

Cloud-enabled e-learning for rural education in rural settings

Ephraim Daka

Email: ephraim.edaka@gmail.com

Abstract

According to the African Union, between 60 and 80% of Africa's population live in rural areas. Rural and distant learners are left without e-learning opportunities due to infrastructure limitations, mainly due to limited or no internet connection. Without proper connectivity, rural learners who are far away still lack shared learning materials that teach them how to engage in an information and communication technology (ICT) intensive world. This article examines the digital divide pervasive in rural Africa's educational environments and proposes cloud-enabled e-learning environments for education as a novel solution to facilitate e-learning in remote rural areas. This solution provides a bridge for digitally disconnected students, individuals and society to join the global ICT community and compete effectively. The article presents facts from the Kenyan education sector in adopting cloud-based web services and calls on African governments and educators to adopt a holistic systems approach to bridge the digital divide.

Keywords: e-learning, digital divide, rural education, cloud-internet, Africa

Introduction

Digital divide

The problem of unequal and, moreover, a lack of access to the Internet persists in Africa. This requires innovative cloud-based internet solutions. For example, while the number of people connecting to the internet around the world is increasing, over a third of the world's population has never been on the internet (Ryan, 2012). According to the International Telecommunication Union (ITU) of 2021, about 96% of people without internet experience live in developing countries. In Africa, most internet activities and infrastructure are located in South Africa, Egypt and Morocco. While in Sub-Saharan Africa (SSA), South Africa leads the way with 71.4 in 2020, Nigeria has the most internet users and Kenya leads Africa with the most mobile internet users and a penetration rate of 83%.



Fig. 1 - Rural School in Malagasy, Madagascar. (The photo was taken by schools in Madagascar using cloud-based internet in primary school.)

Given the current circumstances and efforts to improve rural education, there is a need to address the growing injustice faced by learners, educators and institutions in Africa. Through a sustainable Internet infrastructure, because rural and remote teachers and students have pressing constraints that require solutions and appropriate ICT-enabled teaching and learning platforms. In the short term, however, the protection of rural populations from the widening digital divide must be strengthened through innovative solutions to promote inclusion. This can be accomplished by leveraging current cloud-based innovations to enable e-learning to provide instant access to those who are not connected, while working to develop an inclusive learning environment across geographic boundaries.

Additionally, local technical infrastructure often faces challenges in providing cellular network coverage and bandwidth, limiting users' access to Internet-based services. Likewise, device scarcity and price thresholds are barriers to accessing ICT services. In a recent literature review

of higher education in Malawi by Gama, Chipeta, and Chawinga (2022), Chipeta and Chawinga (2022) confirmed that underdeveloped ICT and electricity infrastructure are the most common barriers to e-learning implementation, followed by the lack of one E-Learning Policy. Remarkably, most African countries still need to improve their ICT policies, so the implementation of e-learning systems requires relevant ministries to do more work guided by updated e-learning policies. In short, ICT policy should constantly evolve and adapt to technological innovations

Today, renewable energy systems such as solar energy have emerged as a suitable energy source to enable ICT functionality for most people in rural areas that are not connected to the national electricity grid. In fact, some rural households can install small solar panels to power devices like radios and cell phones. With the provision of solar energy, ICT infrastructures in the health, agriculture or education sectors can function and enable electronic devices to function and provide services.

Exploring ICT solutions and requirements

To use ICT for improved access to education in rural areas, learners and institutions need to consider solutions that provide a link to overcome isolation. For example, insufficient or no access to connectivity remains a key challenge in rural areas. As noted in the study by Madimabe & Omadan (2021), it shows that in rural secondary education South Africa, insufficient equipment and access to connectivity has been found to hamper the rapid adoption of the e-learning process. The high costs for the ICT infrastructure were identified as a further challenge. To drive this forward, ICT infrastructure for rural people needs to be inexpensive, easier to acquire and maintain, and easy to use. In the study by Madimabe et al. (2022) and Gama, Chipeta & Chawinga (2022) focusing on e-learning in higher education, similar considerations and approaches also apply to primary education.

To this end, investing in innovative e-learning infrastructure in rural schools, especially in difficult environments, is a positive approach and the government and other partners need to do more for the rural population. This article emphasizes bridging the gap between the educated in developed cities and the rural underdeveloped communities. We also rely on the study by Anand (2012) who found that e-learning was beneficial for rural people to build knowledge and learn new technologies, but most importantly it helped develop rural people's social and intellectual skills to develop in order to develop what is crucial for improving their well-being.

Conquering the digital divide through micro-cloud solutions

The micro-cloud is thus an alternative infrastructure solution that offers a way to bridge the digital divide as it combines a cloud-based solution with on-premises technology to isolate the lack of

connectivity. This provides a faster way to address issues of constrained economics, hardware deployment, dynamics of multi-hardware compatibility, and integration through inclusivity with rural communities. It is an approach that can use educational content in school with any cloud enabled internet services and browser-enabled devices such as tablets or smartphones. Today, both young and older adults in rural areas with access to primary education are more than likely to use mobile internet technologies such as phones at home. Both familiarity with and access to these devices can be important factors in their acceptance in their families and community.

The C3 micro-clouds for education as a solution for e-learning

The *C3 micro-cloud*, also known as a *cloud-enabled web service*, creates a rich learning environment that offers a local content repository and powerful e-learning tools. Teachers and students connect to the local micro-cloud via Wi-Fi and have access to a fully cloud-based learning environment. It provides an excellent foundation for developing means to deliver e-learning capabilities, including content, rich media, and lessons that do not require constant internet access. Serious ministries of education should consider working towards the implementation cloud-based platforms to improve e-learning and combine these initiatives with micro-clouds for education for their most isolated rural populations. With this solution, students and teachers across the region have access to cloud-based learning management systems (LMS), curriculum, content and resources, even in situations where the school has no connectivity or power supply.

In a micro-cloud enabled scenario, the school's micro-cloud platform (usually an extremely small device) hosts the learning infrastructure as well as the curriculum, content, and resources. Below is the proposed cloud-enabled internet layout, the requirements for the rural school are a contract with Critical Links and the purchase of electronic devices, computers, or mobile phones.

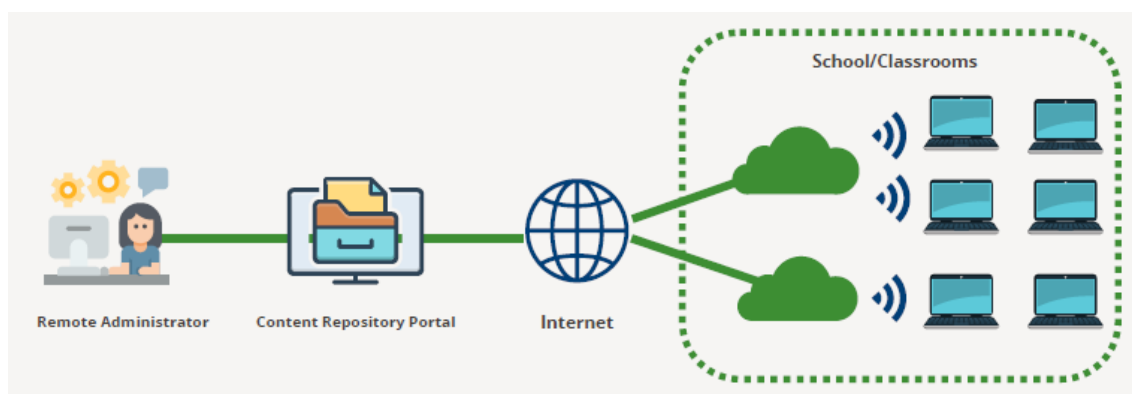


Fig. 2– Cloud enabled internet connection for education architecture (C3 micro-cloud infrastructure)

Students connect via local Wi-Fi (offered by the micro-cloud), which is an internet connection, hence the ability to use a cloud-based e-learning paradigm even when no internet connection or even electricity is available. Valuable incremental resources (such as YouTube videos,

simulations, interactive maps, educational games, educational apps, Wikipedia content, etc.) are housed locally in the micro-cloud. Most importantly, hundreds of micro-clouds are managed in a given region, in a given country, and from a single, centralized point. Department of Education administration can curate a unified curriculum and content to be populated into the micro-clouds as sporadic connectivity becomes available.

The micro cloud systems have so far been implemented and operated in several African countries, including Nigeria, Senegal, Madagascar, Mozambique, and Angola. However, apart from the Kenya case study, specific country studies are not yet ready for dissemination.

Kenya case study

We are learning from a Kenyan education sector program implementing cloud-enabled e-learning. In the pilot phase, the results show that the micro-cloud promotes collaboration between students and teachers in environments without an internet connection. In this study, students were able to discuss various topics and help each other study in a safe created by teachers (Critical-Links, 2020).

The micro-cloud improved the quality of education for 110 students at St. Aloysius Gonzaga Secondary School in Nairobi, Kenya. For these students, lessons are no longer based on outdated textbooks. Books are now just one of many other educational resources available to students, complemented by videos, podcasts, games, websites, etc. The micro-cloud has been immensely helpful in the proliferation of teaching services and technologies that enhance and enhance students' thinking and writing skills the ability to solve complex problems. In addition, the students found that the high bandwidth of the cloud-based Internet allowed for efficient use of the gadgets and they confirmed a better understanding of the mediated content. Although St. Aloysius Gonzaga Secondary School is not located in a rural setting, the ICT infrastructure program has been extended to other schools in both urban and rural areas.

More importantly, African governments must prioritize and ensure solar power or national grid connectivity for all schools, with a particular focus on rural schools, to enable ICT infrastructure to function. At the same time, education ministries need to develop or revise e-learning strategies to support learning and knowledge generation in Africa.

Conclusions

ICT-related social and economic opportunities are increasing in Africa. However, research has traced difficulties in extending ICT to rural populations to technological limitations and concerns about socio-technological prospects and lack of proximity to power grids. As a result, these issues

often directly impact the livelihoods of low-income, low-skilled people and their families. Therefore, cloud-based internet services for education provide solutions for most phases of ICT capacity building, which are crucial for the education sector. The paper presented insights into the development of innovative cloud-enabled internet solutions to bridge the existing gaps related to the digitally disconnected students, individuals, and society in rural areas with the mainstream African ICT community. This in turn can lead to a competitive advantage beyond the African education sector. Based on this, we further propose to close the digital divide between educated, developed cities and rural, underdeveloped areas with the following recommendations:

- I. The government should expand programs that provide schools with the necessary ICT infrastructure before embarking on full-scale implementation of e-learning. For example, in a rural setting, apart from schools, micro-entrepreneurs selling goods and using electronic devices gather important local social and economic activities, as well as being important users of the local ICT infrastructure. However, the technical reality of local ICT ecosystems in rural settings hardly provides satisfactory services for local users, educators and entrepreneurs. Therefore, the relevant ministries responsible for ICT and education need to take a collaborative approach to these issues.
- II. There are challenges related to the local technical infrastructure that provides cellular coverage and bandwidth and restricts users' access to Internet-based services. Most studies come to the conclusion that insufficient electricity supply is widespread, especially in rural areas. However, solar energy has emerged as a viable source of electricity for most people in rural areas and therefore governments should focus on investing in these renewable energy technologies.

We conclude that micro-clouds for education provide solutions relevant to most phases of ICT capacity building, which are most needed in rural Africa. In particular, the fact that it lays a foundation for an ICT platform in rural settings helps to bring the isolated rural population who do not have access to e-learning into the mainstream African educational community. Especially in a world where learning is increasingly taking place online. It is important to ensure that the education sector provides a stable and powerful internet connection in all schools.

Therefore, this paper seeks to provide a fresh perspective for decision makers and policy makers to take a systems approach to bridging the digital divide by engaging the rural and marginalized population in the education ladder across Africa.

References

- Anand, R. (2012). E-Learning and Its Impact on Rural Areas, Vol 5. *International Journal of Modern Education and Computer Science*, 46-52.
- Gama, L. C., Chipeta, G. T., & Chawinga, W. D. (2022). Electronic learning benefits and challenges in Malawi's high education: A Literature review. *Education and Information Technology Vol. 27*, 11201-11218.
- Madimabe, M. P., & Omadan, B. I. (2021). Investigating the Effects of E-Learning as a Method of Curriculum Dissemination for Rural TVET College students. *Research in social science and technology, Vol. 6 (3)*.
- Mulwa, A. S., & Kyalo, D. N. (2011). The Influence of ICT infrastructure on readiness to Adopt e-learning in Secondary Schools in Kitui District, Kenya. *Department of Extra-Mural, University of Nairobi, Kenya*.
- Ryan, P. S. (2012). *The ITU and the Internet's Titanic Moment*. Retrieved 11. 28, 2022