STEM Education

STEM Education, 5(4): 714–731
DOI: 10.3934/steme.2025033
Received: 08 January 2025
Revised: 13 June 2025
Accepted: 19 June 2025
Published: 08 July 2025

https://www.aimspress.com/journal/steme

Research article

A qualitative study of sustainability of female teachers' digital literacy in the post-covid 19 era

Sulaimon Adewale[1,*] and Onoriode Collins Potokri[2]

[1] Department of Educational Foundations, University of South Africa, Pretoria, South Africa; sulady.sa@gmail.com
[2] University of the Free State, South Africa; potokriOC@ufs.ac.za

*** Correspondence:** Email: sulady.sa@gmail.com; Tel: +2348038738347.

Academic Editor: Madhu Dhar

Abstract: This study aimed to determine the sustainability of female teachers' digital literacy in the post-COVID-19 pandemic period in Lagos State, Nigeria. This study adopted a phenomenology qualitative research method. A purposive sampling technique was utilized to select ten female participants from female public secondary school teachers in Lagos State. Semi-structured interviews were conducted, transcribed, and analyzed using the QSR NVivo software, version 1.7.1. The study found, among other things, that all the benefits achieved by female teachers in digital literacy during the COVID-19 pandemic may be wasted if the challenges facing the sustainability of the skill are not addressed. In addition, the study found strategies that the educational stakeholders can employ, especially the government, to sustain digital literacy among female teachers during the post-COVID-19 pandemic period. These findings imply that the education ministry should integrate digital literacy into the national teacher education curriculum to sustain the teachers' digital competence. School principals should advocate digital inclusion by setting up internal digital culture policies, information and communication (ICT) committees, and ensuring regular appraisal. The originality of this study can be found in the approach used by the researchers to seek strategies that educational stakeholders can employ to sustain digital literacy skills among female teachers.

Keywords: sustainability, digital literacy, post-COVID-19, female teachers, secondary schools, ICT

1. Introduction

The unpalatable experience during the COVID-19 pandemic brought an unprecedented paradigm shift from conventional face-to-face teaching and learning to digital learning platforms across the globe. This sudden change disrupted educational systems, with developing countries like Nigeria facing greater challenges. [1] reported that much of the gains recorded in education before the appearance of the pandemic were lost, particularly within primary and secondary levels, where learners are generally less autonomous. Schools were closed as one of the numerous measures to protect the lives of the citizens and forestall the spread of the pandemic disease [2,3], compelling education stakeholders to urgently seek alternative teaching and learning models.

Consequently, the transition to digital platforms became inevitable. The governments of countries employed online teaching and learning platforms, including Zoom, WhatsApp, and Google Meet, to ensure continuity in learning [4]. This shift underscored the need to prepare the teachers who facilitated the teaching and learning sessions. Teachers' digital literacy not only ensures educational continuity, but also addresses classroom concerns, including repetitive use of outdated content. In the modern world of social digitalization, it is important for all teachers to know how to use technology [5]. However, this strategy was alien to many, especially female teachers, in the face of pressure to adapt to new technology tools and platforms to facilitate teaching and learning. Their experience was influenced by institutional and socio-cultural factors, which determined their level of engagement with learning technology. In Nigeria, particularly in Lagos State, the need for teachers to develop digital literacy skills became unavoidable when the transition to digital learning was decided. Teachers' digital literacy enables the creation of diverse, up-to-date lesson materials, moving beyond static notes that are reused annually.

Before the outbreak of the pandemic, digital literacy was not a prerequisite for teaching in Nigerian public schools. Many teachers, especially females, relied heavily on traditional face-to-face teaching methods. The sudden transition exposed their lack of preparedness and gender-based digital literacy gaps. Studies have shown that women often report lower self-efficacy in using technology, which can impede their willingness and ability to effectively engage with digital tools [5,6].

Digital literacy, a subfield of modern literacy, including information, network, visual, and library literacy, is essential in today's information and communication (ICT)-driven world [7,8]. According to [3], digital literacy is the ability to use digital technologies to enhance conscious civic involvement in numerous ways. It encompasses a variety of skills such as ICT literacy, media literacy, and information management [9], thus enabling teachers to effectively access, manage, and create digital learning content [10,11]. A digital literate teacher is expected to communicate and collaborate, solve problems, secure data, and navigate diverse ICT platforms to enhance teaching and learning.

The spontaneous switch to online learning during the pandemic has exposed the variation in the level of preparedness among teachers, as found by [12]. Some teachers lacked the confidence and competencies to effectively engage in digital learning environments [2]. Therefore, digital literacy became a prerequisite not just for relevance in the teaching profession, but for surviving and thriving in the continuously developing educational environment [10,13].

Recognizing these gaps, the Lagos State Ministry of Education, in partnership with Microsoft, initiated ICT training programs aimed at professional development [5]. While these efforts were commendable, sustaining digital competencies, especially among female teachers, remains a major concern. Factors including dual caregiving roles, societal expectations, poor institutional support, and infrastructural deficits continue to hamper the long-term use of digital skills [14].

Digital literacy has significantly redefined teaching roles, moving educators from being the only source of information to facilitators of knowledge who interactively engage with students [15,16]. Due to the increasingly digital nature of daily life, basic computer skills are now expected of everyone. This transformation necessitates an increase in a teacher's responsibility and creative problem-solving using digital tools [17]. Digital literacy remains a critical barrier, as many teachers still rely on manual paperwork and resist innovation due to fear or lack of support.

Several studies have identified causes for digital literacy gaps, including a limited access to digital infrastructure, low self-efficacy, lack of technical support, and time constraints, particularly among female educators [5,17,18]. In addition, an overdependence on analogue methods such as manual lesson notes and registers reduces the practicality and retention of digital skills acquired during training.

Efforts to sustain digital literacy must address these systemic issues. Scholars propose the establishment of a digital literacy fund for ongoing training, awareness, and infrastructure development [13,19,20]. Creating an internal digital culture within schools where technology is seen as part of everyday activities can improve its adoption and sustainability [17]. Additionally, bridging gender disparities requires equal access to technologies and the opportunity to develop ICT skills [21,22].

To foster ongoing engagement, strategies such as third-space access to technologies beyond the classroom and continuous mentoring for female teachers are essential [23,24]. A teacher's comprehensive awareness of the importance of digital literacy to their teaching and learning activities in the classrooms will not only prepare them digitally [9,18], but will also help sustain the tempo of using the acquired 21st-century skills and promote collaborative learning among other teachers.

Despite previous studies that highlighted the numerous benefits of digital literacy [2,25] to education, the digital gender divide [2,5,26], the need to organise a series of digital literacy trainings for teachers in general [27], and quality assurance [28], little has been done to understand how trained female teachers either maintain or lose these digital competencies over time. Therefore, this study explores the sustainability of digital literacy among female teachers in Lagos State after the COVID-19 pandemic. It aims to determine the benefits of ICT training, identify the challenges to sustaining digital skills, explore strategic solutions, and provide recommendations to educational stakeholders.

1.1. Theoretical perspective

This study is anchored in institutional theory, which examines how structures, rules, and norms become established as authoritative guidelines for social behavior [29]. The theory's three dimensions—political, historical, and sociological institutionalism—collectively provide a robust framework for analyzing the sustainability of female teachers' digital literacy in Lagos State's secondary schools. Below, we articulate how each dimension aligns with and informs our study's hypotheses:

Hypothesis 1: Benefits of ICT Training (Political Institutionalism)

Political institutionalism focuses on how policy interventions and resource allocations shape outcomes. The Lagos State government's ICT training initiatives (e.g., mandatory Microsoft Teams workshops) exemplify this dimension, where top-down policies aim to reduce digital disparities. Institutional theory predicts that such resource provision (training, infrastructure) directly enables

behavioral change [30]. Empirical evidence supports this: studies confirm that structured ICT training improves a teachers' digital competence [5,31], but its long-term impact depends on institutional reinforcement to prevent skill attrition [28]. Thus, this hypothesis tests whether government-led training translates to sustained benefits, which are contingent on ongoing policy support.

Hypothesis 2: Challenges to Sustainability (Historical Institutionalism)

Historical institutionalism emphasizes how pre-existing conditions, including gendered roles, infrastructural gaps, and sociocultural norms, constrain the adoption of new practices. In Nigeria, female teachers face dual caregiving responsibilities and a limited access to devices [6], while schools often lack reliable electricity and internet [17,32]. Institutional theory explains why these historical and structural barriers hinder digital literacy retention, even post-training. This hypothesis investigates how these entrenched challenges mediate the sustainability of acquired skills, thus aligning with findings that institutional path dependencies often undermine technological adoption [14].

Hypothesis 3: Sustainability Strategies (Sociological Institutionalism)

Sociological institutionalism highlights the role of cultural norms and shared expectations in sustaining change. Strategies such as subsidized laptops, blended learning policies, and school-based "digital culture" committees reflect attempts to institutionalize digital literacy as a normative practice [30]. Evidence suggests that schools that embed technology into everyday routines achieve longer-term sustainability [33–35]. This hypothesis explores whether strategies that shift institutional culture, beyond one-off trainings, can mitigate the gaps identified in Hypotheses 1 and 2.

Theoretical Contribution

While prior studies identify gender disparities in digital literacy [36], they rarely employ institutional theory to explain why systemic barriers persist. Our hypotheses address this gap by linking macro-level institutional actions (e.g., policies, resource allocation) to micro-level teacher outcomes. By testing these hypotheses, we reveal how institutions, through political, historical, and sociological mechanisms, can either enable or hinder the sustainability of digital literacy.

1.2. Research questions

i. What are the benefits of the ICT training organized by the government for female teachers' digital literacy in Secondary schools in Lagos State, Nigeria?
ii. What are the challenges to the sustainability of digital literacy of female teachers in post-COVID-19 pandemics in Secondary schools in Lagos State, Nigeria?
iii. What are the sustainability strategies for female teachers' digital literacy in Lagos State, Nigeria, secondary schools?
iv. What recommendations can be made for further trainings in digital literacy among female teachers in Nigeria?

2. Materials and methods

2.1. Research design

This study utilizes a phenomenological qualitative research method. According to [37], this is "an

approach for exploring and understanding the meaning individuals or groups ascribe to a social or human problem" (p. 4). Using an open-ended semi-structured interview, a qualitative research design allows the researcher to elicit the participants' data based on their perceptions. It allows the researcher to ask the participants questions relating to their experiences about what happened in their lives [38]. A phenomenological qualitative design type was chosen for this study because it allows the researcher to take information from the participants based on their experiences to describe a particular phenomenon [37]. The focus of a phenomenology qualitative study is to understand a situation from the perspective of the participant's life experience [38].

2.2. Population

The population in research is the target population of interest to the researcher, which is meant to be treated or examined [39]. The study population consisted of all female teachers in public secondary schools, Education District V, Lagos State, Nigeria. Public schools were considered for this study because they are owned, financed, and controlled/ managed by the government. Teachers in Public schools are provided with specialized trainings [40] more than those in privately owned schools. All public-school teachers in Nigeria are graduates who have been trained in the arts and science of teaching.

2.3. Sample and sampling technique

The research sample is the statistical representation of the population of interest [39]. This study used a purposive sampling method to select ten female teachers in five schools in District V, Lagos State. Moreover, two female teachers were chosen in each of the five schools. The sampled teachers met the criteria, including being from public secondary schools in Lagos and having attended at least one training course on digital literacy as a teacher. Any female teacher who joined the public service during the sudden outbreak of COVID-19 in 2019 were excluded from this study. Data saturation, which is the point in data gathering when all critical issues and insights are exhausted in qualitative research [41], was used in determining the sample size for this study.

2.4. Procedures

The study made use of a semi-structured interview protocol to elicit data from the participants. An interview is considered appropriate when the researcher intends to understand the interviewees' subjective viewpoint instead of generalizing it [42]. Adhering to the suggestion of [43], the researchers ensured that the subject matter of this study was maintained. Additionally, this was guided by the individual meaning ascribed to each of the interview questions. The interview protocol was developed through a literature review of digital literacy frameworks [7,10] and validated by two experts in ICT education. Pilot testing with three teachers ensured question clarity and relevance. Each interview lasted approximately 25 minutes, totaling 250 minutes across all the participants. Some of the interview questions in the protocol included the following:

1. *Have you participated in any ICT training organized by the government? If yes, which one(s)?*
2. *What skills or knowledge did you gain from the ICT training?*
3. *How has the training improved your teaching or professional work?*
4. *What challenges have you experienced in maintaining digital literacy after the COVID-19*

pandemic?

5. *Are there specific tools, platforms, or technologies you find difficult to access or use currently?*
6. *What strategies do you think can help ensure that female teachers stay digitally literate in the long term?*

While commenting on the significance of the observation field note in qualitative studies, [37] noted that field notes provide rich sources of data that provide a firsthand and multimodal depiction of the research setting in addition to the interview responses. The researchers triangulated the findings from the interviews with the aid of observation fieldnotes, which concentrated on the interactions of the female teachers with the individual personal computers in the staff rooms.

2.5. Data analysis

The researchers adopted a three-step thematic approach for the analysis. After conducting the semi-structured interview with 10 female participants who were conveniently selected from among all the teachers in the public secondary schools in Lagos state, Nigeria, the interview transcript materials and field notes were cross-checked for completeness. [42] suggested that data checking helps to ensure trustworthiness in qualitative data-driven exploration. The researchers adopted the peer method to check, validate, scrutinize, and evaluate the responses [44]. Second, the researchers transcribed and read the interviews for comparative purposes with the original audio recordings. This assisted the researchers in generating the appropriate key themes [45]. Similarly, all related codes were merged as a theme at this stage. Third, the researchers utilized a qualitative analysis tool, the QSR NVivo software, version 1.7.1, to obtain the final codes. The NVivo tool was chosen because it is simple, methodical, adaptable, and organizes the data into categories and sub-categories. In addition, the software eased the organization of data into the appropriate themes. The coded data were well represented with the parents' and children’s nodes.

2.6. Ethical consideration

The issue of ethics is germane to research that has to do with human beings. To bring that into play, the trustworthiness of the data was upheld in this study. While formal ethical approval was not obtained, the study adhered to core ethical principles: informed consent, anonymity, and voluntary participation. The participants provided verbal and written consent after receiving a full disclosure of the study’s purpose, risks, and benefits. Additionally, the researchers hid the participants' real names to protect their identities. However, the alphabet was used to represent the participants in this study for ease of recognition. Similarly, the participants were free to withdraw at any stage.

3. Results

3.1. Demographic information of participants

Table 1 presents the demographic information of the participants in this study. The ten participants were identified with letters A to J to conceal their real identities. Regarding marital status, all the participants are married female professional teachers in Lagos State. They are all public-school teachers. Among them, one participant is a senior teacher who has spent 32 years in

service, while the minimum year of experience of the participants is six years of service. Years of working experience and age have been found to influence a secondary school teachers' digital literacy [28]. Furthermore, two participants attended three ICT training courses, five participants attended two training courses, and three participants attended just one ICT training course. Meanwhile, not all of the participants have personal computers; five participants did not have one, while the remaining five did.

Table 1. Demographic information of the participants.

S/N	Marital Status	Year of Teaching Experience	Number of ICT trainings attended	Ownership of Computer
Participant A	Married	10	2	No
Participant B	Married	9	2	No
Participant C	Married	6	1	Yes
Participant D	Married	14	1	Yes
Participant E	Married	15	1	No
Participant F	Married	10	2	Yes
Participant G	Married	9	3	No
Participant H	Married	32	3	Yes
Participant I	Married	15	2	Yes
Participant J	Married	10	2	No

3.2. Common digital literacy training attended by female teachers in Lagos state

Figure 1 shows the type of digital literacy training attended by the female teachers in Lagos state, Nigeria. The interview report indicates that all of the participants had training on the use of Microsoft Teams, where they learned how to use both the synchronous and asynchronous learning modes. The training took place during the COVID-19 lockdown. In addition, other training courses attended by the participants included post-COVID-19 computer appreciation training and training on using ICT for effective teaching. One of the participants shared her digital literacy training experience as follows:

> *During the COVID-19 period, the Lagos State Ministry of Education collaborated with Microsoft to train teachers to use Teams for virtual teaching and learning. The training was made mandatory for all teachers, irrespective of the teachers' level*- Participant H

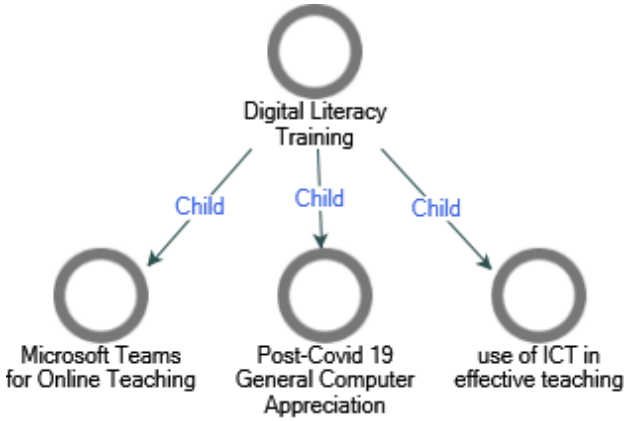

Figure 1. Digital literacy trainings attended by female teachers in Lagos state.

3.3. Benefits of ICT training to female teachers' digital literacy

Figure 2 presents the benefits of the ICT training on a female teachers' digital literacy. From the interviews conducted, eleven items emerged as benefits: it has allowed female teachers to be appointed as the Education Management Information System (EMIS) officers of their various schools; it eases database management for female teachers; it makes the collation of results easier; the female teachers' ICT knowledge improved; it has helped to bridge the gap between genders in digital literacy; it serves as an information source for curriculum implementation; it improves their knowledge of education database management; it has helped female teachers to do research in their various fields of specialization; it makes teaching and learning more effective; it improves teaching skills; and it motivates regular trainings.

One of the participants opined that various *ICT training courses organized for teachers had helped female teachers to understand computers more, and they can teach it very well- Participant E*

> *It has contributed dramatically by increasing a teachers' learning experience. It has improved teaching and learning activities in public schools. We use the knowledge to collate results and help female teachers conduct further research in their various subject areas. Through it, the EMIS officers can manage data or information about teachers and students. It simplifies and eases database management*. Participant A

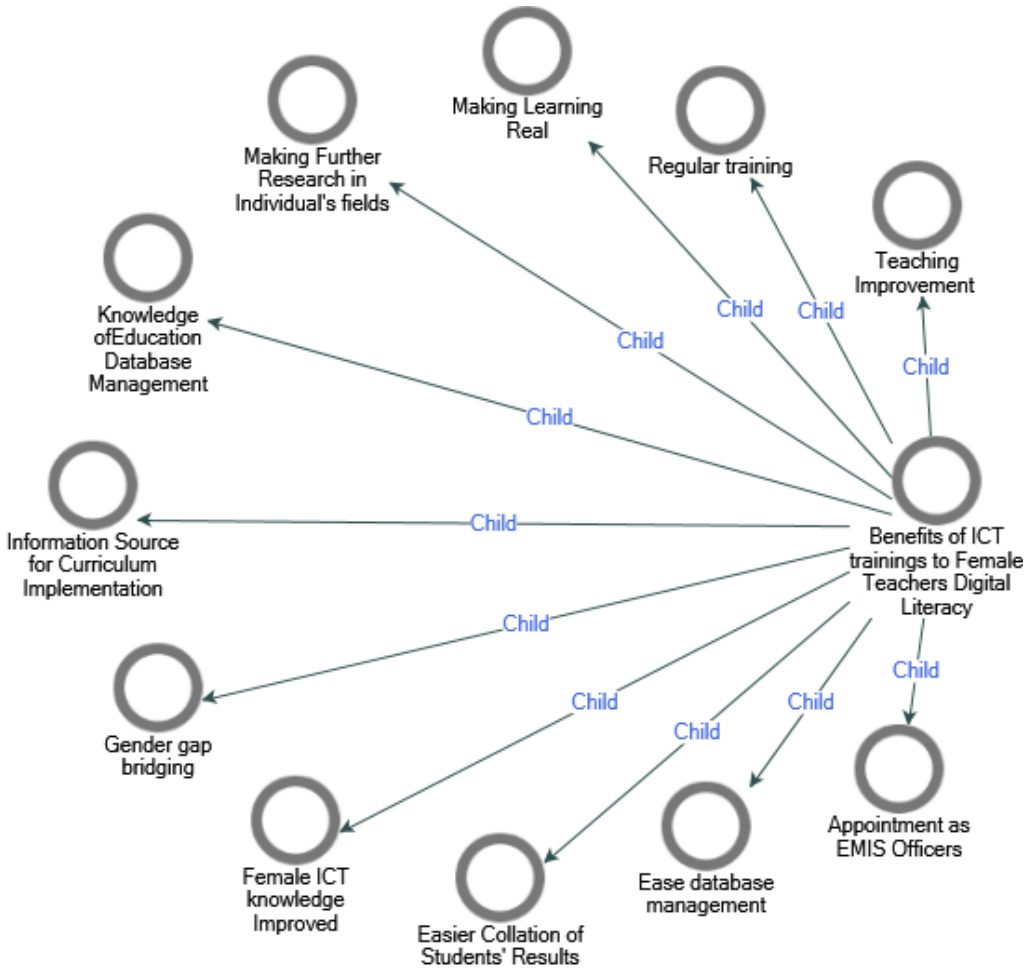

Figure 2. Benefits of ICT training on female teachers' digital literacy.

3.4. Challenges to the sustainability of digital literacy of female teachers in the post-covid-19 era

The study identified ten challenges to the sustainability of the female teachers' digital literacy in the post-COVID-19 period in secondary schools in Lagos State, Nigeria. These challenges, as presented in Figure 3, include unstable electricity (power supply), time constraints, the cost of acquiring personal laptops, a lack of ICT equipment, a lack of internet access, a lack of an alternative power supply, the teachers' workload, the parents' unpreparedness, and the school management's negative attitude towards ICT. In addition, the parents' unpreparedness was further categorized into material readiness, which manifested in the lack of access to the internet and smartphones. Cognitive readiness is another subdivision of the parents' unpreparedness. The participants argued that parents do not monitor their children's virtual learning, especially when nobody supervises the children. One of the interviewees lamented how the attitude of the school leadership is posing a threat to the sustainability of digital literacy of female teachers, especially as follows:

Principals are not even embracing the use of ICT in teaching students by not providing the

basic things like computers and projectors, and are not ready to run on generators – Participant D

Furthermore, Participant G submitted that *there are more men in ICT than women using it. Most female teachers go for the training but do not use it, owing to a lack of facilities, and they eventually forget it. The schoolwork needs to encourage teachers to use their knowledge. You can't use the projector for 40 minutes, which is a period, because others will want to take their classes too.*

3.5. Sustainability strategies for female teachers' digital literacy in the post-COVID-19 era

Figure 4 presents the proposed strategies for the sustainability of the female teachers' digital literacy in secondary schools in Lagos State, Nigeria. Nine items were identified: motivating teachers with rewards; monitoring knowledge use; free and unlimited access to the internet; enlightenment of the education stakeholders; continuous training; provision of soft loans for female teachers to buy ICT gadgets; provision of subsidized laptops for teachers; provision of solar inverters in schools to power the ICT equipment; and the provision of ICT equipment by the government in public secondary schools. One of the participants identified a list of strategies that can be adopted to sustain the gains recorded in the female teachers' digital literacy after the COVID-19 pandemic.

The government should organize more follow-up training courses for teachers to sustain the acquired ICT skills. Provision of accessible internet facilities and access within the school premises, in particular. Provide soft loans for acquiring a laptop/ gadget, especially for female teachers. In an ideal situation, each teacher should be given a free laptop. Female Teachers should be determined and more committed to using the knowledge. There should be monitoring of the use of digital knowledge, especially by school managers. Similarly, there should be rewards for outstanding digital literate teachers- Participant H

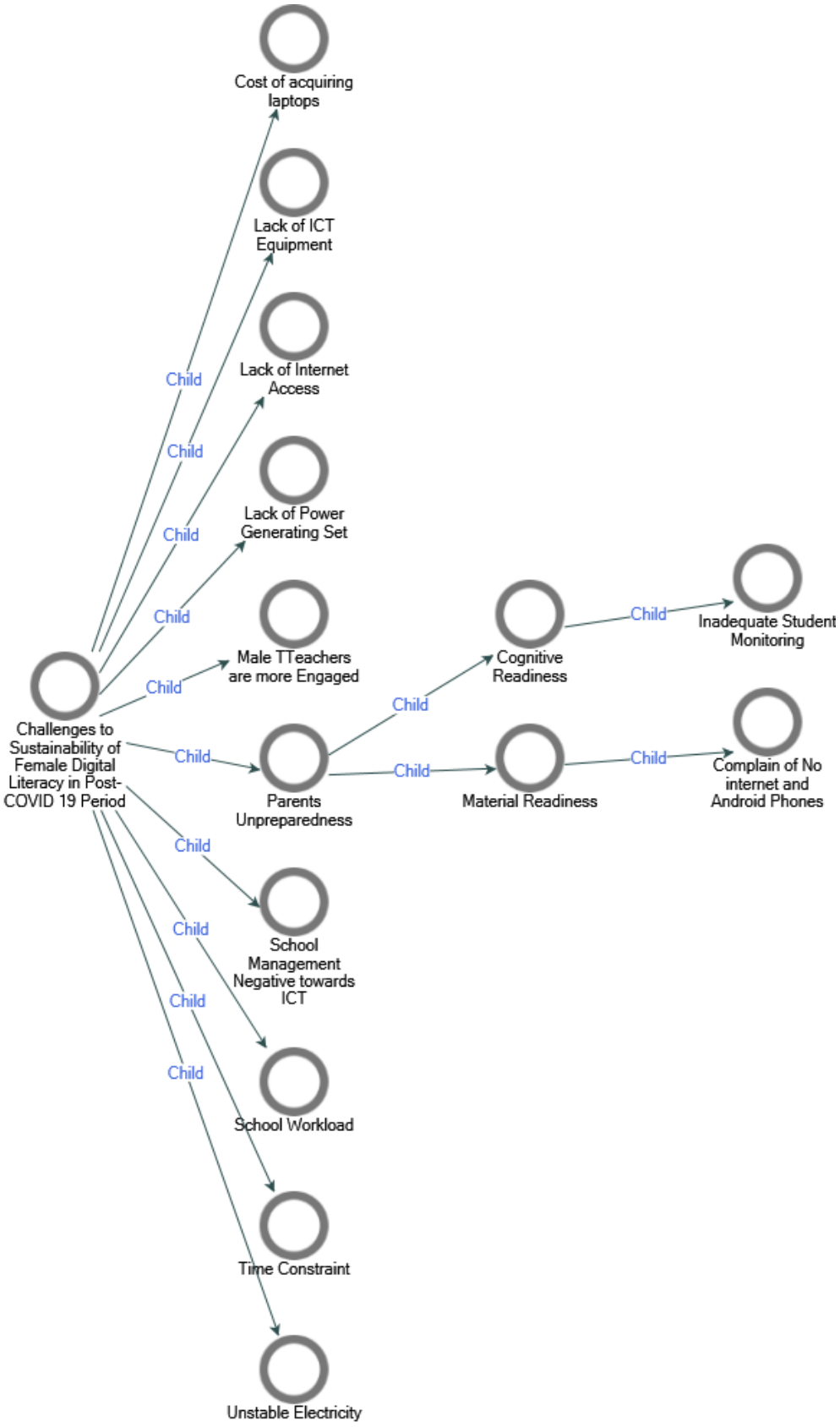

Figure 3. Challenges to Sustainability of Digital Literacy of Female Teachers in Post-COVID 19 Era.

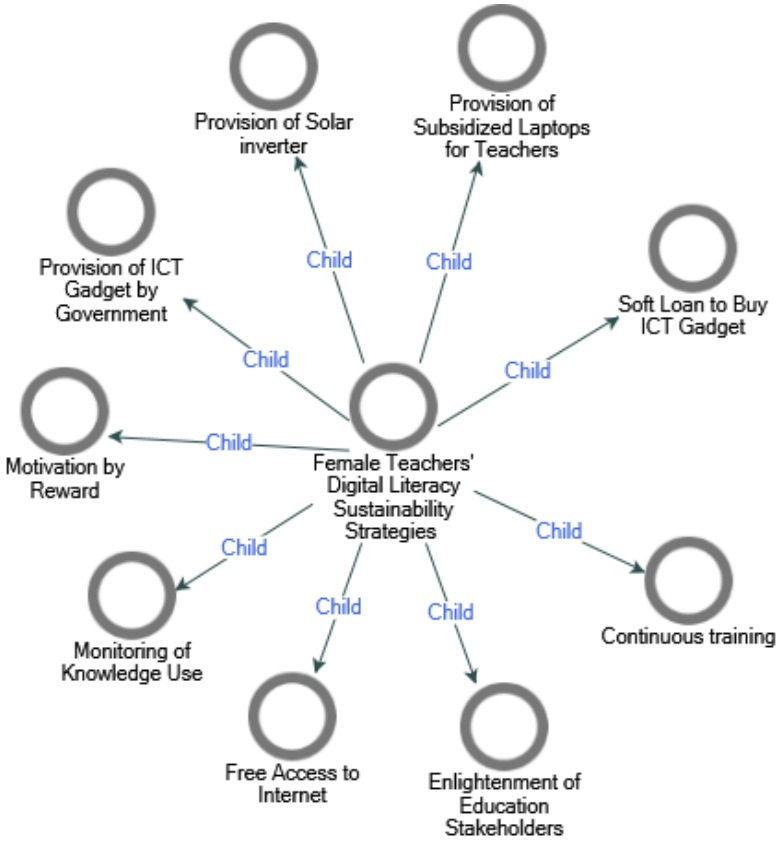

Figure 4. Sustainability strategies for female teachers' digital literacy in the post-covid-19 era.

4. Discussion

This paper examines the sustainability of female teachers' digital literacy in post-COVID-19 in Nigeria. In this study, it was found that female teachers benefited from various ICT training courses organized by the government, especially during the COVID-19 period. It has immensely contributed to digital literacy among female teachers in Secondary schools in Lagos State, Nigeria. These findings align with a related study by [46], which found that a teachers' digital literacy will enable them to use digital technologies to enhance their teaching. By so doing, learning will be more real to the learners, and their sustained interest and attention will be achieved.

Furthermore, the study also identified the institutional and individual challenges to the sustainability of digital literacy for the female teachers in the post-COVID-19 pandemic period. These findings agree with [2], which found that a teachers' lack of interest in online teaching is basically due to a lack of access to materials or gadgets, internet access, and motivation. Similarly, [15] found that all the challenges facing digital literacy are from three groups: the institution, the teachers, and the students.

The challenges related to facilities and equipment are institutional, while the lack of interest is a teacher-related challenge, and the lack of time for students to study ICT is student-related. However, the historical institutionalists believe that the environment in which individuals were brought up affects their attitudinal disposition. It is the institution's duty, irrespective of the approach adopted, to create an enabling and creative environment for the sustainability of any good initiative [33,34]. Edeh, et al. [36] found that there still needs to be more digital literacy on the part of the two genders.

It also aligned with [47], which found that financing digital literacy programs is a big burden on the organizer. Hiring more qualified trainers to facilitate the training session is a great challenge, which affects the continuity of the program. In their studies [48,49], researchers found that there was a sharp increase in the level of anxiety and depression among teachers, especially females, during the pandemic due to their job demands. Transitioning from face-to-face teaching to online learning required them to develop their digital literacy skills and acquire devices. These findings aligned with a related study by [46], which highlighted that a lack of confidence and insufficient knowledge, time, and tools constituted the major barriers to achieving and sustaining a teachers' digital literacy.

To overcome the challenges to the sustainability of the female teachers' digital literacy, this study found sustainability strategies for the female teachers' digital literacy in secondary schools in Lagos State, Nigeria. One identified strategy is providing follow-up training courses for the female teachers, in particular, on emerging digital literacy skills. A digital literacy training proposal should be drafted by the relevant agency or group of agencies and must be made feasible. As part of their contribution, [11] came up with a digital literacy training proposal for teachers to be competent. This agrees with the finding of [23], which studied the use of digital literacy tablets that were pre-loaded with different applications and were given to selected families to see how they used them. Researchers found that self-regulation, collaboration [50] and regular workshops on how to use technology will improve and keep up digital literacy skills. This aligns with the findings of [7]; when teachers were interviewed, they said they needed hands-on training courses on the ideal and effective ways of using digital technologies for teaching and learning activities. In addition, [28] reported that monitoring the individual digital competence of teachers will contribute more to the sustenance of digital literacy among female teachers in schools. This implies that efforts should be made to institutionalize internal and external measures to keep an eye on the development of the female teachers' digital literacy and sustain the ones already acquired by them before and during the COVID-19 pandemic. It is also worth noting that the improvement of digital literacy skills should not be limited to the teachers; the students' digital knowledge should also be given adequate consideration and attention [11].

Furthermore, the government should provide digital literacy centers where all teachers and students will have unrestricted access. In the study conducted by [7], teachers suggested the establishment of a digital literacy library, which teachers should be given free access to. By so doing, teachers will have access to media and self- learning equipment and facilities.

5. Limitations

This study has its own limitations, among which is the use of a convenient sampling technique to choose the participants. This method may have left out some experienced female digital literacy teachers. In the same way, the problems that have been found that make it hard for female teachers to keep up their digital literacy skills may need to be more related to the subject matter after the problem has been solved. In addition, a qualitative research design is usually criticized for being subjective. Therefore, another study that uses a quantitative design could be conducted for comparison and confirmation of the findings of this study. The study did not seek formal ethical committee approval, which represents a methodological limitation. Future research should ensure adherence to institutional ethical review processes. The absence of comprehensive socio-demographic data on the participants restricts the ability to contextualize findings across diverse subgroups within the study population.

6. Recommendations

Based on the findings of this study, the following recommendations are made:

i. The government should subsidize the purchase of ICT gadgets for female teachers to motivate them to use the digital literacy skills they acquired, especially during the COVID 19 pandemic. This could be combined with a soft loan to help obtain the gadgets.
ii. Principals of secondary schools should set up a committee to monitor the use of the acquired digital skills by supporting and helping female teachers proffer realistic solutions to their technology challenges.
iii. The use of a reward system by the government for female teachers can be considered. This, without any iota of doubt, will create healthy competition in the use of digital skills in schools. The reward should be made known to other teachers to also motivate them. The reward should involve both material and non-material rewards (recognition).
iv. The government should continue to organize training courses to sustain digital literacy among female teachers. The training courses should be scheduled regularly, though periodic. The training could be domesticated to each school to reduce the cost and rigor of teachers moving from one place to another.
v. Since schools have returned to classrooms for face-to-face teaching and learning, blended learning can be introduced. The introduction of blended learning will serve as one of the best means of refreshing the digital knowledge of female teachers and their students.

7. Conclusions

This study has made a big difference in balancing the digital skills of men and women in the 21st century. Industry 4.0 comes with a strong belief in the digitalization of teaching and learning activities through the Internet of Things. The study found that if female teachers learn just a little bit more about technology, then the difference between men and women in technology can be lessened, if not eliminated. This study found several problems that are making it hard for female teachers to keep up with digital literacy in the time after the COVID-19 pandemic. Additionally, the study put all the suggested strategies together to assist female teachers, no matter where they are during the COVID-19 pandemic.

Implications for secondary school leadership

The ministry of education should integrate digital literacy into national teacher education policies and professional development frameworks to ensure long-term digital competence. In addition, the government should establish a digital literacy fund to continuously support teacher training courses, infrastructure development, and an equitable access to digital tools. Additionally, it implies that the government should encourage policy frameworks that promote blended learning across secondary schools to maintain and apply digital competencies post-pandemic. Admission and staffing processes should consider gender equity in training opportunities, with special support for female educators balancing multiple roles. Moreover, school principals should champion digital inclusion by setting up internal digital culture policies, ICT committees, and regular audits on technology use.

Author contributions

Dr. Adewale contributed the background to the study, the analysis and the presentation of results. At the same time, Prof. Potokri reviewed the literature, wrote the method section and proofread the work of the research paper.

Use of Generative-AI tools declaration

The authors declare they have used Artificial Intelligence (AI) tools to edit the research paper.

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Ethics declaration

The issue of ethics is germane to the research that has to do with human beings. To bring that into play, the informed consent of the participant was secured, and the trustworthiness of the data was upheld in this study. The researchers also hid the participants' real names to protect their identities, upholding the principle of anonymity. However, alphabets were used to represent the participants in this study for ease of recognition.

References

1. UKaid, The Effect of Covid-19 on Education in Africa and its Implications for the Use of Technology, 2020. DOI: 10.5281/zenodo.4018774
2. Adewale, S., Awodiji, O.A. and Ariyo, S.O., Assessment of Teachers ' Competence and Interest in Online Teaching during the COVID-19 Pandemic in Nigeria. *Int. J. Pedagog. Teach. Educ.*, 2022, 6(2): 61–74. https://doi.org/10.20961/ijpte.v6i2.61430
3. Sá, M.J. and Serpa, S., COVID-19 and the Promotion of Digital Competences in Education. *Univers. J. Educ. Res.*, 2020, 8(10): 4520–4528. https://doi.org/10.13189/ujer.2020.081020
4. Adewale, S., Is virtual learning still virtually satisfactory in the post-COVID-19 era for pre-service teachers?. *Educational Technology Quarterly*, 2024, (2): 1–14. https://doi.org/10.55056/etq.713
5. Grande-De-prado, M., Cañón, R., García-Martín, S. and Cantón, I., Digital competence and gender: Teachers in training. a case study. *Futur. Internet*, 2020, 12(11): 1–15. https://doi.org/10.3390/fi12110204
6. Naidoo, V. and Potokri, O.C., Female School Leaders and the Fourth Industrial Revolution in South Africa. 2021.
7. Yildiz, E.P., Opinions of academicians on digital literacy : A phenomenology study. *Cypriot J. Educ. Sci.*, 2020, 15(3): 469–478. https://doi.org/10.18844/cjes.v15i3.4913
8. YÜNKÜL, E. and GÜNEŞ, A.M., The Relationship Between Prospective Teachers' Digital Literacy Skills, Attitude Towards the Teaching Profession and Academic Motivations. *Educ. Policy Anal. Strateg. Res.*, 2022, 17(3): 140–163. https://doi.org/10.29329/epasr.2022.461.7
9. van de Oudeweetering, K. and Voogt, J., Teachers' conceptualization and enactment of

twenty-first century competences: exploring dimensions for new curricula. *Curric. J.*, 2018, 29(1): 116–133. https://doi.org/10.1080/09585176.2017.1369136
10. David-west, B.T., Digital Literacy Skills and Utilization of Online Platforms for Teaching by LIS Educators in Universities in Rivers State , Nigeria. *Int. J. Knowl. Content Dev. Technol.*, 2022, 12(4): 105–117.
11. Cristina, S., Campión, R.S. and Sánchez-Compaña, T., Teacher Digital Literacy : The Indisputable Challenge after. *sustainability*, 2021, 13(1858): 1–29. https://doi.org/10.3390/su13041858
12. Gouseti, A., Lakkala, M., Raffaghelli, J., Ranieri, M., Roffi, A. and Ilomäki, L., Exploring teachers' perceptions of critical digital literacies and how these are manifested in their teaching practices. *Educ. Rev.*, 2023, 1–35. https://doi.org/10.1080/00131911.2022.2159933
13. Edeh, J.O., Pathways for Promoting Basic and Digital Literacy in Post-COVID-19 Nigeria. 2020, 410–423.
14. Potokri, O.C., Positioning African women for the fourth industrial revolution (4IR) era: Insights for women students. *Prizren Soc. Sci. J.*, 2022, 6(1): 84–94. https://doi.org/10.32936/pssj.v6i1.281
15. Eryansyah, E., Erlina, E., Fiftinova, F. and Nurweni, A.R.I., EFL Students ' Needs of Digital Literacy to Meet the Demands of 21 st Century Skills. *Indones. Res. J. Educ.*, 2019, 3(2): 442–460.
16. Osakwe, N., The Influence of Information and Communication Technology on Teacher Education and Professional Development in Delta State, Nigeria. *Asian J. Inf. Technol.*, 2010, 9(5): 280–285. https://doi.org/10.3923/ajit.2010.280.285
17. Ozkan-ozen, Y.D. and Kazancoglu, Y., Analysing workforce development challenges in the Industry 4.0. *Int. J. Manpow.*, 2022, 43(2): 310–333. https://doi.org/10.1108/IJM-03-2021-0167
18. Sadaf, A. and Gezer, T., Exploring factors that influence teachers' intentions to integrate digital literacy using the decomposed theory of planned behavior. *J. Digit. Learn. Teach. Educ.*, 2020, 36(2): 124–145. https://doi.org/10.1080/21532974.2020.1719244
19. Kerkhoff, S.N. and Makubuya, T., Digital Literacy and Transformative Teaching in a Low- - Income Country : A Case Study of Rural Kenya. *Read. Res. Q.*, 2021, 57(1): 287–305. https://doi.org/10.1002/rrq.392
20. Adewale, S., Assessment of Public-Private Partnership in Technical Colleges in Nigeria: A Case of Lagos State. *Int. J. Innov. Teach. Learn.*, 2021, 7(2): 36–51. https://doi.org/10.35993/ijitl.v7i2.1948
21. Cardosa, D.R.G., *A major challenge for e-literacy: the gender digital divide*, eLearning Innovation Center Blog.
22. ITU, Bridging the Gender Divide, 2023. Available from: https://www.itu.int/en/mediacentre/backgrounders/Pages/bridging-the-gender-divide.aspx
23. McDougall, J., Readman, M. and Wilkinson, P., The uses of (digital) literacy. *Learn. Media Technol.*, 2018, 43(3): 263–279. https://doi.org/10.1080/17439884.2018.1462206
24. Adewale, S. and Adebayo, S.S., School-Based Mentoring Programme as a Catalyst for Quality Education in Nigeria : Challenges and Prospects. *Int. J. Educ. Manag.*, 2020, 18(2): 91–99.
25. Yusuf, M.O., Information and communication technology and education : Analysing the Nigerian national policy for information technology. *Int. Educ. J.*, 2005, 6(3): 316–321.
26. Huyer, S. and Sikoska, T., *Overcoming the Gender Digital Divide: Understanding ICTs and their Potential for the Empowerment of Women*, 2003.

27. Akoni, O., COVID 19 lockdown: Lagos partners Microsoft, ATB on digital training for teachers. *Vanguard*, 2020.
28. Krumsvik, R.J., Jones, L.Ø., Øfstegaard, M. and Eikeland, O.J., Upper secondary school teachers' digital competence: Analysed by demographic, personal and professional characteristics. *Nord. J. Digit. Lit.*, 2016, 2016(3): 143–164. https://doi.org/10.18261/issn.1891-943x-2016-03-02
29. Gibson, D. and Foss, L., Developing the Entrepreneurial University: Architecture and Institutional Theory. *World Technop. Rev.*, 2017, 6(1): 1–15.
30. Amenta, E. and Ramsey, K.M., Institutional Theory. In: *Handbook of politics: State and society in global perspective*, 2010, 15–39. https://doi.org/10.1007/978-0-387-68930-2
31. Bradley, L., Bahous, R. and Albasha, A., Professional development of Syrian refugee women: proceeding with a career within education. *Stud. Contin. Educ.*, 2022, 44(1): 155–172. https://doi.org/10.1080/0158037X.2020.1840342
32. Adewale, S. and Tahir, M.B., Virtual learning environment factors as predictors of students ' learning satisfaction during COVID-19 period in Nigeria. *Asian Assoc. Open Univ. J.*, 2022, 17(2): 120–133. https://doi.org/10.1108/AAOUJ-10-2021-0121
33. Wamsler, C., Education for sustainability: Fostering a more conscious society and transformation towards sustainability. *Int. J. Sustain. High. Educ.*, 2020, 21(1): 112–130. https://doi.org/10.1108/IJSHE-04-2019-0152
34. Eshet, Y., Thinking in the Digital Era : A Revised Model for Digital Literacy. *Issues Informing Sci. Inf. Technol.*, 2012, 9: 267–276. https://doi.org/10.28945/1621
35. Valdés, K.N., Alpera, S.Q.Y. and Suárez, L.M.C., An institutional perspective for evaluating digital transformation in higher education: Insights from the chilean case. *Sustain.*, 2021, 13(17): 1–27. https://doi.org/10.3390/su13179850
36. Edeh, N.C., Amedu, A.N. and Eseadi, C., Assessing Gender Differences in Teachers ' Digital Literacy Skills for Assisting Students with Functional Diversity. *Int. J. Early Child. Spec. Educ.*, 2022, 14(5): 7952–7958. DOI: 10.9756/INTJECSE/V14I5.1021
37. Creswell, J.W., *Research design: Qualitative, quantitative, and mixed methods approaches*, 4th ed., Sage Publications, Inc, 2014.
38. Austin, Z. and Sutton, J., Qualitative Research : Getting Started. *Res. Prim.*, 2014, 67(6): 436–440. https://doi.org/10.4212/cjhp.v67i6.1406
39. Majid, U., Research Fundamentals: Study Design, Population, and Sample Size. *Undergrad. Res. Nat. Clin. Sci. Technol. J.*, 2018, 2(1): 1–7. https://doi.org/10.26685/urncst.16
40. Kirkpatrick, M., Akers, J. and Rivera, G., Use of Behavioral Skills Training with Teachers: A Systematic Review. *J. Behav. Educ.*, 2019, 28(3): 344–361. https://doi.org/10.1007/s10864-019-09322-z
41. Hennink, M. and Kaiser, B.N., Sample sizes for saturation in qualitative research: A systematic review of empirical tests. *Soc. Sci. Med.*, 2022, 292: 114523. https://doi.org/10.1016/j.socscimed.2021.114523
42. McGrath, C., Palmgren, P.J. and Liljedahl, M., Twelve tips for conducting qualitative research interviews. *Med. Teach.*, 2019, 41(9): 1002–1006. https://doi.org/10.1080/0142159X.2018.1497149
43. Strauss, A., *Qualitative analysis for Social Scientists*, Cambridge University Press, 1987. https://doi.org/10.1017/CBO9780511557842
44. Stahl, N. and King, J.R., Expanding approaches for research: understanding and using

trustworthiness in qualitative research. *J. Dev. Educ.*, 2020, 44(1): 26–28. https://doi.org/10.4324/9780429464232-3
45. Kamarudin, F. and Adams, D., Mentoring leaders of tomorrow : insights on the role of college directors. *Int. J. Mentor.*, 2023, 12(1): 82–94. https://doi.org/10.1108/IJMCE-05-2022-0034
46. Mokhtari, F., Fostering Digital Literacy in Higher Education: Benefits, Challenges and Implications. *Int. J. Linguist. Lit. Transl.*, 2023, 6(10): 160–167. https://doi.org/10.32996/ijllt.2023.6.10.19
47. Detlor, B., Julien, H., La Rose, T. and Serenko, A., Community-led digital literacy training : Toward a conceptual framework. *J. ofthe Assoc. Inf. Sci. Technol.*, 2022, 73(10): 1387–1400. https://doi.org/10.1002/asi.24639
48. Silva, D.F.O., Cobucci, R.N., Lima, S.C.V.C. and de Andrade, F.B., Prevalence of anxiety, depression, and stress among teachers during the COVID-19 pandemic a PRISMA-compliant systematic review. *Med. (United States)*, 2021, 100(44): e27684. https://doi.org/10.1097/MD.0000000000027684
49. Conte, E., Cavioni, V. and Ornaghi, V., Exploring Stress Factors and Coping Strategies in Italian Teachers after COVID-19: Evidence from Qualitative Data. *Educ. Sci.*, 2024, 14(2): 1–13. https://doi.org/10.3390/educsci14020152
50. Blau, I., Shamir-inbal, T. and Avdiel, O., How does the pedagogical design of a technology-enhanced collaborative academic course promote digital literacies, self-regulation, and perceived learning of students ?. *Internet High. Educ.*, 2020, 45: 100722. https://doi.org/10.1016/j.iheduc.2019.100722

Author's biography

Dr. Sulaimon Adewale is a postdoctoral research fellow at the Department of Educational Foundations, University of South Africa. He specialises in educational leadership and management. His research interests include women in leadership and development, TVET and digital leadership and online learning. He is a member of NAEAP and CCEAM.

Dr. Onoriode Collins Potokri is an associate professor at the Department of Educational Management, policy and Comparative Education, University of the Free State, South Africa. He specialises in educational leadership and management. His research interests include women in leadership and development.