Assessment of Female University Students' Digital Competence: Potential Implications for Higher Education in Africa

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Abstract

This study assessed the digital skills of female university students and the implications for higher education in Africa. A descriptive survey was used to sample 100 female university students from four African countries (Nigeria, Rwanda, South Africa, and Uganda). The instrument used was the digital competence survey. Two research questions and two hypotheses were postulated and tested. According to the study's findings, most female university students in Nigeria and South Africa have expert and advanced levels of information and digital literacy, communication and collaboration, digital content creation, and safety. Uganda was mainly found at the basic or no levels, whereas Rwanda was mostly found at the intermediate levels. The chi-square analysis reveals a significant difference between the ages of female university students and their DC levels (χ^2 =.000; $p < 0.05$). A significant difference exists between female university students' program of study and their levels of DC (χ^2 = .000; $p < 0.05$). Students also faced challenges such as a lack of ICT tools, insufficient knowledge and skills, data issues, and poor internet connectivity. The implications of these findings for African higher education institutions suggest that female students, particularly in Rwanda and Uganda, require training to be digitally competent and compete globally with their peers. As a result, we recommend that students from different programs of study with less demand in technology be allowed to take compulsory electives in technology courses while older female students are given adequate support.

Keywords: Africa, assessment, digital competence, female students, higher education

1. Introduction

Technology has become increasingly important in our daily lives, influencing how we work, communicate, and interact socially. Africa has some of the world's fastest-growing economies, as well as a rapidly growing population and a generation that is increasingly interested in urban lifestyles and technology. It is now more critical than ever for individuals to be digitally qualified for the new economy. As a result, both male and female students in higher education (HE) must acquire the digital competencies (DCs) required to fit into today's digital environment and stay ahead of the curve. Ferrari, Punie, and Redecker (2012: 84) described digital competence as a set of knowledge, skills, attitudes, strategies, and awareness that is needed when using ICT and digital media to perform tasks; to solve problems; to communicate; to manage information; to act ethically and responsibly; to work together; to create and share content and knowledge for work, leisure, participation, and learning. However, several concepts such as ICT skills, media literacy, digital technology, digital literacy, information literacy, and e-literacy have been used in different contexts to interpret digital skills (Gallardo-Echenique, De Oliveira, Marqués-Molias, Esteve-Mon, Wang, & Baker, 2015; He & Zhu, 2017). According to studies, digital competence should entail the confident, imaginative, and vital application of technological, informational, multimedia, and or communication skills, knowledge, and resources at various levels of accessing, processing, obtaining, analyzing, and consuming information, as well as solving societal problems (Esteve-Mon, Llopis, & Adell - Segura, 2020; He & Zhu, 2017; Spante Hashemi, Lundin, & Algers, 2018). As a result, improving learning experiences in a rapidly changing environment necessitates mobilizing awareness, cognitive and functional skills, and social and behavioral components such as attitudes, emotions, values, and

motivational resources. Hence, developing digital competence is becoming a practical and necessary skill for students to prepare for the twenty-first century.

According to research, digital competence is critical for the success of higher education's educational process (López-Meneses Sirignano, Vázquez-Cano, & Ramírez-Hurtado, 2020). It necessitates the use of digitalised media for information retrieval, critical analysis, and communication using a variety of digital resources (Alam, Erdiaw-Kwasie, Shahiduzzaman, & Ryan, 2018). Thus, for students to develop digital competence, they must have access to digital resources (Gudmundsdottir & Hatlevik, 2018). Thus, the State Library of Victoria in Australia described digital resources as materials or services that have been created and conceived digitally or by converting analog materials to a web or digital format. Nonetheless, the issue of the digital gender gap and inequalities with a particular focus on girls and women remains a global concern, particularly in workforce training (Organisation for Economic Co-operation and Development, OECD 2018). Several studies have looked at factors that influence the level of digital competences from a gender perspective (Mariscal, Mayne, Aneja, & Sorgner, 2018; Vázquez-Cano, Meneses, & García-Garzón, 2017). Authors have also noted that variables such as age, access to digital resources, unequal access to tools, opportunities for skills acquisition, motivation, and consequently unequal chances of employment can influence the level of women's digital skills; however, no consensus has yet been reached on these variables (Bornman, 2016; Guillén-Gámez, Lugones, Mayorga-Fernández, & Wang, 2019; Mumporeze & Prieler, 2017; Sánchez Prieto, Trujillo Torres, Gómez García, & Gómez García, 2020).

Gillwald (2018) reports that results from the 2017 Global South Access survey have shown that women have less access to mobile services in countries like Rwanda and Nigeria, while women in low and middle-income countries are 10% on average more likely than men to have a mobile telephone. Even among mobile owners, women are 18% less likely than men to use mobile internet. According to the survey, African countries such as Kenya, Ghana, Nigeria, Tanzania, Rwanda (are the most unequal countries with 50% male population and 32% female population) while mobile phone penetration was higher for men than for women in Mozambique. In the case of smartphone penetration, the male population has a higher percentage than the female population. South Africa was considered the highest penetration, with 60 percent of men and 52 percent of women having access to smartphones. According to the study's findings, girls and women are frequently underserved regarding communications, information, and technology in particular. Even though women increasingly use digital technology, many have less advanced or basic digital literacy and competence than men (Casillas, Cabezas, Ibarra, & Rodríguez, 2017; OECD, 2019). Most women learn in various contexts and with multiple resources to achieve advanced levels of digital competence in networks (Rebollo-Catalán., Mayor- Buzon, & Garcia-Perez, 2015). According to a study conducted by Jiménez-Cortés, Vico-Bosch, and Rebollo-Catalán (2017) on ICT learning strategies for female university students and their effect on digital competence, it was found that most of the female university students perceive their digital competence levels to be focused on dealing with digital tasks such as using Google to search for and find information, using email, video-conference, and instant messaging to communicate on the internet, and skills for configuring privacy options to protect personal data.

He and Zhu (2017) examined the effects of digital competence and personal preferences on Chinese university students. They discovered a significant difference in digital competence between male and female university students. Comparatively, the digital competence levels of different age groups appear to differ for various reasons, including personal preferences, device availability, and area connectivity. As a result, Guzmán-Simón, García-Jiménez, and López-Cobo (2017) considered age as a critical factor in determining digital competence among university students. Some proponents of digital competence believe that adults between 18 and 30 years of age have a higher level of digital competence in technical skills related to instrumental use and interaction. In contrast, adults over 30 have a higher level of digital competence in terms of their use of technology in developing critical, analytical, reflective, creative, and participatory skills (Agustin, Carlos, Arturo, & Alicia, 2017).

Similarly, a study conducted by the Organisation for Economic Co-operation and Development (OECD, 2019) on the role of education and skills in bridging the digital gender divide found that fewer older women (between the ages of 55 and 74 years old) are digitally competent in using the internet than men. The digital gender gap in Internet use narrows in the middle-aged (between the ages of 25 and 54) or young women (aged 16-24). The study also found that young women and girls (16-24 years old) in Chile and Mexico are less likely than boys and men to be digitally competent, whereas young women in Japan are more digitally skilled than young men. Given that computer and Internet use is negatively correlated with age, one could argue that girls' and women's digital competence is negatively influenced by their socioeconomic status, ability to socialize, work, and life patterns as they get older.

The importance of digital competence amongst female university students in the 21st century cannot be

over-emphasised, particularly when e-Learning and advanced use of ICT tools or devices has become the order of the day. As a result, digital competence skills, knowledge, and resources are critical to supporting and improving female students' digital competence and African women's equality in the rapidly changing global context of the modern workplace. Though the issue of digital competence could have been downplayed before this period, the worldwide pandemic and global shutdown have prompted this research on digital competence among female university students in Africa since digital skills are increasingly becoming essential for life learning and work. However, there are no empirical studies documenting students' levels of digital competencies. It, therefore, calls for an investigation into developing country context with a focus on Africa. Thus, it is assumed that this study will be one of the few studies in the African context that investigates students' level of digital competence. The ongoing debate concerning the DC levels of male and female students, especially in Africa, shows that researchers have not yet reached a consensus on the competency levels among female students. Instead, the focus has been on the access, perception, development, and differences between male and female digital competence levels (Svensson & Baelo 2015, Tusiime, Johannessen, & Gudumundsdottir, 2019). Generally, a shortage of literature exists in Africa and developing countries. Hence, we identified the need to explore the digital competencies of female university students in Africa; and understand the potential skills and demonstrated competence levels required by the 21st-century workplace. Accordingly, the following research questions and hypotheses guided this study:

1) What levels of digital competence do female university students report across four African countries?

2) What are the female university students' barriers to the effective use of ICTs as a university student?

Hypotheses

HO_1: There is a significant difference between female students' age and digital competence levels.

HO_2: There is a significant difference among female university students' programs of study and their digital competence levels.

2. Methodology

A descriptive survey research design was employed in this study. Female university students from four African countries (Nigeria, Rwanda, South Africa, and Uganda) were included in the study population, with data collected from 100 students as reported in this study. The DigComp competence framework was chosen as a data collection instrument. Google Form was used to create the questionnaire. Similarly, the instrument elicited open-ended responses from students about their perceptions of ICT barriers. The questionnaire was first piloted with 12 students (3 from each country) who were not involved in the research. Designated researchers conducted the pilot study in each of the four countries in a traditional face-to-face setting. The pilot study results were used to make minor wording changes in the final survey. Data for this study was gathered by sending the Google Form link to students in each country via email and WhatsApp. Although 250 links were sent out, only 100 responses were received, containing 25 random samples from each country. The collected data was organized, coded, and analysed using chi-square at a significance level of 0.05. The open-ended questions were first coded and then double-checked for accuracy. The codes were then patterned, quantitatively recorded, and represented in graphs.

3. Conceptual Framework

Research indicates that various international frameworks have been developed to understand digital competence and literacy in the 121st century (UNESCO, 2019). Some of these frameworks include "the UNESCO Global Framework of Reference on Digital Literacy Skills, the European Commission DigComp framework, the UNESCO Media and Information Literacy (MIL) framework, the Digital Citizenship Education framework by the CoE, the OECD Skills Research framework or the Digital Intelligence (DQ) framework, the UK Jisc Digital Capability Model, 23 the Learning Wales programme or the British Columbia Digital Literacy Curriculum, the International Computer Driving Licence (ICDL) or the Microsoft Digital Literacy Standard Curriculum, the Common Sense Education K-12 Digital Citizenship Curriculum, or the Mozilla Web Literacy Framework, the International Society for Technology in Education (ISTE) standard, the International Computer and Information Literacy Study (ICILS), the UNESCO ICT Competency Framework for Teachers, and the International Association for K-12 Online Learning (iNACOL) National Standards for Quality Online Teaching" (Nascimbeni, & Vosloo, 2019: p18). The European Digital Competence Framework is suitable for measuring the minimum skills in digital literacy on a global scale based on practical approaches that have been used and implemented in various contexts. This framework benefits from its maturity, application to young people, and accompanying clear guidelines and metrics for implementation based on the lessons learned. Moreover, while it was developed for the European context, it has also been used in more than 20 countries, mainly in advanced settings (Nascimbeni, & Vosloo, 2019). Thus, in this study, the European

framework for digital competence (DigComp) has been adopted for data collection because it offers a complete and comprehensive framework for citizens and has the potential to be tailored to specific target groups' requirements.

The use of computer networks, the internet, and social media has increasingly impacted the way people communicate. Thus, embracing change with knowledge, skills, and attitude towards utilizing technology and digital tools has become a crucial ability required by female university students in the 21st century. To acquire these skills, the European Commission's Joint Research Centre (JRC) created a framework called "Digital Competence Framework for citizens (DigComp)" to develop and understand the digital competence of European citizens and European Union member states of the (Global Education Monitoring Report (GEM, 2017). Ferari (2013) defined digital competence in the context of the DigComp framework as a set of knowledge, skills, and attitudes that citizens require to use ICT to achieve goals related to work, employability, learning, leisure, inclusion and participation in society. The need to engage females in STEM subjects or jobs that require digital skills as fundamental requirements for lifelong learning is significant in today's globalized world. The DigComp framework elaborates on 21 generic knowledge, skills, and attitudes required for understanding digital competence and its development across eight proficiency levels, ranging from foundation/beginner to highly specialized. The knowledge, skills, and attitudes are summarized in Figure 1 using the Dig Comp framework.

Competence Area	
1. Information and Data literacy	
2. Communication and Collaboration	
3. Digital content creation	
4. Safety	
5. Problem-solving	

Figure 1. Digital Competence framework (DigComp): A Framework for Developing and Understanding Digital Competence (Ferrari, A. 2013)

Figure 1 summarizes the DigComp framework, which identifies the critical components of digital competence in five areas, as follows:

- **Information and data literacy**: This refers to the ability to express information needs, locate and retrieve digital data, information, and content, and assess the sources and their content's relevance. It also includes understanding how data, information, and content from the digital world are collected, controlled, and organised.
- **Communication and collaboration**: This entails using emerging technology for connecting, interacting, communicating, and collaborating while still being mindful of cultural and generational differences. This also includes participating in society through public and private digital networks and the opportunity to manage one's digital identity and reputation.
- **Digital Content Creation:** This refers to developing and editing digital content and enhancing and incorporating information and content into an established body of knowledge while also recognizing how copyright and licenses can be enforced and how to offer computer systems understandable instructions.
- **Safety:** In a digital world, this refers to protecting computers, content, personal data, and privacy. It also includes successful consumer security against physical and psychological health threats, self-awareness of the usage of digital technology for social well-being and social inclusion, and awareness of the effects of digital technologies and their use on the environment.

- **Problem-solving:** This entails recognizing and addressing fundamental needs and technological issues in a digital world. It also entails learning how to use digital technologies to build information, innovate processes, and keep up with self-development due to the digital revolution (Carretero, Vuorikari & Punie, 2017).

According to Yazon, Ang-Manaig, Buama, and Tesoro (2019), a person's digital competence level is directly and significantly related to their job, academic, and research efficiency. Since girls and women need skills that allow them to adjust to a new type of individual-information and individual-knowledge relationship in the 21st century, the DigComp framework used in this study provides a basis for assessing the digital competencies of female university students in Africa. Female students draw from their experience and reflection on the knowledge, skills, and attitude they need to improve the digital competencies required to succeed in a changing workplace. The DigComp assessment tool also provides opportunities for students, teachers, researchers, various educational stakeholders, and policymakers across Africa to reiterate policy documents and sustainable strategies aimed at addressing key areas where there is still a digital gender gap while at the same time stimulating the growth of the African economy towards sustainable development. In this study, the feasibility of the DigComp framework could encourage educational providers in Africa to strengthen and expand the development of digital capabilities and support content, applications, and services that meet women's needs as agents for sustainable development.

4. Results

Research Question 1: What levels of digital competence do female university students report across four African countries?

The following charts (figures 2-6) on female university digital competencies answer the stated research question.

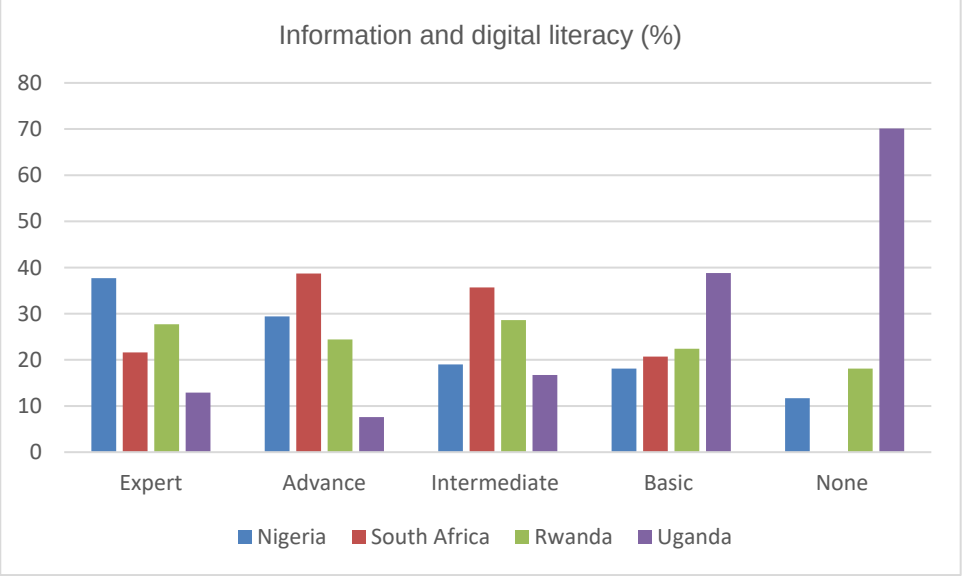

Figure 2. The bar chart on female students' information and digital literacy competence

The result shows that, at the expert level, 37.7% of Nigerian female students had adequate information and digital literacy competence, followed by Rwanda (27.7%) and South Africa (21.6%), with Uganda having the lowest percentage (12.9%). At the advanced and intermediate levels, South Africa (38.7%) was found to be well represented, followed by Nigeria (29.4) and Rwanda (24.4%), while there is a lower representation in Uganda (7.6% and 16.7%), respectively. Similarly, as shown in the graph, most Ugandan female students seem to be at the basic (38.8%) and none (70.1%) levels.

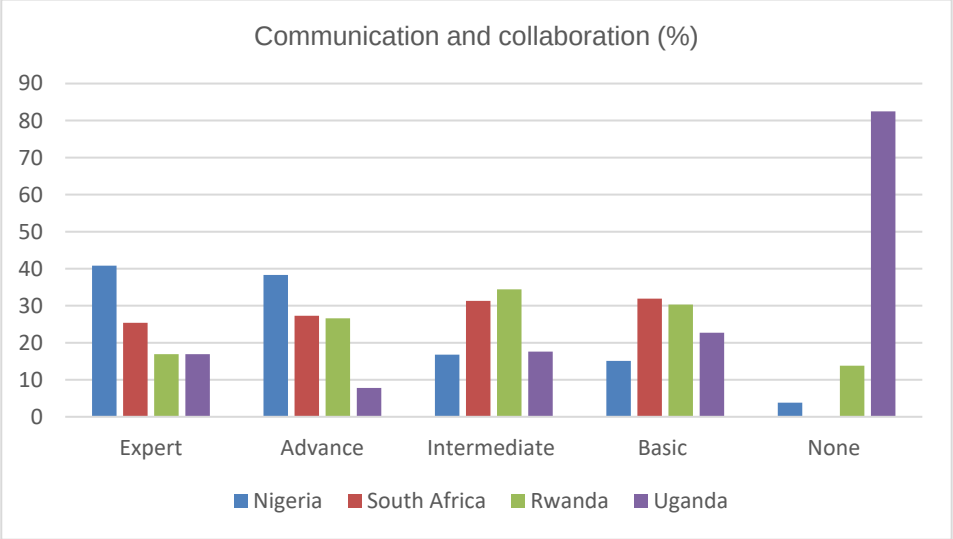

Figure 3. The bar chart on female students' communication and collaboration

In the collaboration and communication competence area, Figure 3 reveals that 40.8% of Nigerian female university students are experts, followed by about a quarter (25.4%) of South Africans, while Rwanda (16.9%) and Uganda (16.9%) are at the close edge. Results show that 38.3% of Nigerian female university students collaborate and communicate well than other African countries at the advanced level. South Africa (31.3%, 31.9%) and Rwanda (34.4%, 30.3%) are almost at a close edge at the intermediate and basic levels. However, most Ugandan female students failed to communicate and collaborate at the none level.

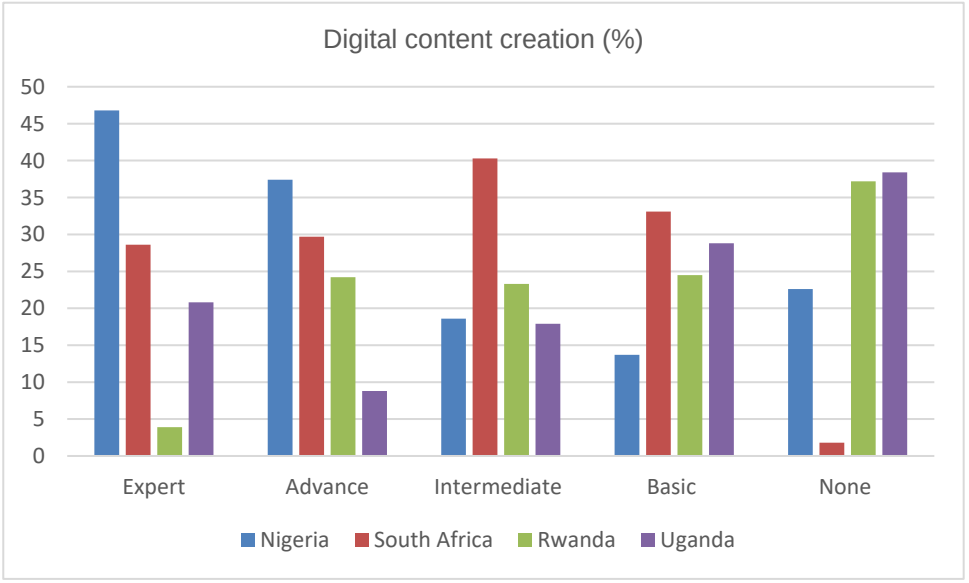

Figure 4. The bar chart on female students' digital content creation

Figure 4 reveals that out of the four countries, Nigerian (46.8%, 37.4%) and South African (28.6%, 29.7%) female university students can make digital content at the expert and advanced levels, respectively, with 20.8% Uganda students at the expert level. More Rwandese (24.2%) seem to be better at the advanced level. Data also reveal that South African (40.3%, 33.1%), Rwandan (23.3%, 24.5%), and Ugandan (17.9%, 28.8%) female students' digital content creation competencies are at the intermediate and basic levels, respectively. However, 38.4% Ugandan, 37.2% Rwandese, and 22.6% Nigerian female students claimed to have no digital content creation competency.

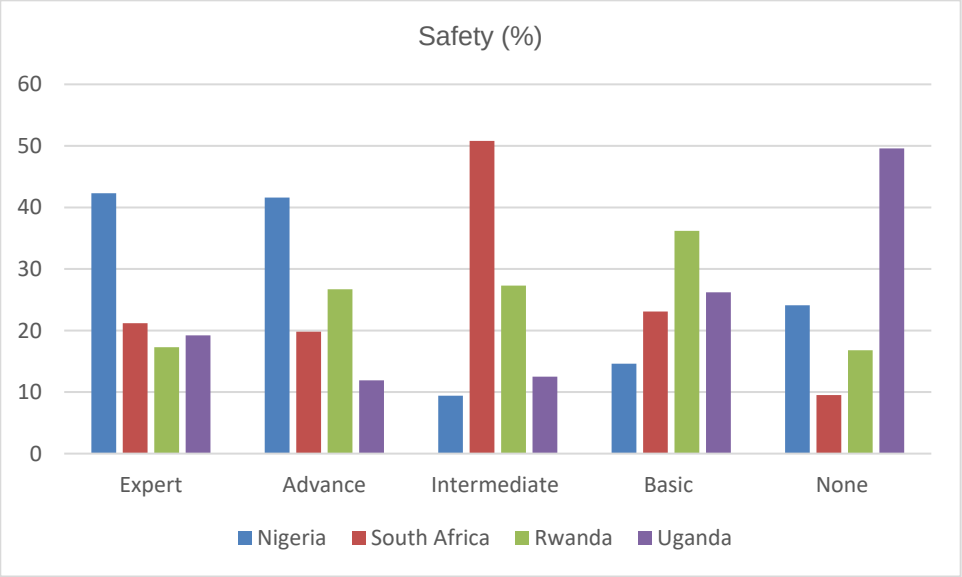

Figure 5. The bar chart on female university students' digital competency on safety

Figure 5 reveals that most Nigerian female university students with digital competence in safety are found at the expert (42.3%) and advanced levels (41.6%). Other African countries reported lesser percentages at these levels. However, over half (50.8%) of South African female university students' digital competency on safety are at the intermediate level, followed by Rwanda (27.3%). At the basic level, Rwandese (36.2%), Uganda (26.2%) and South Africa (23.1%), and Nigeria (14.6%) have digital competence in safety. A higher percentage of Ugandan (49.6%) female university students do not have digital competence on safety. A percentage of 24.1% of Nigerians were also found at this level.

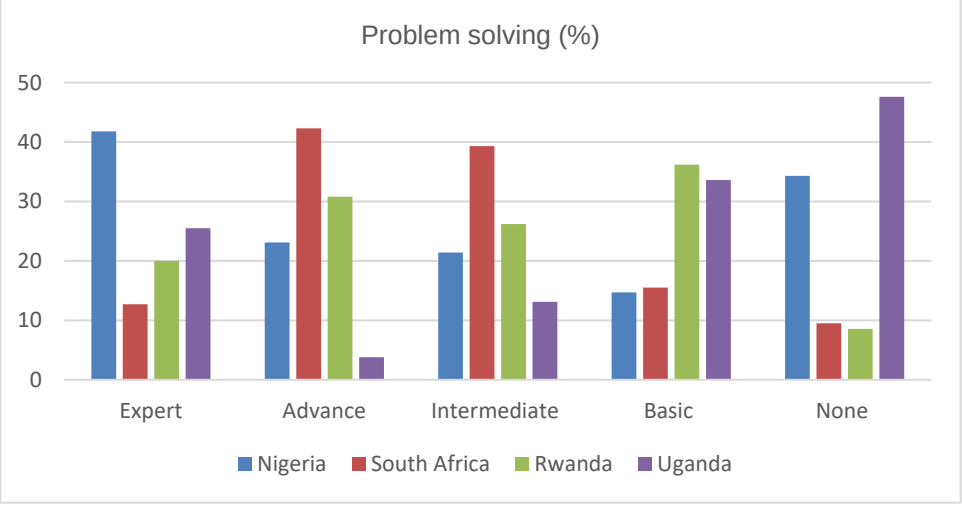

Figure 6. The bar chart on female university students' digital competency in Problem-solving

With problem-solving digital competence, Nigeria (41.8%) seems to be well represented at the expert level, followed by a quarter of Ugandans. South African students (42.3%) are well represented at the advanced level, followed by (30.8% Rwandan and 23.1% Nigerian). At the intermediate level, 39.3% of South African are competent with problem-solving, followed by Rwandan (26.2%), Nigerian (21.4%), and Ugandan (13.1%). Most of the Rwandans (36.2%) and Ugandans (33.6%) are at the basic level, and the highest percentage of Ugandan (47.6%) and Nigerian (34.3%) were found to lack problem-solving competence.

Research Question 2: What are the female university students' barriers to the effective use of ICTs as university students?

In this section, two themes were generated. The themes are ICT tools, access and connectivity barriers, and personal

and institutional barriers. The two themes are represented in Bar charts 7 and 8.

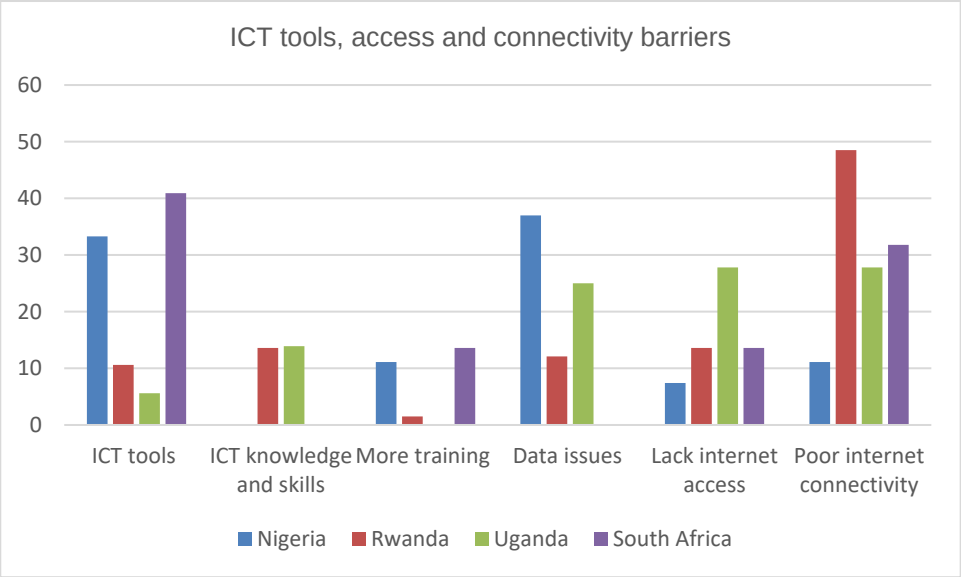

Figure 7. The bar chart on theme 1: ICT tools, access, and connectivity barriers

From Figure 7 above, theme 1 shows that female university students in the four countries lack ICT tools, but they further mentioned that more ICT tools should be provided for their usage. Therefore, 40.9% of students from South Africa, 33.3% from Nigerian topped the list. Only two countries, Rwanda (13.6%) and Uganda (13.9%) do not have the ICT knowledge and skills needed to attain digital competence in using ICT. Still, data shows that students from Nigeria (11.1%) and South Africa (13.6%), and a few from Rwanda (1.5%) have prerequisite knowledge and skills on the use of ICT. Nevertheless, they still need more training for them to be digitally competent. However, almost all countries have data, internet access, and internet connectivity issues. On data issues, the students reported problems relating to the high cost of data which might have affected them in surfing the internet as intended. Nigeria (37%) had the most significant percentage, followed by Uganda (25%) and Rwanda (12.1%). South African students had no data issues challenge. This may be due to the government's provision of free Wi-Fi data package for its communities. Lack of internet access relates to the inability to connect to the internet for browsing opportunities. Here, Ugandan (27.8%) female students mostly lacked access to the internet, with Rwanda and South Africa sharing the same percentage of 13.6%, while Nigeria had a 7.4%. On poor internet connectivity, female university students in all the countries were experiencing this problem.

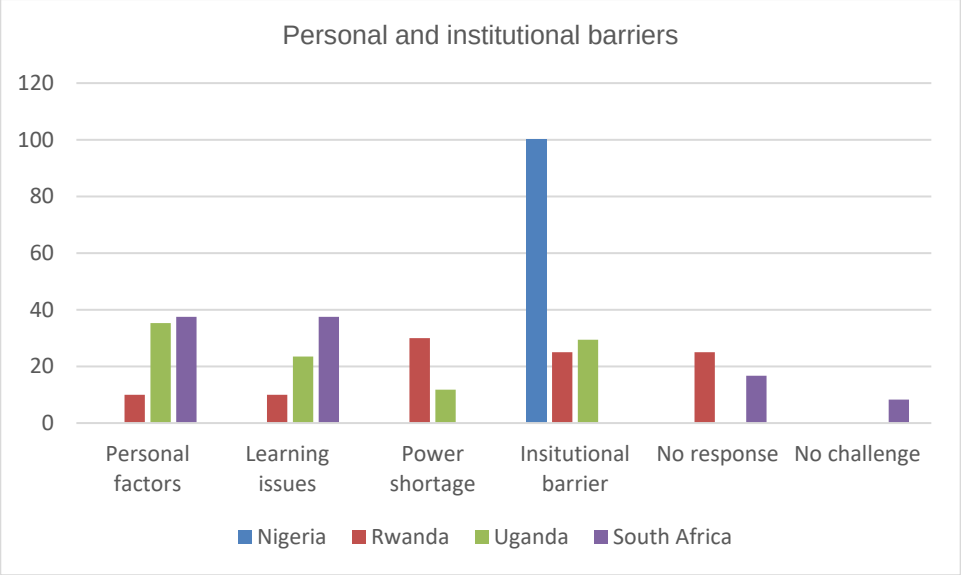

Figure 8. The bar chart on theme 2: Personal and institutional barriers

The theme on personal and institutional barriers discusses female students' challenges related to them personally and those relating to their institution of learning. From Figure 8 above, students from Rwanda (10%), Uganda (35.3%), and South Africa (37.5%) faced personal factors relating to a non-functional computer system, phone incompatibility with the network, health, and financial issues which affected them from being digitally competent. Rwanda (30%) and Uganda (11.8%) female students reported that lack of electricity affected them from being digitally competent. The institutional barrier faced includes the communication gap between the university and students, especially during the COVID-19 lockdown when students were learning via online means. In contrast, some universities did not kick off online learning on time. Therefore, all Nigerian (100%), Uganda (29.4.5), and South Africa (25%) students fall into this category. While some South African and Rwandan students gave no response, 8.3% of Ugandan students said they had no challenge.

Hypothesis testing

HO_1: There is a significant difference between female students' age and digital competence levels.

Table 1. Chi-Squared test on age and digital competence levels

	Value	df	Asymp. sig. (2-sided)
Pearson Chi-Square	238.009[a]	96	.000
N of Valid Cases	100		

The chi-square test statistic value is 238.009, the degrees of freedom (df) for this test is 96, and the corresponding p-value is .000. Consequently, clear evidence of a significant difference exists between female university students' age and digital competence levels since the p-value is less than 0.005. This implies that the different age of female university students directly influences their digital competencies.

HO_2**:** There is a significant difference among female university students' programs of study and their digital competence levels.

Table 2. Chi-Squared test on programs of study and digital competence levels

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	508.446[a]	192	.000
N of Valid Cases	100		

The chi-square test statistic value is 508.446[a], the degrees of freedom (df) for this test is 192, and the corresponding p-value is .000. Consequently, clear evidence of a significant difference exists between female university students' programs of study and their digital competence levels since the p-value is less than 0.005. By implication, the students' programs of study at the university determine their knowledge and their digital competencies.

5. Discussion and Conclusion

There appears to be a high level of gender imbalance in the representation of women in STEM (Science, Technology, Engineering, and Mathematics) fields in Sub-Saharan Africa (UNESCO, 2019). As technology expands in Africa, UNESCO claims that empowering young girls and women to build confidence and develop solutions through innovative technologies can foster 21st-century change while equipping them with basic and cutting-edge skills. Results of the study confirm that female university students from Uganda considered their level of digital competence to be very low in all dimensions, as most of them reported their None level competencies compared to female university students from other countries. On the contrary, the empirical findings show a higher percentage of digital competence in all dimensions at the expert level for female university students in Nigeria. This indicates that female students in African universities can be more inclined towards technological devices depending on their attitude, knowledge, and use of a wide range of learning contexts and technological resources, thereby enabling them to achieve an advanced level of digital competence in their networks supporting the findings of Rebollo-Catalan et al. (2015). During the hypothesis testing, results indicate that Hypothesis one: the age level of the sampled female university students plays a significant role in determining their level of digital competence, thus accepting the stated hypothesis HO_1. Looking at the result analysis in response to hypothesis two, one also finds a clear difference between the digital competence level of female university students and their programs of study, thus accepting the reported HO_2 hypothesis. One may argue that enhancing the digital competencies of female students in African universities depends heavily on the type of academic programs they are enrolled in and/or activities they are exposed to (Muller, 2017). Findings further indicate that female university students across the four African countries face common barriers that hinder their effective use of technology, thus negatively impacting the growth of their digital

skills and abilities. These findings, therefore, call for female students in Africa to be proficient in the use of technology (Ferrari, 2013). It should also be noted that female students can only attain an advanced level of DC by participating in intensive, reasonable, and extended forms of learning, which may also include using several strategies during the learning process (Jiménez-Cortés et al., 2017).

It is common knowledge that employers look for digital abilities when screening job applications. Improving girls' and women's digital skills would enhance their employability opportunities, allowing them to remain employed or advance in their careers (Vrana, 2016). As women are central to realizing the Sustainable Development Goals in the digital society, HE and other educational stakeholders must be responsive to the preferences and types of didactic and strategic educational processes offered to help the growth of women's DCs in Africa (Gros, 2015). Policymakers in the different countries must encourage change, expand infrastructure, and develop new reform strategies to increase women's digital inclusion. In addition, the different countries need to develop mentorship programs that can be used to enhance the growth of DC for female students and women in Africa. More specifically, education providers and curriculum designers in the different regions need to align their ICT and digital skills training courses to accommodate the needs of women.

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