DISTANCE LEARNING PERSPECTIVES FOR MOZAMBIQUE: THE ROLE OF NRENS AND INTERNATIONAL COLLABORATION

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Facing the difficulties of developing countries in a global system of high-quality face-to-face education, e-learning technologies and initiatives became mandatory. At a higher education level, these initiatives, involving worldwide partnerships with developed countries, represent many times the convenient way to sustain international curricula and research projects, crucial to guide these countries to the next level from an education and research perspective. National Research and Education Networks (NRENs), providing either connectivity and operational support services, represent the current trend of collaboration and sharing of scientific knowledge among the various communities spread throughout the world.

This paper aims to discuss the NRENs panorama in Africa and analyze the challenges inherent to providing sustainable distance learning services for the NRENs academic and research community. In particular: the contextualization of distance learning initiatives and directives in the framework of Mozambique will be explored; the barriers and weaknesses for the improvement of the Mozambican higher education system will be identified; the role of MoRENet and international e-learning collaboration will be stressed; finally, proposals for the effective deployment of distance learning strategies to overcome the identified challenges will be presented.

Keywords: Distance Learning, NRENs, Higher Education, Science and Technology, Developing Countries, Africa and Mozambique.

1 INTRODUCTION

In developing countries, deploying National Research and Education Networks (NRENs) infrastructures is viewed as a determining step for fostering science and education. In most cases, these countries are still scientifically and technologically immature, largely due to the lack of qualified human resources, the economic dependence, and the lack of a consistent system for managing science, technology and higher education. NRENs represent crucial vehicles to stimulate regional and international scientific collaboration, by allowing the nationwide linking of universities and research centers, and access to scientific applications and data. NRENs also promote distance learning and other key services related to the activity of education and research.

In Africa, several NRENs initiatives have been promoted, having as critical success factors: (i) NREN deployment coverage; (ii) NREN sustainability policies; and (iii) the services provided to the enrolled community. The AfricaConnect project [1] is one of the examples of the international collaborative effort, supported by the European Commission (EC). AfricaConnect allowed to interconnect NRENs in sub-Saharan Africa to an international network of high capacity, fulfilling the goals of the UbuntuNet Alliance [2] (the regional research and education network in East and Southern Africa).

The aim is that African students and researchers benefit from high-speed, reliable broadband connectivity and services, such as eduroam, access to innovative e-learning tools and advanced research resources, and collaborative learning and research with peers around the world. However, the implementation and application of e-learning are still taking the first steps in African countries. Despite the shortage of resources, infrastructures and access to information, many African countries have shown an interest in implementing e-learning to foster scientific and social development. This led to the definition of national and African Union projects and strategies in the e-learning context.

Despite the initiatives taken so far, and especially the projects implemented in Mozambique, they lack a more comprehensive view of the implementation of e-learning. The problems identified reveal the need to create a common platform that benefits the entire academic and scientific community, with Mozambique Research and Education Network (MoRENet) as primarily responsible for promoting the production, distribution and consumption of educational, cultural or entertainment content in a national audiovisual format. The use of e-learning tools and resources in digital format aims to improve the

access to information especially for users in remote locations, allowing the academic and scientific community to share educational and scientific content at any time and in any place.

In this context, having introduced the panorama of NRENs in Africa (see Section 2), this paper is devoted to discussing the role of MoRENet in providing sustainable services for the Mozambican academic and research community, and the challenges and perspectives for the effective concretization of distance learning in this country. These aspects are debated in Section 3 and 4, respectively. Final remarks, clarifying existing barriers and future concerns to address for fostering the sustainable evolution of developing countries' science and education ecosystem are presented in Section 5.

2 NRENS PANORAMA IN AFRICA

NRENs in Africa began to emerge about 15 years ago, especially in Eastern and Southern Africa. The high cost of broadband access and the lack of national and international infrastructures based on optical fiber are factors that have limited their development.

Similarly to other continents, such as TERENA in Europe, the UbuntuNet Alliance is the association of African NRENs created in 2005 by 5 members established in Eastern and Southern Africa, MAREN (Malawi), MoRENet (Mozambique), KENET (Kenya), RwEdNet (Rwanda) and TENET (South Africa). To interconnect African NRENs with each other and with NRENs worldwide are the main goals of the alliance [2].

Currently, the Ubuntunet Alliance has 16 members: Burundi (BERNET), Democratic Republic of Congo (Eb@le), Ethiopia (EthERNet), Madagascar (i RENALA), Kenya (Kenet), Malawi (MAREN), Mozambique (MoRENet), Uganda (RENU), Rwanda (RwEdNet), Somalia (SomaliREN), Sudan (SudREN), South Africa (TENET), Tanzania (TERNET), Namibia (Xnet), Zambia (ZAMREN) and Zimbabwe (ZARNet). The interconnection of the association members through GÉANT will support research and education in Africa, through the integration into the global research community. Researchers around the world use these advanced networks to participate and contribute to the development of international projects [1][3][4].

Regarding the West and Central African Research and Education Network (WACREN), created in 2012, the following countries are included: Benin, Burkina Faso, Cameroon, Côte d'Ivoire, Gabon, Ghana, Mali, Niger, Nigeria, Senegal and Togo. In order to reduce the digital divide and integrate the countries of this region, snRER, the Senegal NREN is responsible for the creation of the NOC that will allow the connection to GÉANT, via Paris, through Réseau National de Télécommunications pour la Technologie, l'Enseignement et la Recherche (RENATER), the French NREN.

The Arab States Research and Education Network (ASREN), is the association of the Arab region created in 2011, and Algeria, Djibouti, Egypt, Libya, Mauritania, Morocco, Somalia, Sudan and Tunisia are the African members. As the main partner of the current EUMEDCONNECT3 (now in its third phase), ASREN also operates for the League of Arab States in North Africa. ASREN intends to expand its geographical area through the creation of the pan-Arab P&E network. In July 2015, the partner countries of North Africa (Algeria, Egypt, Morocco and Tunisia) became partners of the AfricaConnect2 project. The countries still served by EUMEDCONNECT3 are Jordan, Lebanon and Palestine.

As mentioned in Section I, to promote African regional networks, the AfricaConnect project interconnects high education and research institutions of UbuntuNet Alliance countries. The first phase, between 2011 and 2015, was supported by the European Commission on 80% of the total budget of e14.75m. This project resulted in the creation of 10 PoPs: 2 working to deliver traffic in Europe via London and Amsterdam routers, providing a 10Gbps link for IP traffic and a 10Gbps link for dedicated point-to-point circuits; 8 PoPs within the regional backbone, which covers 7 countries in the Alliance.

AfricaConnect2 represents the expansion of this project involving other African regional NRENs, in addition to the UbuntuNet Alliance, namely the countries of WACREN and ASREN. The aim was to connect North African NRENs, between 2016 and 2018 to GÉANT and, through it, to connect other NRENs of the world at reduced bandwidth costs. This enlarged connectivity provided opportunities to introduce advanced services, such as e-Education, and benefits international scientific collaboration in different research areas, including the areas related to climate change, food security, malaria and other infectious diseases affecting these countries [5][6][7].

AfricaConnect3 represents the third phase of the AfricaConnect project, building on the success of two predecessor projects in supporting the creation, development and use of advanced, reliable Internet connectivity for the teaching, learning and research communities of Africa. AfricaConnect3 is co-funded by the EU and delivered locally by regional organizations - UbuntuNet Alliance, WACREN and ASREN, together with GÉANT [1][7].

3 MORENET PROVIDING SUSTAINABLE E-LEARNING SERVICES

In the context of Mozambique, MoRENet implementation began in 2008, due to the Ministry of Science and Technology (MST) need for the acquisition of external financing, having been carried out in different stages. Despite the difficulties and challenges faced by MoRENet, its effective implementation resort to appropriate measures and political decisions, that allowed it to become a reality. The proper allocation of financial resources and the creation of an environment that would enable the participation of key stakeholders in an initiative such as MoRENet contributed to its success.

Currently, MoRENet is operational and interconnects 160 research and education institutions around the country. The MoRENet Conference is an event held annually that aims to serve as a platform for debate between the different participants, regarding the value and services of MoRENet for the academic and scientific communities, the dissemination and use of services by members of beneficiary institutions, and the innovation and creativity to address the challenges of using communication technologies.

Despite this, there remains the challenge of making an analysis of MoRENet service quality levels, ensuring that institutions already connected may discard existing contracts with commercial operators, to ensure the reduction of investment costs previously held by them. Other main challenges regarding MoRENet [8] include:

- the need to institutionalize MoRENet and define an economic sustainability model. This will allow increasing autonomy, for instance, to hire more skilled human resources for its deployment;
- the implementation of new services on the network to promote the information exchange between national and international scientific communities. As mentioned, in the future, to sustain science growth, it will be necessary for MoRENet to provide other types of services beyond connectivity and Internet access;
- the need for increasing the Internet access bandwidth and the national/international connectivity. The increase in the number of beneficiary institutions and in the number of MoRENet users will imply to increase networks capacity in terms of national and international connections;
- regarding service quality, it is necessary to create technical teams in the institutions (e.g., Communications Services in higher education institutions) that work directly with MoRENet in solving network problems, while promoting the evolution and the creation of new services to the enrolled community.

Regarding e-learning in the scope of MoRENet, it is clear that this service should be included in the provided services to member institutions. As an example, considering the case study of the Portuguese NREN initiative Educast@fccn [9], the use of Podcast platforms should improve the quality of distance education, promoting the publication of audio and video contents and their download, as a way to motivate the academic community to take advantage of this facility. Podcast can be used to record classes, seminars, material lectures in the courses, academic and scientific events that are published on the web for later use of the community of scientific and research contents. To successfully implement a podcast service in an NREN, the quality/capacity of the Internet services, especially wireless connectivity, is an important factor to take into account. Other factor includes the support of technical staff and audio-visual equipment for the recording of multimedia educational content on the platform.

4 E-LEARNING CHALLENGES AND PERSPECTIVES

To mitigate existing gaps in accessing education, of the approximately 50 higher education institutions in Mozambique, some have decided to use advanced e-learning as an alternative to face-to-face teaching.

As an example, the cooperation between the Catholic University of Mozambique (UCM) and the Catholic University of Portugal (UCP) allowed the creation of a doctoral program in educational sciences in Mozambique. In this sense, the doctoral program arises from the need to train teachers in one of the UCM campuses located in the province of Nampula in the northern region of Mozambique. To complete the course, it was necessary to adopt a training model that would ensure that the curriculum developed in Portugal was also fully complied with this new context [10]. Being difficult to lecture in person, an e-learning model was defined with a plan centered on the Mozambican reality

The specific measures of this plan, reflect the existing constraints and the actions to overcome them. In particular:

- taking into account the lack of qualified human resources and teaching materials made available on the e-learning platform to support the learning process, the doctoral program was structured and developed by UCP;
- considering the doctoral program location and cost reduction, the lack of resources, such as the difficulty in accessing Internet tools and the reduced students' digital proficiency, the adoption of blended learning strategies was considered, i.e., the hybrid learning modality. The adopted model seeks to combine pedagogical practices in face-to-face and distance learning, with the aim of improving student performance in both types of teaching. In this sense, the course was built combining online materials and in-person classes to optimize knowledge retention.

In general, several constraints and adjustments for e-learning in developing countries need to be considered, which may become a challenge, namely:

- it is necessary to carry out adaptations to diversify the teaching and learning modalities. The interaction between teacher and student in distance learning is subject to a set of constraints that are different from those that occur in person. It is also necessary to ensure that everyone has the same tools to support learning;
- Internet connectivity and access problems are identified as one of the most significant obstacles to an effective response to the establishment of e-learning. While a weak communications infrastructure jeopardizes distance learning, providing universal access to reliable and affordable connectivity is not simple, and the move to e-learning will increase inequality and disadvantage the poorest students;
- high-quality Internet services are needed in distance learning. Connections must not be interrupted frequently and increased bandwidth for sharing content, especially in synchronous collective sessions using web conferencing software, is needed. The lack of quality of service on Internet access leads to the abandonment of the e-learning model. In addition to the problem of connectivity, most students are used to the close presence of teachers and hardly do without personal contact, which is essential to promote socialization that facilitates the process of learning building;
- the financial resources for technology to reach most students are a problem. There is a restricted infrastructure, the integration of technological platforms for education in African countries, and in particular in Mozambique, faces enormous challenges due to cultural, political and economic factors. This stresses the need to consider e-learning strategies and, in particular, the use of audio and video-based applications to support the formation of a large number of students with economic difficulties and little access to ICT. As a basic requirement for the development of any learning strategy outside the classroom, it is necessary to have electricity, at an affordable price. Too many zones of Mozambique, particularly rural areas, do not have access to electricity. Most of the poorest and most marginalized students are found in rural areas, a problem that exists in most countries in Africa. Enabling everyone to have affordable and sustainable electricity will be the key to developing balanced economies in Africa;
- personal devices and technology are required. Laptops are expensive compared to tablets and smartphones, which most people can buy for personal use. The diversity of mobile digital devices on the market and the use that citizens already make of them highlight the spectrum of possibilities they offer, both on a personal, academic, social and occupational level, which can be considered means of support for distance learning. Currently, access to knowledge and information is no longer restricted to specific physical spaces: schools, universities, libraries, etc. In this way, learning becomes increasingly mobile. In fact, the emergence of the paradigm of ubiquitous education derives from the benefit obtained from the potential and

possibilities that the Internet offers, through mobile devices, at any time and in almost any part of the world;

- the lack of teacher training and professional development on the inclusion of technology in teaching means that teachers are poorly prepared to give an effective distance learning response. So, it is important to invest in the reinforcement of skills, professional development and teacher training in terms of e-learning. This involves actions of mutual cooperation at the national and international level, sharing resources, as well as experiences between teachers.

The problems identified reveal the need to create a video management service for the simple registration and distribution of teaching content (classes). As in the case of educast@fccn service [9], provided by the Portuguese NREN, this platform should allow: recording of classes, uploading to the central server, editing and subsequent publication, integration in e-learning systems, portals and websites. The central system guarantees the necessary post-processing, so that contents are available to students through the Internet and mobile devices, in a streaming delivery format. In this case, MoRENet should be the main responsible for promoting the production, distribution and consumption of educational, cultural or entertainment content in a national audiovisual format. This solution also allows students to view the videos of classes afterward at their own pace. Podcast as a service supported by MoRENet can be viewed as a comprehensive alternative/complement to e-learning in Mozambique, enrolling and supporting multiple higher education institutions in a large-scale vision and deployment of e-learning.

Despite the enormous potential of this e-learning strategy, there are critical success factors that help managers define the main guidelines for the implementation of a podcast platform in Mozambique that should be considered, namely:

- definition of policies, rules and procedures at the national level that should lead to the successful implementation of a podcast platform;
- selection of the appropriate supporting technologies, that is, use the technology in favor of education, taking into account the network capacity, the existing resources and the location of the service;
- implementation of a solution based on the Mozambican reality, i.e., including technical assistance, considering the dissemination of the podcast service and the training of teachers and students are important factors for success;
- collaboration and international cooperation can be considered as a mechanism for joint development between countries in response to common challenges in terms of technical and technological management. It is important to look for experiences and existing success stories, enabling the transfer of knowledge and techniques from other countries and from international organizations;
- identification and acquisition of technological solutions and registration equipment for deployment, which also involves the constitution of a technical team that responds to the needs of the participating institutions.

5 CONCLUSIONS

The effective implementation of e-learning is still in its infancy in Mozambique, and in African countries in general. Only those who have access to the Internet can access this type of learning model. For the most part, neither students nor teachers have any learning and teaching experience outside the classroom. Thus, lack of access to technology, inadequate learning environment at home, and lack of access to teaching materials represent real issues. For teachers, the main obstacle was the lack of adequate training to create and manage distance learning programs. This was compounded by the lack of infrastructure (connectivity, electricity, computing devices), and the lack of adequate learning materials. The conclusions are evident: the poorer the students and the more dispersed they are geographically, the greater the risk of falling behind in education. The government must invest in education systems more suited to this century. E-learning, by definition, is a convenient response, requiring not only electricity but also access to a data connection and devices through which e-learning materials can be accessed. These are in short supply in many parts of Africa, including Mozambique, emphasizing the digital divide in education between those who have access to technologies and those who do not. National curricula must also be adapted to enable more effective distance learning.

NRENs projects, such as AfricaConnect3, are crucial in the e-learning context, as they will connect Africa to unlimited possibilities by improving and enabling access for researchers, students and

institutions to digital infrastructures and technologies. African students and researchers will benefit from high-speed, reliable broadband connectivity and services such as eduroam, access to innovative e-learning tools and advanced research resources, and collaborative learning/research with peers around the world. African NRENs will benefit from capacity building to upscale science output, fostering the participation in global research and education events for increased exposure, knowledge transfer and exchange.

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