservice teachers in Turkey were heavy users of social media platforms for different purposes. Dai (2023) empirically examined 425 English preservice teachers' digital competence in the context of infrastructure support, collaboration with colleagues, and self-efficacy in ICT. The results showed that there were statistically significant associations between ICT self-efficacy, digital competence, infrastructure support, and collegial collaboration among preservice English teachers. Jere and Mpeta (2023) evaluated digital competence of preservice teachers in South Africa through a quantitative approach of a descriptive survey of a cross-sectional type. The results showed that preservice teachers perceived ICT use in school as an enhancer, while recording a higher technical digital competence and positive attitudes towards digital technologies.

However, the preservice teachers recorded lower digital competence in using digital technologies and low knowledge of ethical issues. Johanson, Leming, Johannessen and Solhaug (2022) examined the digital competence of 395 preservice teachers in Norway through a quantitative paradigm and found that preservice teachers' experiences and attitudes towards virtual communication solutions were the main drivers of their digital competence in communication and interaction. Marais (2023) investigated preservice teachers' development of digital competencies in South Africa through a case study approach and found that despite the support from tertiary institutions, many preservice teachers lacked the digital competencies to use technologies needed for academic success and progress. Cabezas-González, Casillas-Martín and García-Peñalvo (2021) investigated the influence of personal variables on preservice educators' digital competence in Spain and found that academic degree, age, and gender were though potent but not predictors of the acquirement of digital competence among the preservice teachers. Momdjian, Manegre and Gutiérrez-Colón (2024) investigated 170 Lebanese in-service teachers' digital competences in comparison with educational standards in Lebanon. The results showed that Lebanese teachers had low digital competence even though their digital competences aligned with the national educational standards.

The above studies showed that the degree of digital competence varied among preservice teachers ranging from low or weak (Benaoui & Kassimi, 2021; Marais, 2023; Momdjian, Manegre & Gutiérrez-Colón, 2024) to moderate (Çebi & Reisoğlu, 2020) to high (Alnasib, 2023; Ata & Yıldırım, 2019; Rahim, Widodo, Suhandi & Ha, 2023) in different countries. In Nigeria, there seems to be no study on digital competence of preservice teachers and this is a call to action to examine prospective teachers' digital competence in Nigeria. Gender as a variable in the present study had been embroiled in conflicting reports. Gender predicted digital competence (Krumsvik, Jones, Øfstegaard, & Eikeland, 2016) in which preservice teachers' digital competence varied based on

gender (Casillas-Martín, Cabezas-González, & García-Peñalvo, 2019), and likewise gender had no significant influence on preservice teachers' digital competence (Hinojo-Lucena, Aznar-Díaz, Cáceres-Reche, Trujillo-Torres, & Romero-Rodríguez, 2019). The seemingly little or no study on Nigerian sample and the yet to be resolved conflicting reports regarding the influence of gender on preservice teachers' digital competence warrant further scrutiny in the present study. Thus, the present study determined the level of digital competence of preservice computer science teachers in Nigeria and as well investigated the influence of gender on their digital competence.

Methods

Research Design

The present study adopted a research philosophy of positivism within the blueprint of quantitative approach of a cross-sectional survey model to describe and test predetermined hypotheses offering explanatory, illustrative, and descriptive data (Awofala, Olaguro, Fatade & Arigbabu, 2024; Rahim, Widodo, Suhandi & Ha, 2023).

Participants

The participants were drawn from a research frame of preservice science teachers at the College of Science and Information Technology of a large University of Education in south-west, Nigeria. This college has six teaching departments including human kinetics and health, physics, computer and information science, mathematics, chemistry, and biology. Computer and information science was purposively selected for the study and the unit has four levels of preservice teachers including freshman, sophomore, junior, and senior. The target population of the senior preservice computer science teachers in the department was 465. Through a simple random sampling, 80% of the total number of senior preservice computer science teachers were selected for the study amounting to 372 participants in which 50% were males and the remaining 50% were females. Their ages ranged between 16 and 32 years ($Mean_{age}$=21.4 years; SD=3.2 years).

Instrument

One instrument tagged Digital Competence Scale (DCS) was used for this study. The DCS has two parts consisting of demographic variables and the construct of the study. The demographic variables included gender, age and level of the participants. The second part which dealt with the digital competence consisted of 30 items which cut across the five domains of digital competence (Çebi & Reisoğlu, 2020; Rahim et al., 2023) including "problem-solving", "safety and security", "digital content creation", "communication and collaboration", and "information and data literacy". Each of these domains has six positive items anchored on five-point Likert scale of Strongly Agree-5, Agree-4, Undecided-3, Disagree-2, Strongly Disagree-1. The DCS was reviewed by two experts in ICT in Education in terms of scope and expression. The experts made some corrections on five of the items and their inputs were incorporated. The face and content validated DCS was administered on 80 preservice computer science teachers not part of the main study sample and a Cronbach alpha coefficient was calculated. A reliability coefficient of 0.94 was computed for the entire DCS. The reliability coefficient for each domain was also calculated: "problem-solving, α=0.94", "safety and security, α=0.92", "digital content creation, α=0.96", "communication and collaboration, α=0.92", and "information and data literacy, α=0.96". Thus, the DCS was adjudged valid and reliable for subsequent analyses.

Method of Data Gathering

Permission was sought from the Head, Department of Computer Science of the University of Education, Nigeria prior to the collection of primary data for the study. Two research assistants who had undergone training in the art of data collection were used for gathering data. The two research assistant manned the senior preservice computer science teachers. Primary data connected to the research questions were collected under the watchful eyes of one of the researchers who happens to be a faculty member. One day was used to gather the primary data. All respondents gave their consent to partake in the research through filled informed consent forms. The study was conducted in an atmosphere free of compulsion, anonymity and confidentiality were guaranteed, and the study posed no risks to the respondents. The DCS was used as instrument for data collection and no attrition of respondents was recorded. The regulations and guidelines in respect of the institutional review board were strictly adhered to.

Data analysis

The primary raw data gathered from the respondents were coded on the IBM SPSS version 25 for analysis. Research question one was answered descriptively using mean and standard deviation. Research question two was answered inferentially through an independent samples t-test. The test of statistics for answering research question two was put at 5% level of significance.

Results

Research Question One: What is the level of digital competence of the preservice computer science teachers?

The 30 items had a score range from 30 to 150 with 90 as the middle score. Scores greater than 90 showed higher digital competence while scores lower than 90 showed low digital competence, and scores of 90 indicate moderate digital competence. From the primary data gathered through the preservice computer science teachers, 34 (9%) had scores less than 90 (M=80.65, SD=7.71, range of score: 72.00-89.00, 95%CI= 77.96–83.34) while 338 (91%) had scores higher than 90 (M=124.29, SD=8.14, range of score: 106.00-146.00, 95%CI= 123.42–125.16). These statistics revealed that most of the preservice computer science teachers had high digital competence. For the entire sample, M=120.30, SD=14.97, range of score: 72.00-146.00, and 95%CI= 118.77–121.82 which showed high digital competence of preservice computer science teachers. The 30 items of digital competence were statistically described in Table 1. The problem-solving dimension of digital competence has six items with averages oscillating from 3.66 to 4.53. Importantly, these preservice computer science teachers put up high level of problem-solving. Safety and security sub-construct has six items with

averages oscillating from 3.51 to 4.19. Significantly, these preservice computer science teachers put up high level of safety and security. The digital content creation subscale has six items with averages oscillating from 3.81 to 4.62. These statistics revealed that the preservice computer science teachers put up high level of digital content creation. The communication and collaboration sub-construct has six items with averages oscillating from 3.51 to 4.53. Generally, these statistics denoted that the preservice computer science teachers put up high level of communication and collaboration. The information and data literacy sub-construct has six items with averages oscillating from 3.61 to 4.19. These recorded statistics showed that the preservice computer science teachers put up high level of information and data literacy.

Table 1. Descriptive statistics of preservice computer science teachers' digital competence

item	Statements	mean	SD
1	**Problem-solving Cronbach** alpha *(α) = 0.94*	3.81	
	I can keep digital skills up-to-date		.91
2	I can use digital tools for accessibility	3.92	.92
3	I can use digital tools to test and iterate digital solutions	4.49	.60
4	I can use digital tools to facilitate design thinking and innovation	3.66	.91
5	I can create and prototype digital solutions to real-world problems	4.53	.75
6	I can use digital tools to identify and solve problems	3.84	1.23
7	**Safety and security** Cronbach alpha *(α) = 0.92*	3.51	1.11
	I understand digital rights and responsibilities		
8	I can back up digital data regularly	4.02	1.03
9	I can use digital tools to backup and recover data	4.10	.87
10	I can create and manage strong passwords and authentication	4.12	.88
11	I can use digital tools to protect personal data and privacy	3.73	.88
12	I can identify and avoid online threats (e.g., phishing, malware)	4.19	.75
13	**Digital content creation** Cronbach alpha *(α) = 0.96*	4.01	.94
	I can create interactive digital content		
14	I can use digital tools for data visualization	4.20	.97
15	I can use digital tools to facilitate online learning or training	4.10	.93
16	I can create and manage digital portfolios or repositories	3.81	1.06
17	I can use digital tools to design and create interactive content (e.g., simulations, games)	3.86	1.14
18	I can create and edit digital multimedia content (e.g., videos, podcasts, and images)	4.62	.89
19	**Communication and collaboration** Cronbach alpha *(α)=0.92*		
	I can engage in online communities related to interests	4.53	.75
20	I can create and share digital content	3.84	1.23
21	I can create and manage online communities or forums	3.90	1.12
22	I can use digital tools to facilitate group work and decision-making	4.01	1.08
23	23. I can collaborate with others on digital projects (e.g., shared documents, online work-spaces)	3.91	1.12
24	I can use digital tool to communicate effectively with others (e.g., email, messaging, video conferencing)	3.51	1.11
25	**Information and data literacy** Cronbach alpha *(α)=0.96*	4.12	.88
	I can effectively search for and evaluate online information		
26	I can identify and avoid online misinformation	3.73	.88
27	I can use digital tools to organize and analyze data	4.19	.75
28	I can create and edit digital content (e.g., documents, presentations, images)	4.26	.93
29	I can identify and avoid fake new	3.61	1.05
30	I can use online resources for research	4.13	.98

Research Question Two: Do preservice computer science teachers' digital competence vary according to gender?

Table 2 indicated the t-test value and its precursor statistics on digital competence score and its dimensions by gender of preservice computer science teachers. The aggregate digital competence average score of the female respondents ($\bar{x}$ =120.02, S.D =15.33) was slimly lower than that of the male respondents ($\bar{x}$ =120.58, S.D =14.64). Statistically, this lean

disparity in average score was not significant (t_{370} = 0.36, p=0.72). The problem-solving average score of the female respondents ($\bar{x}$ =24.18, S.D =2.15) was slimly lower than that of the male respondents ($\bar{x}$ =24.33, S.D =1.94). Statistically, this slim disparity in average score was not significant (t_{370} = 0.73, p=0.46). The safety and security average score of female respondents ($\bar{x}$ =23.63, S.D =3.71) was little lower than that of the male respondents ($\bar{x}$ =23.72, S.D =3.58) and statistically, this slim disparity was not significant (t_{370} = 0.23, p=0.82). The communication and collaboration average score of the female respondents ($\bar{x}$ =23.62, S.D =4.48) was little lower than that of the male respondents ($\bar{x}$ =23.78, S.D =4.34) and statistically, this little disparity in average score was not significant (t_{370} = 0.35, p=0.72). The information and data literacy average score of female respondents ($\bar{x}$ =24.01, S.D =2.90) was little lower than that of the male respondents ($\bar{x}$ =24.10, S.D =2.80) and statistically, this small disparity in average score was not significant (t_{370} = 0.31, p=0.76). The digital content creation average score of female respondents ($\bar{x}$ =24.58, S.D =4.34) was little lower than that of the male respondents ($\bar{x}$ =24.65, S.D =4.17) and statistically, this little disparity in average score was not significant (t_{370} = 0.16, p=0.87). However, the conclusion is that gender was not a decisive element in preservice computer science teachers' digital competence even at the sub-construct levels. Statistically, gender had no evidentiary influence on the pre-service computer science teachers' digital competence.

Table 2. Independent samples t-test analysis of preservice computer science teachers' digital competence based on gender

Construct	Gender	N	M	SD	df	t	p
Problem-solving	M	186	24.33	1.94			
	F	186	24.18	2.15	370	0.73	0.46
Safety and security	M	186	23.71	3.58	370	0.23	0.82
	F	186	23.63	3.71			
Digital content creation	M	186	24.65	4.17	370	0.16	0.87
	F	186	24.58	4.34			
Collaboration and communication	M	186	23.78	4.34	370	0.35	0.72
	F	186	23.62	4.48			
Information and data literacy	M	186	24.10	2.80	370	0.31	0.76
	F	186	24.01	2.90			
Digital competence	M	186	120.58	14.64	370	0.36	0.72
	F	186	120.02	15.33			

Note: p>0.05.

Discussion

The present study has shown that the preservice computer science teachers demonstrated a high level of digital competence. This high level of digital competence seems to stem from preservice computer science teachers' high level of problem-solving, high level of safety and security, high level of digital content creation, high level of communication and collaboration, and high level of information and data literacy. This result did not agree with some researchers who had found that preservice teachers' digital competence was low or weak (Benaoui & Kassimi, 2021; Marais, 2023; Momdjian, Manegre & Gutiérrez-Colón, 2024) and moderate (Çebi & Reisoğlu, 2020).

However, the result agreed with the researchers who had found that preservice teachers had a high level of digital competence (Alnasib, 2023; Ata & Yıldırım, 2019; Rahim, Widodo, Suhandi & Ha, 2023). The high level of digital competence displayed by the preservice computer science teachers could be ascribed to the integration of digital competences into their curricula thereby enabling them to have a first-hand learning of these competences in their teacher education programme. This means that the preservice computer science teachers not only hear about these competences but they experienced teaching of the competences. This high digital competence is a good start for the preservice computer science teachers in their mobility from training to the world of work as this could close the disparities that often exist between graduate teachers' work and training (Awofala et al., 2019).

The preservice computer science teachers in this study were used to identifying and solving problems using digital tools, keeping digital skills up-to-date, using digital tools for accessibility, and often test and iterate digital solutions to facilitate design thinking and innovation that could help them to create and prototype digital solutions to real-world problems. Additionally, the present study showed that the preservice computer science teachers understood digital rights and responsibilities, could back up digital data regularly, and use digital tools to backup and recover data. It was easy for them to create and manage strong passwords and authentication, use digital tools to protect personal data and privacy, and can identify and avoid online threats (e.g., phishing, malware). Moreover, this study showed that the preservice computer science teachers possessed the ability to create interactive digital content, use digital tools for data visualization, use digital tools to facilitate online learning or training. Obviously, they showed prowess in creating and managing digital portfolios or repositories, using digital tools to design and create interactive content (e.g., simulations, games), and creating and editing digital multimedia content (e.g., videos, podcasts, images).

Furthermore, most of the preservice computer science teachers engaged in online communities related to interests,

could create and share digital content, create and manage online communities or forums, and use digital tools to facilitate group work and decision-making. They were good at collaborating with others on digital projects (e.g., shared documents, online workspaces) and using digital tools to communicate effectively with others (e.g., email, messaging, video conferencing). In addition, most of the preservice computer science teachers possessed the ability to effectively search for and evaluate online information, identify and avoid online misinformation, and use digital tools to organize and analyze data. They were good at creating and editing digital content (e.g., documents, presentations, images), identifying and avoiding fake news, and using online resources for research.

The outcome of this study showcased no statistically evidentiary influence of gender on pre-service computer science teachers' digital competence and even at the sub-construct levels. Hence, both female and male preservice computer science teachers showed similar practices and comparable experiences in digital competence. Being male or female had nothing to do with the preservice computer science teachers' digital competence in general. Specifically, this study has shown that there was no gender disparity in information and data literacy, communication and collaboration, digital content creation, safety and security, and problem-solving. The zero influence of gender on digital competence resonated with the outcomes of some researchers who showed evidence of no significant influence of gender on preservice teachers' digital competence (Hinojo-Lucena et al., 2019). However, this result disagreed with some others that found the predictive influence of gender on digital competence (Krumsvik, Jones, Øfstegaard, & Eikeland, 2016) and that preservice teachers' digital competence varied based on gender (Casillas-Martín, Cabezas-González, & García-Peñalvo, 2019). By the outcomes of this study, digital competence was not sensitive to gender.

Implications for policy, curriculum, and teacher training

The implications of this study are numerous. First, educators could develop policies that enhance resource allocation, teacher training, and digital education. Second, pairing preservice computer science teachers with experienced educators can promote their pedagogical skills and digital competence thereby promoting mentorship programme. Third, institutions of learning should invest in modern digital infrastructure to promote efficient pedagogical discourse. Fourth, a review of computer science curriculum at the teacher education level should be enacted to incorporate emerging technologies, computational thinking, and digital literacy. Lastly, the preservice computer science teachers in Nigeria need all-inclusive training in digital competences to efficaciously incorporate technology into their teaching practices.

Conclusion and Recommendations

It is important to enhance the digital competence of Nigerian preservice computer science teachers for effective pedagogical delivery in the digital era. Although, there are challenges in the form of cultural and linguistic barriers, limited digital literacy among educators, high cost of data and internet services, limited access to digital devices, and infrastructure limitations like electricity, interventions from stakeholders in teacher education can bridge these gaps. By situating these challenges in context, Nigeria can be proud of producing educators who are technologically savvy, prepare students for the digital workforce, and increase the quality of computer science education. This study is not without limitations.

The generalisability of the study could not be done to people outside computer science education. Reliance on self-reported data could have introduced prejudice. The study used small sample and the study was carried out in one university out of 180 universities in Nigeria. Future studies can investigate the impact of emerging technologies on digital competence.

Comparative studies between Nigerian and international preservice teachers can be carried out. A longitudinal study that tracks preservice teachers' digital competence development can be initiated. However, it is recommended that digital competence development be integrated into teacher education curricula in Nigeria. Educators should define teacher digital competences by establishing clear standards for teacher digital competences, including generic digital skills, digital teaching competence, and professional digital competence. Educators should link standards to accreditation by formally link rules on teacher digital competences with the contents of initial teachers education programmes.

Educators should prioritise preservice teacher training in the use of ICT for teaching, focusing on practical skills, and pedagogical integration. Teacher training institutes should offer flexible and accessible training opportunities for in-service teachers to develop their digital competences. Governments and employers of labour should recognise digital skills development in career progression and provide financial incentives for teachers. Governments should create a wider digital education ecosystem to coordinate school digitalisation initiatives and innovation projects. Teacher training institutes should implement systematic evaluation and assessment of teacher digital competences in pre- and in-service teacher education.

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