

Information and Communication Technology (ICT) Interventions for Enhancing Access to Education in Rural sub-Saharan Africa: A Systematic Review

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Abstract

The incorporation of ICT in the learning environment is essential for preparing learners for future employment, as education is an ever-evolving process. However, sub-Saharan African learners are being left behind due to limited access to ICT infrastructure, resulting in disparities in education. This study presents the findings of a systematic review conducted in accordance with the PRISMA protocol, which aimed to investigate various ICT interventions, challenges, barriers, and key factors that contribute to their successful implementation and scalability in enhancing access to education in rural sub-Saharan Africa. The review was based on scientific databases, which were the primary sources of articles retrieved. The selected articles underwent a process of defining and applying inclusion and exclusion criteria, resulting in the selection of 17 articles that aligned with the study. The study further identified four focus areas that aided in discussions of the findings and recommendations to enhance ICT adoption and integration in education in rural sub-Saharan Africa. The findings revealed a disproportionate focus of research on ICT interventions in rural sub-Saharan Africa, with a notable bias towards South Africa.

Keywords: ICT Interventions, Education Access, Systematic Review, ICT Challenges, Technology, Rural Africa, Sub-Saharan Africa, Developing Countries

Introduction

Information Communication and Technology (ICT) plays a pivotal role in facilitating globalization (Aruleba & Jere, 2022) and has a beneficial influence on education. The integration of technology within educational systems holds significant promise in unlocking many benefits (D'Angelo et al., 2022). The growing interest in integrating information and communication technology (ICT) into teaching practices is due to the desire of modern education systems to provide students with more enriched learning opportunities (Aydın & Gürol, 2019). However, the COVID-19 pandemic has revealed the digital divide experienced in developing regions, especially rural sub-Saharan Africa. Van de Werfhorst et al. (2022) observed that as the digitalization of education increases, the more there exist inequalities in opportunities and academic performances due to disparities in access to digital resources and technologies. These inequalities underscore the importance of examining the effectiveness and impact of Information Communication, and Technology interventions meant to improve access to education in developing countries, particularly in the rural areas of sub-Saharan Africa.

Nchake and Shuaibu (2022) recognized ICT as a crucial driver for fostering inclusive and sustainable growth. However, rural regions, more so in sub-Saharan Africa, have limited access to ICT infrastructure, hindering services in critical sectors such as education, health, and agriculture (Aruleba & Jere, 2022). Underdeveloped infrastructure between countries and sub-regions in Africa has widened disparities in ICT access, especially in the realm of education, creating access gaps in education (Nchake & Shuaibu, 2022). This lack of enhanced access to ICT services and infrastructure in education has created barriers to acquiring knowledge and developing critical skills that would otherwise be brought about by ICT intervention. According to Lopez-Vargas et al. (2020), 264 million children globally cannot access and complete their education, and most of them are found in sub-Saharan Africa, where more than 20% of children aged 6 to 11 are out of school (Eltahir, 2019). Lopez-Vargas et al. (2020) further observes that most people with no access to electricity live in sub-Saharan Africa and Southeast Asia significantly hindering the implementation and sustainability of ICT initiatives in these regions. Therefore, there is a need to assess the adequacy and relevance of available ICT interventions to enhance access to education in rural areas of sub-Saharan Africa. This study is motivated to answer the following main research question, *“How can the effective implementation and sustainability of ICT interventions be achieved to enhance education access in rural sub-Saharan Africa, taking into account various current interventions, challenges, barriers, and key success factors?”*

The study focused on educational institutions in rural sub-Saharan Africa, with an emphasis on both primary and higher education establishments.

Aydın and Gürol (2019) identified that students' increasing desire for the presence of and easy access to information technologies in their daily lives, as well as their interest in connecting and sharing e-learning materials within the school environment, has led to an increasing interest in the integration of ICT into teaching and learning approaches. However, a significant knowledge gap is evident regarding effectively facilitating information access and promoting the use of ICT for the betterment of citizens, especially in the education sector in developing countries (Aruleba & Jere, 2022). Current research focuses on ICTs in developed regions, ignoring the unique challenges and needs faced by rural sub-Saharan Africa. The effective adoption of ICTs in rural sub-Saharan Africa setting faces various challenges, including limited

access to electricity, which is essential for powering ICT gadgets, infrastructural inadequacies, as well as concerns about the sustainability and security of ICT devices in remote areas (Santos et al., 2018). A systematic literature review is imperative to bridge this gap and gain comprehensive insights into the impact of ICT in rural Africa, and more so in the education sector, to adequately understand the multifaceted implications and potential outcomes associated with the integration of ICT in rural sub-Saharan Africa.

Citing Harper and Milman (2016), Aydın and Gürol (2019) opined that continuous and systematic ICT research review studies are imperative in the dynamic landscape of technology, as ICT is constantly evolving, and educational institutions, educators, and students are increasingly seeking innovative technologies to enrich and optimize instructional practices. Consequently, it is necessary to conduct a systematic literature review with a specific focus on consolidating the literature pertinent to the global south, thus filling this research gap by providing a comprehensive and up-to-date synthesis research focusing on ICT interventions in rural sub-Saharan African education (Aydın & Gürol 2019). According to Thierry et al. (2022), there is still significant room for ICT penetration in sub-Saharan Africa (SSA) compared to other emerging economies (such as those in Asia and Latin America) and developed nations, where ICT penetration has reached a saturation point.

This paper discusses the different ICT interventions, challenges, barriers, and key factors that contribute to their successful implementation and scalability in enhancing access to education in rural sub-Saharan Africa through a systematic review of existing scientific literature. The study further aims to make recommendations for improving the implementation and sustainability of ICT interventions in rural sub-Saharan African educational settings. To address the main research question, this study aimed to investigate the following research inquiries/questions:

- What are the different ICT interventions used in rural sub-Saharan Africa to improve access to education?
- What are the main challenges and barriers to implementing ICT interventions in rural sub-Saharan Africa?
- What are the key factors contributing to the successful implementation and scalability of ICT interventions in rural sub-Saharan Africa?
- What recommendations can be made to improve the implementation and sustainability of ICT interventions in rural sub-Saharan Africa education settings?

The main contribution of this systematic review is that it compiles and examines the current literature on ICT interventions in the education sector in rural sub-Saharan Africa, highlighting the challenges and obstacles faced during their implementation. Additionally, it provides valuable guidance for policymakers by, facilitating informed decisions on ICT interventions in the education sector, particularly in rural sub-Saharan Africa, with the goal of achieving substantial and impactful results.

Related Literature

Information and Communication Technology interventions aim to reduce the digital gap through the deployment of information systems and technology in developing countries (Ramadani et al., 2018), thus promising to enhance access to education in rural sub-Saharan Africa. Several academic studies have revealed the significant role of ICT interventions in driving socioeconomic development in rural areas (Maphosa, 2021; Ramadani et al., 2018; Mavengere & Ruohonen, 2016). According to Maphosa (2021), ICT solutions tailored for rural communities should offer information resources that are specific to their contexts and directly influence their daily lives. Mavengere and Ruohonen (2016) noted that since the 1990s, the educational benefits of ICT interventions have been widely recognized hence the need to conduct more research on impact of ICT4D in education. In the context of ICT4D in education, Mavengere and Ruohonen (2016) recommended that collaborative platforms such as wikis and group support systems should be employed to foster collaboration.

Manara and Gelderblom (2016) noted that while ICT4D projects cannot guarantee socio-economic improvement, they have the potential to make a substantial impact on developing communities. The impact of ICT interventions in education is significant, as it provides access to quality educational resources and opportunities for learning (D'Angelo et al., 2022). Dick Mwapwele and Roodt (2018) commented that Information and Communications Technologies (ICTs) such as mobile devices facilitate diverse avenues for accessing information, consequently enhancing knowledge acquisition. However, Dick Mwapwele and Roodt (2018) observed that there is a dearth of research examining teachers' utilization of mobile devices beyond the confines of the classroom for educational purposes. Mavengere and Ruohonen (2016) emphasize the importance of considering the context and user needs to facilitate the learning process. These previous studies confirm that ICT interventions can augment the efficiency and efficacy of educational delivery while also fostering heightened student motivation and enthusiasm towards learning.

In rural sub-Saharan Africa, the provision of quality education continues to pose challenges, attributable to factors such as inadequate infrastructure, lack of digital skills, resource scarcity, shortage of teachers, and geographical remoteness (D'Angelo et al. 2022). Connectivity has emerged as the main obstacle to expanding ICT interventions in developing countries (Lopez-Vargas et al., 2020). Although there have been some gradual improvements in Africa's infrastructure, the continent still faces unresolved challenges that demand greater investment to achieve the inclusive growth desired for the progressive implementation of ICT interventions (Nchake & Shuaibu, 2022). Mwapwele et al. (2019) identified a conflicting situation between the potential of ICTs to enhance education, the inadequate digital support available to teachers, and the increasing digital expectations placed upon teachers in the use of technology. While Mwapwele et al. (2019) saw this as a challenge, their findings noted that teachers embraced tablets and other digital devices for both personal and academic purposes.

Successful implementation of sustainable ICT interventions requires the collaboration of the government, NGOs, community, local administrators, partners providing support in research, science and development, and human resources across various domains (Manara & Gelderblom, 2016). Mavengere and Ruohonen (2016) equally observed that the key factors that influence the adoption of technology in education in developing countries include computer literacy, infrastructure availability, collaboration culture, IT (Information Technology) staff presence, and leadership support. The need to implement and sustain

Information and Communication Technologies calls for African governments to collaborate with respective mobile network operators and other development partners in setting up complimentary Wi-Fi hotspots and expanding the mobile network infrastructure (Manara & Gelderblom, 2016).

Bahrini and Qaffas (2019) while focusing on developing countries noted that many previous studies have conducted empirical works using different econometric models and using transnational data to understand the relationship between ICT diffusion and economic growth (Nasab and Aghaei 2009; Andrianaivo and Kpodar 2011; Sassi and Goaid 2013; Pradhan et al. 2015, 2018; Aghaei and Rezagholizadeh 2017). These studies yielded inconclusive findings, leading to significant discrepancies among researchers regarding the extent of the growth-enhancing impact of ICT diffusion in developing countries. Consequently, this unresolved issue presents a significant research gap that requires further investigation (Bahrini and Qaffas, 2019). Therefore, it is imperative to conduct synthetic studies to identify the key factors that influence how the education sector uses ICT in a teaching and learning environment (Aydın & Gürol, 2019).

Methodology

This systematic review aims to identify the different ICT interventions, challenges, and barriers to their implementation and scalability, as well as recommendations for improving their implementation and sustainability in rural sub-Saharan African educational settings. To ensure rigor and quality of the review process, the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) was used as a guide (Aydın & Gürol, 2019) to identify the criteria for inclusion and exclusion. The review process followed the PRISMA guidelines, which include four stages: identification, screening, eligibility, and inclusion (Aydın & Gürol, 2019). The criteria were derived from the research questions, and the review diligently identified and examined all the relevant studies. However, the research considered only those studies that met the following conditions:

- Rural areas of sub-Saharan Africa and did not include urban areas, except in cases in which a comparative study was conducted between rural and urban areas.
- The studies were peer-reviewed.
- The language of publication was English.
- Publications relevant to the defined search strings.
- Study papers must be full and complete; preprints and abstracts are excluded from the study; and
- Studies published between 2013 and 2022.

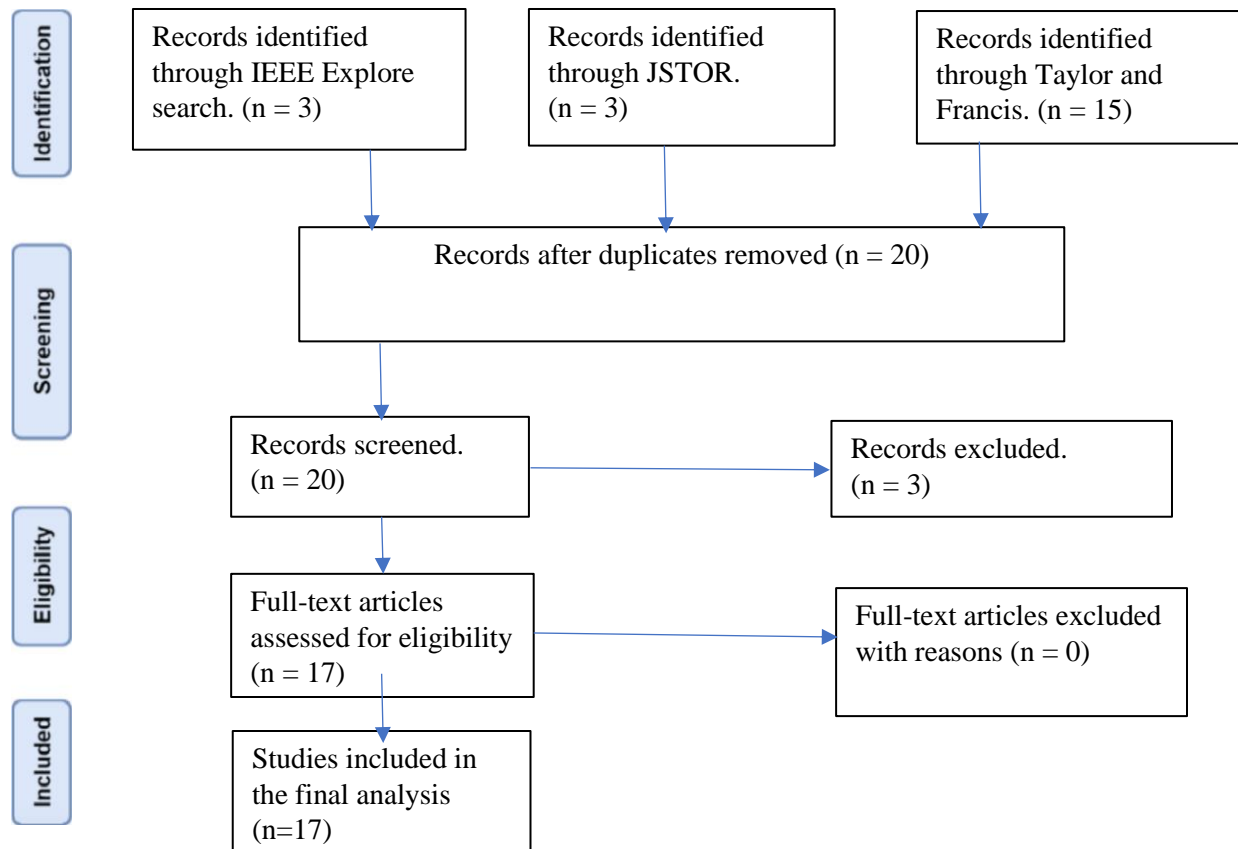


Figure 1: PRISMA flowchart for the study selection process.

This study excluded other pertinent research materials such as conference papers, letters, surveys, magazines, preprints, and books.

Search Strategy

The search approach centers on three globally acknowledged and respected databases, namely:

- JSTOR <https://www.jstor.org/>
- IEE Explore <https://ieeexplore.ieee.org/>
- Taylor & Francis <https://www.tandfonline.com/>

These databases are highly regarded in academia and provide rich research resources to facilitate various types of research. In addition, these databases have rich content in ICT and social sciences, further justifying the reason for choosing them for this study. The main keywords and descriptors were identified, and search strings were formed.

Table 1: Search Strings

Database	Search Descriptors
IEEE Explore	"ICT interventions" AND "access to education" AND "rural Africa" OR "Developing Countries." Challenges of implementing ICT OR "Information and Communication Technology" interventions in rural Africa Barriers to ICT implementation in rural Africa AND education Factors for successful implementation of ICT interventions in rural Africa Conditions for successful ICT adoption in rural Africa AND education Suggestions for improving ICT adoption in rural Africa AND education Determinants for improving ICT use in rural Africa AND education
JSTOR	ICT interventions AND access to education AND rural Africa OR Developing Countries Challenges of implementing ICT OR "Information and Communication Technology" interventions in rural Africa Barriers to ICT implementation in rural Africa AND education Factors for successful implementation of ICT interventions in rural Africa Conditions for successful ICT adoption in rural Africa AND education Suggestions for improving ICT adoption in rural Africa AND education Determinants for improving ICT use in rural Africa AND education
Taylor & Francis	[All: ict] AND [All: interventions] AND [All: access] AND [All: to] AND [All: education] AND [All: rural] AND [[All: africa] OR [All: developing]] AND [All: countries] AND [Article Type: Article] AND [Publication Date: (01/01/2013 TO 31/12/2022)] [All: challenges of implementing] AND [[All: ict] OR [All: "]] AND [All: information and communication technology interventions in rural africa] AND [Article Type: Article] AND [Publication Date: (01/01/2013 TO 31/12/2022)] [All: barriers to ict implementation in rural] AND [All: africa] AND [All: education] AND [Article Type: Article] AND [Publication Date: (01/01/2013 TO 31/12/2022)] [All: factors for successful implementation of ict interventions in rural africa] AND [Article Type: Article] AND [Publication Date: (01/01/2013 TO 31/12/2022)] All: conditions for successful ict adoption in rural] AND [All: africa] AND [All: education] AND [Article Type: Article] AND [Publication Date: (01/01/2013 TO 31/12/2022)] [All: suggestions for improving ict adoption in rural] AND [All: africa] AND [All: education] AND [Article Type: Article] AND [Publication Date: (01/01/2013 TO 31/12/2022)] [All: determinants for improving ict use in rural] AND [All: africa] AND [All: education] AND [Article Type: Article] AND [Publication Date: (01/01/2013 TO 31/12/2022)]

Search Coding and Analysis

The research publications that met the search criteria and thresholds were collected and recorded in an Excel sheet for further processing. While conducting the search, the total hit recorded was 5535, and upon further processing, 21 hits (Fig. 1) were downloaded. The hits were distributed as below (Table 2.)

Table 2: Articles Initially Coded for Study Examination

Online Database	Number of Publications (Initial Coding)
IEEE Explore	362
JSTOR	1019
Taylor & Francis	4154
Total	5535

Findings

The data presented in Table 3 suggest that a significant proportion of the studies reviewed on ICT interventions in sub-Saharan Africa were primarily conducted in South Africa. Despite the acknowledgment of the paucity of literature on ICT interventions in sub-Saharan countries in the introduction of this paper, subsequent analysis of the studies included in the final work highlights the significant disparity between South Africa and other countries in the Global South. The data in Table 3. also suggests that sub-Saharan countries face several challenges in their efforts to use ICT to improve access to education.

Table 3: Studies Included in The Final Analysis and Respective Databases

Ref	Year	Country	Study Aim/Scope	Data Collection Method	Focus Area	Database
(Eltahir, 2019)	2019	Sudan	Investigates whether e-learning serves as a solution for education in developing countries, particularly focusing on Sudan	Questionnaires and semi-structured interviews	ICT Intervention	IEEE Explore
(Agbatogun, 2013)	2013	Nigeria	To predict the utilization of digital technologies by faculty members in Nigerian universities	Questionnaires	Factors that contribute to ICT implementation	JSTOR
(Jere-Folotiya et al., 2014)	2014	Zambia	To investigate the potential of a computer-based literacy game (GraphoGame™ M) to enhance literacy skills among first-grade students in Zambia	Observation	Factors that contribute to ICT implementation	JSTOR
(Mahlomaholo & Tshelane, 2022)	2022	South Africa	Focuses on the deliberate construction of a framework for integrating ICT into the school's professional curriculum leadership practices, driven by critical emancipatory theory.	Participatory action research (generating data through collaboration with a research team)	ICT and Sustainability	JSTOR
(Du Toit-Brits, 2016)	2016	South Africa	To explore the perspectives of Batswana Advanced Certificate in Education (ACE) students on their willingness to use Information Communication Technology (ICT) in Distance Education (DE).	Qualitative	Challenges in the use of ICT Interventions	Taylor & Francis

(van Niekerk & Blignaut, 2014)	2014	South Africa	To investigate how principals influence teachers' effective and sustainable integration of Information and Communication Technologies (ICTs) in education, particularly through teacher professional development (TPD), within the context of South Africa.	Qualitative	ICT Interventions and Sustainability	Taylor & Francis
(Masango et al., 2020)	2020	South Africa	The aim of the study is to investigate the barriers and challenges hindering the adoption and use of digital technologies	Semi-structured interviews and Questionnaires	Barriers and challenges hindering the adoption and use of digital technologies	Taylor & Francis
(Bester, 2016)	2020	South Africa	To identify the challenges that History teachers face when integrating multimedia and provide recommendations for effectively incorporating multimedia in the teaching of the subject. Also, to identify factors that are preventing these teachers from integrating multimedia into their lessons.	Questionnaires	Challenges in the use of ICT Interventions and recommendations	Taylor & Francis
(Eyo, 2014)	2014	Nigeria	The aim of the study is to investigate the digital divide in the utilization of Information and Communication Technology (ICT) within the context of counsellor education in Nigerian universities, particularly focusing on the South-South geopolitical zone.	Questionnaires	Challenges to ICT Interventions	Taylor & Francis

(Karakara & Osabuohien, 2019)	2019	Ghana	The aim of the study is to examine the factors contributing to the educational disadvantages and the risk of school dropout among children in Sub-Sahara Africa, with a specific focus on Ghana.	Cluster and Systematic Sampling	Challenges to ICT Interventions	Taylor & Francis
(Macharia & Pelsler, 2014)	2014	Kenya	To identify factors influencing ICT use in Kenyan higher education.	Questionnaire	Factors influencing ICT use	Taylor & Francis
(Mihai, 2017)	2017	South Africa	To assess the success factors and challenges of the Mpumalanga IWB project in improving Science and Mathematics teaching in rural South African schools.	Interview	Factors enhancing ICT interventions and challenges to ICT interventions	Taylor & Francis
(Chisango et al., 2019)	2019	South Africa	To explore the readiness and challenges related to ICT integration in education.	Interviews and focus groups	Challenges to ICT Interventions	Taylor & Francis
(Dlamini & Rafiki, 2022)	2022	South Africa	To explore how teachers perceive and intend to use ICT for teaching and learning, specifically in a situation where they have access to computing infrastructure but the actual utilization of ICT tools in the classroom is constrained.	Questionnaires	ICT interventions and their usage	Taylor & Francis
(Lembani et al., 2019)	2019	South Africa	To understand how access to ICTs can help students in marginalized and peripheral communities in Africa to access Higher Education through Open Distance Learning. It	Questionnaires and Online Interviews	Challenges accessing ICT interventions	Taylor & Francis

			also seeks to understand the disparities in educational experiences between students with varying levels of ICT access in different geographical areas.			
(Mhandu et al., 2021)	2021	South Africa	To evaluate the effectiveness of online learning for rural-based first-year students at the University of KwaZulu-Natal (UKZN) during the COVID-19 pandemic, assessing whether it addresses their needs or exacerbates existing educational inequalities.	Remote digital ethnography	ICT interventions and challenges affecting ICT access	Taylor & Francis
(Lediga & Fombad, 2018)	2018	South Africa	To investigate the role of ICTs in bridging the digital divide within South African public libraries.	Interview	ICT interventions and challenges affecting ICT access.	Taylor & Francis

Discussion of Findings

After coding and analysing the data, specific areas of focus were identified: ICT interventions used in rural sub-Saharan Africa, barriers and challenges encountered in implementing and using ICT interventions, factors influencing the adoption of ICT for educational access in rural Africa, and recommendations to improve the implementation and sustainable impact of these interventions.

ICT Interventions Used in Rural Sub-Saharan Africa for Education Access.

Learners must be equipped to meet the demands of the twenty-first century, which necessitates proficient and sustainable utilization of ICT in education. The rural areas of sub-Saharan Africa are increasingly looking for digital learning to provide learners with more authentic learning opportunities and simulated experiences. Policy makers, academics, and learners consider educational technology and online learning as valuable tools to improve education in the rural areas of sub-Saharan Africa. The affordability and accessibility of mobile phones and tablets are increasing in rural sub-Saharan Africa, and this has spurred the creation of mobile learning platforms providing learners with access to educational resources such as eBooks, videos, and quizzes, which is especially beneficial for students in remote areas with limited access to traditional schools. Equally, the emergence of wireless digital technologies has heralded the increasing adoption of interactive digital technologies in traditional classroom instruction. Interactive technologies, which aim to facilitate interactions between educators and learners, are challenging traditional non-interactive teaching and learning methods (Agbatogun, 2013).

ICT interventions in the rural parts of sub-Saharan Africa already offer a cost-efficient means of providing education to rural students; however, there is a need to ensure that these interventions are accessible and affordable for all learners. Various ICT interventions have been noted, encompassing the provisioning of the needed ICT infrastructure to educational institutions. This includes supply of internet connectivity, computers, tablets, smart boards, and projectors, alongside the implementation of online interactive discussions, as elucidated in studies by Lediga and Fombad (2018) and Chisango et al. (2019). Masango et al., (2020) equally noted some of the ICT interventions that aimed at creating paperless classrooms, supporting tech-based teaching, and focusing on increasing access to a wide range of media to enrich the education of learners.

All the articles touched on the need to enhance ICT interventions in the rural areas of sub-Saharan Africa in a quest to minimize the digital divide and promote the actual use of the available interventions, as many learning institutions in rural areas of Africa are poorly resourced with underqualified teaching staff (Eltahir, 2019).

Barriers And Challenges Encountered in Implementing and Using ICT Interventions in Rural Sub-Saharan Africa for Education

The findings in Table 3 suggest that several barriers hinder the successful implementation of digital learning in rural schools in sub-Saharan Africa. The lack of reliable Internet connection and sufficient bandwidth in the classroom still hinders the effective use of interactive online resources (Masango et al., 2020). Some responses from the participants, as discussed by Lediga and Fombad (2018), highlighted significant barriers to ICT interventions in sub-Saharan Africa, including slow Internet connection hindering timely tasks,

unstable Wi-Fi disrupting device connections and logins, limited time allocation for users, insufficient time for meaningful research due to short computer kiosk usage periods, unresponsive and frequently broken computers, and lengthy waiting times (3–4 hours) when there are few available computers. These responses emphasize the essential nature of ICT interventions and the urgency for stakeholders to address obstacles that impede the effective utilization of ICT resources for educational access.

The findings noted observations made by Jere-Folotiya et al. (2014) that their research team regularly encountered disruptions and deviations due to the many adverse conditions common in most public primary schools in Zambia and other sub-Saharan Africa countries. These challenges include overcrowding, inadequate infrastructure, unfavorable teaching conditions, limited family literacy, insufficient teaching resources, and student absenteeism.

The cultural influences and preferences of students within their cultural context can directly affect their willingness or unwillingness to use ICT in their academic pursuits in rural areas of sub-Saharan Africa, as they “do not consider computer and Internet technology as part of their cultural heritage, and that is why they are not prepared for the excessive focus on ICT” (Du Toit-Brits, 2016). An analysis of the works of Du Toit-Brits (2016) seems to have extensively examined how cultural traditions and norms have a strong influence on individuals' lives in rural communities of Africa. Therefore, it is critical to involve the local community in the design, development, and implementation of ICT interventions. This ensures that technology aligns with cultural values, respects local practices, and meets the needs of the community, thereby improving its adoption and effectiveness.

The implementation of ICT in education within rural Sub-Saharan Africa encounters obstacles such as limited infrastructure and disparities in digital literacy. Nevertheless, it presents significant opportunities for pedagogical innovation and community engagement, necessitating the consideration of cultural sensitivity and the development of localized content.

Factors Influencing the Adoption of ICT for Education Access in Rural Sub-Saharan Africa

The findings in Table 3 highlight the factors that play a key role in the implementation of ICT interventions in the rural regions of sub-Saharan Africa. Limited or unreliable power supply and inadequate network coverage can hinder ICT implementation. As discussed by Agbatogun (2013), a significant challenge faced by many teachers in many education institutions in rural areas of Africa is the difficulty of integrating technology into the teaching process due to insufficient financial support to purchase sufficient equipment and setting up essential infrastructure. While discussing on the same, Macharia and Pelsler (2014) observed that the key factors that influence the diffusion and infusion of ICT in Kenyan higher education include environmental, technological, organizational, and individual elements. These factors greatly impact ICT adoption in student learning in higher education.

Notably, the availability and access to ICT and the characteristics of the institution's chief executive officer play critical roles in the spread of ICT in developing countries. The study by Macharia and Pelsler (2014) provides valuable insights into students' technology adoption decisions and offers innovative approaches to ICT diffusion and infusion management. The education sector, especially higher education, has largely been neglected in research on technology acceptance in information systems. This is because most studies

have focused on other sectors, such as healthcare and business. As a result, little is known about the factors that influence the adoption and diffusion of ICT in the education sector (Macharia & Pelsler, 2014).

Recommendations to Improve the Implementation and Sustainable Impact of ICT Interventions

From the discussions of the focus areas of ICT interventions, barriers and challenges, and factors influencing the adoption of ICT, it is clear that there are issues that need to be addressed regarding the use of ICT interventions in rural sub-Saharan Africa. The Global South needs to be integrated into the information society for skill building and enhancement of education access to many African children in need. The findings showed that there is a digital divide within sub-Saharan Africa, and stakeholders should collaborate to bridge the digital divide, enhance educational access, and improve the overall quality of learning experiences in rural sub-Saharan Africa through ICT interventions (Bester, 2016). The government and other stakeholders should invest in improving the power supply, network coverage, and technology infrastructure in rural areas to ensure a stable environment for ICT adoption. The discussion is slowly shifting towards the use and access to ICT, and there is an urgent need for the governments in the sub-Saharan countries to formulate and implement policies that promote the integration of ICT in education and incentivize private sector involvement in rural areas while regularly evaluating the impact of ICT interventions on education outcomes in rural areas and make adjustments as needed based on feedback and data.

As outlined by Du Toit-Brits (2016), most rural sub-Saharan settings are culturally sensitive. To ensure successful implementation and sustainability, it is important to engage local communities in the design and implementation of ICT interventions to consider their specific requirements and viewpoints. Equally important is the creation of educational content tailored to the specific needs and interests of rural learners using linguistic and cultural references they can identify, making learning enjoyable and meaningful (Du Toit-Brits, 2016).

It goes without saying that teachers and educators at different levels need to be supported for the integration of ICT interventions in the classrooms to be effective. There is a need for ongoing training and support for teachers to effectively integrate IT tools into their teaching methods, thereby improving students' engagement and learning outcomes. There should be a mechanism in place to provide training and workshops for teachers, students, and community members to develop their digital literacy skills and to ensure the effective use of ICT tools for education. In summary, to light the digital torch in rural sub-Saharan Africa, policymakers must bridge infrastructure gaps, ignite digital literacy, and fuel innovation with sustainable solutions. Customized content and community engagement, kindled by respect for linguistic diversity, can illuminate the path forward.

This finding highlights the disproportionate focus of research on ICT interventions in rural sub-Saharan Africa, with a notable bias towards South Africa. As most research on ICT in education in sub-Saharan Africa has been conducted in South Africa, it is important to conduct research in other countries within the region to gain a more comprehensive understanding of the challenges and opportunities for ICT in education in this region.

Conclusion

The use of ICT in education has been shown to be effective in improving learning outcomes. However, equitable access to ICT is still a challenge in many parts of the world, especially in the rural sub-Saharan Africa. This research focuses on ICT interventions in rural sub-Saharan African education. These findings suggest that further research is needed in the Global South to better understand the challenges and opportunities of ICT in education in the rural regions of sub-Saharan Africa. The literature analyzed primarily originated from three databases, potentially excluding articles published in other databases from this review. At the same time, the study only considered papers published from 2013 to 2022, and the study might have left out relevant papers before and after these times, limiting this review. Overall, the study systematically reviewed articles that investigated ICT interventions, challenges and barriers, and factors that affect the implementation of ICT interventions in sub-Saharan and provided recommendations on how to ensure that future ICT interventions in education are implemented and sustained.

The study has equally identified limitations, including constraints in ICT infrastructure, inadequate power supply, lack of qualified staff, computer illiteracy and limited access to computers. Addressing these constraints necessitates enhancements in ICT infrastructure, power supply, and computer accessibility. By strategically addressing these concerns, policymakers can establish a foundational framework for the implementation of ICT interventions to enhance educational outcomes across both primary and higher education levels in rural sub-Saharan Africa.

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