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The Digital Transformation of Higher Education in Sub-Saharan Africa

Research Report

Education 2030

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Foreword

The outbreak of the Covid-19 pandemic has had far ranging impact on more than 190 countries in the world, and has disrupted educational systems, affecting 1.6 billion students. It is reported that 77% of Higher Education Institutions' (HEIs) campuses closed because of COVID-19 in Africa, the highest percentage in the world.

Most of the institutions have been confronted with a sudden and unprepared transition to online teaching to ensure continued teaching and learning. The migration from face-to-face to online teaching did not come without challenges, the main ones being access to technical infrastructure, competences and pedagogies for distance learning and the requirements of specific fields of study. However, the forced move to online teaching and learning presents great opportunities to explore blended or hybrid learning and to mix synchronous learning with asynchronous learning.

Having understood the common challenges that most African countries face in their bid to improve access and quality of Higher Education, UNESCO-ICHEI has devoted itself to using new technology, especially ICT to promote higher education innovation in developing countries by leveraging the robust development of ICT industries in Shenzhen, China. Since its establishment in 2016, UNESCO-ICHEI has established several higher education flagship programmes in African countries, to help HEIs and their teachers to improve capacities on online and blended teaching. These programmes, which include Smart Classroom Project, International Institute of Online Education (IIOE), cover a wide range of topics and focus on resolving key higher education challenges faced by most African countries, i.e., lack of ICT infrastructure, capacity building of teachers, quality assurance, etc.

As an innovative centre, its innovation reflects not only in its institutional name, but also in the whole process of its project design and implementation. One innovative feature of UNESCO-ICHEI's project is the sustainable resources and support it gained from its global enterprises network in terms of technology, resources, and funds. UNESCO-ICHEI's higher education network is composed of its HEIs partners in Africa and Asia Pacific, technology enterprises and higher education research institutions guarantees that its project is not only sustainable, but also up to date.

Besides, UNESCO-ICHEI's project is supported by educational research. This report demonstrates how UNESCO-ICHEI uses its research outcome to guide its project design, implementation, and evaluation in African countries.

Being UNESCO's category II institute, UNESCO-ICHEI works closely with UNESCO Headquarters and UNESCO's regional offices in Africa to make sure that its projects are properly supported by UNESCO's expertise and network. On behalf of UNESCO, I would like to congratulate UNESCO-ICHEI for its achievements in African higher education cooperation and wish that more African HEIs could join UNESCO-ICHEI's network and make changes within.

Mr. Yue Du

Director, Priority Africa Coordination, UNESCO

Disclaimer

The report strives to provide information and data as accurately as possible. However, the accuracy and completeness of the report cannot be guaranteed. All opinions included in the report are for reference. UNESCO-ICHEI does not assume responsilibities for any action or related risks ensuing from this report.

Table of Contents

List of tables, figures, and images

Tables

Figures

Images

01 Executive Summary

Technological advancements can bring about benefits for human development. This is especially the case in higher education, as it is the backbone of human capital development for social progress. The COVID-19 pandemic and the ensuing unprecedented changes has demonstrated the importance of harnessing technologies, particularly digital technologies, for good and for all. Campus closures pushed teachers, students and administrators to shift activities to the virtual world. The HE sector has been forced to rethink how to deliver its services, what to deliver, and with whom it should share its resources. Against this backdrop, the Digital transformation of Higher Education (HE) has never been more relevant and urgent.

Digital transformation of HE is the full integration of new technologies and digital tools into all core functions of HE, namely, teaching and learning, management and administration, research and innovation.

The report aims to evaluate the current state of digital transformation of HE in sub-Saharan Africa, identify gaps and best practices, and discuss how digital transformation can improve HE in sub-Saharan Africa.

To improve HE access, equity and quality, ICT and digital tools are major drivers. However, to fully leverage the power of ICT and digital tools for HE development in sub-Saharan Africa, major challenges exist - uneven national and institutional regulatory frameworks for digital transformation and unsatisfactory policy implementation; insufficiency of accessible, quality digital infrastructures; lack of massive, systematic ICT capacity building, and shortage of open-source, quality, locally produced online education resources.

Digital transformation provides various paths to address these challenges. The report selected national and international best practices addressing each of the above challenges.

In line with this, the report identifies key ingredients for a successful Digital Transformation of HE, summarised as recommendations for policy makers:

Regulatory framework

Create an enabling regulatory framework for digital transformation of HE, notably strong leadership support with a clear vision, supportive financial framework, quality assurance (QA), accreditation and recognition systems for online and blended teaching and learning (OBTL)

Infrastructure and devices

Increase investments in quality digital infrastructure and devices, and access to affordable internet

Technical capacity

Conduct massive, systematic, and sustainable teacher ICT capacity building

Educational resources

Develop quality, open-source online education resources adapted to local realities

The report concludes that digital transformation of HE is a means and not an end. Digital transformation can only be successful if it empowers socio-economic development and benefits all, leaving no one behind.

02

Digital transformation of Higher Education in sub-Saharan Africa: An Overview

I. Higher Education in sub-Saharan Africa: rapid growth, but access and quality remain to be improved

Higher education in sub-Saharan African countries has achieved significant progress since the beginning of the 21st century.

The World Bank's *Sharing higher education's promise beyond the few in sub-Saharan Africa* report highlighted the rising demand and supply of tertiary education, along with disparities in access and economic payoffs across income groups.[1] Sub-Saharan Africa saw the fastest growth in its tertiary gross enrolment ratio (GER) during 1970-2013 at 4.3 percent annually, faster than the global average of 2.8 percent. Even with this growth, sub-Saharan Africa has the lowest tertiary gross enrolment ratio globally.

However, rapid growth has also brought about challenges.

First, following the population boom, there has been a substantial increase in the number of youths at the age of entering university. The total population of Africa reached nearly 1.3 billion in 2018 and is estimated to reach 1.7 billion in 2030 and 3 billion in 2063.[2] Africa has the youngest population worldwide: the population under 20 years increased by 25.6% during 2010-2020. Thus, it becomes the continent with the fastest population growth in history at a rate much higher than that of other regions.[3] Against such background, the total number of highereducation enrolment in Africa surged from 2.5 million in 2000 to 7.4 million in 2015.[4] However,

1. Darvas, Peter, Gao, Shang, Shen, Yijun, Bawany, Bilal, 2017, Sharing higher education's promise beyond the few in sub-Saharan Africa
2. African Development Bank, 2020, African Economic Outlook 2020: Developing Africa's Workforce for the Future.
3. Ibid
4. World Bank, World Bank Open Data, "Tertiary education enrolment"

the increase of enrolment has exerted pressure on local higher education institutions (HEIs) in various aspects, including infrastructure, teachers and quality of education.

Second, most Africans still lack access to higher education, though the number of university students has been increasing. Africa's overall higher education enrolment ratio, graduation rate, gender equality, and other key indicators still fall behind those of other regions in the world. For instance, the average higher education enrolment ratio of the Sub-Saharan Africa (SSA) region in 2018 was 9.39%, while the world average was 38.04%.[5] The increasing demand and limited supply of tertiary education in the SSA region has led to tertiary education being available only to a subset of the youth population.

Third, the quality of higher education is a big concern. The mismatches between labour market demands and higher education remains a major issue. In many African countries, the number of students majoring in humanities and social sciences is disproportionately high compared to that of science, technology, engineering and mathematics (STEM). The short supply of STEM professionals inevitably leads to insufficient support for national economic development and transformation. The educational programmemes offered struggle to meet labour market needs. As a result, many students experience difficulties in seeking employment after graduation.

Fourth, infrastructure such as electricity and internet connectivity are underdeveloped in many SSA countries. Africa's internet penetration rate is rapidly growing, however, the average number of internet users only took up 27% of the total population in 2017, far behind the world average of 49.72%.[6] While other regions are adopting information and communication technologies (ICT) in education, healthcare and public administration, SSA countries are at a comparatively preliminary stage of applying new technologies. International connectivity, Internet Exchange Points (IXPS), Backbone, campus networks remain a challenge in many countries.

With all aforementioned factors combined, a 'trust crisis' is bubbling among the young people towards the higher education systems in African countries: migration to other countries becomes a preferred choice due to the disappointment caused by limited access to quality HE and uncertainty in employment prospects. Therefore, digital transformation as a way of improving HE access, quality and equity has become the common and urgent need of HEIs in Africa.

II. Digital transformation of Higher Education in sub-Saharan Africa: An Imperative Task

1. What is the digital transformation of higher education? >>>>>>>>

Despite the various challenges facing African HE systems, some of them can be considerably eased using ICT and digital tools. The use of ICT and digital tools could enhance access to quality education for all; improve education equity with special attention to marginalised groups, particularly female and rural

5. Ibid.
6. International Telecommunications Union, ICT-Eye 2020

learners; empower learners by raising digital awareness and equipping them with ICT knowledge, skills and qualifications. These will enable learners to fully participate in the knowledge society.

"Digital transformation" bears many definitions. For example, Gobble defines it as "the profound transformation of business, activities and organisations, processes, competencies and models, for the maximum transformation of the changes and opportunities of a technology mix and its accelerated impact on society, in a strategic and prioritized way".[7]

The digital transformation of higher education can therefore be defined as the full integration of new technologies and digital tools into all core functions of higher education, namely, teaching and learning, administration and management, research and innovation.

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The digital transformation of African higher education is a journey for HEIs to fully embark on digital ecosystems which satisfy their objectives and address the challenges of access, equity, quality and relevance. This means fully leveraging technologies to automate teaching and learning processes, courses, assessment and administration as much as possible, in order to address challenges facing HEIs.

In line with the definition, this report specifically focuses on the utilisation of ICT to empower higher education, including enabling regulatory framework, encompassing dedicated quality assurance framework for online and blended teaching and learning, appropriate and affordable digital infrastructure, professional development for qualified teachers in technology-enabled teaching and learning, administration and management, research and innovation, as well as accessible and quality online education resources.

7. Gobble, M.M. Digital strategy and digital transformation. Res. Manag. 2018, 61, 66–71.

2. Digital transformation of higher education in sub-Saharan Africa - before COVID-19

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Digital transformation is one of the most important trends in global HE development. The adoption of ICT in HE has generated tangible benefits, such as better sharing and access of quality education resources, increased educational equity, and improved outcomes and effectiveness. The digital transformation of higher education is also crucial for adapting professionals to the global trend of digitalisation and serving countries' economic development.

Many African countries have adopted ICT as an important means to realise the massification of HE and to boost its quality and outcomes. In the face of the pressure brought about by the rapidly increasing number of students, many African countries need to build new universities to accommodate more students. However, constructing facilities and curriculum development require long-term efforts and substantial financial investments. These could place heavy financial burdens on governments. Thus, the adoption of ICT to further expand access to HE come as the most appropriate solution.

Meanwhile, due to imbalanced educational programme set-up and the lack or underdevelopment of STEM-related subjects, many universities inAfrican countries are not well-equipped to train STEM professionals who are in high demand by employers. Although many universities have realised the issue, some universities do not have the capacity or readiness required to develop complete STEM-related educational programmes. Moreover, some STEM subjects, in particular ICT-related ones, are experiencing rapid, constant knowledge renewal.

Online education, as a potential low-cost solution to increase higher education access, has been gaining wider attention. The COVID-19 pandemic and the ensuing interruption of face-to-face HE activities further illustrate the role of online education in ensuring the continuity, accessibility and equity of HE.

3. Digital transformation of higher education in sub-Saharan Africa - after COVID-19

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The global outbreak of the COVID-19 pandemic in 2020 further exposed the problems of HE in sub-Saharan Africa. HEIs in developed countries have a good foundation in infrastructure, teaching mode and online learning, and are better able to cope with the impact of the pandemic. They are also less dependent on government support. However, the capacity of HEIs to cope with this crisis in developing countries, especially in African countries, is low. African HEIs are forced to take measures to deal with the impact of the pandemic on HE in a short period of time, and to continue teaching in various non-traditional forms when campuses were closed.

The impact of COVID-19 on Higher Education Around the World - IAU Global Survey Report by the International Association of Universities (IAU) found that, two thirds of African HEIs were not ready for online teaching and learning. When campuses were closed due to COVID-19-related measures, teaching had to be suspended. Only 29%of HEIs in Africa quickly transitioned to online teaching and learning, while 85% of HEIs in Europe were able to do so.[8] Fortunately, many HEIs in Africa are developing plans to continue teaching and learning through digital means or self-teaching.

However, there is a substantial gap in the resilience of African countries to withstand the impact of the pandemic. Some countries attached importance to online teaching even before the outbreak of the pandemic and have established a certain basis in the construction of digital infrastructure and pedagogical resources. After the outbreak of the pandemic, the governments and universities of these countries could accelerate the digital transformation of higher education on existing basis.

8. Giorgio Marinoni, Hilligje van't Land, Trine Jensen, 2020, The impact of COVID-19 on Higher Education around the World: IAU Global Survey Report

III. Features of Digital transformation of Higher Education in sub-Saharan Africa

1. Many countries have formulated national ICT strategies but lack institutional plans for ICT application in higher education

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On the continental level, Agenda 2063 of the African Union and the Continental Education Strategy for Africa 2016 - 2025 (CESA) outline strategies to leverage ICT to improve the accessibility, quality and administration of the educational systems in Africa. CESA also stipulates that African Union member countries shall formulate policies to facilitate the adoption of ICT in education; offer trainings for teachers, students and administrators; develop online courses based on African realities; and provide necessary infrastructure.[9]

Guided by continental strategies, most African countries have developed their own national ICT strategies. Some national strategies also set ambitious goals in promoting education by utilising ICT. However, not allcountries have well-defined guidelines or action plans to guide ICT application in education which is properly implemented. Although universities are well aware of the importance of ICT in promoting education, they still lack practical implementation plans.

2. The overall ICT environment in Africa has significantly improved, but internet connection cost is still very high, with noticeable discrepancies between regions and countries

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The delivery of OBTL relies heavily on electricity supply and the support of internet infrastructure. Recent years have witnessed significant improvement in internet connectivity in Africa. The statistics of the International Telecommunications Union (ITU) show that the penetration rate of mobile communication services in Africa reached 76.57% in 2018.[10] Smartphones have taken up 39% of all mobile service subscriptions in SSA, and the number is expected to reach 66% by 2025.[11] Although there has been enormous progress in internet connectivity in Africa, significant gaps among countries persist. For example, only 10.7% of the population in Niger has access to the internet.[12] On the contrary, almost two thirds of South Africans have access to the Internet.[13]Due to the varying degrees of internet access in different African countries, ICT solutions for education should also be tailored to country-specific conditions.

9. African Union, 2015, Continental Education Strategy for Africa 2016-2025
10. ITU, 2020, ICT-Eye
11. GSMA Mobile Economy, 2020
12. ITU, 2017, ICT-Eye
13. Independent Communications Authority of South Africa, 2020, The current state of the ICT sector in South Africa

The following table shows the price difference between 3 sub-Saharan countries. Prices for land-locked countries are much more expensive.

Price of Broadband Connection at Universities in Kenya, Uganda and Zambia

Country	Price of 1Mbps circuit/month 2011	Price of 1Mbps circuit/month 2015	Price of 1Mbps circuit/month 2016
Kenya	$600	$160	$120
Uganda	$630	$210	$180
Zambia	$1200	$380	$300

Table - 1: TENET's TVET Connectivity Project (ubuntunet.net): NRENs in Kenya, Uganda and Zambia [14]

3.HEIs are gradually accepting online education, but its quality remains a major concern, despite recent efforts

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According to the UNESCO Institute for Statistics (UIS), the number of HEIs in the SSA region has increased significantly in the past decades, providing local citizens with better access to higher education. Nevertheless, the rapid increase in the number of students has led to a sharp decline in quality. Many HEIs' teachers and students have expressed their concerns about the quality of OBTL programmes. The lack of quality assurance (QA) mechanisms for online programmes and diplomas have also hindered the integration of ICT into HE.

Currently, there are some QA initiatives in Africa, but their implementation is far from satisfactory, while QA for OBTL is often overlooked. For example, the African Union has already set QA as one of its priorities and provided support for the African Quality Assurance Network (AQAN), a QA programme initiated in 2010 by the Association of African Universities (AAU) in collaboration with the African Union commission, to establish a quality rating mechanism. However, this continental initiative does not cover online and distance education. It is critical that the revised version of ARM considered Distance learning.

14. Ubuntunet, https://ubuntunet.net/services/connectivity/

The African Council for Distance Education (ACDE) is also making efforts to facilitate the QA of OBTL, in order to tap the potential of online and distance education and training in Africa. Despite its limited resource, ACDE has started its work by developing key QA instruments.

At its 30th meeting, the ACDE Executive Board approved the ACDE Quality Assurance Institutional Certification in line with its vision and mission of assuring the quality of Online and Distance Learning (ODL) processes and practices in African ODL institutions in conformity with international best practices through the ACDE QA Toolkit.[15]

Consequently, the ACDE-Quality Assurance and Accreditation Agency (ACDE-QAAA) has been directed to start the full implementation according to the decision made. The certification will have a 5-year life span. The process of the certification includes:

Institutions that have taken the first step are advised to carry-out its self-appraisal process and invite ACDE-QAAA for external peer review within the next six months. Other institutions are encouraged to start the certification process soonest by inviting ACDE-QAAA for a 3-day train-the-trainer workshop in their respective universities/institutions.

In addition, a QA manual was developed to help remove the burden of proof that is hinged on the credibility and comparability of ODL programmes withcampus-based/conventional delivery mode. With the QA Toolkit and its policy framework and manual ACDE has taken important steps that will help ODL practices in Africa within the global perspectives.

15. African Council for Distance Education, "Quality Assurance", acde-afri.org/qa
16. Ibid.

The most critical part to operationalise the framework and the manual is at the institutional level because it is the responsibility of HEIs to develop QA policies that are suitable for their own environment and practices. This is the most challenging part, and more work needs to be done in this respect.

A project initiated by the Commonwealth of Learning (COL) is another example. The project aims to promote the sustainable development of education through OBTL as well as relevant technologies. With the support of COL, the University of Edinburgh and the University of Mauritius developed the Quality Assurance Rubric for Blended Learning.[17] Accordingly, HEIs in Eswatini, Lesotho, Zambia, Botswana, Namibia and other countries in Southern Africa have conducted self-assessment in various ways following rigorous guidelines and standards. Such valuable experience and tangible, positive results can serve as an example for online education QA agencies.

To sum up, institutional and national QA systems for OBTL are of utmost importance to the delivery and accessibility of OBTL. Many challenges persist. There is neither a unified standard nor sufficient professional knowledge to regulate QA, which hampers the full potential of OBTL in Africa.

4.The private sector actively explores and pioneers online learning

Investment in the African education sector has been growing rapidly in the past few years. Major countries in Africa (e.g., Kenya, Nigeria and South Africa) welcome foreign investments in the local education sector. EdTech start-ups and enterprises are booming in Africa, attempting to decrease education inequality through ICT against the backdrop of inadequate education infrastructure and teachers. However, most of the enterprises are focused on primary education, while relatively few enterprises meet the needs of HE. According to a ranking published on the website IT News Africa

17. Dr Kirk Perris, Professor Romeela Mohee, Quality Assurance Rubric for Blended Learning, Commonwealth of Learning, 2020

in 2020, most of the top 10 EdTech companies are dedicated to primary education.[18] The majority of the EdTech companies also target their services towards specific groups and have not yet achieved scale or demonstratable effects. Regarding business models, these EdTech companies' priorities are to connect students and teachers and create virtual spaces for interactions. For example, Brainshare, a company based in Uganda, has created an online space for teachers, students and parents to communicate with each other, which enables teachers to upload assignments, create course notes, organise student group discussions and perform other tasks. Another company based in South Africa, Obami, also offers similar features. In terms of content, Africa needs companies that can provide quality online HE courses and educational content that meet local needs.

The COVID-19 pandemic has forced many African HEIs to close their campuses, but on the other hand accelerated the pace of university-business cooperation and business engagement in higher education reforms. Telecommunication networks also provided free-of-charge or discounted network service to HEIs during the school closure. For instance, the Kenya Education Network Trust (KENET) worked with local mobile network operators to provide eLearning discounted bundles for HEIs in response to education disruption caused by the pandemic.[19]

> **5.Online education platforms are emerging, but quality higher education e-learning courses are direly needed**
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In recent years, e-learning platforms have been widely used across the globe, including in Africa. In Kenya, Eneza Education, an e-learning platform developed through mobile technology in 2011. Students can follow classes, finish their assignments through text messages with their mobile phones, and pose questions to teachers through the platform. The number of Eneza users reached 5 million by early 2019. Moodle, another e-learning platform, has also

18. IT News Africa, February 6, 2019, "Top 10 EdTech startups transforming learning in Africa", https://www.itnewsafrica.com/2019/02/top-10-edtech-startups-transforming-learning-in-africa/
19. Kenya Education Network, KENET Support for Research and Education during COVID-19, https://www.kenet.or.ke/covid-19-support

been used to pool teaching resources and enable faculty members to send emails and announcements to student groups. It also offers online tutorial programmes to high school students who are interested in STEM-related subjects in collaboration with Safaricom.

Vodacom Business and Microsoft jointly launched the Connected Digital Education Platform, an online digital education platform, in South Africa in 2020. The platform enables distance learning with affordable connectivity, ultimately turning the learning environment into a single, simple solution for the learners and giving them access to the tools, apps and resources they need to learn. The solution also provides access to cost-effective data and educational apps and resources through Vodacom Business's Edu Data Bundle and Microsoft Office365 Education, a cloud-based service that offers Microsoft productivity apps such as Teams, OneNote, Outlook, Word, PowerPoint and Excel.

Concerning online content, the e-learning platforms in Africa mainly use or purchase courses from internationally renowned platforms such as Coursera and edX. Local e-learning courses are underdeveloped. In South Africa, the enrolment of South African students to e-learning degree programmes offered by UK-based platforms increased by 135% between 2011 and 2015/16. South African universities, including the University of Cape Town, Stellenbosch University and Witwatersrand University, started to provide a small number of self-developed online courses with African perspectives. The virtual universities in Côte d'Ivoire and Senegal have also created their own MOOCs. Despite all the efforts, locally developed e-learning courses in Africa are not sufficiently focused on STEM, especially ICT-related subjects.

6.The development of online education puts forward new requirements for university teachers' abilities. Continuous, systematic support for teacher development is in high demand

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ICT offer enormous possibilities for educational transformation, encouraging teachers to update their pedagogical approaches and models. In turn, it requires teachers to equip themselves with new teaching methods, and learn to implement them in their teaching, research and administrative work. The huge demand for capacity building, however, is underserved due to the lack of sufficient training and supportive measures. 50% of African higher education professionals believe that insufficient capacity is a major obstacle to achieving digital transformation.[20] Professional training is no longer an individual pursuit, it also requires the support ofgovernment and universities. However, the trainings provided by governments and HEIs in many African countries cannot keep up with the needs of educational transformation in the digital age. In addition, teachers in many African HEIs undertake many daily teaching and administrative tasks. There is neither time nor financial guarantee or policy support for teachers' professional development. All these indicate that African governments and HEIs need to pay more attention to the teachers' professional development and provide institutional guarantee and support.

7.More continental initiatives on OBTL are emerging, but coordination and complementarity between initiatives need to be improved

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Although online education initiatives and projects have been springing up, many programmes do not fit in the structures or needs of HEIs, thus failing to fill the existing gaps and causing repetition and waste of resources. For example, the African Union officially launched the Pan African Virtual and E-University (PAVEU) in 2019. The PAVEU was established as an institute of the Pan African University, which aims to build institutions of excellence in science, technology and innovation, laying down the foundation for world-class HE and research activities in Africa and nurturing a new generation of African leaders.[21] PAVEU seeks to

20. Trine Jensen, 2019, Higher Education in the Digital Era: The current state of transformation around the world, International Association of Universities
21. Pan-African Virtual and E-University, “About us”, paveu.africa-union.org/about-us

leverage the opportunities offered by innovative ICT and new pedagogical methods to enable students and teachers to participate in its pedagogical activities through distance learning. The PAVEU project was created partly due to the need to reorganise a number of AU initiatives. These include the Pan African University, the Pan-African Quality Assurance and Accreditation Framework (PAQAF), the Mwalimu Nyerere Scholarship Scheme, and the Science, Technology and Innovation Strategy for Africa (2015-2024). This highlights the diversity of projects and insufficient coordination in the field of HE digital transformation and innovation.

8.The use of ICT Frontier technologies: bright future ahead, but long way to go

The rapid development of ICT frontier technologies, such as Big Data, Artificial Intelligence (AI), Internet of Things (IoT), and Cloud Computing are bringing new opportunities for education. However, inappropriate use of such technologies could exacerbate inequalities among countries and communities. Against this background, an important question facing sub-Saharan Africa is how to grasp the opportunities and to not fall behind in the Fourth Industrial Revolution. A UNESCO survey covering 32 African countries revealed that sub-Saharan African countries require support in terms of institutional capacity building, policy advice, standard setting, partnership building and ensuring gender equality.[22] Only 5 African countries have ratified the African Union's Convention on Cybersecurity and Protection of Personal Data, while only 28 African countries have national legislations on data protection.[23] An IAU survey on digital transformation of higher education shows that, 40% of African higher education leaders who responded to the survey believed that their HEIs are not prepared for ICTfrontier technologies such as AI, Big Data, Blockchain and the IoT. This percentage is on par with the Middle East, but higher than the Asia-Pacific (20%), Europe (20%) and Latin America (28%).[24]

22. UNESCO, “Building Institutional Capacity in Public Policy Development in the Field -A Decision Maker’s Toolkit of AI”, https://en.unesco.org/artificial-intelligence/decision-makers-toolkit
23. Dr. Youssef Travaly, Aretha Mare, Kevin Muvunyi, The Next AI Battlefield: An opinion paper, African Institute for Mathematical Studies
24. Trine Jensen, 2019

African policy makers are increasingly cognisant of the importance of frontier ICT technologies and have begun to act. In October 2020, the African Union adopted the African Digital Transformation Strategy. Meanwhile, African ministers agreed to establish an AI working group dedicated to building a common African stance on AI, as well as to build a pan-African capacity building network and a think tank responsible for evaluating and recommending AI cooperation projects.[25] In the same year, the incumbent AU President, President of South Africa Cyril Ramaphosa, proposed to launch the "African Forum on AI ". He also appointed a presidential committee on the Fourth Industrial Revolution in April 2019. In 2018, the Kenyan government appointed a special task force on blockchain and AI, which was mandated to advise on the utilisation of frontier technologies in the next five years. However, most African countries' digital transformation strategies do not have specific guidelines on frontier ICT technologies.

Despite this, many good practices of using Big Data, AI and other frontier technologies to solve local problems are emerging, especially in the fields of public health, agriculture and education. Zenvus, a Nigerian start-up helps farmers to improve irrigation through analysing earth temperature and nutrients using big data.[26] A Nigerian NGO, Data Science Nigeria (DSN) is cooperating with the Mastercard Foundation to provide technical support for school children unable to return to campus due to the Covid-19 pandemic. DSN provides training in AI and data sciences for children, pre-college students, professionals and business elites, and support start-ups in AI through building world-class AI knowledgeand business apps.[27] However, these good practices lack economies of scale and have limited influence facing big multinational companies.

25. African Union, October 26, 2019, “African Digital Transformation Strategy and African Union Communication and Advocacy Strategy among major AU initiatives in final declaration of STCCICT3”, https://au.int/en/pressreleases/20191026/african-digital-transformation-strategy-and-african-union-communication-and
26. Dr. Youssef Travaly, Aretha Mare, Kevin Muvunyi, ibid.
27. Data Science Nigeria, “About us”, datasciencenigeria.org/about-us/

As the backbone of building talents for socio-economic development, the leading role of HEIs in ICT frontier technologies is crucial. An increasing number of African HEIs are providing courses in ICT frontier technologies. For example, HEIs in Côte d'Ivoire, Namibia, South Africa, Kenya, Uganda, Senegal, Nigeria, Zambia have established degrees in AI and Big Data. The African Centre of Excellence for Data Sciences and ACE in IoT at the University of Rwanda provides degrees in Big Data and IoT from bachelor's to doctoral level.

To fully participate in the Fourth Industrial Revolution, sub-Saharan African countries have a long way to go in terms of policy, capacity, investments and human capital. [v]

03

Regulatory framework for Digital transformation of Higher Education

I. Definition

In a report by the IAU, regulatory framework for higher education digital transformation is assessed according to two dimensions: national and institutional. National regulatory framework includes HE law or decree, HE policy framework, system of accreditation, recognition and quality assurance, other national bodies and financial support. On the institutional level, it includes HEI leadership support and institutional digital transformation strategies or plans.[28]

This report will follow the above structure to compare and assess the regulatory frameworks of sub-Saharan African countries, identify commonalities, gaps, good practices, and draw a few conclusions with a view of the future of higher education digital transformation in the region.

II. Situation analysis

According to an IAU survey, 45% of African HEI leadership who took part in the survey believed that national regulatory frameworks are supportive of digital transformation.[29] This proportion is lower than the global average of 48%, as well as the Asia-Pacific (62%), the Middle East (60%), Latin America and the Caribbean (47%), but higher than Europe (41%).

In terms of national financial frameworks, 30% of African HEI leadership believe it is sufficiently supportive of digital transformation, which is lower than their peers in the Asia-Pacific (43%), Middle East (43%) but higher than those of Europe (28%) and Latin America and the Caribbean (36%).

28. Trine Jensen, 2019
29. Ibid.

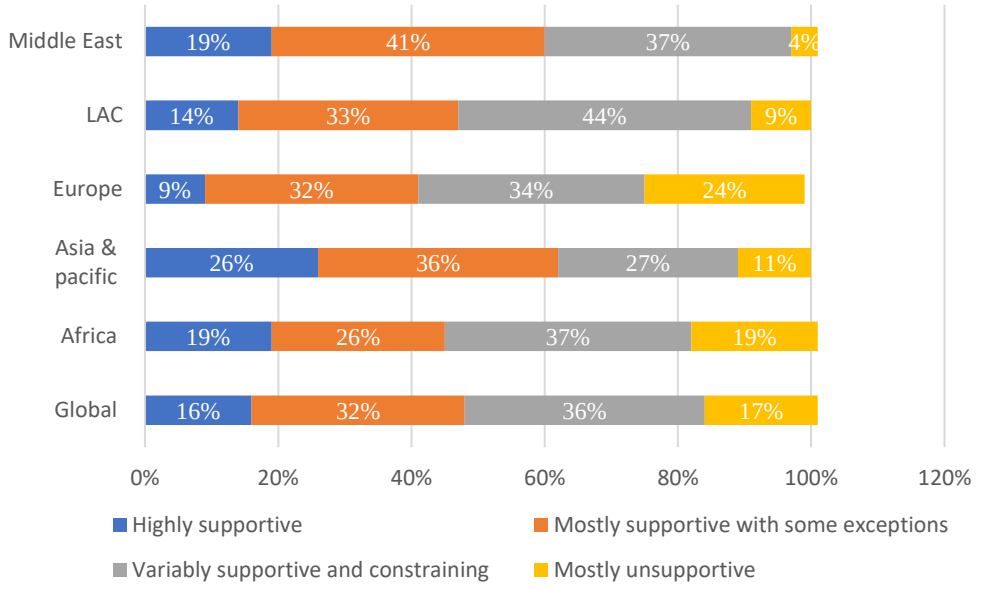

Figure - 1: HE leadership perception of national regulatory policies for digital transformation of HE (Source: IAU)

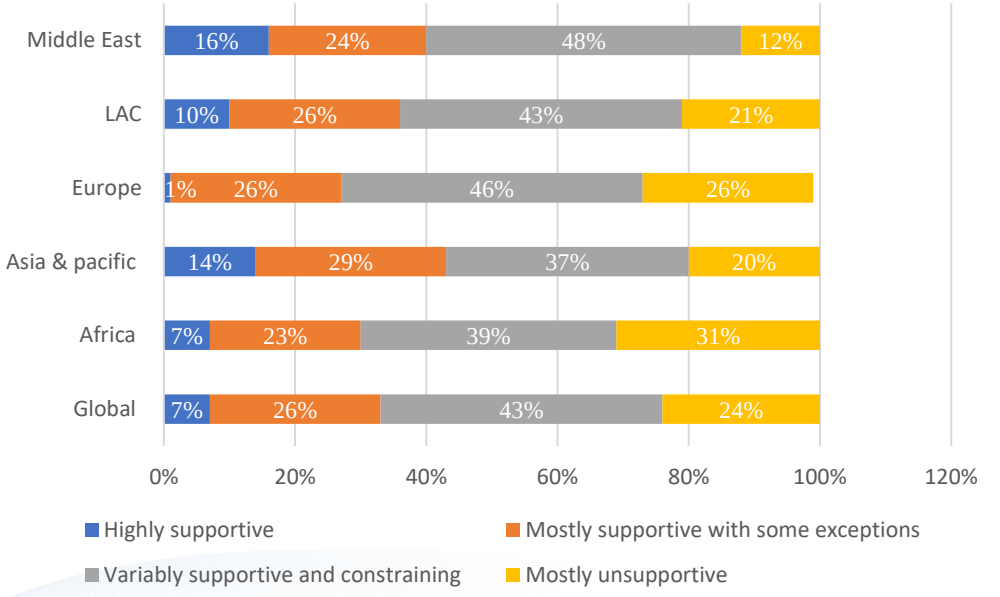

Figure - 2: HE non-leadership perception of financial frameworks for digital transformation of HE (Source: IAU)

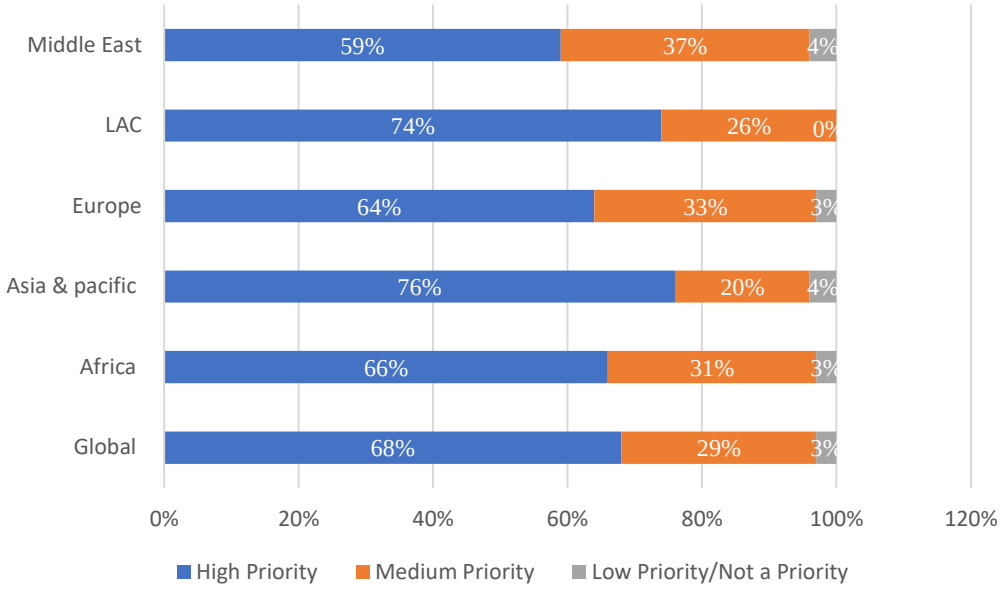

Figure - 3: Importance given to digital transformation among HE leadership (Source: IAU)

On the level of HEIs, the IAU survey demonstrated that 77% of non-leadership HE professionals believe there is strong leadership support for digital transformation, which is higher than the global average.[30] Nevertheless, only 66% of HE leadership who took part in the survey lists digital transformation as a priority, which is lower than the global average of 68%, Asia-Pacific (76%) and Latin America and the Caribbean (74%), but higher than that of Europe (64%) and the Middle East (59%).

Another notable outcome of the survey is that 63% of African HEI leadership indicated digital transformation of HEIs are carried in bottom-up manner, which is higher than the global average.[31] Globally, financial framework is considered as the least conducive to digital transformation, while the recognition and quality assurance systems are considered as less conducive to digital transformation compared to the other factors.

Based on the results of this survey, it could be argued that the regulatory framework for digital transformation of HE in sub-Saharan Africa exhibits the following characteristics and trends. First, the overall regulatory framework and financial framework are perceived as rather unfavourable. Second, despite such difficulties, most African HE professionals and the leadership consider digital transformation to be a key priority on the institutional level, although there seems to be a level of discrepancy between the perceptions of non-leadership and leadership. Third, HEIs in sub-Saharan Africa tend to implement digital transformation in a bottom-up manner, which means lower-level practitioners and grassroot initiatives tend to act before top-level policies and guidelines are issued.

30. Trine Jensen, 2019
31. Ibid.

Based on desk research, it was identified that all sub-Saharan countries have promulgated HE legislations. Nevertheless, not all countries have developed accreditation frameworks for online and distance education or have included online and distance education in the wider curriculum. As is the situation globally, financial investments and HE quality assurance are insufficient in sub-Saharan Africa. This is especially the case in OBTL, for example, lack of accreditation of online and distance degrees; insufficient investments in digital infrastructure or access to internet service which is often inhibited by unaffordable data packages.

III. Existing gaps

The COVID-19 pandemic and the ensuing campus closures and disruption of offline education has further highlighted the challenges facing regulatory frameworks for digital transformation of sub-Saharan African HE. The pandemic exposed the unpreparedness of many sub-Saharan African nations in terms of educational system resilience and transition towards OBTL.

1.Insufficient national guidance and plans for implementing HE digital transformation. The COVID-19 pandemic further highlights the issue. Due to the closure of physical campuses, many HEIs were forced to transition towards online education in very short time, which left governments and HEIs unprepared alike. In response to the sudden interruption of offline teaching and learning, governments have realised the need for digital transformation and directed HEIs to take steps towards transformation. However, due to the lack of overarching guidelines, HEIs are often left to themselves to devise strategies and plans for digital transformation. The discrepancies between HEIs that could ensue will lead to widening inequalities among HEIs.

2.On the institutional level, not all HEIs have the same level of commitment or capacity to embark on digital transformation. For example, in terms of quality assurance, not all institutions have sufficient capacity or resources to implement national QA guidelines or to conduct self-evaluations.

3.Although HE professionals in sub-Saharan showed greater commitment to HE digital transformation and stronger belief in the role of digital transformation in improving HE access compared to their peers in other regions of the world according to the IAU survey, such enthusiasm is underserved by insufficient financial investments, insufficiently supportive regulatory framework and QA framework. To harness these commitments, regulatory frameworks are therefore crucial for realising the full potential of digital transformation of HE in sub-Saharan Africa.

IV. Best practices

Case study 1: South Africa – an enabling regulatory framework for OBTL

South Africa was the first African country that set up a dedicated department at the ministry of Education to develop online and blended education. The Draft Policy Framework for Open Learning and Distance Education in South African Post-school Education and Training encouraged all universities to expand online and blended learning as a way to offer niche programmes, especially at postgraduate level. The White Paper for

Post-School Education and Training was approved in 2013 then updated in 2017. In response to the COVID-19 pandemic, the government issued the Guidelines on Distance Education during COVID-19.

Following national guidelines, the University of Cape Town designed an institutional policy strategy. The university has organised many seminars to assist other universities across the continent to develop the own. Three other universities in South Africa have been doing very well in terms of quality online and blended learning, namely University of Witwatersrand, Stellenbosch University, and University of Pretoria.

In terms of QA, the Department for Post-school Education and Training promulgated the QA Framework for Distance Higher Education in 2014, which outlined provisions for monitoring and evaluating distance learning in HEIs. In line with the national framework, HEIs such as University of Witwatersrand, University of South Africa, and Stellenbosch University have set up dedicated units for QA. South Africa's experience highlights the need for clear and responsive national QA policies as well as dedicated QA units on the HEI level.

Case Study 2: Senegal – building a national QA system for quality HE

In response to the growing number of HE enrolments and HEIs, both public and private, the increasing mobility of students regionally and internationally, in view of the deteriorating quality of HE in Senegal, the Ministry of Higher Education, Research and Innovation (MESRI) of Senegal created the National Authority of Higher Education Quality Assurance (ANAQ-SUP) in 2012.[32]

Since its creation, ANAQ-SUP has published guidelines on self-evaluation for HEIs. Notably, the ANAQ-SUP has published guidelines on evaluating distance training HEIs and programmes, in addition to guidelines for traditional HEIs and programmes. Following national guidelines, internal QA units were created in public and private HEIs. These units work closely with ANAQ-SUP to conduct self-evaluations of the HEIs and HE programmes according to the guidelines published by ANAQ-SUP. After self-evaluations were completed, the resulting reports are sent to ANAQ-SUP, who will conduct external evaluations on the basis of self-evaluations. An external evaluation report will then be produced, with recommendations on accreditation to be transmitted to a scientific council. The council examines the reports and takes a decision, which will be sent to the HEIs and HE programmes evaluated, as well as to the MESRI. The final reports are published on the websites of ANAQ-SUP and MESRI.[33] Based on these evaluations, the quality of HEIs and HE programmes can be made public, which provides directions for improving the quality of HE and capacities of HE personnel.

32. MESRI Senegal, 7 August 2012, Decree on the creation, organisation and functioning of the National Authority of Quality Assurance of Higher Education
http://www.anaqsup.sn/sites/default/files/publications/anaq_decret-signe1-21.pdf
33. ANAQ-SUP, "Evaluation", http://anaqsup.sn/evaluation

From 2013 – 2019, ANAQ-SUP has organised over 100 trainings and conferences for public and private HEIs, selected and employed over 187 external expert evaluators, completed institutional evaluations of 7 public HEIs and 309 evaluations of private HEIs across the country.[34] Public HEIs completed some 500 self-evaluations. In addition, ANAQ-SUP accredited 74 degrees offered by public HEIs, as well as 88 degrees offered by private HEIs.

Image - 1: SFIT-supported event in collaboration with ANAQ-SUP, Senegal
(Source: Higher Education Section, UNESCO)

With the support from the UNESCO-Shenzhen Funds-in-Trust (SFIT), ANAQ-SUP's institutional capacity was strengthened. 52 external expert evaluators were trained on theoretical and methodological framework of QA in HE, the national strategy for QA and internal QA mechanisms. ANAQ-SUP played a leading role in terms of HE QA in the sub-region and has received delegations from Mali to share good practices with Malian counterparts.[35] In February 2020, the Network of National Quality Assurance Agencies for French-speaking Africa was established in Dakar, Senegal, and the president of ANAQ-SUP was appointed as President of the Network, showcasing Senegal's excellence in QA in Francophone Africa.[36]Senegal's experience is of particular value for concretising national policies through national and HEI-level capacity building and regular evaluations, and creating dedicated QA guidelines for distance education programmes and institutions.

34. MESRI Senegal, Activity Report 2012 – 2019
35. UNESCO, March 2018, Annual Report: UNESCO-Shenzhen Funds-in-Trust Project on Strengthening Quality Assurance in Higher Education in Africa
36. HAQAA2, Establishment of the Reseau africain francophone des agencies nationales d'assurance qualite (French-speaking African Network of National Quality Assurance Agencies) https://haqaa2.obsglob.org/establishment-of-the-reseau-africain-francophone-des-agences-nationales-dassurance-qualite-rafanaq-french-speaking-african-network-of-national-quality-assurance-agencies/

V. Conclusion

To create enabling regulatory frameworks for digital transformation of HE in sub-Saharan Africa, three elements are crucial. First, clear national policies and guidance for HE digital transformation. Second, adequate financial investments from governments and leveraging private sector contributions. Third, QA adapted to the needs of OBTL in HE.

1.National policies and guidelines for HE digital transformation >>>>>>>>

(1) Accreditation and recognition

African governments need to set up strong standards of national accreditation mechanism compatible with international and regional accreditation frameworks. This would allow national governments to accredit qualified institutions to deliver teaching and degrees via OBTL.

There also needs to be national recognition frameworks for OBTL degrees and diplomas, in line with international and regional standards, notably, the latest Global Convention on the Recognition of Qualifications Concerning Higher Education.

(2) Guidelines for HEIs to implement OBTL and digital transformation

To ensure equity among HEIs so that no one is left behind, national guidelines are needed to ensure consistency of the transitional process towards OBTL. Due to disparities in terms of capacity, material and human resources, some disadvantaged HEIs might be left behind in the digital transformation, which could negatively affect the overall national HE quality and equity. Therefore, it is the government's role to ensure that HEIs follow defined processes to achieve consistency.

2.Enabling financial and regulatory frameworks for infrastructure, equipment, and campus >>>>>>>>

Digital transformation needs solid infrastructure. This includes broadband networks, high-capacity fibre, wireless infrastructure, including in remote and underserved areas. Stable electricity supply is also crucial, which should be ensured through expansion of grids or alternative sources of energy to HEIs. In order to ensure these conditions, there needs to be enabling financial and regulatory frameworks, to leverage public and private investments in electricity, networks and campus

facilities, fair electricity and ICT market competition environment, and investment-friendly environment for infrastructures.

To ensure that no one is left behind, there needs to be affordable bandwidth and wireless for the education sector, as well as tax reductions on devices such as computers, smartphones, and tablets to popularise the use of digital devices.

To ensure that campus buildings are fit for digital transformation of HE, governments and HEIs should also develop new school building codes that help create modern physical environments compatible with new technologies.

3. Quality Assurance >>>>>>>>

Policy makers should set up dedicated QA frameworks for OBTL on continental, regional and institution levels. To ensure successful QA, the following steps are

01. Secure a political mandate at the national and institutional levels (and ensuring that such a mandate is binding, where relevant);

02. Seek synergies with other regional QA and harmonisation efforts in education;

03. Develop QA for Online Education frameworks in respective regions;

04. Encourage and facilitate use of these frameworks;

05. Assess and research the impact of the use of these frameworks on the quality of HE, especially distance education;

06. Provide other support services to national agencies and distance education providers and ensure their financial sustainability.

The objective of delivering quality standards of education to all in Africa remains unfulfilled, but the news technologies and digital tools presents a real chance and an opportunity for this to become a reality. Online education has a huge potential to improve education systems in African countries. If implemented well with strategies that focus on overcoming key challenges, radical transformation of the education system is possible.

04 ICT Infrastructure and technology

I. Definition

Information and communication technology (ICT) is a combination of information technology (IT) and communication technology (CT). According to the World Economic Forum, the International Telecommunication Union, and other international organisations, ICT is an organic combination of communication services, telecommunication services, online intelligent services, and applications. As a virtual commodity, it is generally understood that ICT infrastructure can not only provide a variety of services based on broadband and high-speed communication network, but also integrate, share, and transfer information, as well as being a general intelligent tool.

No.	Indicator
ED1	Proportion of educational institutions with radio for pedagogical purposes
ED2	Proportion of educational institutions with TV for pedagogical purposes
ED3	Proportion of schools with telephone for pedagogical purposes
ED4	Learner-to-computer ratio
ED5	Proportion of educational institutions with Internet
ED6	Proportion of students with internet access
ED7	Proportion of students enrolled in higher education institutions in ICT related fields
ED8	Proportion of ICT-qualified teachers in schools
EDR1	Proportion of schools with electricity supply

Table -2: Core Indicators of ICT in Education

Since the 1960s, with the start of the information era, great changes have taken place in people's living, production, and even learning styles. Digital education has gradually spread to various fields of society. Led by the International Telecommunication Union and composed of more than ten international organisations, such as the Organisation for Economic Cooperation and Development (OECD), UNESCO, and the World Bank, the Partnership on Measuring ICT for Development has started to formulate and publish ICT core indicators since 2005. Table 2 shows the contents of the report issued by the Partnership in 2010.[37] This report will analyse the ICT infrastructure of higher education in sub-Saharan Africa with reference to the indicators in the table below.

II. Situation analysis

With the rapid development of the global digital economy, informatization has become the focus of development in various countries and regions. The rise and development of new technologies represented by Big Data, the Internet of things, Blockchain, Artificial Intelligence, and 5G marks the advent of the smart era. The rapid development of emerging technologies brings not only hope to higher education but also challenges to colleges and universities. The traditional teaching mode can no longer adapt to the demands of the new era. The overall ICT infrastructure level in countries, the ICT awareness of the general public, and the gap between countries will affect the transformation of higher education in the whole region.

1. Continuous improvement in the penetration of ICT infrastructure lay the foundation for the digital transformation of higher education

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First of all, in terms of the penetration rate of communication equipment (fixed telephone and mobile phone), the scale of telephone users has been steadily expanded in sub-Saharan Africa, and the penetration rate of mobile phones has been greatly improved, from only 12 out of every 100 residents in 2005 to 76 out of every 100 residents in 2018 using mobile phones. The compound annual growth rate is 15%. According to the data of ITU in 2018, the mobile phone ownership percentage in South Africa is 159.93%, while 119.16% in Namibia, 89.16% in Zambia, 77.89% in Togo, 134.86% in Côte d'Ivoire, and 75.9% in Nigeria.[38]

Secondly, in terms of internet penetration rate, Africa is still lagging behind. But in recent years, the number of Internet users and broadband users has shown a very considerable growth trend. The number of people using the Internet increased from 2.1% in

37. Jingying Yang, Youda Xiong, Report on ICT Core Indicators at the world summit on the information society -- Statistical Evaluation of Informatization series 3, October 2011, Information in China, 67-72
38. World Bank open data, 2018

2005 to 24.4% in 2018, an increase of nearly 12 times and a compound annual growth rate of 21%. In recent years, Internet usage has been significantly improved, which provides a prerequisite for the digital transformation of higher education.[39]

Sub-Saharan Africa has shown great potential in the popularization of ICT technology. This has laid a good foundation for the digital transformation of higher education.

2. The low level of ICT development inhibits the digital transformation of higher education >>>>>>>>

The ITU information technology development index (IDI) is an important yardstick to measure the development level of ICT in different countries. According to this indicator, Africa is one of the regions with the worst IDI performance, with an average IDI score of 2.64 in 2017 while the world average of 5.11. This shows that the level of the ICT industry in this region is still lower than the global average.

In Ethiopia, telephones and computers are still a luxury. Long-distance calls and Internet devices are very expensive. But distance education requires people to bear the cost of telephone and Internet. Namibia, as the benchmark and leader of ICT education in Africa, has a very uneven distribution of network construction areas. It also urgently needs to improve ICT and related infrastructure in order to promote the balanced development of education. In Niger, due to the long-term lack of sufficient funds, the telecommunications infrastructure cannot guarantee the development of the Internet service industry. In 2017, Niger's Internet users accounted for 10.7% of the country's population. At present, the Internet penetration rate is 2.1%, the broadband access rate is 0.2%, and the 3G service population coverage rate is less than 36%.[40] Nowadays, the average download speed is still very low: about 1.1Mbps. The backward electricity and communication infrastructure hinders the development of ICT in the education and public sector. The lack of financial resources makes it almost impossible for the government to provide basic education infrastructure.

39. ITU, ITC-Eye, 2020
40. UNESCO Institute for Statistics, Niger, http://uis.unesco.org/fr/country/ma

3. Great differences exist in terms of digitalisation level of higher education among sub-Saharan African countries

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Sub-Saharan African countries vary greatly in terms of development. South Africa is the second-largest economy of Africa and BRICS member. Botswana and Namibia, among others, rank as middle-income countries. 33 out of the 55 African countries are least developed countries.[41] Due to the huge differences in the development, the level of ICT infrastructure and technology in sub-Saharan countries also varies greatly, which leads to a large gap in the digitalisation level of higher education among countries.

South Africa is leading in the development of ICT in the region and even in the whole of Africa, and it has a complete ICT strategic plan. The ICT Vision 2020 issued by the government guides thelong-term development of its ICT industry and plans to make South Africa a leading country in the information era.[42] Because of its historical and economic ties with South Africa, Namibia also has good ICT infrastructure. In 2020, optical fibre cables would increase from 12000km to 14000km, and the penetration rate of fixed broadband would reach 35.3%.[43]

In the least developed countries in sub-Saharan Africa, ICT infrastructure is lagging behind, which affects the digitalisation level of education. For example, in Malawi many university computers are not properly maintained, which undermines the enthusiasm of teachers and students to use computers to learn ICT skills. At the same time, using ICT for teaching requires sufficient and continuous electricity, but Malawi suffers from acute shortage in electricity. Only 10% of the population have access to electricity conveniently, while most of the rural areas experience power shortages daily. High electricity fees and slow network speed are fundamental obstacles to promoting the usage of ICT.

41. UNCTAD, Map of the least developed countries, https://unctad.org/topic/least-developed-countries/map
42. Ministry of Foreign Affairs, PRC, South Africa Overview, 2020, https://www.fmprc.gov.cn/web/gjhdq_676201/gj_676203/fz_677316/1206_678284/1206x0_678286/
43. UNDP, World Bank, UNESCO Institute for Statistics, ITU, 2020

III. Opportunities and challenges

1. African countries attach great importance to the ICT industry >>>>>>>>

Sub-Saharan African countries are generally aware of the importance of ICT in improving productivity and promoting economic development. As early as 1995, the Economic Commission for Africa put forward the "African Information Society Plan". Ethiopia has formulated the "National ICT Policy and Strategy", which designated the construction of information infrastructure as an important national long-term task.

At the national level, Uganda plans to launch the "Last Mile" project to promote the use of key networks. According to the plan of the Ministry of Digital Economy and Postal Service of Côte d'Ivoire, by 2020, the telephone service will cover 100% of the national population, the network service will cover 90% of the national population, and the high-speed broadband will cover 50% of the national population.[44] In 2018, the digital economy will account for 9% of the GDP of Côte d'Ivoire. The government plans to increase the proportion to more than 17% by 2020 and introduce 5G technology.[45]In the latest World Trade Policy Statement provided to the World Trade Organisation in September 2014, Djibouti emphasized the importance of its ICT sector. In order to achieve the policy objectives of "Djibouti Vision Plan 2035", the government has formulated aspecific ICT strategy (comprehensive strategic plan) since 2014 to develop and popularize ICT.[46]

All countries have made plans for the development of ICT through policies, regulations, and other measures, which shows the determination of African countries in the development of ICT infrastructure.

44. RIA 2007-2008, 2011-2011 data
45. Ministry of Commerce, 2019, Country (region) guide for foreign investment cooperation: Côte d'Ivoire (2019 Edition), http://www.mofcom.gov.cn/dl/gbdqzn/upload/ketediwa.pdf
46. Ministry of Education and Professional Training of Djibouti, 2020, Covid-19 Response Plan, http://www.education.gov.dj/images/covid19/Plan%20de%20r%C3%A9ponse%20COVID19%20secteur%20%C3%A9ducation%20MENFOP%20DJIBOUTI.pdf

2.International cooperation facilitates the development of ICT infrastructure in sub-Saharan Africa

Given the close historical ties between many African countries and the global north, many northern countries' international development policies invest heavily in Africa, including in the field of ICT infrastructure.

Since 1996, the Agence Universitaire de la Francophonie (AUF) has funded four Togolese universities including the University of Lomé to implement the French Digital Campus project. The French digital campus centre at the University of Lomé has computers and high-speed Internet service. AUF pays for the Internet fees for the centre and provides online accounts for students to study online courses of French-speaking universities. According to the needs of students, AUF offers scholarships equivalent to 10-15% of the online course tuition. In Côte d'Ivoire, the MOOCs4DEV project of the EPFL (Switzerland) funded by the French Development Agency, helped to build a "MOOCs factory" in the Université Félix Houphouët-Boigny (Abidjan). Teachers and students at the university can use classrooms equipped with computers, cameras, projectors, and recording equipment for MOOCs production, learning, and distance teaching. The University of Gambia (UTG) joined the Pan African eNetwork project in 2009 and began to participate in open and distance learning. The Indian government has provided some project support to help UTG set up its first open and distance learning centre, which has launched online postgraduate courses.

3.The urgent demand for ICT technology exerts pressure on the digital transformation of higher education

The economic growth of sub-Saharan Africa has an urgent demand for the development of the ICT industry. Africa is the only region in the world where the overall population is young – people under 25 make up 60% of Africa's population. According to the data released by the ITU in 2017, young people are the main group to promote informatization – the proportion of young people aged 15-24 using the Internet (71%) is significantly higher than that of the total population (48%). In Africa, the proportion

ofyoung people of this age group using the Internet is also much higher than that of the total population. With the improvement of the social economy and education level, many young people have an increasing demand for ICT.

Africa's large population is unmatched by its number of internet users. By March 2019, the total population of Africa was nearly 1.3 billion, accounting for 17% of the world's population, close to one fifth. As of the fourth quarter of 2017, the number of people using the Internet in the world had reached 3.65 billion, while the number of people using the Internet in the African continent was only 210 million, less than 6% of the total population using the Internet. According to a report released by the Global System for Mobile Communications Association (GSMA) in July 2019, sub-Saharan Africa will have the fastest growth in the number of mobile users in the world in the next few years. By 2025, the number of mobile internet users would increase to 483 million[47] With such mismatch between the population and the degree of informatization, the demand for ICT in Africa is obvious.

IV. Best practices

Best practice 3: South Africa – Committed to the realisation of ICT dividend benefiting the whole population

In 1998, the telecoms market in South Africa began to flourish. At that time, the number of telecom users in South Africa was about 86% of that in Africa. Nowadays, with the development of ICT technology in Africa as a whole, most Africans have access to the most basic ICT services. However, compared with the average Internet usage rate of 20.7% in Africa, South Africa is undoubtedly still in the leading position.[48]

1.Vigorously develop mobile networks

Mobile network is the main way of internet access in South Africa. In 2009, the growth rate of Internet users in South Africa exceeded 50%, of which the growth rate

47. GSMA, Mobile Economy 2020, https://www.gsma.com/mobileeconomy/wp-content/uploads/2020/03/GSMA_MobileEconomy2020_SSA_Infographic_Eng.pdf
48. Department of Higher Education and Training of South Africa, 2020, Supply and Demand of Skills in South Africa in 2020

of fixed broadband users was 21%, while the growth rate of mobile network users was 88%.[49] By 2010, the mobile network has gradually become the main way for South Africans to access the Internet.[50] The main reason for this is to follow the development trend of mobile terminals in the world on one hand. On the other hand, it is because, in South Africa, the cheaper and more flexible mobile network is the better choice for the majority of the population.

2.Strive to reduce telecommunication fees

In order to reduce the communication charges of mobile networks, the Ministry of Telecommunications has adopted the method of promoting market competition. As early as 1997, Telkom, the only fixed-line telephone company in South Africa, began its share reform. The government sold 30% of its shares to private capital. In 2006, Neotel, the second fixed-line telephone company, was established. In 2010, Cell C, the third mobile communication company, was established. In recent years, mobile communication companies such as 8ta, Virgin and many network services companies such as iBurst have been established one after another.[51] Mobile phone charges and network charges gradually decreased. The Independent Communications Authority of South Africa has also demanded mobile phone operators to gradually reduce their call charges based on the designated timeline.

3.Taking the development of ICT technology as an important strategy to promote economic development

In December 2012, the Presidential Infrastructure Coordinating Commission of South Africa officially launched a strategic integrated project (SIP 15), which aimed to expand the penetration of communication technology, aiming to ensure that all South Africans can enjoy stable and affordable broadband services, and give priority to rural areas and areas with relatively insufficient ICT services.

Because South Africa has excellent ICT infrastructure covering the whole country, the ICT infrastructure at its universities is also better than other sub–Saharan African countries. For example, the University of Cape Town has advanced classroom equipment, nearly 100 teachingplaces are equipped with cameras, data projectors, customized platform, and built-in PC, so that teaching can be flexible. Lecture recording and comprehensive learning management system further provide tools to optimize teaching. Students at the University of the Witwatersrand can also access the Internet within the whole campus. The University of the Witwatersrand has its online learning portal Wits-e and online learning management system (LMS).

49. World Economic Forum, 2019, Global Competitiveness Report 2019
50. The Independent Communications Authority of South Africa, 2020, Report on the Status of the Information and Communication Technology Sector in South Africa
51. African ICT Research, 2018, Information and communication technology in South Africa

Best practice 4: Namibia – actively deploying ICT infrastructure for education

Telecom Namibia Limited has the most advanced telephone network in Africa. At present, the Namibian mobile phone penetration rate has exceeded 110%. According to the fifth national five-year development plan, the Namibian government will establish a complete ICT infrastructure by 2020 by means of innovation, research, and development, to promote the development of the national economy and improve national competitiveness. The development of ICT infrastructure and technology in Namibia is inseparable from its efforts in education. As early as 1995, the National Institute for Educational Development (NIED) of Namibia issued the first national ICT Education Policy, which laid a solid talent foundation for the development of the ICT industry in Namibia. The policy was revised in 2000, and the corresponding objectives and development strategies for ICT education's software, hardware, training, and cost were formulated. In the 2030 Vision Plan, the Namibian government also clearly states that ICT skills are the core elements of education in the 21st century. ICT is not only a discipline, but also an effective means to promote education, teaching, and management. At the same time, it is an important way to promote economic transformation for the development of the ICT industry.[52]

1. Strive to improve infrastructure for higher education

In 1998, Namibia's first Gigabit Ethernet was put into use at the Namibia University of Science and Technology. Namibia University of Science and Technology has a central management system (ITS), which allows students and staff to register and check scores, financial statements, examination schedules, etc. through computers. In 2014, more than 10,000 devices were connected to the central management system. Most of the computerrooms on the campus are used for IT courses, and each computer room has about 25 computers on average, all of which are connected to the campus Gigabit Ethernet. The school library is also equipped with free laboratories, open resource laboratories, and Internet cafes. After 2008, all registered students and staff can use the campus network free of charge. By the end of 2010, there were 770 computer classrooms in Namibia. The University of Namibia has established an information learning and resource centre with video conference facilities.[53]

2.Attach importance to ICT education for teachers

Since 2003, ICT education has been formally included in the teacher training programme. E-learning and School Net also provide many opportunities for teacher ICT competency training, such as online learning and distance learning. By the end of 2007, 50% of the teachers had obtained the intermediate ICT skill certificate, and 80% of the

52. Namibia Office of the President, 2017, Namibia Vision 2030: National Long Term Development Policy Framework Document
53. Namibia University of Science and Technology, https://www.nust.na/

teachers had obtained the comprehensive ICT education certificate.[54] Namibia attaches great importance to ICT training for teachers, mainly through pre-job training and on-the-job training.

3.Focus on the deployment of distance learning programmes

Due to the vast territory and sparse population of Namibia, the higher education commission believes that distance learning can effectively alleviate the plight of students in remote areas to receive higher education. Namibian e-Learning Centre (eLC) was officially launched in 2006. Under the sponsorship of NOLNet, eLC has become a service hub for online learning activities in Namibia at home and abroad. The Namibia open learning network (NOLNet) provides more than 40 open learning centres. More than 19% of the students at the Namibia University of Science and Technology are enrolled in distance learning programmes.[55]

Namibia has been promoting the digital transformation of higher education through infrastructure construction, improving ICT education, and deploying distance learning programmes.

V. Conclusion

On the basis of situation analysis, opportunities, challenges, and best practices of ICT infrastructure and technology in sub-Saharan Africa identified as above, in order to lay a solid foundation and technical support for the digital transformation of higher education, the key elements are as follows.

Governments should provide an enabling environment for the development of the ICT industry and the application of ICT in the education sector.

Governments should provide an enabling environment for the development of the ICT industry and the application of ICT in the education sector. For example, increase investments in electricity and ICT infrastructure, cooperate with telecommunication operators to provide free or discounted data packets for HEIs, and provide tax reductions for electronic devices such as computers, smartphones, and tablets.

54. Chainda, Allen Mukelabai, 2011, Third-Year Students' Perception of the Use of ICT at a Teacher Training College in Namibia, University of Stellenbosch
55. Namibia University of Science and Technology, https://www.nust.na/

Narrow the connectivity gap between countries and promote the sharing of internet connectivity among countries through multilateral cooperation

Narrow the connectivity gap between countries and promote the sharing of internet connectivity among countries through multilateral cooperation. Many countries in sub-Saharan Africa have established a National Research and Education Networks (NREN) to share network connections among higher education and scientific research institutions. Regional NREN networks have been established in East, West, South, North, and Central Africa. Based on this, focus should be on helping countries and institutions that have not yet established NREN or do not yet have access to regional NREN networks to join the network sharing mechanism.

HEIs should formulate campus building rules and regulations to adapt to OBTL and digital management and research

HEIs should formulate campus building rules and regulations to adapt to OBTL and digital management and research , so that new campuses are equipped with the physical environment that meet the needs of higher education digital transformation.

05 Teacher ICT capacity building

I. Definition

"Capacity" is usually defined as "a series of complex knowledge, skills, understandings, values, attitudes and expectations that guide effective, specific human action in a certain area".[56] This chapter discusses Teacher ICT Capacity in 3 dimensions: (1) Teacher ICT literacy; (2) the ability of teachers to use ICT to facilitate teaching and learning, management and administration, research and innovation; (3) the professional competencies of ICT discipline teachers.

The UNESCO ICT Competency Framework for Teachers (UNESCO ICT CFT) is a standard-setting document for decision-makers and HE professionals to assess and evaluate teacher ICT capacity, develop national and institutional guidelines, develop curricula and has been used in a variety of countries and contexts. Since its launch in 2018, the UNESCO ICT CFT has had 3 versions. Based on UNESCO-ICHEI's experience of cooperating with African and Asian HEIs, combining the UNESCO ICT CFT, ISTE for Educators, and TPACK, a team of international HE experts convened by UNESCO-ICHEI developed the IIOE ICT CFT, with special focus on HE and OBTL.

The IIOE ICT CFT has 3 dimensions. Namely, ICT in OBTL, ICT in administration and management, frontier ICT knowledge and competencies, corresponding with the 3 core functions of HEIs: teaching and learning, management and administration, research and innovation. Each dimension is divided into 3 levels, ranging from basic level – awareness raising and intermediate level – capacity building, to the advanced level – knowledge application.

A holistic approach towards teacher ICT capacity building should include pre-service training, in-service continuing professional development and knowledge sharing among HE professionals.

56. HAQAA2, Establishment of the Reseau africain francophone des agences nationales d'assurance qualite (French-speaking African Network of National Quality Assurance Agencies) https://haqaa2.obsglob.org/establishment-of-the-reseau-africain-francophone-des-agences-nationales-dassurance-qualite-rafanaq-french-speaking-african-network-of-national-quality-assurance-agencies/

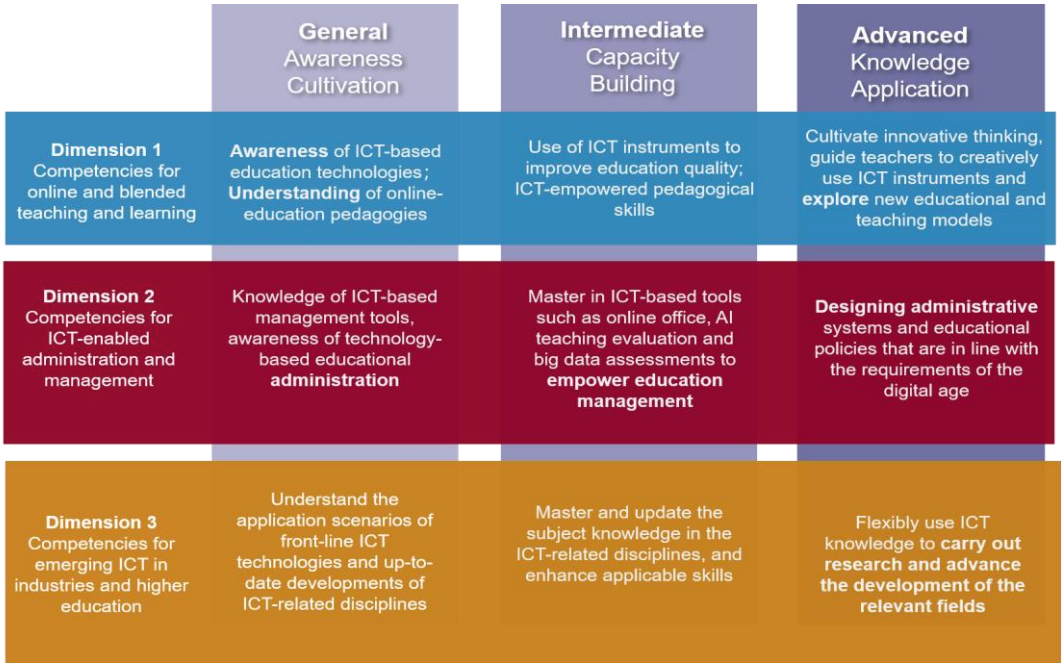


Figure - 4: IIOE ICT Competency Framework for Teachers
(Source: UNESCO-ICHEI)

II. Situation analysis

A survey by the IAU showed that 49% of HE professionals in sub-Saharan Africa believe insufficient capacity is one of the main obstacles towards digital transformation of HEIs. This percentage is higher than the global average.[57]

Sub-Saharan African governments have taken measures to build teachers' ICT capacities, but translating government policies into concrete actions remains a challenge. Among the leading countries is Rwanda, where strategies for building ICT capacities for teachers are evident in national policies of HEIs.[58]However, the implementation of such policies can be a different story. Only a limited number of HEIs translated national policies into institutional policies, and even so, there is lack of consideration of motivation and provision of incentives to innovators, which is crucial for integrating ICT in HE.[59] At the University of Rwanda, a new eLearning platform was integrated in 2016. Although staff found it useful, the intention to adopt and use it was very low due to insufficient managerial and technical support.[60] In South Africa,

57. Trine Jensen, 2020, p.43
58. Jean Claude Byungura, ICT Capacity Building: A Critical Discourse Analysis of Rwandan Policies from Higher Education Perspective, July 2016, European Journal of Open, Distance and E-Learning, (19 2)
59. Ibid.
60. Jean Claude Byungura, Henrirk Hansson, Thashmee Karunaratne, Exploring Teacher Adoption and Use of an Upgraded eLearning Platform for ICT Capacity Building at University of Rwanda, May 2016, IST-Africa 2016 Conference, Durban, South Africa.

the South African Council for Educators (SACE) developed standards for teacher training in accordance with the Integrated Strategic Planning Framework for Teacher Education and Development in South Africa (2011 – 2025), thus standardising the usage of ICT in teaching across the country.[61] SACE also provides MOOCs on ICT integration in education. Nevertheless, only 6 out of the 14 major HEIs in the country are providing ICT in education courses for teachers. Although policies are in place, their implementation is not guaranteed.

International cooperation have long played important roles in building teachers' ICT capacity in sub-Saharan Africa. For example, China, Japan, and Korea established Funds in Trust with UNESCO to implement an array of projects in enhancing teacher training quality and institutional capacity, so that teachers in sub-Saharan African countries could better harness ICT in teaching, management and research.[62] As an intergovernmental organisation specialised in promoting online and distance education, the COL has organised multiple capacity building activities for Commonwealth countries in sub-Saharan Africa. These include training teachers to study MOOCs on technology-enabled education, to participate in trainings on ICT-enabled education, curriculum design, ODL policy and QA framework development.[63]

The private sector is playing an increasingly active role in teacher ICT capacity building. One of the pioneering enterprises is Cisco. Cisco provides certified trainings in operating systems, programming languages, IoT, cybersecurity, etc. and has established cooperation partnerships with over 977 education institutions in Africa. Over 1850 teachers have used Cisco's educational content in their teaching.[64] Huawei has established a number of ICT Academies established in cooperation with African HEIs, providing certified ICT capacity training for teachers and students. Teachers who successfully completed the training courses will become certified Huawei teachers. The training courses include Cloud Computing, AI, Network Security, Big Data, WLAN, Routing and Switching, etc. As of October 2020, in the Huawei Northern Africa Region, there are over 180 Huawei ICT Academies, over 1000 certified teachers and over 30,000 students using Huawei certified courses each year.[65] Partner HEIs' teachers and students can benefit from certified ICT training and courses. At some universities, such as the University of Nairobi has incorporated the Huawei certified Cloud Computing course into its academic programmes.[66]

Against the backdrop of the COVID-19 pandemic, many sub-Saharan African HE teachers were forced to convert to online and distance teaching mode in a very short time span. The response to this change has been uneven. Many teachers have adopted a "learning by doing"

61. SACE, About – Professional Development and Research, https://www.sace.org.za/pages/about-professional-development-and-research
62. See: UNESCO-China Funds-in-Trust: Harnessing Technology for Quality Teacher Training in Africa, https://en.unesco.org/themes/teachers/cfit-teachers; UNESCO-Korean Republic Funds-in-Trust: ICT Transforming Education in Africa, https://en.unesco.org/themes/ict-education/kfit; The Japanese Trust Fund for the Promotion of Effective use of Information and Communication Technologies in Education, https://www.mofa.go.jp/policy/culture/coop/unesco/programme/list.html
63. Commonwealth of Learning, https://www.col.org/programmemes/higher-education
64. Cisco, "Networking Academy" https://www.netacad.com/region/africa
65. Huawei, Huawei ICT Academy: Building a Talent Ecosystem and Boosting the ICT Industry's Development, https://e.huawei.com/en/publications/global/ict_insights/201907041409/talent-ecosystem/huawei-ict-academy
66. University of Nairobi ICT Centre, "Huawei certified information associate (HCIA) Cloud Computing", https://ict.uonbi.ac.ke/node/375

approach to meet the challenges brought about by this sudden change.[67] Although some HEIs have reopened their campuses, this does not mean a simple return to normal. The most likely scenario is that teachers would have to deliver teaching via online and offline modes simultaneously, which calls for strengthening teacher ICT capacity building.

III. Main gaps

Gap between Teacher Professional Development (TPD) policies and policy implementation.

Gap between Teacher Professional Development (TPD) policies and policy implementation. Although the need for teacher ICT capacity building is being acknowledged across national legislations in sub-Saharan Africa, the implementation of such policies is far from satisfactory. Key bottlenecks include ineffective translation of policies from national to institutional level, lack of incentives for teachers to adopt new technologies and pedagogy, insufficient managerial and technical support for teachers.

Lack of systematic, free-of-charge teacher ICT capacity building programmes.

Lack of systematic, free-of-charge teacher ICT capacity building programmes. Although there has been a plethora of teacher training workshops, seminars, programmes and other capacity building activities provided by governments, international organisations, NGOs and the private sector, many of them were ad hoc and lacked regular follow-up. Some of the programmes provided by private sector partners were structured, but they primarily served industry needs, and in some cases are paid. In order to build teacher ICT capacity on scale, there needs to be massive, free-of-charge and systematic training.

Lack of infrastructures and devices to support teacher ICT capacity building.

Lack of infrastructures and devices to support teacher ICT capacity building. As described in chapter III, sub-Saharan Africa suffers from shortages of electricity, poor internet connectivity, high prices of data packages, and insufficient ICT devices. Despite progress in recent years, remote areas and marginalised groups are still left behind. Without quality infrastructure and devices, ICT capacity building for teachers will not be able to concretise.

67. Giorgio Marioni, Hilligje van't Land, Trine Jensen, May 2020

IV. Best practices

Case Study 5 : UNESCO-China Funds-in-Trust: Improving the quality of teacher education in sub-Saharan Africa

Image - 2: Ugandan teachers participating in CFIT-supported training
(Source: UNESCO Education Sector)

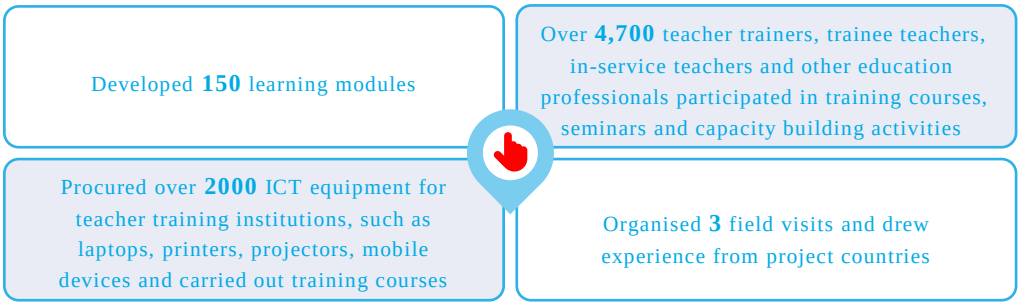
In 2012, the Chinese government signed an agreement to establish the UNESCO-China Funds in Trust (CFIT) and launched the project "Harnessing Technology for Quality Teacher Training in Africa" through promoting the use of ICT in teacher training. The project is in line with UNESCO's Priority Africa Strategy, and serves SDG4 – Quality Education, more specifically Goal 4.C: "By 2030, substantially increase the supply of qualified teachers, including through international cooperation for teacher training in developing countries, especially least developed countries and small island developing States". The project involved ten countries: the Congo, Côte d'Ivoire, Democratic Republic of the Congo, Ethiopia, Liberia, Namibia, Tanzania, Togo, Uganda, Zambia, and was implemented in 3 phases. The main beneficiaries on national level were teaching training institutes.

The project had 4 components:

- Strengthen existing pre-service teacher training programmes, especially through ICT-enabled blended training programmes and successful ICT innovation
- Strengthen in-service teacher professional development, especially through blended learning mode and successful ICT innovation
- Improve ICT capacity of teacher trainers in order to enhance teaching quality
- Strengthen teacher training and teacher training institutes network, promote effective knowledge sharing of policies and teaching practices

Main outcomes and outputs:

the CFIT project enhanced the capacity of key teacher training institutes, improved pre-service teaching training programmes, strengthened support for in-service teacher professional development, and promoted knowledge sharing among policymakers, institutional leaders and relevant stakeholders. More specifically, the project had the following outputs:



The CFIT project received positive feedback from project countries. The good practices emerging from the project gained international recognition and formed reproducible experience.[68]

Clear division of labour： the project implementation was at the level of beneficiaries – national teacher training institutes. In various countries, UNESCO offices and institutes provided support to countries according to their respective comparative advantages, capacities and geographical proximity.

Phased project implementation: the first phase of the project was implemented in 3 countries (Côte d'Ivoire, Ethiopia and Namibia). After the mid-term evaluation of the first phase, the second phase was launched in 5 countries (the Congo, DRC, Liberia, Tanzania and Uganda) based on existing experience. After the end of the second phase, the third phase was launched in 2 countries (Togo and Zambia) based on the achievements of the first and second phase. This implementation mode allowed continuous improvement through the project cycle.

Country ownership of the project: (a) each project country team is comprised of education experts and individuals from universities. UNESCO employed national project officers to support, coordinate and monitor project implementation. Under the overall objectives and implementation strategy, each country project team could flexibly adjust the content and method of implementation, which ensured the relevance of the project to local context. (b) As an example, CFIT cooperated with the Ugandan Ministry of Education to develop a localised ICT competency framework for teachers. This filled a gap in the Ugandan national teacher training system, and provided guidance for designing teacher ICT competency courses, as well as improving training quality.

68. UNESCO Education Sector, Improving the quality of teacher education in sub-Saharan Africa: Lessons Learnt from a UNESCO-China Funds-in-Trust project, 2018.

Influence and sustainability of the project: the CFIT project strengthened knowledge sharing networks, connecting education professionals through online and offline forums. For example, "champion schools" were selected from Namibian schools that participated in the project. These "champion schools" supported teachers from other schools to improve ICT capacity. In-service professional forum connected teachers and teacher trainers. In the Congo, the DRC and Tanzania, CFIT-sponsored national teacher training online platform gained governmental recognition and were transformed into official national teacher online training platforms.

Case study 6: OER@AVU: enhancing teacher capacity of ICT integration in education through Open Education Resources (OER)

The African Virtual University is a pan-African intergovernmental organisation with a mandate to increase access to quality HE through the innovative use of ICT. AVU launched the OER@AVU project in 2011 with the support of the African Development Bank and the African Development Fund, a teacher education programme that aims to improve the teaching and learning quality through the use of ICT, to increase the number of teachers competent in using ICT skills and to promote regional integration and partnerships with other teacher education initiatives in Africa.[69]

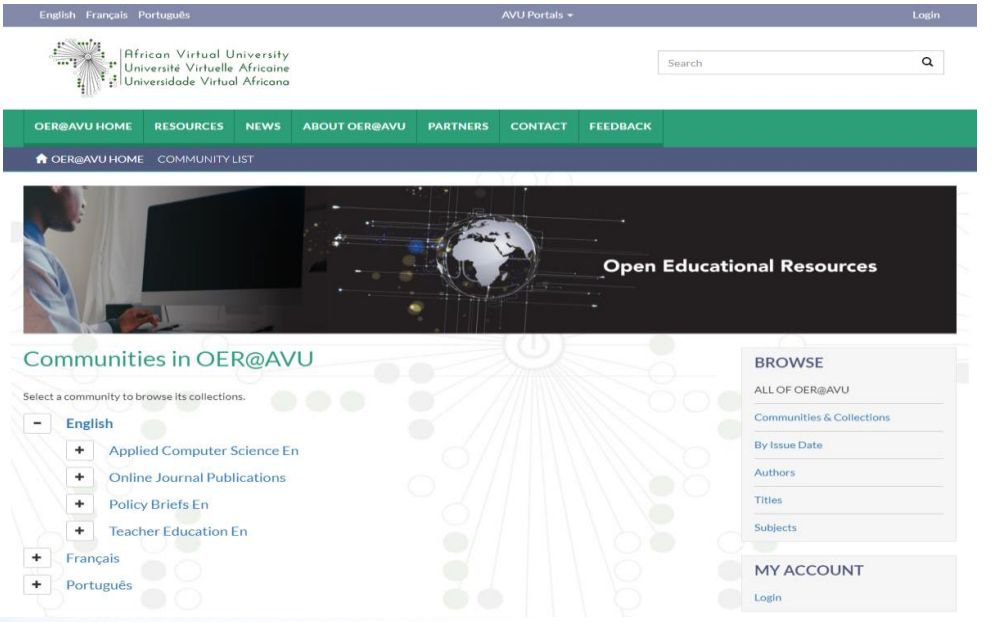


Image - 3: online portal of OER@AVU (Source: OER@AVU)

69. A. Atieno Adala, Current State of Advancement of Open Educational Resources in Kenya, 2016, UNESCO Institute for Information Technologies in Education, https://iite.unesco.org/pics/publications/en/files/3214744.pdf

The OER@AVU hosts a total of 1,623 resources in English, French and Portuguese as of July 2018.[70] Through collaboration among a consortium of universities across the African continent, modules on ICT integration in education, teacher education professional courses, ICT basic skills and other disciplines were developed. Through a collaborative process, experts from universities drafted recommendations for developing OER, identified common thematic areas in curriculum and discussed how ICT could be used in teaching and learning. After conceptualising the curriculum, a needs analysis was done for ICT integration in education. Experts then identified necessary ICT competencies for teachers and drafted recommendations for appropriate in-service and pre-service teachers' curriculum. The module content was then developed and made available online as well as in printed and DVD version.

The OER@AVU platform hosts a comprehensive set of modules on ICT integration in education. For example, the modules on ICT integration in teaching mathematics, physics, biology, and chemistry include guidance for integrating ICT in designing learning activities, conducting evaluation, research and problem solving, professional development in the teaching of disciplines, and helping students take ownership of ICT in their learning. The platform also provides modules on educational research, classroom management and supervision, managing educational resources, etc.[71]

In recognition of its contribution towards improving open and distance education, including enhancing teacher professional development through ICT integration in education, the AVU received 5 international awards, such as the 2017 Open Education Consortium (OEC) Individual Leadership Prize, the International Council for Distance Education (ICDE) Institutional Prize 2015 and 3 other OEC prizes related to OERs in 2013, 2012 and 2011.[72]

The OER@AVU project serves as an example of regional inter-university collaboration for development of open and distance teacher education and training programmes. The availability of resources in multiple languages via both online and offline delivery mode improved the accessibility and openness of the project. However, the resources are only available in text format, without multimedia resources. This is an area to improve on, so that teachers could better utilise the resources in a more interactive manner.

70. AVU, "AVU releases hundreds of new open educational resources", https://avu.org/avuweb/en/avu-releases-hundreds-of-new-open-educational-resources/
71. AVU, "Teacher Professional Development Courses", https://oer.avu.org/handle/123456789/499
72. AVU, "AVU releases hundreds of new open educational resources", https://avu.org/avuweb/en/avu-releases-hundreds-of-new-open-educational-resources/

V. Conclusion

HEIs should establish incentives for TPD and encourage HE professionals to improve their ICT capacity.

HEIs should establish incentives for TPD and encourage HE professionals to improve their ICT capacity. The key bottleneck in implementing TPD policies is insufficient incentives and support for teachers. As a key driver of digital transformation of HE, HE teachers themselves need to be empowered to equip themselves with technologies. To do so, there needs to be clear TPD plans, which incorporates ICT capacity into teacher assessment mechanisms and ensures there is adequate time for teachers to participate in trainings. There also needs to be dedicated structures in HEIs for TPD, adequate financial and material resources, psycho-social and managerial support for teachers to adapt to new technologies and become full agents in harnessing technologies in their daily work.

HEIs should explore multi-stakeholder partnerships and jointly build systematic, sustainable and accessible teacher ICT capacity building programmes.

HEIs should explore multi-stakeholder partnerships and jointly build systematic, sustainable and accessible teacher ICT capacity building programmes. To make TPD effective, capacity building programmes need to be on-scale, following national and institutional competency frameworks which suit the needs of HE and the labour market. These programmes should also be sustainable and be equipped with appropriate monitoring and evaluation mechanisms, in order to track the relevance of such programmes and to continuously improve it. To make sure that no one is left behind, these programmes should ideally be open and free-of charge. HEIs can also harness the resources and training programmes of enterprises, construct training courses and jointly issue teacher competency certifications with third parties.

Provision of quality digital infrastructure, devices and tools enabling teacher ICT capacity building.

Provision of quality digital infrastructure, devices and tools enabling teacher ICT capacity building. This includes reliable power supply, appropriate campus buildings and classrooms, affordable and stable internet services, user-friendly devices and software supporting OBTL. V

06 Online Education Resources

I. Definition

In this chapter, “online education resources” bears two dimensions. First, disciplinary online course resources for teaching, including online credit courses. Second, teacher professional development online resources, such as online teacher TPD and tool packages for TPD.

II. Situation analysis

Currently, there is an increasing number of local education resources and platforms in sub-Saharan Africa. However, they do not yet fulfil the needs of HE in sub-Saharan Africa. Among the 15 current and perspective partner countries of UNESCO-ICHEI in sub-Saharan Africa, 7 countries established national online course and education platforms, 3 countries have online platforms on the university level, while 5 do not have or are in the process of building online education platforms. On the continental level, the Pan-African Virtual and E-University is an AU flagship project to promote online and distance HE. The PAVEU online platform is based on Moodle and hosts 7 online courses, with over 1934 participants. It has also organised over 350 activities. On the national level, local platforms and resources have emerged in Côte d’Ivoire, Ethiopia, Kenya, Senegal, South Africa, and Uganda, among other countries. For example, Witwatersrand University MOOC platform at Wits University of South Africa provides free-of-charge or partly free online courses using edX. EthioStudy platform of Ethiopia, the Virtual University of Côte d’Ivoire and the Virtual University of Senegal host locally developed online education resources.

However, the emergence of these platforms has not yet managed to change the overall situation of the lack of local online education resources tailored to sub-Saharan perspectives. There are several main reasons. First, teachers lack training on integrating ICT in education, many teachers are accustomed to traditional pedagogy. Thus, there is gap in capacity to transform offline courses into online education resources. Second, the communication towards

student and the public remains insufficient. This resulted in low degree of recognition of online education, or even resistance towards online education on the part of students and the public.[73]

The COVID-19 pandemic has further highlighted the issue of insufficient online education resources in sub-Saharan countries. A report by eLearning Africa and EdTech Hub in 2020 shows that the lack of appropriate online education resources and curricula is a major challenge to ensuring education continuity in the COVID-19 era.[74] In the report, a survey targeting over 1,000 teachers in sub-Saharan Africa demonstrated that many teachers call for the inclusion of eLearning in curriculum, development of online education resources and relevant trainings and tools.

III. Major gaps

There exists several major gaps in the online education resources in sub-Saharan Africa.

Locally produced, systematic quality online education resources remain insufficient.

Locally produced, systematic quality online education resources remain insufficient. Online education resources provided by international commercial platforms and the global north lack African perspectives, which negatively impacted on the relevance of such resources. In addition, online education resources dedicated towards HE teacher professional development are in shortage. Many existing online education resources are tailored to K-12 teachers.

In order to realise digital transformation of HE, online education should not merely be a supplement to offline education. Rather, online education should be systematic and fit HEIs' disciplinary and pedagogical needs. The wide application of OBTL in the COVID-19 era further underlined this trend. However, online education resources in sub-Saharan Africa are not well systematised, which do not meet the requirements for digital transformation.

73. Nicolas Roland, Marie Stavroulakis, Nathalie François, Philippe Emplit, 2017, « MOOCs Afrique : analyse de besoins, étude de faisabilité et recommendations »
74. eLearning Africa and EdTech Hub, September 2020, The Effect of COVID-19 on Education in Africa and its Implications for the Use of Technology: A Survey of the Experience and Opinions of Educators and Technology Specialists

Inadequate free-of-charge, quality online education resources.

Inadequate free-of-charge, quality online education resources. Due to copyrights constraints, many online education resources provided by commercial platforms and the global north cannot be adapted according to local conditions in sub-saharan africa. The high costs of these resources also hinder the use of these resources. Amid disruptions to offline education due to the COVID-19 pandemic and the trend towards digital transformation of HE, heis, education professionals and students who are unable to access digital tool packages and online education resources would be even more disadvantaged.

Lack of coordination among multiple online education platforms and initiatives.

Lack of coordination among multiple online education platforms and initiatives. Governments, universities, NGOs, and international development agencies have launched a plethora of online education platforms and capacity building initiatives. On the national level, there are virtual universities (e.g. Côte d'Ivoire, Nigeria and Senegal) and national MOOCs platforms (e.g. Egypt, Ethiopia). Many African universities have their own online education platforms (e.g. Astria platform of the University of Zambia). International development partners also launched initiatives such as the Atingi Platform by GIZ, the REAMOOC network by AUF with financial support from the European Union. On the one hand, this shows that online and distance education is getting more attention, which is beneficial for more financial investments and transferring know-how to facilitate the digital transformation of HE in sub-Saharan Africa. On the other hand, the multiple platforms and initiatives bear similarities in terms of content, objectives and target audiences, which could be counterproductive for concentrating resources to meet the demands of African HE. Inevitably, different stakeholders would insist on keeping the independence of their respective initiatives. Therefore, the coordination of various stakeholders' interests and resources remains a challenge to be solved.

IV. Best practices

Case study 7: Virtual University of Côte d'Ivoire – localised MOOCs content + capacity building for local teachers

The Virtual University of Côte d'Ivoire (UVCI) is a public university established by the Ivorian government in 2015. **It has 3 main functions:**

Offer online and distance education and degrees from bachelor's to doctoral level, covering humanities, sciences, and engineering disciplines.

Construct national MOOCs platform and online learning platform, provide trainings on MOOCs production to public university teachers.

Publicise scientific culture and improve the public's acceptance of online and distance education.

In terms of MOOCs production, UVCI is a leading institution in Côte d'Ivoire and even West Africa. UVCI and the Ivorian Ministry of Higher Education launched an appeal to all public universities in the country at the end of 2017 and beginning of 2018, calling for MOOCs production. The selected projects came from 7 public universities, covering chemistry, agriculture, ICT, disaster management, etc. Under the coordination of UVCI and with financial support from the Ivorian and French governments, French and Swiss universities provided trainings on MOOCs production for teachers. The trainings supported Ivorian teachers on curriculum design, production of courses and uploading of courses to the national MOOCs platform ivoiremooc.uvci.edu.ci. Through this international project, Ivorian teachers benefited from trainings and improved their capacity to produce MOOCs. The ivoiremooc platform now hosts 14 MOOCs produced UVCI, other public universities in Côte d'Ivoire, the Ivorian Ministry of Higher Education and French universities.

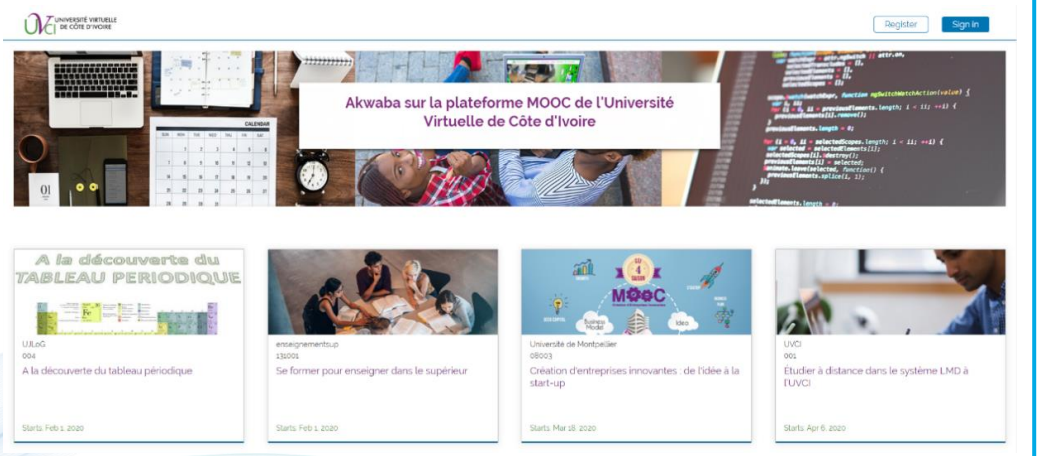


Image - 4: ivoiremooc online platform (Source: ivoiremooc.uvci.edu.ci)

In 2020, due to the COVID-19 pandemic, university campuses across Côte d'Ivoire closed in March. Amid these circumstances, UVCI has received a new mandate from the Ivorian government to coordinate the training on distance education for all university teachers. During campus closure, UVCI worked to ensure education continuity via 2 main means. First, online pedagogy – transferring face-to-face teaching online, preserving traditional pedagogy and learning methods. Second, techno-pedagogy – train teachers to produce online courses.[75] UVCI also established an online assistance platform to help other Ivorian universities ensure education continuity through digital technologies.

UVCI's practices embodied the spirit of adapting MOOCs to African local realities and development needs. During the process of MOOCs production, local teachers' capacities were enhanced through international cooperation. National MOOCs platform and online learning management systems were built. Compared to purchasing courses from commercial platforms, this was a significant progress. UVCI has established a complete local online and distance education support ecosystem for Ivorian HEIs. Appealing to public universities in the country for MOOCs project ensured the quality of MOOCs through a competitive mechanism. However, the number of MOOCs produced is very limited and does not have a systematic disciplinary structure. The repository of online resources is not yet capable of independently supporting OBTL.

Case study 8: UNESCO ICT CFT OER project – multilateral open-source education resources and support ecosystem for teachers' ICT capacity building

The project was initiated by the UNESCO Communication and Information Sector, with the aim to help improve teachers' ICT in education capacity through developing localised ICT CFT and online training modules, as well as through organising teacher capacity building activities. As of 2019, 12 African and Asian member states joined the project. The UNESCO ICT CFT is a normative guidance on teachers' ICT capacity in education. The current version was published in 2018 as the third version.

UNESCO built an online platform to host open-source, free-of-charge teacher ICT capacity building modules and TPD tools.[76] The modules were developed by member states' ministries of education and leading national universities according to the UNESCO ICT CFT, in the form of videos and texts. The tools were developed jointly by UNESCO, the Commonwealth Secretariat, COL, Microsoft, and several countries in the Caribbean and the Pacific. The modules and tools were shared on the platform under the Creative Commons License. In addition, the project also supports member states to develop national ICT in education strategies, collect education data and develop curricula.

75. Ministry of Higher Education and Scientific Research of Côte d'Ivoire, 10 April 2020, "Professeur Koné Tiemoman, DG de l'Université Virtuelle de Côte d'Ivoire/ " Notre savoir-faire nous permet d'accompagner toute structure "
http://www.enseignement.gouv.ci/index.php?open=actualite&actu=article&artID=1075
76. UNESCO, ICT CFT OER Commons, https://www.oercommons.org/hubs/UNESCO

Image - 5: UNESCO ICT CFT OER Commons website
(Source: https://www.oercommons.org/hubs/UNESCO)

ICT CFT Aligned Resources

The Framework is arranged in three different approaches to teaching. Knowledge Acquisition, enabling students to use ICT in order to learn more efficiently. Knowledge Deepening, enabling students to acquire in-depth knowledge of their school subjects and apply it to complex, real-world problems. Knowledge Creation, enabling students, citizens and the workforce they become, to create the new knowledge required for more harmonious, fulfilling and prosperous societies.

	Knowledge Acquisition	Knowledge Deepening	Knowledge Creation
Understanding ICT in Education	Policy Understanding **24 Resources**	Policy Application **18 Resources**	Policy Innovation **8 Resources**
Curriculum and Assesment	Basic Knowledge **13 Resources**	Knowledge Application **22 Resources**	Knowledge Society Skills **11 Resources**
Pedagogy	ICT-enhanced Teaching **29 Resources**	Complex Problem Solving **29 Resources**	Self Management **11 Resources**
Application of Digital Skills	Application **31 Resources**	Infusion **28 Resources**	Transformation **7 Resources**
Organization and Administration	Standard Classroom **11 Resources**	Collaborative Groups **13 Resources**	Learning Organizations **12 Resources**
Teacher Professional Learning	Digital Literacy **16 Resources**	Networking **18 Resources**	Teacher as Innovator **9 Resources**

Image -6: ICT CFT aligned resources on the UNESCO ICT CFT OER Commons website
(source: https ://www.oercommons.org/hubs/UNESCO)

The project has several important lessons. First, it operationalised the UNESCO ICT CFT, transforming a normative document into concrete online resources and tools for TPD resources and tools. Second, through multilateral cooperation, UNESCO mobilised education ministries and universities from Africa and Asia to jointly build resources and tools adapted to local realities. Third, the open-source principle ensured that these outcomes could benefit teachers worldwide free-of-charge. Nevertheless, most resources on the platform correspond to the basic and intermediate levels of the UNESCO ICT CFT, while advanced level resources remain limited.

V. Conclusion

The main issue of online education resources in sub-Saharan Africa could be summarised as: insufficient quality, open-source, local online education resources. Combining best practices, the construction of online education resources adapted to the needs of digital transformation of HE in sub-Saharan Africa should embody the following elements:

The construction of online education resources should be systematic.

The construction of online education resources should be systematic. HEIs should build online education resources according to local development needs and HEIs' teaching and research. Its construction should be systematic, in line with disciplinary needs. Considering that mobile device is the main tool for accessing the internet in sub-Saharan Africa, online education resources should be mobile-friendly and accessible offline.

Build capacities of local teachers to develop and utilise online education resources.

Build capacities of local teachers to develop and utilise online education resources. To sustainably produce quality local online education resources, local teachers should have the capacity to independently analyse local needs, plan, produce and apply online education resources. This involves pre-service training, in-service continuous TPD and networking among teachers. This requires systematic, multi-level, certified teacher capacity building programmes, with appropriate monitoring and evaluation. Teachers will need support from governments, universities, international organisations, NGOs and the private sector.

Enhance the co-construction and sharing of online education resources.

Enhance the co-construction and sharing of online education resources. There is need to develop more open-source online education resources adapted to the needs of HE and to build knowledge sharing networks among universities and countries. The Creative Commons License is an effective way of sharing open-source online education resources.

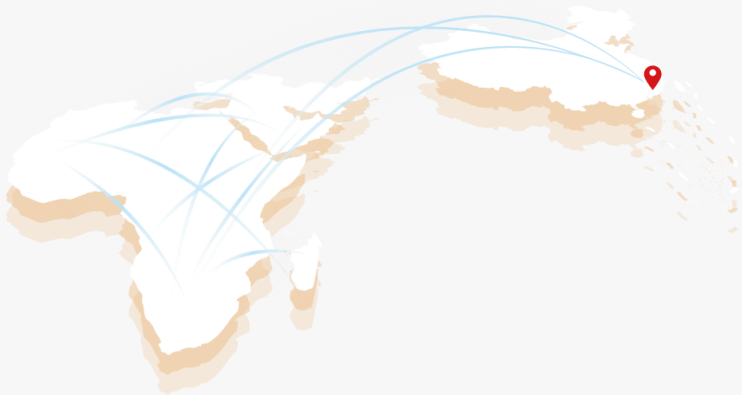
Improve the quality and public recognition of online education resources.

Improve the quality and public recognition of online education resources. Without public support, online education resources cannot be applied widely and effectively, or realise its full potential in promoting the digital transformation of HE.

Strengthen online education resources through multi-stakeholder cooperation.

Strengthen online education resources through multi-stakeholder cooperation. Coordinate among multiple platforms and initiatives, in order to form synergies for the digital transformation of HE in sub-Saharan Africa. This requires partnerships on national, regional, and international levels, especially south-south and south-north-south cooperation to promote joint building of resources and sharing of benefits.

Finally, the production and application of online education resources cannot be realised without the support of other elements of digital transformation: enabling regulatory framework, quality ICT infrastructure and devices, well-trained qualified teachers capable of producing and applying online education resources. All these elements are indispensable for a holistic digital transformation of HE. V



07 The Case of UNESCO-ICHEI: Leveraging Multi-stakeholder Partnerships for Digital Transformation of Higher Education

I. Mission of the International Centre for Higher Education Innovation under the auspices of UNESCO (UNESCO-ICHEI)

As the only UN agency with a mandate in higher education, UNESCO has pointed out the importance of ICT in education. The Incheon Declaration and Framework for Action for the implementation of Sustainable Development Goal 4, released in September 2015, points out that "Information and communication technologies (ICT) must be harnessed to strengthen education systems, knowledge dissemination, information access, quality and effective learning, and more effective service provision."[77] UNESCO has been adhering to its “Priority Africa” strategy, putting special focus on the development needs of African countries to support the realisation of Agenda 2063 adopted by the African Union. Enhancing teacher training and education through ICT-enabled and other blended methods, ICT competency training for teachers are included as flagship programmes.[78]

As a UNESCO Category 2 Centre, UNESCO-ICHEI actively responds to UNESCO's call to assist and support the ICT competency development of university teachers in African developing countries to improve HE access and quality.

In 2020, COVID-19 had a major impact on higher education. Schools and universities in many countries were forced to close their campuses. Many universities and teachers in developing countries could not ensure education continuity during the pandemic, higher education was widely disrupted due to insufficient preparedness. To support the higher education sector in developing countries to effectively tackle the current challenges and assist African HEIs' efforts in ensuring education continuity, UNESCO-ICHEI co-launched the International

77. UNESCO, 2015, Incheon Declaration and Framework for Action for the implementation of Sustainable Development Goal 4: Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
78. UNESCO, 2014, Operational Strategy for Priority Africa 2014-2021

Institute of Online Education (IIOE) in April 2020 with 11 top-tier partner universities, EdTech companies and HEIs in Africa and the Asia-Pacific. IIOE serves as a platform for teachers' ICT competency training in developing countries, which provides teachers with tailored ICT competency training programmes to enhance their capacity of utilising ICT in teaching activities, as well as their awareness of frontier ICT-related subject matters. To assist teachers in competency development and education delivery, IIOE also provides partner HEIs with a large pool of open online courses, focusing on the ICT field.

II. UNESCO-ICHEI Smart Classrooms: Infrastructure and Hardware Support for African HEIs in the Digital Transformation

In order to improve the digital infrastructure of African universities, UNESCO-ICHEI, together with global enterprise partners in educational technology, has established multi-functional smart classrooms for African universities, integrating hardware and software. Smart Classrooms are equipped with advanced hardware and software tools to enable online and blended teaching, including interactive touch panel, student terminals, a server, an uninterruptible power supply unit, a recording and broadcasting system, a wireless visualiser, wireless microphones and network switches. Smart Classrooms are also equipped with a learning management system which provides an interactive learning environment. As of December 2020, 2 Smart Classrooms were implemented in Djibouti and Egypt respectively. During the critical period of the global response to COVID-19, partner HEIs conducted course recording and online teaching through smart classrooms, effectively mitigating the disruption to learning caused by the pandemic.

III. IIOE: empowering digital transformation higher education of in Africa through enhancing teachers' ICT competencies

1.Customised and Micro-Credential ICT Competency Training Programme for Teachers >>>>>>>>

The main function of IIOE is to enhance the competency of higher education teachers in developing countries, especially their ability to use new technologies to transform traditional teaching, carry out online and blended teaching and management, and realise digital transformation in HEIs. In contrast to traditional teacher training programmes, IIOE's teacher capacity building and online training programmes emphasise customisation and ICT competencies. The IIOE training programme was launched based on a comprehensive needs assessment of African universities, aiming to enhance the capacity of African university teachers to carry out online and blended teaching, transform educational administration and management with new technologies, and help HEIs to train talents that

meet the demands of national development and the digital era.

IIOE's Competency Framework consists of three dimensions, each of which is divided into three different levels. The details are as follows:

	General Awareness Cultivation	Intermediate Capacity Building	Advanced Knowledge Application
Dimension 1 Competencies for online and blended teaching and learning	**Awareness** of ICT-based education technologies; **Understanding** of online-education pedagogies	Use of ICT instruments to improve education quality; ICT-empowered pedagogical skills	Cultivate innovative thinking, guide teachers to creatively use ICT instruments and **explore** new educational and teaching models
Dimension 2 Competencies for ICT-enabled administration and management	Knowledge of ICT-based management tools, awareness of technology-based educational **administration**	Master in ICT-based tools such as online office, AI teaching evaluation and big data assessments to **empower education management**	**Designing administrative** systems and educational policies that are in line with the requirements of the digital age
Dimension 3 Competencies for emerging ICT in industries and higher education	Understand the application scenarios of front-line ICT technologies and up-to-date developments of ICT-related disciplines	Master and update the subject knowledge in the ICT-related disciplines, and enhance applicable skills	Flexibly use ICT knowledge to **carry out research and advance the development of the relevant fields**

Figure - 5: IIOE Competency Framework for Teachers (source: UNESCO-ICHEI)

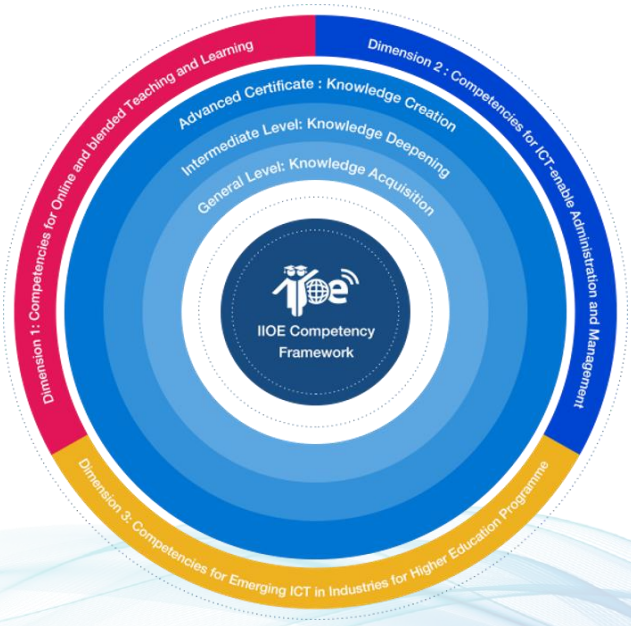


Figure - 6: IIOE Competency Accreditation Framework (Source: UNESCO-ICHEI)

Under the guidance of the IIOE Competency and Accreditation Frameworks, IIOE trainings were launched in the form of competency-based micro-credential programmes. Students who successfully complete each programme of study will receive a UNESCO-ICHEI Certificate of Competency.

In order to respond to acute shortages in capacity and human capital in the fields of ICT frontier technologies, the IIOE ICT Competency Training Programme prioritises eight key areas: Cloud Computing, Big Data, IoT, AI, Blockchain, Programming languages and development, 5G, and Quantum Computing. Through enhancing the awareness of frontier ICT technologies among African university teachers and administrators, the training programme seeks to empower HE professionals to use frontier ICT technologies in teaching, research, and management. The enhancement of teacher capacity will in turn benefit students with the latest ICT knowledge, thus providing innovative talents for Africa to fully embark on the Fourth Industrial Revolution.

2.Stable Cloud-based Training Platform

In order to solve the problem that many African universities do not have a stable and independent online learning platform, IIOE built an online training platform to facilitate teachers' training and communication, which is open to African universities for free. IIOE online training platform is available in three versions: English, French and Chinese, hosting a variety of online learning resources, online teaching and management tools, and supports teachers' competency assessment and QA functions.

3.Quality Online Courses Free of Charge

In order to support teacher competency building and assist teachers in teaching, IIOE platform provides a large number of quality online courses for IIOE's partner HEIs in Africa. IIOE's online curriculum resources focus on ICT, including ICT frontier disciplines, teacher training courses, and vocational education courses. The courses are mainly in English and French and are produced by teachers from top universities around the world.

IV. UNESCO-ICHEI supports the Digital Transformation of Higher Education in Africa through multilateral cooperation and research

UNESCO-ICHEI, with the support of partners and through the IIOE and Smart Classroom projects, provides universities in African and Asian developing countries with quality and much-needed support for teacher capacity building and digitalisation of HEIs. As of the end of 2019, UNESCO-ICHEI has established a network of seven project countries in Africa, with which it works on a long-term, one-to-one basis and has established comprehensive partnerships. The seven project countries are Djibouti, Egypt, Ethiopia, the Gambia, Kenya, Nigeria, and Uganda.

UNESCO-ICHEI selects one university in each project country as its long-term partner university and conducts a range of cooperation activities in higher education. The selection of UNESCO-ICHEI's long-term partner universities in the seven project countries was based on the recommendations of ministries of project countries, UNESCO and member states' permanent delegations to UNESCO, international enterprises based in these countries, as well as UNESCO-ICHEI's research on these countries. UNESCO-ICHEI's seven long-term partners are Addis Ababa University (Ethiopia), Ahmadu Bello University (Nigeria), Ain Shams University (Egypt), University of Djibouti (Djibouti), University of the Gambia (the Gambia), University of Nairobi (Kenya), and Makerere University (Uganda).

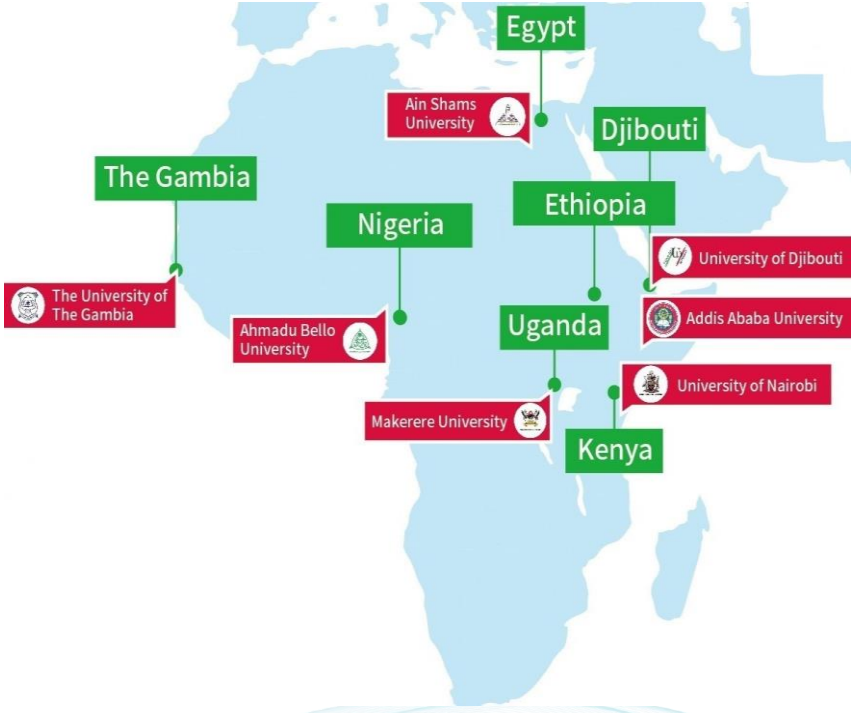


Image - 7: UNESCO-ICHEI's long-term partner universities in Africa (as of December 2020)

Following the recommendations of UNESCO HQ, UNESCO regional offices in Africa and various countries, UNESCO-ICHEI plans to extend its projects in 9 additional sub-Saharan African countries starting from 2020, namely, Burundi, the Comoros, Côte d'Ivoire, Malawi, Namibia, Senegal, South Africa, Togo, and Zambia.

Image - 8 : UNESCO-ICHEI's current and prospective project countries
(Africa and West Asia, as of December 2020)

6 out of the 9 countries were included in the UNESCO-Shenzhen Funds in Trust Project (Côte d'Ivoire, Malawi, Namibia, Senegal, Togo, and Zambia), as well as 3 other countries which were not included in the SFIT Project (Burundi, the Comoros, and South Africa). UNESCO-ICHEI projects will then be covering all five sub-regions of Africa. This plan serves the Education 2030 Agenda, UNESCO's Priority Africa Strategy and needs of African countries.

In order to ensure sustainable, quality cooperation in higher education with partner countries, UNESCO-ICHEI conducted comprehensive research on these countries, focusing on regulatory framework for digital transformation of HE, ICT infrastructure, teacher ICT capacity building, and online education resources. As the research outcome, this report will hopefully provide useful insights and recommendations for the digital transformation of UNESCO-ICHEI's partner HEIs.

08 Policy Recommendations

In this section, we would like to provide key recommendations for policymakers and HE professionals. The recommendations are structured in accordance with the 4 analytical dimensions of this report: regulatory framework, digital infrastructure, teacher ICT capacity building and online education resources.

Based on the previous situation analyses, gaps identified, and best practices highlighted, the key ingredients for a successful digital transformation are:

An enabling regulatory framework for digital transformation of HE, notably strong leadership support with a clear vision, supportive financial framework, QA and accreditation and recognition systems for OBTL

Massive, systematic, and sustainable teacher ICT capacity building

Appropriate investments in quality digital infrastructure and devices, and access to affordable internet

Quality, open-source online education resources adapted to local realities

I. Recommendations on Regulatory Framework

Achieving digital transformation requires policy makers to articulate holistic visions on ICT integration in HE. ICT in education policies and visions should incorporate important principles such as access, equity and quality.

1. Policymakers in the education sector should embrace multi-stakeholder partnerships by working with their counterparts in the communications sector, HEIs, international organisations, development partners, NGOs and the private sector to understand and shape the digital eco-system of higher education through policies and regulations so that it is friendly for the

education sector. Infrastructure sharing should be promoted, such as simplified right of way approval, and dig-once policies and processes. Community-based access initiatives and educational networks should also be encouraged.

2. Governments should work with private sectors to design well-articulated business models to remove the barriers to investments by creating transparent and affordable licensing, and efficient market-based allocation processes, to guarantee affordable Internet access by HEIs.

3. The lack of QA standards at the regional, national and institutional levels is another major obstacle in the promotion of OBTL. Therefore, there is need to strengthen QA at national, regional and global levels.

- Integration of requirements/standards of OBTL into existing national/institutional QA frameworks. Existing QA frameworks, such as the African Quality Assurance Network and the East African Higher Education Quality Assurance Network, should incorporate OBTL elements.
- Strengthen the functionality of national QA agencies. National QA agencies should strengthen their institutional functions under a solid QA framework. HEIs should implement national QA mechanisms on the institutional level and establish institutional level QA units for internal evaluation and quality enhancement.
- Cooperation of QA on regional level. University leaders should give attention to the regional and global QA initiatives, such as African Council for Distance Education (ACDE) activities and sign related QA agreement. This will help African countries benefit from regional and global best practices, which will also facilitate mutual exchange and strengthen regional coordination.

II. Recommendations on educational digital infrastructure

Solid digital infrastructure and access to them are the bases for digital transformation.

1. Policy makers should adopt multi-stakeholder partnerships and especially public private partnerships to ensure quality digital environment for HEIs. The digital environment should include the affordability of broadband and wireless connectivity for the education sector, provide tax discounts on devices such as computers, smart phones and tablets to facilitate universal access to internet for HEIs. This should also be accompanied by expansion of grids or alternative sources of energy to schools and colleges.

2. Upgrade existing HEIs building standard, such as fixed broadband and wireless networks, electric and fibre outlets, and digital systems enabling cross-campus teaching and exchanges, that help create or upgrade modern HEIs, so that the physical and architectural design of new HEIs take into consideration the requirements for online and blended teaching and learning.

III. Recommendations on Teacher Professional Development

Teacher professional development should be an important area of policy focus because teachers remain the primary agents of ICT integration into education.

1. Provision of massive and updated teacher professional development programmes to cope with teaching in digital age. Without a massive training for teachers on how to use ICT and digital tools for teaching, the digital transformation of HE cannot be achieved. The training should focus not only on ICT skills but also on a new pedagogy related to OBTL.

2. Establish teacher professional development mechanisms. There are three different ways to deliver professional development for teachers:

- Pre-service training for teachers should integrate technology into the teacher training courses to enable teacher and educators with basic ICT literacy and competencies.
- In-service training for teachers should serve as an opportunity to reinforce the training offered at pre-service level and to upgrade capacities required for new pedagogy.
- Special training programmes should be designed for ICT personnel who will compose at each university level, the technical team support for the digital transformation.

3. HEIs should issue relevant regulations to promote and guarantee teachers' professional development. For example, the professional training received by teachers and especially the competencies mastered or certified should be considered as part of the criteria for teachers' career development.

4. Provide teachers with managerial, material, technical, and psychological support, as well as career development plans, to facilitate the transition to online and blended teaching.

- Managerial support should come from national and institutional levels. On the national level, there should be a training strategy and plan for all HE professionals. On the institutional level, there should be dedicated structures and unit responsible for teacher training, such as teacher professional development department and online and distance education centre.
- Material support includes providing teachers with electronic devices (desktops, laptops, smartphones, tablets, etc.), as well as free or discounted data plans and improved campus connectivity.
- Technical support may include training teachers in developing online courses, synchronous teaching, online assessment, knowledge about network and information security, data analysis of student performance, etc.
- Governments, HEIs, the private sector, and development partners should jointly mobilise resources to provide ICT training for teachers and students to facilitate the transition to more flexible teaching practices. To maximise training outcomes, participants should be actively involved and provide constant feedback to make the training more relevant to their needs.
- Psychological support is also essential to the successful implementation of OBTL. Teachers should be encouraged to embrace science and technology and engage in self-education to achieve lifelong learning. HEIs should set up online forums for teachers to share best practices and support each other.

IV. Recommendations on online education resources

Each university should set up its institutional repository for a better knowledge management.

It is essential for university leaders to take the lead of knowledge production, build scientific and technical information databases and set up online university libraries that are accessible for all and from anywhere.

1. Digitisation of textbooks. The first step to provide online learning resources is to make national textbooks available on a designated website in digital formats. In addition, there is need to ensure other OER are available for students and teachers through a central repository or multidisciplinary web portals.

2. Utilisation of OER. Efforts should also be made to avail teachers with tools to reuse, revise, remix and redistribute the content that is available under open licenses. The effective use of OER needs familiarity with the OER model and help building the capacity of educators to source and adapt OER to their local settings. A special attention should be given to the global OER movement in order to implement the principles contained in the Paris OER Declaration 2012.

3. Creation of localised, quality online courses. Policy makers and educational stakeholders should ensure that teachers see the value of sharing and open license content for the public good. While adaptation of open educational content is important, more effort needs to be put into the creation of MOOCs in local languages that could meet the local demands.

09 Conclusion

In contribution to achieving the Education 2030 goals, UNESCO-ICHEI works with HEIs in African and Asian developing countries to promote the digital transformation of Higher Education.

The report is the outcome of research and analysis on the current state of digital transformation of HE in sub-Saharan Africa, focusing on 4 dimensions: regulatory framework on ICT integration in education, digital infrastructure and technology, teacher ICT capacity building, and online education resources. Within each dimension, the report identifies commonalities and gaps among sub-Saharan countries, highlights good practices, and draw conclusions in view of the future of digital transformation of HE in Africa. Its main objective is to analyse how Digital Transformation can improve HE access, equity and quality in sub-Saharan Africa. It also proposes solutions at each decision-making level: continental, national and institutional.

The report indicates that digital technologies and tools should be considered as a means, not an end. The full integration of digital technologies to transform HE must be interwoven with a holistic approach that considers all relevant aspects, in particular pedagogical practices and training. To prevent ICT from being misunderstood as a standalone factor, it is therefore critical to use a methodology that is based on the challenges facing African HE and to devise how digital tools can be carefully deployed to improve HE access, equity and quality.

The key policy recommendations are creating enabling regulatory frameworks, establishing accreditation/recognition and QA mechanisms for OBTL, investing in ICT infrastructure, fostering teacher skills, developing quality online education resources.

It provides case studies of successful digital transformation plans and practices, which requires not only physical infrastructures but also enabling policies, digital tools and more importantly relevant curriculum.

It welcomes emerging OBTL systems, while underlining the quality aspect and the cruciality of providing concrete tools to improve e-learning courses.

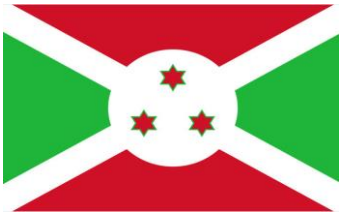
It advises universities to put forward new requirements for HE teachers' capacities, as well as continuous, systematic support for teacher professional development.

It proposes more coordination among initiatives on OBTL, in order to form synergies.

It concludes that digital transformation is to empower the socio-economic development of the continent through leveraging technology. ICT can be a powerful tool, but only so if it is harnessed appropriately and made accessible for all.

This report could hopefully serve as a reference to assist sub-Saharan African HEIs in delivering future innovations, ensuring that technology benefits all, particularly African youth who are leaders of tomorrow.

10 Country Profiles



Burundi lies on the south side of the equator in central Africa. Burundi borders Rwanda to the north, Tanzania to the East and south, Congo to the west, and Tanganyika Lake to the southwest. The country covers an area of 27,834 square kilometres and has a population of about 11.5 million. The official languages are Kirundi and French, with Kirundi being the traditional language of Burundi.[79] Since the beginning of 2015, due to the tense domestic situation, the Burundian economic situation has deteriorated sharply, which has not yet returned to the level before the conflict.

There are 6 public universities and 24 private universities in Burundi. The University of Burundi is a comprehensive public university and has an online course platform.[80] In 2015, there were more than 13000 students at the University. The government of Burundi decided to reform higher education and adopted the Bologna system in 2011. Ministerial Order No. 610 / 2240 (2011) aims to unify the conditions of higher education in order to coordinate the education system at all levels and improve HE quality.

Burundi has a high population density and remains one of Africa's most attractive telecom markets. The government of Burundi launched the Burundi broadband project in early 2018 and plans to achieve nationwide connectivity by 2025. Mobile operators launched 3G and LTE mobile services to meet the growing demand for Internet access. The number of Internet users in the country was about 660,000 in 2018. In 2008, the French-speaking distance education initiative was launched in Burundi, and 1,733 teachers in Burundi were trained by French professors, and 94.3% of the teachers obtained certification through training.[81]

ICT-related data	Burundi	Sub-Saharan Africa average	World average
Internet users (% of population)	2.66 (2019)	25.13 (2018)	50.76 (2018)
Fixed broadband subscription (per 100 people)	0.03 (2019)	0.42 (2018)	14.15 (2018)
Mobile subscriptions (per 100 people)	57.62 (2019)	76.16 (2018)	104.07 (2018)
International bandwidth per Internet user	20,372 (2017)	NA	24,900.10 (2018)

Table - 3: ICT-related data (Burundi)

Higher education-related data	Burundi	Sub-Saharan Africa average	World average
Tertiary education gross enrolment rate	4.06 (2018)	9.44 (2018)	38.85 (2019)
Tertiary education enrolment gender parity index	0.61 (2018)	0.77 (2018)	1.13 (2018)
Tertiary education completion rate	4.18 (2014)	NA	NA
Tertiary education teacher/student ratio	19.80 (2017)	NA	NA
% of government expenditure on tertiary education	1.45 (2013)	NA	NA

Table - 4: Higher education-related data (Burundi)

79. Ministry of Foreign Affairs of the People's Republic of China, October 2020, Country profiles of the Republic of Burundi, https://www.fmprc.gov.cn/web/gjhdq_676201/gj_676203/fz_677316/1206_677486/1206x0_677488/
80. Official website of The University of Burundi, http://moodle.ub.edu.bi/course/index.php
81. Distance Training programme for French teachers (IFADEM), https://www.ifadem.org/fr/presentation/evaluation

The Comoros is an island state and an African Arab country located between Mozambique and Madagascar. The capital of Comoros is Moroni, which is also its largest city. The official languages are Comorian, French and Arabic. Comoros has a total area of 1,862 square kilometres and a population of 874,601. 29.4% of Comorians live in cities, with a median age of 20.9 years.[82] Comoros is one of the least developed countries in the world. Agriculture is the mainstay of the country's economy. It is worth mentioning that Comoros is the world's producer of Elan oil (the main ingredient of many perfumes) and the second largest producer of vanilla.

Comoros has a relatively low level of higher education, and the Ministry of Education and Vocational Training is responsible for formulating national education policies. There is only one university in the country, the University of Comoros. The country's talent training and teacher training rely to a large extent on international cooperation and international organisations.

In the past 7 years, Comoros has made great progress in the field of ICT, but there is still a big gap compared with other Arab countries and the world average.[83] Since 2013, the World Bank has provided Comoros with a large amount of technical, financial and regulatory assistance. With the help of the United Nations Economic Commission for Africa, the Comorian government has formulated a series of ICT development policies, including the use of ICT to increase the potential of human resources, the application of ICT to primary and secondary schools and universities, and thereby promote and support students and teachers. Since entering Comoros in 2005, Huawei has been committed to working with local operators to provide the Comorian people with a safe, stable and high-quality communication network. In addition, Huawei has closely integrated its ICT technology capabilities to actively fulfil its corporate social responsibilities, and conducted ICT equipment donations and ICT certification trainings with well-known local universities to consolidate the ICT talent base required for national development.

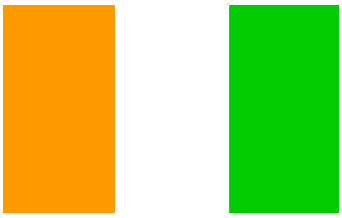
ICT-related data	Comoros	Sub-Saharan Africa average	World average
Internet users (% of population)	8.48 (2019)	25.13 (2018)	50.76 (2018)
Fixed broadband subscription (per 100 people)	0.13 (2019)	0.42 (2018)	14.15 (2018)
Mobile subscriptions (per 100 people)	67.60 (2019)	76.16 (2018)	104.07 (2018)
International bandwidth per Internet user	17,390.50 (2017)	NA	24,900.10 (2018)

Table - 5: ICT-related data (The Comoros)

Higher education-related data	Comoros	Sub-Saharan Africa average	World average
Tertiary education gross enrolment rate	9.00 (2014)	9.44 (2018)	38.85 (2019)
Tertiary education enrolment gender parity index	0.81 (2014)	0.77 (2018)	1.13 (2018)
Tertiary education completion rate	5.00 (2013)	NA	NA
Tertiary education teacher/student ratio	26.31 (2014)	NA	NA
% of government expenditure on tertiary education	0.26 (2015)	NA	NA

Table - 6: Higher education-related data (The Comoros)

82. Central Intelligence Agency, 2020, world factbook, https://www.cia.gov/library/publications/the-world-factbook/geos/print_cn.html
83. International Telecommunications Union，2018, Measuring the Information Society Report 2018 – Volume 2, https://www.itu.int/en/ITU-D/LDCs/Documents/2017/Country%20Profiles/Country%20Profile_Comoros.pdf



Côte d'Ivoire is a coastal country in West Africa, with Yamoussoukro as its political capital and Abidjan as its economic capital. The official language of Côte d'Ivoire is French. From 2012 to 2019, the average GDP growth rate of Côte d'Ivoire reached 8.5%, ranking first in sub-Saharan Africa. GDP is expected to grow by 1.6% in 2020 despite the impact of the Covid-19. The main industries in Côte d'Ivoire are telecommunications, cash crop planting, timber harvesting, and tourism.[84]

The country's higher education system is organised according to the French education system. In terms of distance learning, the Virtual University of Côte d'Ivoire (UVCI) was established in 2018. The current general programme for the development of Côte d'Ivoire is the national development plan (PND 2016-2020), with education and training listed as national priorities. The 2016-2025 Education Sector Plan points out that the higher education sector is facing severe challenges, such as a lack of adequate infrastructure, the uneven quality of private universities, and the insufficient implementation of the system of master's degree and doctoral degree.

In order to develop the digital economy, Côte d'Ivoire has established the African Higher Institute of Information and Communication Technology (ESATIC) to train technicians and engineers in the ICT industry.[85] As a French-speaking country, Côte d'Ivoire has carried out a number of cooperation with France, Switzerland and other French-speaking countries in teaching and ICT capacity-building. In addition, the MOOCs4DEV project of the EPFL (Switzerland) funded by the French Development Assistance Agency helped to build a "MOOCs Factory" equipped with computers, cameras, projectors and recording equipment at the University of Félix Houphouët-Boigny (Abidjan) in Côte d'Ivoire. Teachers and students can use it to produce MOOCs and carry out online learning and teaching.[86]

ICT-related data	Côte d'Ivoire	Sub-Saharan Africa average	World average
Internet users (% of population)	36.45 (2019)	25.13 (2018)	50.76 (2018)
Fixed broadband subscription (per 100 people)	0.84 (2019)	0.42 (2018)	14.15 (2018)
Mobile subscriptions (per 100 people)	145.34 (2019)	76.16 (2018)	104.07 (2018)
International bandwidth per Internet user	8,832.18 (2018)	NA	24,900.10 (2018)

Table - 7: ICT-related data (Côte d'Ivoire)

Higher education-related data	Côte d'Ivoire	Sub-Saharan Africa average	World average
Tertiary education gross enrolment rate	9.34 (2017)	9.44 (2018)	38.85 (2019)
Tertiary education enrolment gender parity index	0.69 (2017)	0.77 (2018)	1.13 (2018)
Tertiary education completion rate	NA	NA	NA
Tertiary education teacher/student ratio	11.67 (2017)	NA	NA
% of government expenditure on tertiary education	0.46 (2018)	NA	NA

Table - 8: Higher education-related data (Côte d'Ivoire)

84. Ministry of Commerce, 2019, Country (region) Guide for Outbound Investment Cooperation: Côte d 'Ivoire (2019 edition), http://www.mofcom.gov.cn/dl/gbdqzn/upload/ketediwa.pdf
85. UNESCO, 2017, Policy Monitoring Platform, Côte d 'Ivoire develops digital economy, https://en.unesco.org/creativity/policy-monitoring-platform/la-Côte-divoire-mise-sur
86. Campus France, January 2019, Université Virtuelle de Côte d'Ivoire (UVCI) : atelier de formation pour les enseignants-chercheurs créateurs de MOOCs, https://www.auf.org/nouvelles/actualites/universite-virtuelle-de-Côte-divoire-uvci-atelier-de-formation-enseignants-chercheurs-createurs-de-moocs/

Djibouti is located in the northeast of Africa. It covers an area of 23,200 square kilometres and has a population of 940,000. The official languages of Djibouti are French and Arabic. The per capita GDP is 2,050 US dollars (2018). Djibouti is one of the least developed countries in the world.[87]

The education system of Djibouti is deeply influenced by France. After graduating from high school, students take the French. examination, those who excel can go abroad to receive higher education. The University of Djibouti is the country's only university. The design of the University of Djibouti is essentially elitist, and fully draws lessons from the French education system. In addition, domestic policies and development planning as well as international aid give priority to the development of basic education, resulting in insufficient investment and support for higher education.

Although ICT has been recognised as a key tool for modernising the education sector to meet the country's diverse human resource needs, there is no specific education policy on ICT in Djibouti. In its Poverty Reduction Strategy, the country is committed to building a resilient education system, promoting university connectivity and establishing ICT training facilities, implementing video conferencing systems, and launching Cisco academy and SchoolNet projects.[88] The Ministry of Communications and Culture has also given priority to building teachers' capacity to use ICT through national education and ICT projects. The e-campus project of the University of Djibouti provides students with services from registration to certification, integrating technologies into university management, including human resources, finance, logistics, etc.

ICT-related data	Djibouti	Sub-Saharan Africa average	World average
Internet users (% of population)	55.68 (2019)	25.13 (2018)	50.76 (2018)
Fixed broadband subscription (per 100 people)	2.66 (2018)	0.42 (2018)	14.15 (2018)
Mobile subscriptions (per 100 people)	41.20 (2018)	76.16 (2018)	104.07 (2018)
International bandwidth per Internet user	19,022.70 (2017)	NA	24,900.10 (2018)

Table - 9: ICT-related data (Djibouti)

Higher education-related data	Djibouti	Sub-Saharan Africa average	World average
Tertiary education gross enrolment rate	5.35 (2011)	9.44 (2018)	38.85 (2019)
Tertiary education enrolment gender parity index	0.76 (2011)	0.77 (2018)	1.13 (2018)
Tertiary education completion rate	NA	NA	NA
Tertiary education teacher/student ratio	19.20 (2011)	NA	NA
% of government expenditure on tertiary education	0.74 (2010)	NA	NA

Table - 10: Higher education-related data (Djibouti)

87. Ministry of Foreign Affairs of the People's Republic of China, October 2020, Country profiles of Djibouti, https://www.fmprc.gov.cn/web/gjhdq_676201/gj_676203/fz_677316/1206_677704/1206x0_677706/
88. International Monetary Fund，2004，Djibouti: Poverty Reduction Strategy Paper, www.imf.org/external/pubs/ft/scr/2004/cr04152.pdf

Ethiopia is an ancient country with 3,000 years of history, located in northeast Africa. It has a population of 105 million and a land area of 1,103,600 square kilometres. There are more than 80 ethnic groups in Ethiopia. Amharic is the federal working language and English is also widely used. In the past 10 years, the average growth rate of Ethiopia's economy was about 10%.[89]

In Ethiopia's current education system, higher education is divided into four different educational pathways: 2-year, 3-year, 4-year, and 5-year. Generally, universities have 3-4-year undergraduate education. In order to expand the scale of higher education, the Ethiopian government has vigorously promoted the development of HEIs since 2000, and has adopted a series of planning policies, such as "Sustainable Development and Poverty Reduction Programme" (2002) and "Five-year Plan Education Sector Development Plans". The government has also liberalized the management of the higher education system and no longer restricts the development of private colleges and universities. Therefore, private colleges and universities have also developed rapidly, keeping pace with public universities and complementing each other. At the same time, the number of students in private colleges and universities has also increased significantly. This also shows that more and more students in Ethiopia have access to school opportunities, and the illiteracy rate has gradually decreased.[90]

According to the data of the World Bank World Development Indicator, Ethiopia's ICT development level is relatively backward compared with other African countries. The development of ICT in the field of education is particularly hindered. Based on the current difficulties faced by the country, the Ministry of Education is determined to change the current situation through the rapid development of network communication technology. In this regard, the Ethiopian government plans to deploy ICT networks in 300 primary and secondary schools and 10 universities to facilitate teachers and students' access to data centre resources and sharing of high-quality pedagogical resources. Meanwhile, the communication between schools and the Ministry of Education has been facilitated, gradually meeting international standards.[91]

ICT-related data	Ethiopia	Sub-Saharan Africa average	World average
Internet users (% of population)	18.62 (2019)	25.13 (2018)	50.76 (2018)
Fixed broadband subscription (per 100 people)	0.06 (2019)	0.42 (2018)	14.15 (2018)
Mobile subscriptions (per 100 people)	36.20 (2019)	76.16 (2018)	104.07 (2018)
International bandwidth per Internet user	1383.17 (2017)	NA	24,900.10 (2018)

Table - 11: ICT-related data (Ethiopia)

Higher education-related data	Ethiopia	Sub-Saharan Africa average	World average
Tertiary education gross enrolment rate	8.11 (2014)	9.44 (2018)	38.85 (2019)
Tertiary education enrolment gender parity index	0.48 (2014)	0.77 (2018)	1.13 (2018)
Tertiary education completion rate	NA	NA	NA
Tertiary education teacher/student ratio	31.22 (2014)	NA	NA
% of government expenditure on tertiary education	2.27 (2015)	NA	NA

Table - 12: Higher education-related data (Ethiopia)

89. Ministry of Foreign Affairs of the People's Republic of China, October 2020, Country profiles of Ethiopia, https://www.fmprc.gov.cn/web/gjhdq_676201/gj_676203/fz_677316/1206_677366/1206x0_677368/
90. Education in Ethiopia, 2020, WENR, https://wenr.wes.org/2018/11/education-in-ethiopia
91. ICT in Education in Ethiopia, infodev, https://www.infodev.org/infodev-files/resource/InfodevDocuments_402.pdf

The Gambia is located in the Atlantic coast area of West Africa, covering an area of 11,295 square kilometres, surrounded by Senegal in the north, East and south. English is the official language of Gambia. Gambia is the smallest country on the African continent, with a population of 2.35 million (2017), and the main religion is Islam. The GDP per capita of Gambia is 762 US dollars, which is listed as one of the least developed countries in the world by the United Nations. Agricultural labour accounts for 75% of the total labour force, and agricultural output accounts for 17.8% of GDP (2016). The industrial output accounts for about 13.4% of GDP (2016), while the service industry accounts for 19% of GDP.[92]

There are 270 literacy centres in Gambia, and primary schools are free of charge.[93] The University of Gambia, the highest educational institution in the country, was founded in 1999. It has colleges of medicine, agriculture and biology, science and technology, humanities, social sciences, education and economics, with an annual enrolment of about 1000. Since 2005, the University of Gambia has been assisted by the Norwegian Education Trust. The Ministry of Higher education, Research, Science and Technology was established in 2007.

There are four mobile operators in Gambia: Africell, Comium Group, Gamcel and Qcell. The goal of Gambia's informatization is to make the country a digital country and establish a modern information society. The Gambia has a 5.12 megabit/sec ace cable connected to Banjul, providing excellent network connectivity to the rest of the world. The number of secure Internet servers is 3.9 per million people. Gambia ranked 10th in ICT among African countries, ahead of other countries, including Nigeria, Senegal and Mali.[94] Gambia has also organised some school teacher trainings to improve ICT skills.

ICT-related data	Gambia	Sub-Saharan Africa average	World average
Internet users (% of population)	19.84 (2019)	25.13 (2018)	50.76 (2018)
Fixed broadband subscription (per 100 people)	0.19 (2019)	0.42 (2018)	14.15 (2018)
Mobile subscriptions (per 100 people)	139.53 (2019)	76.16 (2018)	104.07 (2018)
International bandwidth per Internet user	12,575.80 (2016)	NA	24,900.10 (2018)

Table - 13: ICT-related data (The Gambia)

Higher education-related data	Gambia	Sub-Saharan Africa average	World average
Tertiary education gross enrolment rate	2.73 (2012)	9.44 (2018)	38.85 (2019)
Tertiary education enrolment gender parity index	0.70 (2012)	0.77 (2018)	1.13 (2018)
Tertiary education completion rate	0.10 (2015)	NA	NA
Tertiary education teacher/student ratio	23.15 (2012)	NA	NA
% of government expenditure on tertiary education	0.24 (2015)	NA	NA

Table - 14: Higher education-related data (The Gambia)

92. Ministry of Foreign Affairs of the People's Republic of China, September 2020, Country profiles of Gambia, https://www.fmprc.gov.cn/web/gjhdq_676201/gj_676203/fz_677316/1206_677632/1206x0_677634/
93. International telecommunications Union, 2019, https://www.itu.int/
94. Ministry of Education of Gambia, 2019, http://www.edugambia.gm/

Kenya is located in the east of Africa. The southeast of Kenya is bordered by the Indian Ocean, with a coastline of 536 kilometres. Kenya is divided into seven provinces and one provincial special zone (Nairobi province). The main cities include Nairobi (capital), Mombasa, Kisumu. Kenya has a total population of 47.564 million (2019). There are 44 ethnic groups in Kenya. Swahili is the national language, and English is the official language. Kenya is one of the countries with a good economic foundation in sub-Saharan Africa. In 2019, Kenya's GDP is US$95.5 billion, and its GDP per capita is US$1,816, with an economic growth rate of 5.4%, ranking seventh in Africa.

Kenya has implemented free primary education for eight years since January 2003. The education system is divided into formal education and non-formal education. Formal education adopts the "8-4-4" schooling system of primary school, middle school and university. Non formal education includes adult education and literacy activities. There are 60 universities, 30 vocational training schools, 3 technical schools and 12 private universities. There are 198,000 university students. Famous institutions of higher learning include the University of Nairobi, Moi University, Kenyatta University, Egerton University, Jomo Kenyatta College of Agriculture and Technology, and Maseno University.[95]

According to the World Bank's World Development Index, compared with other African countries, Kenya's ICT development level and ICT market are at the upper middle level, and it is the country with the highest network connectivity in East Africa. In recent years, Kenya has developed rapidly in digital learning. More and more digital platforms have emerged in Kenya to help students and teachers interact online. In terms of online courses, many universities and institutions in Kenya have set up online learning departments and provide online courses. The Digital School of the University of Kenya offers degree, diploma and master's courses; the open and distance learning centre of the University of Nairobi provides undergraduate and postgraduate courses in distance learning; the Kenya Open Learning Institute, the self-funded e-learning programme of the Egerton University, Moi University distance learning programme, and Jomo Kenyatta College of Agriculture and Technology's distance learning and continuing education centre also provide different types of online degree courses.[96]

ICT-related data	Kenya	Sub-Saharan Africa average	World average
Internet users (% of population)	17.83 (2017)	25.13 (2018)	50.76 (2018)
Fixed broadband subscription (per 100 people)	0.93 (2019)	0.42 (2018)	14.15 (2018)
Mobile subscriptions (per 100 people)	103.77 (2019)	76.16 (2018)	104.07 (2018)
International bandwidth per Internet user	386,743 (2017)	NA	24,900.10 (2018)

Table - 15: ICT-related data (Kenya)

Higher education-related data	Kenya	Sub-Saharan Africa average	World average
Tertiary education gross enrolment rate	11.47 (2017)	9.44 (2018)	38.85 (2019)
Tertiary education enrolment gender parity index	0.74 (2017)	0.77 (2018)	1.13 (2018)
Tertiary education completion rate	NA	NA	NA
Tertiary education teacher/student ratio	27.00 (2017)	NA	NA
% of government expenditure on tertiary education	0.69 (2015)	NA	NA

Table - 16: Higher education-related data (Kenya)

95. Ministry of Foreign Affairs of the People's Republic of China, October 2020, Country profiles of Kenya, https://www.fmprc.gov.cn/web/gjhdq_676201/gj_676203/fz_677316/1206_677946/1206x0_677948/
96. Kenyayote, March 2020, Online Courses in Kenyan Universities: Apply for distance learning, degree, diploma, https://kenyayote.com/online-courses-kenyan-universities-apply-distance-learning-degree-diploma/

Malawi is a landlocked country in southern Africa and is surrounded by Tanzania, Mozambique, and Zambia. It has an area of 118,000 square kilometres and a population of 18.092 million. The official language of Malawi is English. Malawi is named after the Malawi Lake, the third largest lake in Africa. With the development of the service industry and the popularisation of education, people with higher education degrees are inclined to non-agricultural employment. Therefore, in recent years, the employment rate in the tertiary industry in Malawi has increased.

At present, Malawi still faces severe challenges in terms of elementary and junior high school education and raising the literacy rate of young people. After independence in 1964 until the 1990s, there was only one university in the country. Currently, the country's higher education faces various challenges, such as low enrolment rate, insufficient supply of higher education and gender inequality.[97]

Malawi promulgated the National ICT Policy in 2013, which states that the development of the ICT industry is an important means for Malawi to actively participate in the world economy. According to the policy, the state has established electronic centres throughout the country to facilitate residents to use telecommunications services and is building electronic schools (e-schools).[98] The Commonwealth of Learning (COL) has carried out several teacher ICT capacity building projects in Malawi. Although the government has formulated ICT policies and made some domestic efforts, Malawi's ICT infrastructure remains underdeveloped. Malawi's lack of human resource capacity and unfamiliarity with ICT exacerbate the situation. For example, the introduction of ICT, open and distance learning (ODL), e-learning and other concepts led to a certain degree of technophobia in Malawian society. Malawi is extremely deficient in electricity resources. Only 10% of the country's population has regular access to electricity, and most rural areas experience power outages daily.[99]

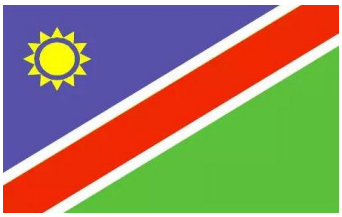
ICT-related data	Malawi	Sub-Saharan Africa average	World average
Internet users (% of population)	13.78 (2017)	25.13 (2018)	50.76 (2018)
Fixed broadband subscription (per 100 people)	0.06 (2019)	0.42 (2018)	14.15 (2018)
Mobile subscriptions (per 100 people)	47.78 (2019)	76.16 (2018)	104.07 (2018)
International bandwidth per Internet user	3,818.78 (2017)	NA	24,900.10 (2018)

Table - 17: ICT-related data (Malawi)

Higher education-related data	Malawi	Sub-Saharan Africa average	World average
Tertiary education gross enrolment rate	0.82 (2011)	9.44 (2018)	38.85 (2019)
Tertiary education enrolment gender parity index	0.62 (2011)	0.77 (2018)	1.13 (2018)
Tertiary education completion rate	NA	NA	NA
Tertiary education teacher/student ratio	NA	NA	NA
% of government expenditure on tertiary education	1.10 (2016)	NA	NA

Table - 18: Higher education-related data (Malawi)

97. The World bank, 2014, How to reverse the situation of higher education in Malawi?
98. Government of Malawi, 2013, Malawi's National ICT Policy: An ICT-led Malawi
99. Albert K.M.Y Kayange, E-Learning Encounters in Malawi Higher Education Institutions, International Journal for e-Learning Security (IJeLS), Volume 8, Issue 1, March 2019



Namibia formerly known as Southwest Africa. Namibia has an area of 824,000 square kilometres and a population of 2.414 million. The population density is less than 3 people per square kilometre, making it one of the countries with the lowest population density in the world. Namibia is divided into 14 administrative regions (provinces). The capital Windhoek is the political, economic, and cultural centre and transportation hub of the country. English is the official language of Namibia. Mining, fishery and agriculture and animal husbandry are the three traditional pillar industries of Namibia. The Namibian government has been actively developing service industry like tourism in recent years.[100]

Higher education in Namibia began in 1980. In the past decade, higher education institutions have experienced rapid growth. In 2016, the National Qualifications Agency registered more than 40 private institutions. The establishment of these institutions is not aimed at the needs of the labour market, but because many young people do not meet the minimum entry requirements but require higher education degrees. HEIs in Namibia mainly include three universities, namely the University of Namibia, the Namibia University of Science and Technology, and the International University of Management.

In 1995, the National Institute for Educational Development (NIED) promulgated the first national ICT education policy, which was revised in 2000. The Namibian government also clearly stated in the "Vision 2030" that ICT skills are the core element of 21st century education. Namibia has a good ICT infrastructure, and the ICT infrastructure of Namibian schools has been significantly improved in the past decade. Nevertheless, the efficiency of ICT education is not satisfactory, and the project expenditure is lower than the actual funds allocated. As of 2011, more than 60% of the allocated funds have not been effectively used. In Namibia, especially in remote and impoverished areas, textbooks and hardware facilities are insufficient, and the development of ICT education in developed and underdeveloped areas is not balanced. At present, most schools use dial-up Internet access, and broadband charges are not consistent across regions. In addition, Namibia still lacks the training of ICT teachers. There is a gap between in-service teacher training and pre-service teacher training, and the training of teachers is still insufficient in terms of quantity and quality.

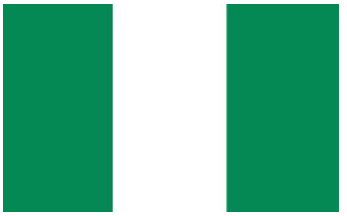
ICT-related data	Namibia	Sub-Saharan Africa average	World average
Internet users (% of population)	36.84 (2017)	25.13(2018)	50.76 (2018)
Fixed broadband subscription (per 100 people)	2.54 (2019)	0.42 (2018)	14.15 (2018)
Mobile subscriptions (per 100 people)	113.17 (2019)	76.16 (2018)	104.07 (2018)
International bandwidth per Internet user	13,490.50 (2017)	NA	24,900.10 (2018)

Table - 19: ICT-related data (Namibia)

Higher education-related data	Namibia	Sub-Saharan Africa average	World average
Tertiary education gross enrolment rate	22.90 (2017)	9.44 (2018)	38.85 (2019)
Tertiary education enrolment gender parity index	1.50 (2017)	0.77 (2018)	1.13 (2018)
Tertiary education completion rate	13.50 (2017)	NA	NA
Tertiary education teacher/student ratio	16.60 (2017)	NA	NA
% of government expenditure on tertiary education	1.60 (2014)	NA	NA

Table - 20: Higher education-related data (Namibia)

100. Ministry of Foreign Affairs of the People's Republic of China, August 2019, Country profiles of the Republic of Namibia, http://na.china-embassy.org/chn/zjnmby/gjgk/



Nigeria is a West African country covering an area of 923,768 square kilometres. Its official language is English. The country is divided into 36 states, comprised of one federal capital region and 774 local governments. The capital of Nigeria is Abuja, located in the centre of the country. In 2020, the estimated population of Nigeria was 206 million, making it the most populous country in Africa. Nigeria's GDP also ranks first in Africa; however, its per capita GDP is relatively low. Nigeria is an energy-rich country in Africa and the largest oil-producing and exporting country in Africa.[101]

By 2017, there were 152 approved universities in Nigeria. These include 40 federal universities, 44 state universities and 68 private universities. There are 82 colleges of education, including 22 federal universities, 46 state-run universities and 14 private universities. Nigeria has not been able to provide high-quality education due to factors such as insufficient funding in the education sector and rising education costs.[102]

Nigeria recently set up an advisory committee for the localization of information and communication technology (ICT) in Lagos. The committee is committed to providing professional knowledge to the government and increasing local companies' contribution to ICT industry. The Ministry of Communications and Technology of Nigeria has been making efforts to promote ICT industry to become the main engine of Nigeria's economic growth. In terms of teacher training programmes in Nigeria, the slow introduction of ICT infrastructure, low network connection rate, lack of audio-visual equipment such as television, projector, electronic whiteboard, and information retrieval system have hindered the development of teacher training programmes in Nigeria. Despite the relevant provisions of the Nigerian government in the national education policy, teachers are not encouraged to use the technology in the classroom and have not received relevant training.[103]

ICT-related data	Nigeria	Sub-Saharan Africa average	World average
Internet users (% of population)	7.47 (2017)	25.13 (2018)	50.76 (2018)
Fixed broadband subscription (per 100 people)	0.04 (2018)	0.42 (2018)	14.15 (2018)
Mobile subscriptions (per 100 people)	88.18 (2019)	76.16 (2018)	104.07 (2018)
International bandwidth per Internet user	12,677.60(2017)	NA	24,900.10 (2018)

Table - 21: ICT-related data (Nigeria)

Higher education-related data	Nigeria	Sub-Saharan Africa average	World average
Tertiary education gross enrolment rate	10.17 (2011)	9.44 (2018)	38.85 (2019)
Tertiary education enrolment gender parity index	0.69 (2011)	0.77 (2018)	1.13 (2018)
Tertiary education completion rate	NA	NA	NA
Tertiary education teacher/student ratio	22.60 (2011)	NA	NA
% of government expenditure on tertiary education	NA	NA	NA

Table - 22: Higher education-related data (Nigeria)

101. Ministry of Foreign Affairs of the People's Republic of China, October 2020, Country profiles of Nigeria, https://www.fmprc.gov.cn/web/gjhdq_676201/gj_676203/fz_677316/1206_678356/1206x0_678358/
102. Education in Nigeria, 2017, WERN, https://wenr.wes.org/2017/03/education-in-nigeria
103. ICT for Education in Nigeria, infodev, https://www.infodev.org/infodev-files/resource/InfodevDocuments_422.pdf

Senegal is a coastal country in West Africa. Its capital is Dakar. Its official language is French. Senegal boasts a stable society and it is one of the few African countries that has not had a military coup. The country's annual GDP growth rate has reached over 5% in the past five years.[104]

Senegal's higher education system originated from France, adopting the undergraduate, master, and doctoral system, with three years for undergraduates, two years for masters, and three years for doctors. As of 2019, Senegal has 8 public universities, 1institute of science and technology, 2 local centres, 5 higher vocational schools, and 21 open digital spaces. The geographical distribution of universities is balanced, from being concentrated in coastal areas to expanding to inland region. Services such as open learning spaces, high-speed network services, remote video classrooms, and electronic medical care have been provided, creating good conditions for higher education to benefit a wider population.[105]

Senegal's ICT industry is in a leading position in West Africa. According to the World Economic Forum's "Network Readiness Index", Senegal ranks 14th in West Africa alongside Ghana, Nigeria and Côte d'Ivoire. To better promote the ICT industry, the government established the Universal Telecommunication Service Development Fund (FDSUT) to promote ICT for all.[106] However, the number of students studying STEM subjects is still insufficient. Since 2014, with the support of the World Bank and the French Development Assistance Agency, the country has launched a financial support project for students enrolled in vocational and technical education. The UNESCO Office in Dakar is implementing a project to encourage women to participate more in the study of STEM subjects. Senegal's telecommunications infrastructure, financial conditions and a growing middle class have laid the foundation for the country's better development of digital industries.[107]

ICT-related data	Senegal	Sub-Saharan Africa average	World average
Internet users (% of population)	29.64 (2017)	25.13(2018)	50.76 (2018)
Fixed broadband subscription (per 100 people)	0.93 (2019)	0.42 (2018)	14.15 (2018)
Mobile subscriptions (per 100 people)	109.72 (2019)	76.16 (2018)	104.07 (2018)
International bandwidth per Internet user	6,804.09 (2017)	NA	24,900.10 (2018)

Table - 23: ICT-related data (Senegal)

Higher education-related data	Senegal	Sub-Saharan Africa average	World average
Tertiary education gross enrolment rate	13.14 (2019)	9.44 (2018)	38.85 (2019)
Tertiary education enrolment gender parity index	0.75 (2019)	0.77 (2018)	1.13 (2018)
Tertiary education completion rate	NA	NA	NA
Tertiary education teacher/student ratio	27.94 (2018)	NA	NA
% of government expenditure on tertiary education	1.59 (2018)	NA	NA

Table - 24: Higher education-related data (Senegal)

104. World Bank Data, 2020
105. Ministry of Higher Education and Scientific Research, Performance Report 2012-2019, March 2019
106. World Economic Forum, 2016, Networked Readiness Index, https://reports.weforum.org/global-information-technology-report-2016/networked-readiness-index/
107. Omar Thiam, Jeune Afrique, Tribune: Big Data - Opportunities in Africa, 19th July 2020, https://www.jeuneafrique.com/mag/1007115/economie/tribune-big-data-lafrique-a-encore-une-carte-a-jouer/

South Africa is known as the "Rainbow Country". It is located at the southernmost tip of the African continent. It has a land area of 1219090 square kilometres and is surrounded by the Indian Ocean and the Atlantic Ocean. The Cape of Good Hope route at its southwestern tip has always been one of the busiest sea lanes in the world. South Africa has a population of 57.78 million (2018). Since the embassies are in the administrative capital of Pretoria, it is recognised by the international community as the capital of South Africa. South Africa is a middle-income developing country and one of the most economically developed countries in Africa. The natural resources are rich and the financial and legal systems are relatively complete.[108] However, the low penetration rate of ICT is an important limitation for enhancing South Africa's competitiveness.[109]

The higher education system in South Africa consists of public and private universities. Most students study in public institutions, accounting for 82.2% of the total annual university enrolment. The South African Ministry of Higher Education and Training is responsible for the supervision and evaluation of higher education across the country. Among South African university graduates, more than half of the graduates in the field of education come from the University of South Africa. Despite the large increase in university enrolment, South Africa's gross enrolment rate is still lower than countries with similar levels of development, such as Brazil and India.

In South Africa, the ICT industry is managed by the Independent Communications Authority of South Africa (ICASA), the government department responsible for policy formulation and the national regulator. South Africa ranks 85th in the global ICT application field, and 54% of adults can use the Internet. In recent years, more and more artificial intelligence companies have emerged in South Africa, including Cortex Logic and DataProphet. Gijima is one of the leading information and communication technology (ICT) service companies in South Africa. There are signs that South Africa is gradually establishing a solid technological foundation.

ICT-related data	South Africa	Sub-Saharan Africa average	World average
Internet users (% of population)	56.17 (2017)	25.13(2018)	50.76 (2018)
Fixed broadband subscription (per 100 people)	2.14 (2019)	0.42 (2018)	14.15 (2018)
Mobile subscriptions (per 100 people)	165.60 (2019)	76.16 (2018)	104.07 (2018)
International bandwidth per Internet user	10,467.80 (2017)	NA	24,900.10 (2018)

Table - 25: ICT-related data (South Africa)

Higher education-related data	South Africa	Sub-Saharan Africa average	World average
Tertiary education gross enrolment rate	23.80 (2018)	9.44 (2018)	38.85 (2019)
Tertiary education enrolment gender parity index	1.30 (2018)	0.77 (2018)	1.13 (2018)
Tertiary education completion rate	10.90 (2018)	NA	NA
Tertiary education teacher/student ratio	NA	NA	NA
% of government expenditure on tertiary education	1.13 (2019)	NA	NA

Table - 26: Higher education-related data (South Africa)

108. Ministry of Foreign Affairs of the People's Republic of China, October 2020, Country profiles of South Africa, https://www.fmprc.gov.cn/web/gjhdq_676201/gj_676203/fz_677316/1206_678284/1206x0_678286/
109. World Economic Forum, Global Competitiveness Report 2019, page 19

Togo is a coastal country located in western Africa, with the capital Lomé located on the Atlantic coast. Togo was once a French colony. After independence in 1960, it still maintains close ties with France in economy, culture, politics, and education. As a member of the West African Economic and Monetary Union and the West African Economic Community, Togo and 7 other French-speaking countries in the region use the West African Franc as the unified currency. Togo lacks skilled workers, and the entire country is still in the initial stage of industrialisation.

Togo has two public universities: University of Lomé and University of Kara. Founded in 1970, the University of Lomé is the oldest and largest comprehensive university in Togo. The University of Lomé has a Francophone digital campus, a Confucius Institute and the Chair UNESCO Formation à Distance (CUFAD, UNESCO Chair of Distance Education). Togo's education development focuses on literacy, improving the completion rate of compulsory education and vocational and technical education.[110] Since 1996, the AUF has funded four universities in Togo, including the University of Lomé, to implement the Francophone Digital Campus project. With the support of the UNESCO Shenzhen Funds-in-Trust, the Togo project team completed preparations for the establishment of a national higher education quality assurance system in 2019.

Togo's internet industry has developed rapidly in recent years. In addition to two network providers, Togo Telecom and CAFE Information (private), Togo Mobile and MOOV also provide network services. However, due to technical problems, the network facilities of public universities cannot meet the needs of teachers and students.

ICT-related data	Togo	Sub-Saharan Africa average	World average
Internet users (% of population)	12.36 (2019)	25.13 (2018)	50.76 (2018)
Fixed broadband subscription (per 100 people)	0.40 (2019)	0.42 (2018)	14.15 (2018)
Mobile subscriptions (per 100 people)	77.20 (2019)	76.16 (2018)	104.07 (2018)
International bandwidth per Internet user	52,295.30 (2017)	NA	24,900.10 (2018)

Table - 27: ICT-related data (Togo)

Higher education-related data	Togo	Sub-Saharan Africa average	World average
Tertiary education gross enrolment rate	14.02 (2019)	9.44 (2018)	38.85 (2019)
Tertiary education enrolment gender parity index	0.53 (2019)	0.77 (2018)	1.13 (2018)
Tertiary education completion rate	NA	NA	NA
Tertiary education teacher/student ratio	21.33 (2018)	NA	NA
% of government expenditure on tertiary education	0.89 (2017)	NA	NA

Table - 28: Higher education-related data (Togo)

110. The Republic of Togo, January 2014, 2014-2025 Education Sector Plan: Improving access, Equality and Quality of Education in Togo

Uganda is a landlocked country located in the east of Africa, with a total area of 241,550 square kilometres. Uganda is divided into four administrative regions: Northern, Eastern, Central and Western. These regions are further divided into 134 district and one city (Kampala, the capital city). The total population of Uganda is 44.3 million (2018). There are about 65 ethnic groups in the country. Agriculture and livestock play a leading role in the national economy, accounting for 70% of the GDP and 95% of the export income. Foreign trade plays an important role in the national economy. In 2010, Uganda and Kenya, Tanzania, Burundi, and Rwanda set up the East African Community and established a unified market.[111]

Since 1997, the government has provided free primary education for four children in each household. In 2008, there were 14,179 primary schools with 131,000 teachers and 7.47 million students.[112] Makerere University is the most famous HEI in Uganda, established in 1937. At present, there are about 35,000 undergraduates and 3,000 postgraduates. In addition, there are more than 20 universities in Uganda.

In Uganda, the cost of broadband network and taxes on imported ICT equipment are very high, and there is a shortage of internet infrastructure, thus hindering the popularisation of ICT. In recent years, the Ugandan government has taken a series of policy measures to improve the application of ICT in the country. The theme of the Second National Development Plan (NDPII) is "strengthening sustainable wealth creation, employment and inclusive growth in Uganda", emphasising the role of ICT in the national development process. ICT facilities in Uganda's higher education institutions and the number of ICT teachers are very limited, which cannot meet the needs of the students and the teachers. Despite a series of ICT and computer programmes launched by Uganda's National Curriculum Development Centre, many students are still unable to learn how to use ICT skills due to insufficient teachers.

ICT-related data	Uganda	Sub-Saharan Africa average	World average
Internet users (% of population)	23.71 (2017)	25.13(2018)	50.76 (2018)
Fixed broadband subscription (per 100 people)	0.23 (2016)	0.42 (2018)	14.15 (2018)
Mobile subscriptions (per 100 people)	57.27 (2019)	76.16 (2018)	104.07 (2018)
International bandwidth per Internet user	7,775.25 (2017)	NA	24,900.10 (2018)

Table - 29: ICT-related data (Uganda)

Higher education-related data	Uganda	Sub-Saharan Africa average	World average
Tertiary education gross enrolment rate	4.84 (2014)	9.44 (2018)	38.85 (2019)
Tertiary education enrolment gender parity index	0.73 (2014)	0.77 (2018)	1.13 (2018)
Tertiary education completion rate	NA	NA	NA
Tertiary education teacher/student ratio	24.47 (2011)	NA	NA
% of government expenditure on tertiary education	0.31(2014)	NA	NA

Table - 30: Higher education-related data (Uganda)

111. Ministry of Foreign Affairs of the People's Republic of China, October 2020, Country profiles of Uganda, https://www.fmprc.gov.cn/web/gjhdq_676201/gj_676203/fz_677316/1206_678622/1206x0_678624/
112. Ibid.

Zambia is a landlocked country in south-central Africa, most of which belong to the plateau area. Zambia is named after the Zambezi River which is rich in copper. The population of the country is about 16 million, and there are 73 ethnic groups. Zambia is one of the most urbanised countries in sub-Saharan Africa, with an urban population accounting for 41.5% of the national population. Its economy depends on mineral resources and its industrial structure is greatly influenced by international commodity prices, which affects the sustainable development of the economy. In 2011, the World Bank reclassified Zambia as a lower middle-income country, before which it was classified as a low-income country.[113]

In 2013, Zambia issued the Higher Education Act, 2013. It stipulates that the Ministry of Higher Education is the highest authority for public and private universities (colleges) and vocational colleges. According to data from the Ministry of Higher Education of Zambia, in 2016, only 5 of the 12 normal universities across the country trained STEM teachers, and only 1,000 of the 5,000 students in normal universities were studying STEM subjects. The goal set by the Ministry of Higher Education is to realize the STEM teacher training programme for all 12 normal colleges by 2021, and that 2,000 out of 6,000 students in normal universities will study STEM subjects.

ICT is regarded as an important way to promote economic diversification and create employment in Zambia's 7th National Development Plan. In accordance with the Zambia's Master Plan, Zambia has cooperated with China to establish a national data centre and an ICT talent training centre. The data centre provides strong hardware infrastructure support for the government's intensive construction and paperless office, improves government office efficiency, and promotes the popularization of e-government, smart transportation, and e-commerce popularization. To meet the needs of the Zambian government to train ICT talents and expand the application of ICT in education, At the same time, Huawei has helped Zambia establish an ICT talent Academy to train teachers and civil servants in Zambia.[114]

ICT-related data	Zambia	Sub-Saharan Africa average	World average
Internet users (% of population)	14.30 (2018)	25.13(2018)	50.76 (2018)
Fixed broadband subscription (per 100 people)	0.50 (2019)	0.42 (2018)	14.15 (2018)
Mobile subscriptions (per 100 people)	96.41 (2019)	76.16 (2018)	104.07 (2018)
International bandwidth per Internet user	14,745.90 (2018)	NA	24,900.10 (2018)

Table - 31: ICT-related data (Zambia)

Higher education-related data	Zambia	Sub-Saharan Africa average	World average
Tertiary education gross enrolment rate	4.10 (2012)	9.44 (2018)	38.85 (2019)
Tertiary education enrolment gender parity index	0.70 (2012)	0.77 (2018)	1.13 (2018)
Tertiary education completion rate	NA	NA	NA
Tertiary education teacher/student ratio	NA	NA	NA
% of government expenditure on tertiary education	0.33 (2017)	NA	NA

Table - 32: Higher education-related data (Zambia)

113. Consular Service of the People's Republic of China, 2020, Country profile of Zambia, http://cs.mfa.gov.cn/zggmcg/ljmdd/fz_648564/zby_652101/

114. Huawei, 2017, Huawei ICT Dedicates itself to Building Smart Zambia: Promoting the National Cloud Data Centre and ICT Talent Cultivation Centre as "enablers" in the digital Era, https://e.huawei.com/cn/case-studies/cn/2017/201710091418

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