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Some Challenges to Building STEM Capacity in Emerging Economies: The Case of Namibia

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Some Challenges to Building STEM Capacity in Emerging Economies: The Case of Namibia

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Namibia is a semi-arid to arid country located in southern Africa with a population of approximately 2.5 million that has one of the largest income inequality gaps in the world as measured by the World Bank. As an emerging economy, one of the major challenges is capacity building in STEM related fields and professions as the country lacks sufficient numbers of technically trained individuals to address the highly complex societal challenges routinely found in such developing countries. As a recent Fulbright Scholar at the Namibia University of Science and Technology (NUST) located in Windhoek, Namibia, the author identifies some of the challenges associated with building STEM capacity in emerging economies. Identified challenges include expanding access to higher education, improving inadequate K-12 educational systems, recruiting students to STEM disciplines, strengthening student support and financial services, and developing and retaining qualified academic staff.

Key Words: STEM Capacity Building, Developing Countries, Africa, Namibia

Introduction

Namibia is a sparsely populated country of approximately 2.3 million people in sub-Saharan Africa (World Bank, 2009). It is categorized as an upper middle-income country but has one of the highest levels of income inequality in the world (African Development Bank, 2007) with a Gini coefficient estimated at 0.58 by the 2009/10 household survey, which is one of the highest figures of any country in the world (World Bank, 2009). The country has an estimated annual GDP per capita of USD 5293. However, it is worth noting that from 1980-1990 Namibia had a GDP per capita which was higher than that of both China and Thailand. But, over the intervening time both countries' rate of economic growth have greatly exceeded Namibia's and, as a result, Namibia's GDP per capita ratio is currently much smaller than either of those two countries (National Planning Commission, 2012).

Despite this disparity in economic growth rates, the country is slowly emerging from the compounding effects of both European colonialization and the imposition of apartheid by South Africa having gained its independence only in 1990. Although having fought an armed conflict with South Africa for political independence, the economy of Namibia is still closely linked to that of South Africa (African Development Bank, 2007) with the Namibian Dollar being pegged at a ratio of 1:1 to the South African Rand (Clerck, 2008). South Africa plays an important role for logistics in Namibia because it has the most developed infrastructure and logistics skills in Africa as well as functioning as a gateway for southern Africa (Cilliers and Nagel, 1994). Approximately 80% of Namibia's total imports are from or through South Africa (African Development Bank, 2007), which is claimed to exercise a great deal of pressure on Namibia through monopoly control, restrictive purchasing, over-pricing and dumping (Clerck, 2008).

Unfortunately, Namibia has experienced a recent decline in economic competitiveness. In 2010/2011, Namibia was ranked 80th out of 139 countries but its ranking had fallen to 92nd out of 144 countries by 2012/2013 (World Bank, 2013). In 2012, the Rand Merchant Bank's (RMB) ladder for the best African countries to invest in, ranked Namibia the 20th most attractive investment destination out of 53 African countries. The country intends to reverse this trend by pursuing long and short term goals as articulated in the government's Vision 2030 plan and recently through *Namibia's 5th National Development Plan (NDP5)* and other sectoral interventions. Some of the long term interventions include increased investment in education and training, health sector, infrastructure, and broad based incentive strategy (Republic of Namibia, 2017).

The role of STEM education and engineering research focused at economic advancement is thus a necessity for the country and the contribution by Namibian institutions of higher learning in the form of development of engineering and applied sciences research is increasingly being recognized. This, despite the fact that the higher education sector faces the challenges of recruiting and retaining Namibians who hold post graduate level qualifications; which is particularly true for the sciences, ICTs and engineering where most of the research and innovation output is expected (National Planning Commission, 2012). The state of research and development in Namibia has been described by Kgabi (Kgabi, 2014) as more subject specific rather than multidisciplinary. The National Planning Commission purports that the ability of the country to perform applied research in critical areas such as agriculture, fisheries, geology, information technology and manufacturing is severely hampered by the lack of qualified graduates in engineering, biology, chemistry, mathematics and information technology (National Planning Commission, 2012).

Literature Review

> *"Higher education is now front and center of the development debate—and with good reason. More than 50 percent of the population of sub-Saharan Africa is younger than 25 years of age, and every year for the next decade, we expect 11 million youth to enter the job market. This so-called demographic dividend offers a tremendous opportunity for Africa to build a valuable base of human capital that will serve as the engine for the economic transformation of our continent.… To be more competitive, expand trade, and remove barriers to enter new markets, Africa must expand knowledge and expertise in science and technology. From increased agricultural productivity to higher energy production, from more efficient and broadly available ICT services to better employability around the extractive industries, building human capital in science and technology is critical to empower Africa to take advantage of its strengths."*

Makhtar Diop, World Bank's Vice President for the Africa Region
High-level Forum on Higher Education, Science, and
Technology in Africa March 13, 2014, in Kigali

According to the Africa Capacity Report 2017 report (African Capacity Building Foundation, 2017), the science, technology and innovation (STI) system, its program inputs, and effective functioning in a country largely determines a country's capacity to innovate and develop appropriate technologies necessary for sustained economic growth. The report states that most STI institutions are inadequately staffed with experts and scientists, feeding into the decline in skilled scientists and engineers across Africa. This decline, in part, is due to the mass migration of skilled African scientists and experts—the brain drain. Low remuneration, lack of research facilities, and preference for foreign consultants are some of the reasons cited for the migration. The report states that few African institutions are producing enough skilled human resources to meet market demand for skills in science and engineering. As a result, Africa may be short 4.3 million engineers and 1.6 million agricultural scientists and researchers, in part because more than 80 percent of current student enrollments are in social sciences and humanities. The report concludes that without reform, Africa is likely in 2020–30 to have more graduates without critical technical skills than those with them (African Capacity Building Foundation, 2017).

STI capacity has been shown to be closely linked to variations among countries in productivity (Allard, 2015). Countries with a larger STI capacity generally tend to be the most prosperous and most industrialized. They also tend to be more politically stable, often with functioning democratic systems; and they provide high-quality employment for their best talent, which helps to stem the brain drain and bolster the country´s human capital. STI capacity has been shown to play a role in the development process of the world´s lagging and emerging economies, and in maintaining technological competitiveness in the most developed ones (Allard, 2015). According to the RAND 2011 S&T Index, among African countries, South Africa was ranked 37th in the world while Namibia was ranked 161st (Allard, 2015).

The African Union's (AU) *Science, Technology and Innovation Strategy for Africa 2024 (STISA-2024)* report (African Union Commission, 2014) places STI at the epicenter of Africa's socio-economic development and growth. The STISA-2024 is the first of the ten-year incremental phasing strategies to respond to the demand for science, technology and innovation to impact across critical sectors such as agriculture, energy, environment, health, infrastructure development, mining, security and water among others. The strategy is firmly anchored on six distinct priority areas that contribute to the achievement of the AU Vision. These priority areas are: Eradication of Hunger and Achieving Food Security; Prevention and Control of Diseases; Communication (Physical and Intellectual Mobility); Protection of our Space; Live Together-Build the Society; and Wealth Creation. The strategy further defines four mutually reinforcing pillars which are prerequisite conditions for its success. These pillars are: building and/or upgrading research infrastructures; enhancing professional and technical competencies; promoting entrepreneurship and innovation; and providing an enabling environment for STI development in the African continent. At the national level, Member States are encouraged to incorporate this strategy into their National Development Plans (African Union Commission, 2014).

A World Bank study examining the Sub-Saharan (Angola, Botswana, Burundi, Lesotho, Madagascar, Malawi, Mozambique, Namibia, Swaziland, Zambia, and Zimbabwe) research enterprise over the period from 2003 to 2012 made the following key findings (Blom, Lan, and Adil, 2016):

1. Sub-Saharan Africa greatly increased both the quantity and quality of its research output (from 0.44 percent to 0.72 percent of the global share);
2. Sub-Saharan Africa research output in STEM lags behind that of other subject areas (only 29 percent of all research);
3. Sub-Saharan Africa relies heavily on international collaboration and visiting faculty for their research output (79 percent of all research);
4. Sub-Saharan Africa's research capacity is fragmentized with very little collaboration with neighboring countries in the region.

In UNESCO's first ever report on engineering at the international level, the report indicated a need to (UNESCO, 2010):

- Affirm the role of engineering as the driver of innovation, social and economic development;
- Develop better statistics and indicators on engineering (i.e. an individual country's demand for engineers);
- Transform engineering education, curricula and teaching methods to emphasize relevance and a problem-solving approach to engineering;
- More effectively innovate and apply engineering to global issues and challenges.

Research Objective and Methodology

The paper is not intended to be a research treatise and, therefore, no formal case study research methodology has been adopted or utilized. Rather, the discussion is a collection of informed perceptions concerning the challenges associated with building STEM capacity in Namibia based on the author's personal experience and interactions as a Fulbright Scholar at the Namibia University of Science and Technology (NUST) during the 2017 calendar year.

Discussion

Namibia has three tertiary institutions of higher education, the University of Namibia (UNAM), the Namibia University of Science and Technology (NUST) and the International University of Management (IUM), which had a combined enrollment of 39,160 students in 2015 (Namibia Statistical Agency, 2016). UNAM and NUST are government supported universities while IUM is a not-for-profit private institution. The institutions were ranked 29th, 33rd, and 56th respectively among the top 200 universities in Africa (UniRank, 2018). Together, the three campuses enrolled a total of 5,360 students (13.7 % of total enrollment) in STEM related majors. Of those STEM majors, 5,097 were enrolled in bachelor degree programs, 208 in master level programs, and 45 in PhD level programs.

By comparison, there were approximately 18 million undergraduate students in the United States in 2012 (NSF, 2018), or 5.7% of the total population, compared to only 1.7% of the total population enrolled in higher education in Namibia. This is an indicator that access to general higher education at-large in Namibia is a constraint when compared to more developed countries. When considering STEM degrees, approximately 30% of all undergraduate degrees awarded in the U.S. are in the STEM disciplines while only 13.7% of the undergraduate enrollment in

Namibia is in STEM majors. Therefore, Namibia has a dual challenge when attempting to build its national STEM capacity; improving general access to higher education while concurrently encouraging more of the students that do enroll to major in STEM related fields.

One of the challenges to improving access to higher education is the generally poor quality of the K-12 school system in Namibia. The K-12 system relies heavily on rote memorization and nationally mandated standardized exams with most teachers not having credentials or certifications in their subject matter areas. Further, there is limited infrastructure for quality teaching, research and innovation, including limited access to broadband (Republic of Namibia, 2012). Most teachers and students have not been exposed to the active and inquiry based learning strategies commonly found in the U.S. As a result, students are very good at memorizing facts but lack any substantial critical thinking skills and, in the end, are inadequately prepared to be admitted to and succeed at a university. This was evident in the author's classes as most students had a strong capability to memorize information but struggled to critically apply the information across a range of engineering problems. It should be noted, however, that despite the limited access to broadband internet noted above, the author found the students to be very tech savvy when it came to mobile phones, tablets, and laptop computers.

Compounding the challenge of general access to higher education is the issue of retention after the students have arrived on campus. Currently, higher education institutions in Namibia enroll around 19% of the grade 12 cohorts. Unfortunately, the university education completion rate is at 50% with access and drop-out rates linked to limited student funding (i.e. grants and loans) and lack of student support systems. Considering that Namibia's per capita income in 2017 was USD 5,293 with a high income inequality index, it is not surprising that many students must rely heavily on student grants and loans in order to pay for college. As a result, many students are forced to drop-out and seek employment before graduating with a degree.

When considering strictly engineering disciplines, the picture is not that much different. NUST is considered the primary engineering school in the country and has an enrollment of approximately 12,447 students and awards bachelor, master and PhD level degrees. Prior to 2015, the institution was known as the Polytechnic of Namibia. The campus hosts six faculties (e.g. equivalent to colleges in the United States), four of which offer STEM based degrees: Faculty of Computing and Informatics, Faculty of Engineering (FOE), Faculty of Health and Applied Science, and Faculty of Natural Resources and Spatial Sciences. Approximately 3,318 students (26.7% of total enrollment) were enrolled in STEM majors in 2014.

The Faculty of Engineering consists of four departments:

- Civil and Environmental Engineering
- Electrical and Computer Engineering
- Mechanical and Marine Engineering
- Mining and Process Engineering.

The FOE enrolled a total of 801 students with 105 students enrolled in diploma or associate degree programs, 264 in Bachelor of Technology programs, 383 in Bachelor of Science programs, and 49 in master level programs. As part of the institution's transition from a polytechnic, the FOE had just recently launched new PhD level programs that had just started to admit students. It should be noted that UNAM also enrolled 383 students in engineering and IT. Therefore, of all STEM majors within the country, approximately 22% of such students are enrolled in engineering related disciplines. Thus, engineering students comprise only 3% of all higher education students in Namibia.

The Namibian government has acknowledged the challenge of increasing its STEM capacity by placing development of technical skills as a stated objective in its *Vision 2030* and *5th National Development Plan (NDP5)* (Republic of Namibia, 2017) and recognizes the importance of a well-trained, technical workforce as a key cornerstone for its socio-economic goals and its efforts to increase the standard of living for its citizens. With 37% of the population between the ages of 16-35 and an unemployment rate of 37% for the youth, Namibia has a large pool of young workers who can contribute to the economic transformation agenda. However, the challenge is that the youth are unskilled and post-graduate education continues to be underdeveloped (Republic of Namibia, 2017), Research by Jauhiaine and Hooli found that STI expenditures were rather limited and the education system was considered to be generally poor (Jauhiaiene and Hooli, 2017). Although they reported that during the early 2000s, the national STI expenditure was annually just a few million USD, an encouraging trend was noted as they expected such expenditures to grow to almost 40 million USD by 2017. However, access to adequate funding is likely to remain a significant challenge in most emerging economies.

NUST has carefully aligned its mission and programs to support the government’s economic development agenda. According to Dr. Samuel John, Dean of the Faculty of Engineering, the degree programs and research focus areas of the Faculty of Engineering were carefully chosen to respond to Namibian national imperatives as presented in the National Development Plans and the National Vision 2030. Global trends and in-house capacity, coupled with support from numerous national and international partners inform the Faculty’s broad research fields, which are: Renewable energy which focuses on the development, analysis, design and implementation of renewable energy systems and technologies; Water resources management aimed at developing efficient ways of generating, distributing and re-using water resources; Manufacturing systems aimed at supporting the manufacturing sector of the nation through research activities in the fields of mechatronics, control systems and appropriate technology developments; and Sustainable mining practices with risk and safety management and environmental issues as a focus area for research activities in the mining sector (John, 2014).

Another challenge in expanding Namibia’s STEM capacity is the lack of university staff with post-graduate credentials in the country, with fewer than 200 having a PhD (Jauhiaiene and Hooli, 2017). The impact of this was something the author witnessed firsthand while hosted by the Department of Civil and Environmental Engineering (DCEE) at NUST. The DCEE had a teaching staff of 11 individuals, with the author bringing the total to 12. Of that total, four (including the author) had PhDs, four had master degrees, and four had bachelor degrees. This lack of advanced degrees hurt particularly the research endeavors of the institution as (besides the author) there was only one research active staff member who had any on-going research funding and had recent publications. For example, the FOE held two faculty research days during the academic year; the author was asked to represent on behalf of the DCEE in both events as none of the other departmental staff had current research to present.

In addition, all master level students at NUST are required to complete an applied research oriented thesis project. In addition, senior-level engineering students were required to complete a team-oriented, design focused capstone project as well as an individual based, research focused project in order to graduate. Both of which were evaluated by the departmental staff. The scope, rigor, and quality of such projects appeared to be similar to those found in the U.S., which was encouraging. However, the lack of staff with academic credentials made this problematic as the number of available project supervisors was so limited to adequately mentor approximately 20 master level and 30 undergraduate students within the department. As a consequence, the author spent considerable time during the year assisting students in formulating appropriate research questions and methodologies for their theses and projects as they had nowhere else to look.

On a similarly related issue was the lack of native Namibians holding academic lecturing positions. Approximately 80% of the academic staff at NUST were from countries outside of Namibia (although the majority were from other African countries), and the DCEE was no exception. Thus, the critical need for Namibia to develop, upgrade their academic staff, and retain their own local citizens rather than relying on expatriates from other areas is another significant challenge in developing their STEM capacity within the country.

As noted previously, K-12 teachers and students had also rarely been exposed to teaching pedagogical models such as active learning strategies. Unfortunately, this carried over to the university level staff as well. Based on the author’s observations, the focus of most staff lecturers was on the volume or quantity of information provided to the students. The larger the volume presented to students the better the quality of teaching was perceived. Often this was to the detriment of student learning as instructors would simply plow ahead with lectures without pausing to assess whether or not the students had understood or grasped the concepts. The author found this to be unworkable, scaled back the syllabi, and focused more on the students’ ability to understand and apply the materials to the solutions of real-life type problems. This included incorporating in-class exercises and other active learning strategies. Student feedback seemed to be overwhelmingly positive with many comments such as “I wish the other instructors would do it this way.”

Some positive notes, in the author’s classes, the student demographics were diverse with students from all across the country and from all tribal backgrounds. About 35% of the students were female, which is significantly higher than the author’s classes in the U.S. Most students place a high value on their educational opportunity and took their studies seriously. Upon graduation, most students were able to find employment somewhere in the local engineering and/or construction sectors, even though the country was experiencing a severe economic recession at the time. Unfortunately, the author was told that many graduates, particularly females, eventually leave the engineering profession and find employment in other non-STEM professions and jobs. As a result, very few females can be found working in any of the R&D labs in the country.

Conclusions

Namibia, as well as most developing countries in Sub-Saharan Africa, suffers from shortage of trained workers in the STEM professions. This in turn impedes the economic development of the country. As a result, the government has placed a priority on the development of technical skills as a key cornerstone for its socio-economic goals and its efforts to increase the standard of living for its citizens. Although Namibia has a large pool of young workers who can contribute to the economic transformation agenda, most are unskilled and post-graduate education continues to be underdeveloped. Some identified challenges to building the STEM capacity in Namibia include:

- Expanding access to higher education to larger portion of the population,
- Improving inadequate K-12 educational systems throughout the country,
- Recruiting students to STEM disciplines,
- Strengthening student support and financial services, particularly loans and grants, and
- Developing and retaining qualified, native resident academic staff.

Ironically, from a high level perspective, most of the challenges are not that much different than those in the United States. Unfortunately, much of this requires significant financial resources which are naturally severely limited in countries with emerging economies. Despite such obstacles, institutions such as the Namibia University of Science and Technology are making significant efforts in expanding STEM education within the country.

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