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Building Capacity in Science, Technology, and Innovation for Africa's Transformation: The Role of Higher Learning and Research Institutions

Contributed by the Knowledge and Learning Department

The Issue

African countries have shown interest and willingness in developing their economies through an approach driven by science, technology, and innovation (STI).[1] Agenda 2063 and the Common African Position on Agenda 2030 identify STI as a key enabler to achieving development blueprints. In response, Africa adopted a 10-year Science, Technology, and Innovation Strategy (STISA–2024). The ACBF's Africa Capacity Building STI Survey (2016) confirms the importance of STI strategies and capacity development in African countries. And institutions of higher learning play a key role in designing, implementing, and evaluating STI policies and in creating and using STI products and services.

The Study

Africa Capacity Report 2017 (ACR 2017) focuses on understanding the capacity imperatives for STI. It helps policymakers draw conclusions critical to STI issues, and it affects policy recommendations to strengthen the policy formulation, implementation, and impact of STI. The report is based on a survey of 44 African countries profiling the dimensions of STI in Africa. It delves into initiatives, challenges, and capacity gaps for African countries, regional economic communities, the African Union, and nonstate actors to pursue STI-driven economic activities. It also puts forward policy options for institutions of higher learning, governments, the private sector, civil society, and development partners to integrate STI into Africa's growth strategies and build the required capacity in STI as key enablers for achieving Africa's development targets.

Key Emerging Issues

State of STI in Africa

Although Africa is reorienting its development policies to include STI at various levels, its STI capacity is still very low. Only 12 African countries of 141 countries surveyed were ranked among the top 100 innovation achievers in the 2015 Global Innovation Index. Only one of 31 African countries surveyed in the 2016 Network Readiness Index was among the world's top 50 network-ready countries. Africa is characterized by poor STI infrastructure, a small pool of researchers, low patronage of science and engineering programs, weak intellectual property frameworks, and low scientific output relative to the rest of the world.

Africa remains disadvantaged on overall STI efforts due to the low investments in STI capacity development. It accounts for about 5% of global gross domestic product but only 1.3% of global spending on research and development (UNESCO 2015).

The poor state of STI is a pressing issue in Africa given that achieving capacity development outcomes has remained difficult. Indeed, about 84% of the African countries surveyed in 2016 were ranked Low or Very Low in capacity development outcomes.

STI capacity gaps in Africa

Africa Capacity Report 2017 shows that STI capacity is one of Africa's biggest challenges. A survey of 44 African countries undertaken by ACBF in 2016 to assess capacity needs in STI priority areas showed that African countries consider training as a High or Very High priority area in STI. Investment in STI development is very low in Africa. African countries are taking a short-term approach in developing STI skills, as is evident in low public spending on research and development and scientific infrastructure.

Most African countries have weak institutional capacity to develop and sustain STI, since few public institutions have adequately qualified human resources in science and engineering. African countries have weak capacity to retain the few qualified scientists and engineers, and the migration of African skilled scientists and other experts—the "brain drain"—has further depleted Africa's STI capacity. For instance, from 2007 to 2011, the number of tertiary-educated Africans who had migrated was estimated at 450,000 (UN-DESA and OECD 2013). So, Africa incurs a net loss in skilled human capital with the critical technical skills to foster Africa's sustainable development. Zimbabwe (43%), Mauritius (41%), and the Republic of the Congo (36%) recorded the highest proportions of educated persons living in OECD countries. Burundi, Algeria, Mauritania, Chad, and Guinea are the top five African countries least able to retain their top talent (WEF 2014). So, Africa's training institutions are somehow subsidizing other developed regions since it is costly to train.

Another key challenge is the lack of accurate data to enable targeting of STI policies and strategies. The lack of a robust common set of African STI indicators has constrained the continent's capacity to make evidence-based decisions on STI. Weak capacity to manage the data affects the ability to update the STI policies and strategies and to determine how much to allocate to build STI capacities and frameworks.

There is also a huge disparity between female and male participation in research, in STEM education, and in higher and tertiary education.

Trends in Africa's higher education and human resource development

Africa's stock of graduates is still highly skewed toward the humanities and social sciences—the share of students enrolling averages more than 75%. Moreover, more than 3 million African students were enrolled (in 2015) in non-critical technical skill areas, and only 1.7 million in critical technical skill areas (ACBF 2016).

Africa's quality of tertiary education is a major concern, with only 5 of the world's top 500 universities from Africa, against 6 in Brazil and 32 in China, and only 2 in the top 300 but none in the top 200 (ShanghaiRanking 2016). This is worrying given that the rankings capture the quality of

1 Science, technology, and innovation refer to all activities closely concerned with generating, advancing, disseminating, and applying scientific and technical knowledge in all fields of science and technology—natural sciences, engineering, medicine, social sciences, and humanities (ACR 2017).

African graduates, the level of innovation of the African workforce, the quality of research, and the ultimate contribution to sustainable development. According to ACBF's 2016 survey, Africa has the lowest number of full-time equivalent researchers, ranging from as low as 19 in Sudan to 1,394 in Tunisia, and the majority of African countries have fewer than 300 researchers per million inhabitants. Similarly, Africa has the fewest scientific publications. Institutions for higher learning in Africa should thus take a leading role to improve enrollments and quality in science and engineering education. The capacity challenges revolve around STI training and development, knowledge production, and technological innovation, and partnerships—private–private, private–public, and public–public—are important interventions. Institutions of higher learning and research should partner with the African Union, the United Nations, and pan-African organizations such as the African Capacity Building Foundation and the New Partnership for Africa's Development in jointly planning and mobilizing resources for Africa's STI requirements (box 1).

Box 1: Notable STI initiatives across Africa

The University of Rwanda improved the quality of Maraba coffee, promoted biogas uptake in prisons, and banned plastic bags in Rwanda.

The Zimbabwe Scientific Industrial Research and Development Corporation invented a seed variety, Sirdamaize, that is drought and disease tolerant, and offers higher yields than traditional strains.

ACBF facilitated the "Capacity Building for African Institutions of Science and Technology" program, which supports the Nelson Mandela African Institution of Science and Technology based in Arusha, Tanzania, and other institutions in science and technology.

In Nigeria, the African University of Science and Technology, founded in 2007 with ACBF support, is a private educational and applied research university offering courses in science, engineering, and technology.

UNESCO launched the African Science, Technology, and Innovation Policy Initiative to build capacities in STI policy formulation and develop national STI policies for African countries. This led to the establishment of many science, technology, and engineering institutions in Africa.

Recommended Policy Options for African Institutions of Higher Learning

African institutions of higher learning have a crucial role in building Africa's STI capacity. Thus, it is imperative that these institutions create appropriate systems that produce well-trained human capital in STI and other sector-specific critical technical skills. This entails refocusing investment priorities to accumulate STI infrastructure, creating and strengthening partnerships, and redesigning curricula to meet Africa's needs. Technical colleges, research institutions, and universities in Africa should work closely with governments and other key stakeholders in the following areas:

- Increase enrollment rates in science, technology, mathematics, and engineering—and teach skills industry demands. This can entail including an STI element in all other faculties, cascading down to primary and secondary education levels, and subsidizing science, technology, and engineering courses to make them affordable. Increasing the share of females enrolled in STI is another way to increase STI skills, since female candidates now constitute a very small proportion of the total STI specialists.

- Hire, retain, and retrain highly qualified engineers and scientists to improve the human resource base in STI. This can be done by conducting practical training in cooperation with industry, giving monetary and nonmonetary incentives to scientists and engineers, and sending STI staff for attachments and refresher courses in advanced economies.

- Technical colleges and universities should improve the quality of higher education by enhancing professional training, providing adequate education facilities, attracting good lecturers, and updating pedagogical materials. This requires innovation-oriented curricula and use of contemporary teaching methods.

- Visionary heads of higher and tertiary institutions should be able to implement policies that promote the development and expansion of STI activities, such as award systems for innovation. They should also increase resources for STI in the education system—say, by implementing the 70/30 allocation of students (70% of enrollments to STI and 30% to other fields), as in Ethiopia. Strong leadership at universities and research institutions can build the required STI skills and capacities, including knowledge on entrepreneurship and innovation, to prepare graduates for the job market.

- STI capacity building through bilateral and multilateral agreements can lead to greater cooperation and integration of STI between universities and research institutes. Bilateral research projects, scientific meetings, and short-term training courses across universities and research institutions is one form of mutually beneficial cooperation that can speed up critical skill-creation suitable for STI.

- Africa's institutions of higher learning should also design mobility programs for scientists and engineers, foster regional universities collaboration, encourage public–private partnerships across national borders, and facilitate frameworks for regional intellectual property rights protection.

- Africa's institutions of higher learning should also strengthen their collaboration with industry, business, and communities to better orient their programs toward the STI-related development challenges in Africa and to improve the employability of graduates.

Implications

In the short term, institutions of higher learning and research institutes have to transform their operating processes to nurture skills that meet Africa's demand. This includes reviewing curricula and teaching methods, changing enrollment policies to reflect STI needs and gender issues, installing state-of-the-art STI infrastructure, creating and strengthening partnerships to foster STI programs, and modifying human resource strategies to allow critical skills retention and utilization.

In the long term, continuing review of the internal processes and procedures for institutions of higher learning can impart relevant STI skills and keep abreast of internationally accepted STI standards. This means that the investment priorities and funding allocations should reflect the importance of STI programs. Creativity and continuous innovation thus remain key in building capacity for STI in Africa.

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