Transforming Engineering Education in Sub-Saharan Africa: A case for Nigeria.

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Abstract

This paper presents the role of improved engineering education in transforming Nigeria and indeed Africa's economy. The paper has determined that the training of engineering graduates in Nigeria is way below the globally accepted standard and basic facilities necessary to impact knowledge are lacking in institutions all across the country. These problems are compounded by government underfunding resulting in poorly equipped facilities, obsolete curriculum and Weak university-industry partnership.

The approach used in carrying out the study include appraisal of government policies, review of research work and studies carried out by experts and academicians.

It is our recommendation that the transformation effort focus on creating a system at every level of education particularly the tertiary institutions, hinged on quality control and full participation of private organizations and relevant industries in terms of sponsoring institutions and mentoring students through the result-based learning methods now being adopted globally. This can be achieved by establishing a body to administer a mandatory post graduate exam to all graduates as a pre-requisite for receiving the engineering degree certificate which will be a prerequisite for employment. Also, a centralised accreditation body should be established that carries out regular quality checks on engineering facilities to ensure they meet the set standard.

This will yield better trained engineers, improved training methods and facilities as well as reduction in failure of infrastructure.

Keywords: Challenges, Transformation, Engineering Education, Nigeria, Africa.

Introduction and problem

Engineering has always been one of the most basic building blocks of modern industrial society. Barakabitze (2019) opines that mastering and understanding basic skills and concepts

of engineering is now a key goal adopted by many countries in Africa through emphasis on teaching science, technology, engineering, and mathematics (STEM) education.

Engineering education is the activity of teaching knowledge and principles to the professional practice of engineering. It includes an initial education (bachelor's and/or master's degree), and any advanced education and specializations that follow. George King (in Maillardet, 2004) described it as a three-legged stool that relies on Science, Mathematics and Techne", with the word 'techne' taken as the creative abilities that distinguish an engineer from a scientist to design, to make, to conceive and to actually bring to fruition. Nsikan (2019) posits that engineering Education entails education with acquisition of professional skills, theoretical and practical knowledge of the subject matter as well as skills to direct effectively.

Most bachelor's degree engineering programs are 4 or 5 years long and require about 2 years of core courses followed by 2 years of specialized discipline specific courses. Required common engineering courses typically include engineering drawing /drafting, materials engineering, statics and dynamics, strength of materials, basic circuits, thermodynamics and perhaps some industrial engineering. After choosing a specialization an engineering student will take classes that will build on the fundamentals and gain their specialized knowledge and skills. Toward the end of their undergraduate education, engineering students often undertake an open-ended design or other special project. Many engineers decide to complete a master's degree in some field of engineering or some other field.

Two types of doctorate are available: the traditional PhD or the Doctor of Engineering. Akinsanya (2013) posits that most national development discussions centre on engineering works in terms of electricity, water supply, roads, telecommunications, transportation, machines and much more, making it obvious that engineering is an important profession that impinges more on our daily life than most other professions. Educational programs should be aimed at solving the problem facing the nation and improving the economy through wealth creation. Onwuka (2009) many developing nations are studying the trends of change and making modifications to their engineering education content in order to produce graduates that can adapt to modern technological trends. Akinsanya (2013) states that engineering is therefore the creative application of scientific principles and skills to design or develop structures, machines, apparatus, or manufacturing processes, etc. Suffice to say that inadequate engineering training will hinder efficiency and effectiveness. It may even cause system failure

or reduced reliability. Oroge (1991), posits that failure is the termination of the ability to perform its required function.

Akinsanya (2013) posits that a system is considered to have failed if it becomes completely inoperative or operative but unable to perform the required function or when it becomes unsafe for its continued use. A complete system will evolve from human resource's effort on the material resources that is how well the human resources can effectively utilize the materials available. The strength of the man resources depends on his engineering education, acquired experience on the job, self-drive and other informal trainings.

The need for engineering-based development is a global resolution particularly relevant to Africa right now in its struggle to strengthen its economy. This paper underlines how an overhaul of engineering education in Nigeria and Africa as a whole is directly related to growth and development in various sectors of a country's economy. This paper sets out to determine the causes and reasons for falling standard of engineering education and examines the strategies for improving engineering. A nation's growth can be hinged on the functionality of the infrastructure, which is a direct index of efficiency of the human and material resources and invested capital, Akinsanya (2013). Increased rate of failure in engineering infrastructure in Nigeria within the walls of economic reforms and a need for repositioning Africa's economy to compete favourably on the world stage called for examining the status of engineering education in the country with a view to finding lasting solutions to the rot in the educational system.

This paper examines the structure of engineering education across different African countries with a focus on Nigeria and goes further to highlight the deficiency in the African educational system and proffers solutions to these problems, how they can be implemented and the advantages to be gained from appropriately repositioning Africa educationally.

Engineering education in Africa

In 2012, The Royal Academy of Engineering published a comprehensive report entitled; 'Engineers for Africa: Identifying Engineering Capacity Needs in Sub-Saharan Africa'. The report is based on a literature review, an electronic survey of 113 professional engineers and 29 decision-makers from 18 African countries, and interviews with 15 engineering stakeholders with experience of leading projects in various SSA countries.

A key conclusion of the study is that there is a severe shortage of skilled and experienced engineers in SSA, and that "this lack of capacity at every level of the profession is a substantive obstacle to achieving almost all the development goals, from the provision of basic sanitation to the reduction of rural poverty". And yet, in most countries, the study found notable levels of unemployment among engineering graduates, mainly because engineers were graduating without the necessary skills and experience to be employable, but also partly due to the local presence of foreign engineering firms who prefer to import their own skilled labour, or the reluctance of the graduates to take up poorly paid positions in rural areas.

While engineering has been introduced in the education system in most African countries the expansion and its adoption remains slow due to a lack of effective education policies, teacher capacity, and financial resources.

Engineering training in Kenya is typically provided by the universities. Registration of engineers is governed by the Engineers Registration Act. A candidate stands to qualify as a registered engineer, R.Eng., if they are a holder of four years post-secondary Engineering Education and a minimum of three years of postgraduate work experience. The board has the responsibility of regulating the activities and conduct of Practicing Engineers. Registration with the board is thus a license to practice. Engineering training in South Africa is typically provided by the universities, universities of technology and colleges for Technical and Vocational Education and Training (previously Further Education and Training). The qualifications provided by these institutions must have an Engineering Council of South Africa (ECSA) accreditation for the qualification for graduates and diplomats of these institutions to be registered as Candidate Certificated Engineers.

Engineering training in Tanzania is typically provided by various universities and technical institutions. Graduate engineers are registered by the Engineers Registration Board (ERB) after undergoing three years of practical training and earning a four-year degree. The board has been given the responsibility of regulating the activities and conduct of Practicing Engineers. Extensive research by scholars across the continent has determined the situation of engineering education and training in SSA to be dire and Goolam (2014) attributes the state of affairs to; shortage of engineers yet unemployment of engineering graduates in some countries, limited funds to procure laboratory equipment and other facilities, obsolete curricula and old methods of teaching as well as poorly educated graduates who are sometimes unemployable and unable to compete with foreign trained colleagues, poorly qualified academic staff with limited

industrial experience. (Lawless, 2005), difficulty in recruiting and retaining staff because of poor employment conditions, weak university-industry partnership, limited opportunities for industrial experience for engineering students.

Other contributing factors identified for the decline of engineering education in Africa include; low level of public investment in engineering infrastructure projects over several decades, inadequate legislation to uphold engineering standards through requirements for professional registration, absence of regulatory laws to compel foreign companies to effect knowledge transfer to local engineers, limited resources of institutions to support engineering activities, limited laboratory experiments, scant internship experience and poor salaries for professional engineers resulting in brain drain of engineering talent (Goolam, 2014).

Engineering Education in Nigeria

Currently the 7th most populous nation in the world and set to become the third largest country in the world by 2050 with 399 million people according to the United nations, the adaptability of education in response to evolving technological and industrial needs of the people is imperative. (Wes staff, 2017). The fields of science, Technology and Engineering have much to offer in terms of economic development and provision of modern conveniences to mankind, this is why governments, institutions and managements emphasize the need for practically oriented engineering education curriculum and the need also, to provide effective teaching of relevant subjects in Nigerian colleges (Nkeweke 2007). Today, efforts are geared towards retrieving Nigeria from the shackles of technological dependence, this is why the younger generation are encouraged to be creative and invention-oriented through participation in introductory technology, technical education, and engineering studies (Wokocha 1985).

Akinsanya (2013) posits that engineering education in Nigeria involves a wide spectrum of activities extending from conception, design, development and formulation of new systems and product through the national Diploma (ND) including four month of SIWES and another two years for Higher National Diploma (HND. A minimum of one-year industrial work experience in addition to the ND is however the requirement for HND studies to produce graduate technologists. Engineering education in this context, refers to formal engineering training received in an established institution in which instructions and principles are disseminated in the classroom while practical classes are supervised and specially controlled to impact skills, (Akinsanya, 2013). According to Council for Regulation of Engineering in Nigeria (COREN),

engineering training can be structured to produce Engineers, technologists, technician and craftsmen depending on the level of educational and professional attainment. It takes five years to study engineering in the University to produce graduate engineers with the award of B.Sc, B.Eng. or B.Tech. Degrees. A period of six months in the second semester of the fourth year is used to acquire industrial skill under supervised industrial work scheme (SIWES). In the Polytechnics, engineering takes two years for Onwuka, (2009) suggested that engineering curriculum should accommodate necessary application of engineering that are prevalent in today's environment.

Quality of engineering education in Nigeria

Nigeria's entire educational system is fraught with difficulties and engineering education, established far back in 1932 when the Yaba College of Technology was founded is not left out. This is largely because Nigerian tertiary institutions are faced with enormous challenges in terms of general conduct of engineering education programs which have failed to equip students with the necessary skills that will adequately prepare them to cope with the challenges of the modern day society, a phenomenon that will generally lead to a setback in the Engineering education of any country.

According to Uwaifo (2009), "a country is said to have a setback in engineering education when the products from (its) engineering institutions cannot produce capital goods such as tractors, lathe machine, electrical & electronics devices, drilling machines, cars, iron and steel, train and other earth moving equipment as well as being unable to provide the engineering skills and expertise to undertake the exploitation of her natural resources".

According to a 2010 UNESCO report on engineering, Nigeria produces about 3,500 engineers from its universities and polytechnics every year. That is a relatively small number for a country with a population of 140 million, and yet there is significant unemployment among engineering graduates. Goolam (2014) attributed the steady decline of the engineering profession to; poor salary after graduation, coupled with decreasing employment opportunities in industries.

Challenges of engineering education in Africa

The challenges facing engineering education in Nigeria today include obsolete curricula, limited exposure to Industrial practice, lack of coordination between research institutes and production enterprise, discontinuance of Technical education among several others.

Engineering training in the University and Polytechnic, though based on theoretical and practical works, differs widely both in curriculum and practical content/skill acquisition. The difference indeed is one of the defects in engineering.

In the University, 2nd Degree of Masters of Science (M.Sc), Master of Engineering (M.Eng) or Master of Technology (M.Tech) is the minimum teaching requirement, it is not so in the Polytechnics where HND, B.Sc or FTC holders form the bulk of the teaching crew with very few members having second Degrees. So there are defects in the quality of lecturers teaching in the institutions. Lecturers have poor attendance of seminars, conferences and workshops that can assist them to update knowledge, interact with contemporaries and be abreast of developments in their area of specialization because of poor sponsorship plans, staff attitude and paucity of funds. According to Elegha (1990), the quality of students produced largely depends on the quality of training impacted in the schools. Olubadewo (2007) concluded that there was a drastic decline in the quality of engineering education in the country due to several years of neglect.

Engineering education like most other areas of education, has experienced a major setback in Nigeria due to what the Maritime Academy of Nigeria, Oron, described as poor funding, lack of functional policy framework, lack of adequate attention to research findings in engineering, inadequate workshop facilities, unstable engineering road maps, non-implementation of educational budgets, infrastructural challenges and poorly equipped laboratories, poor remuneration and low staff morale, lack of functional policy framework, lack of adequate attention to research findings in engineering, unstable political situation, unstable engineering road maps, limited exposure to Industrial practice, little or no coordination between research institutes and production enterprises (Nwohu, 2011).

Underfunding

One of the most pressing problems for Nigeria's higher education system remains the severe underfunding of its universities. The Punch (2019) states that government which is responsible for sustaining public universities, has over the past decade not significantly increased the share of the government budget dedicated to education, despite exploding student numbers. Between 2003 and 2013 education spending fluctuated from 8.21 percent of the total budget in 2003 to 6.42 percent in 2009, and to 8.7 percent in 2013. In 2014, the government significantly increased education spending to 10.7 percent of the total budget. The country budgeted N

398billion on education in 2017, In 2018, the president initially proposed N496. 9 billion, but it was later raised to about N 605. 8 billion by the National Assembly.

According to the Punch (2019) budgetary provision for education in the 2019 budget again fell below the 15%- 20% minimum recommended for developing countries by the United Nations Educational Scientific and Cultural Organisation (UNESCO). President Muhammadu Buhari had on December 19, 2018, presented N8. 83 trillion estimates to the National Assembly as 2019 budget. The executive summary of the proposal showed that the education sector got N 620. 5 billion (about 7. 05%) a marginal raise over the total of N 605. 8 billion budgeted for the sector in 2018. The 2020 education budget is N652.94bn (6.9%) over the years, Nigeria's funding for education continues to rotate between 5-7% of the national budget. Recent reports suggest that current spending levels have already decreased well below 10 percent.

WENR. Wes staff, (2017) reports that due to funding constraints, most of Nigeria's public universities are in deteriorating condition. And while efforts at increasing capacity by building new universities have generally been positive for access in absolute terms, they have also created issues related to instructional quality. A large proportion of lecturers at universities are assistant professors without doctoral degrees: Reports from 2012 suggested that only 43 percent of Nigeria's teaching staff held Ph.D. degrees, and that Nigeria had one of the worst lecturer-to-student ratios in the world. The University of Abuja and Lagos State University, for example, reportedly had lecturer to student ratios as high as 1:122 and 1:114 respectively.

Although rankings are a notoriously poor proxy for university quality, they do provide the best relative guide available. It's thus worth noting that as at, 2017, only one of Nigeria's universities is currently listed among the top 1,000 in international university rankings in the Times Higher Education Ranking – the University of Ibadan at 801. Universities from other African countries like South Africa, Ghana, and Uganda are ranked considerably higher. Over the past decade, strikes have become an almost ritual occurrence at Nigerian universities, disrupting lectures, causing delayed graduations, the loss income for university staff, and further eroding the already low trust in the education system. In 2013, 60 public universities were paralyzed by strikes for more than five months over demands for funding increases and better employment benefits for university staff. In 2016, strikes, likewise, disrupted classes at 10 federal and state universities.

ICT and Facilities

Most technical education departments in Nigeria Universities do not have laboratories or workshop space let alone usable equipment and facilities and where they exist, they are grossly inadequate, as the laboratories only have the items or equipment that were provided when the d who departments were established. The end results are ill prepared graduates lacks the tools for driving the technological and socio-economic development of the nation. There is also a dearth of ICT facilities for the training of students. The high cost of computer and teaching aids ownership is a major constraint to acquisition of the items.

Brain drain

In the context of this paper, brain drain refers to the movement of lecturers of engineering who are needed for the socio-economic and technological advancement of Nigeria from institution to institution or to other professions for better conditions of service. Bassi (2004) identified five different components of brain drain:

i). Experts in academics who moved to the industry where they get better pay for their services.

ii). Lecturers and students who leave the country to acquire more knowledge and skill but later refused to return.

iii). Lecturers who move from one country for better conditions of service.

iv). Skill professionals who abandon the practice of technical education in favour of other more lucrative economic activities and political appointments which are not related to their training.

v). Skilled professionals, although in their field of training, who do not devote their full attention to their jobs because of their efforts to supplement their earnings through other unrelated economic activities.

In the 70s, Nigerian universities were able to attract experts from other countries like India because the economic conditions then were favourable but the downturn of the economy and ineffective efforts of the government to resuscitate it, saw the foreigners leave in their numbers and their Nigerian counterparts relocate as well in order to earn a better living.

Bassi (2004) reported that:

i) About 45% of all Nigerian Professionals including engineering educators have left the Nigerian shores over the decades since colonization.

ii) Between 1997 and 2007 alone, Nigeria lost over 10,000 middle level and high-level managers to the western economies.

iii) About 500 Lecturers from Nigerian universities continue to emigrate each year, particularly to Europe, America, and other African countries where the condition of service is relatively better. These Nigerians in diaspora contribute 35 times more wealth to Europe, America, and other African economies.

Staff training and retention

Uwaifo (2009) opines that usually, local training within the nation is cheaper but more strenuous because of inadequate facilities, literature and distractions arising from the need to meet the necessary demands. Overseas training requires a lot of foreign exchange, but the enabling environment exists to achieve success in record time. However, it has become increasingly difficult to get the trainees back to their respective countries after the completion of their studies.

Academic Corruption and Fraud

While corruption is a covert activity that is difficult to measure, Nigeria scores low on the global "Corruption Perceptions Index" published by the organization Transparency International. The 2018 report ranks Nigeria 27th out of 180 countries. Nigeria's education sector is particularly vulnerable to corruption. Osipian (2013) noted that limited access to education no doubt contributed to the use of bribes and personal connections to gain coveted places at universities, with some admissions officials reportedly working with agents to obtain bribes from students. In 2013, Transparency International reported that about 30 percent of Nigerians surveyed said they had paid a bribe in the education sector.

Australian scholar Tracey Bretag summarized the conditions when describing Nigeria as a country where "academic fraud is endemic at all levels of the … education system, and misconduct ranges from … cheating during examinations to more serious behaviours, such as impersonation, falsifying academic records, 'paying' for grades/certificates with gifts, money or sexual favours, terrorising examiners and assaulting invigilators".

According to WENR, Wes staff, (2017) the West African Examinations Council (WAEC) has deemed it necessary to start using biometric fingerprint technology when admitting students to SSC examinations. In 2015, WAEC stated that Nigeria had the highest number of cheating incidents of all five countries in which the Council operates. the following year, WAEC ceased

recognizing 113 Nigerian secondary schools implicated in examination malpractice, and annulled the results of some 30, 654 candidates who sat for the 2012 SSC exams. The extent of fraud in university applications has caused the Council to develop an elaborate scratch-card system that utilizes an online pin-code verification method to verify the authenticity of exam results.

Nigeria is also home to a substantial number of diploma mills and institutions of dubious quality. The prevalence of fraud is apparent in credential reviews at WES; forged Nigerian degrees and other credentials are, by comparison to documents received from many other countries, relatively common. For this reason, WES goes to great lengths to verify the authenticity of academic documents from Nigeria.

Obsolete curricular and inadequate infrastructure

According to Afe Babalola former Pro Chancellor and Chairman of Council of the University of Lagos between 2000 and 2007 and founder of Afe Babalola university, Nigeria's entire engineering curriculum remains what was bequeathed to us at independence without any effort to modify the colonial curriculum. Equally distressing is the dilapidation of laboratories and the lack of, or obsolete equipment for training in Nigeria stemming from no disbursement of funds, mismanagement or diversion of funds.

Poor quality of teaching staff and paucity of requisite experience

Many universities are fraught with lecturers without Ph. Ds. The NUC should make it mandatory that unless a candidate has a Ph.D. and the requisite professional qualifications, he/she cannot rise beyond certain specified limits within the profession.

Lack of coordination between research institutes and production enterprise:

In advanced countries, there is an unbreakable nexus between universities and industrial concerns. This is largely because the academia work hand-in-hand with the industries in that the universities do the research while the industries translate the research findings into visible machines and services for the use of all (Juma 2006). In Nigeria there is a gap between the academia and the industries, inventions and discoveries are rarely translated into goods and services. This lack of symbiosim is one the reasons why truly skilled engineering workers, engineers, scientists, technicians, and managerial personnel will continually be in short supply (Wodi, 2012).

Shortage of skilled engineers to train new ones and accreditation inconsistencies

In South Africa it was noted that the shortage of senior engineers meant that they were seriously overworked and had little time to train junior engineers. This situation created a vicious circle: "herein lies a conundrum: it is only possible to develop capacity if there is sufficient capacity to develop this capacity" (Lawless, 2005: p. 3).

Accreditation exercise is an exercise that ought to expose the true status and quality of an Engineering program. Often times Engineering departments pretend to have facilities needed to run engineering program. They go as far as hiring equipment, manpower and office space to give an impression that standards are kept. This covers the actual need for such equipment.

Short Duration of Project Design and Participation: Intense academic project work is always given a serious look at the last semester of the final year which is not enough time to initiate and execute a well thought out and truly innovative project. This often ends in rushed design projects which is often unoriginal and error prone. (Azubuike, 2016)

NYSC Posting of Engineering Graduates to Secondary and Primary Schools: National Youth Service Corps is a Nigerian federal Government Organization in charge of organizing one-year compulsory service to the nation by all graduates below the age of 30 years. There is arguably Very little to be gained in terms of practical experience by engineering graduates from teaching in secondary and primary schools. Azubuike (2016) opines that a nation desirous of industrialization should not be relegating its young engineering manpower to classrooms but to industries, ministries, private engineering firms to gain practical experience and hone their skills.

Limited access to Public Internet Facilities by Students and Instructors: Often times engineering students pay for their personal internet facilities while in school. This complicates the process of making engineering education accessible to all for the development of the society. Public internet facilities will aid students by giving them access to the global network of engineering innovations and a wider knowledge pool.

Transforming engineering education in Nigeria

The immediate future of engineering education all over the world is changing, there is a movement towards a more practical based learning approach, teamwork development, open-ended problem solving, experimental learning and active research. Most of these cannot be found in the educational system in Nigeria. To meet up with the demand of the industry and to

be able to compete favourably internationally, a number of changes have to be implemented to improve the quality of engineering education in Nigeria.

There is, first of all, an urgent need to upgrade the infrastructure and laboratories of the existing institutions. Publicly funded African tertiary education institutions have for several decades suffered from lack of investment and maintenance and this has led to a deterioration of their infrastructure.

The curricula of engineering courses also need to be revised. Most of them have been copied from universities in Europe or the United States, have not been updated, and are not necessarily relevant to African situations. (Goolam, 2014)

Goolam (2014) posits that teaching methodology needs to be improved as well. Because of large student numbers, the subjects are mostly taught by the magisterial mode with hardly any opportunity for the students to discuss and interact with the lecturer or among themselves. It has been suggested that the Problem Based Learning approach in engineering education could result in noticeable improvement in the students' ability to solve problems and, in addition, help them acquire certain "soft" skills such as good communication, team spirit, creativity and adaptability- all key requirements for graduate employability.

Goolam (2014) holds that Closely linked to improving teaching methodology is the need for pedagogical training of engineering lecturers. Many of whom, although they may have a doctorate degree in their field, are ill-equipped to help students to learn using appropriate pedagogical techniques. All the studies highlight the importance of strong university-industry linkages. These linkages can take different forms: involving industry in advising on curricula reform; inviting representatives from industry to serve on the Faculty of Engineering board or even on the higher administrative bodies of the institution; and using professionals from business and industry as adjunct professors. Perhaps the most important role of industry is to provide practical training to the students at two different stages: during the course in the form of industrial attachments, which exposes the students to the world of work and subsequently facilitates their employment; and on completion of the course, to meet the necessary professional registration requirements. Several universities in Africa have unfortunately abandoned the in-course industrial attachments, because of the difficulty in placing the ever-increasing number of students—leaving the students to acquire training on employment after graduation.

Bridging the skills gap and building the right talent for Africa's future cannot be left to the government alone. The private sector needs to adopt a more collaborative and concerted approach to help drive initiatives that will build capacity at the scale and speed required. In South Africa, the government has recognised that skills development is a key ingredient in the quest for economic growth and prosperity. It has therefore mandated organisations to spend 1.5% of their payroll on training their workforce. Financial services group MMI Holdings, for example, is investing in nurturing students and partnering with professional bodies to raise the quality of education. Former CEO Nicolaas Kruger says 60% of the allocation of funds via its foundation is channelled into education initiatives.

The Royal Academy of Engineering, (2012) proposes that Capacity building strategies targeted at governments, industry and higher education institutions include:

Governments: adopt industrial policies so as to create jobs, promote enterprise development and improve skills training; establish and enforce a statutory requirement for the professional registration of engineers; invest in higher education institutions to improve engineering education; develop policies to mitigate brain drain of engineers.

Industry: support higher education institutions by providing industrial placements for academic staff and work placements for undergraduates; provide continuous professional development opportunities for engineering staff; foreign companies to ensure knowledge transfer to local engineers.

Higher Education Institutions: continuously review and update engineering curricula and involve industry in the process; build stronger links with industry.

Many companies now dabble in international business, as such new engineers are being trained on the job to meet global challenges, however African universities education curricula have not kept pace. Our curriculum needs to be overhauled to match current international standards. Another approach is to innovate our engineering curricula according to world economy demands (Kumar, 2004). Transforming engineering education can be achieved by having accredited cosmopolitan engineering faculties offer courses that are geared toward addressing both national and international issues. Africa has the human resource with adequate international experience required to internationalize engineering education. A stable political and economic system is necessary to retain the highly qualified African engineers who are the drivers of the engineering education toward achieving this goal.

Accreditation of engineering qualifications in Africa is key to improving the quality of degrees awarded. Most African countries have taken steps towards accreditation of their engineering qualifications but only a few have really established a robust accreditation system. This study suggests that these countries should take the lead in assisting other countries, on a sub regional basis, to improve their accreditation system, the ultimate goal being to establish a Pan-African engineering accreditation system. Language, too, plays a significant role in international collaboration on education and accreditation, because it enhances or deters the sourcing and dissemination of ideas.

Funding

The extensive restructuring required by the system requires a level of continuous funding that can not be left to the government solely. The Nigerian government has continuously under budgeted and Underfunded the education sector against the better advice of UNESCO and concerned experts as observed above. Consequently, there is an urgent need for industries and organizations to chip in as well if the transformation agenda is to succeed.

Well equipped research institutions

Juma (2006) stressed the importance of the development of high-quality research institutions to improve capacity for technological innovation in engineering. He suggested that one approach to resource constraints would be for countries to pool resources to create regional institutions. The technological innovation facilitated by such institutions would generate opportunities for economic growth, and would facilitate the development of African solutions to African challenges, such as the need for affordable, decentralised, renewable energy to meet the dual challenges of climate change and modern energy provision in rural areas.

The role of the internet in transformation

Recently the use of computerized delivery methods in higher education has become popular as a means of delivering information. The Internet is a global information network, which has affected the education scene from primary to tertiary education. The two modes used in the world of academia are Web-based instructions and Web-based learning (Barron, 1998). It is generally agreed that the Internet can revolutionize the gathering and dissemination of knowledge to strengthen traditional teaching methods. Teaching engineering now makes use of multimedia, computing, communications, electronic publication, and common databases.

Governments in Africa also need to introduce measures to reduce the brain drain –of highly qualified people in search of opportunity – by creating a conducive environment for young professionals to thrive in their country of birth. A draft African Union report, The Revised Migration Policy Framework for Africa and Plan of Action (2018–2027) , urges African countries to halt the exodus of skilled nationals to developed countries, this can be achieved by providing employment and home-based professional development opportunities that meet global standards.

Collaboration

There is an urgent need for collaboration between engineering faculties and industries to achieve industry-based training which is vital for the purposes of stimulating and sustaining the economy through hiring of students, sponsorship of research and grants. Stakeholders of industries should also be made advisory board members in a number of universities. Industries should suggest and sponsor training for graduate engineers and technologists where emphasis will be placed on marrying classroom training with industrial practical requirements.

Skill development, Continuous evaluation and modification of the curriculum

Skill development and acquisition centres should be established in different parts of the country to strengthen the engineering profession.

To meet current and future technological demands and accommodate the rapid technological changes now being experienced the curricula has to be constantly updated (Oloyede, 2017).Teamwork should also be encouraged to tackle complex processes systems engineers would have to conceive, create and operate. Curricula should be reviewed and harmonized to ensure quality standard is maintained across board in the engineering syllabus countrywide.

Adoption of result or outcome-based learning methods and internships

There is a need for the interaction and reinforcement of the essential fundamentals an engineer would need when on the field. Africa's educational system must adapt to the practical-based teaching methodology now being practised in developed countries. Research must be done to identify and resolve real life problems and scenarios that are faced by tech industries and everywhere technological solution are needed.

Internships are offered as temporary positions by engineering companies. They provide a way for companies to recruit and get familiar with individual students as potential full-time

employment after graduation. Students who have practical engineering experience are considered to be more attractive to engineering employers.

Innovative approach to teaching and learning

Quality assurance test results reveal 96% of respondents who studied engineering abroad are satisfied with the quality of education they while only 14% their Nigeria-trained counterparts were satisfied with the quality of education they received in Nigeria necessitating the need for a thorough over haulage of the syllabus and entire teaching system. Oloyede (2017).

Degree specialization and an option to spend a full year in the industry

The present 5-year engineering learning structure without specialization will not meet the need of future engineers. There is a need to breakdown the areas of specialization and reduce the number of years spent in the classroom to allow for a full year to be spent as part of the degree in the industry (Oloyede 2017)

Conclusion

Engineering is one of the areas requiring the most attention especially as it serves a key role of providing highly skilled personnel for technological and industrial development. The actualisation of an educational overhaul, however, faces a number of challenges earlier identified, these challenges need to be addressed jointly by African governments, educational institutions, representatives of industry and the private sector. It is imperative the right decisions are made, supported by generous funding, controls, facilities and favourable policies. Education and training, especially in STEM subjects are necessary tools for the continent to unlock its potential.

This paper concludes that the training of engineering graduates are deficient and suggests the establishment of a single body to administer mandatory post graduate exams as a pre-requisite for receiving the engineering degree certificate on completion of their degree programme, which will be a prerequisite for employment as an engineer. Also a centralised accreditation body should be established that carries out regular quality control checks on engineering facilities and faculties to ensure they meet the set standard.

For economic development and technological advancement to happen in Africa the challenges confronting engineering education must be recognized and fought vigorously. A comprehensive reform plan and modern ICT support is the necessary first step on the road to economic recovery and global competitiveness. Adoption of best practices, on-the-job training and curriculum updated to reflect industrial requirements are also imperative. If the suggested recommendations are adopted, engineering as a profession will be positioned as a catalyst to drive Nigeria and indeed Africa out of its current economic stagnation. The Federal Government through National Universities Commission (NUC) and National Board for Technical Education (NBTE) should embark on advocacy to educate the public on the potential role of engineering education in national economic development and also promote policy changes that advance the course of STEM education.

Engineering education should be result-based to improve real skills. Technological projects should be assigned to schools and software skills relevant to their particular arm of engineering should be developed by every department in the faculty of engineering. Universities and departments should connect with industries and organizations that can help provide practical work, real-world problem-solving learning opportunities and keep them abreast of current trends and innovations in engineering. Emphasis should also be placed on learning outcomes and performance-based education not syllabuses which should be frequently revised to align with current industry demands. Professors should be rated based on quality of research done and private organizations should play a major role in managing higher education in Nigeria and across Africa.

Contribution of new knowledge

In line with fostering stronger industry-tertiary institution relationships, adopting the current approach of innovation at every level and result-focused learning methods, this paper suggests that final year students be mandatorily assigned to engineering and tech companies with the task of innovating a solution to meet an existing need at the assigned organization. The focus being to assess their level of innovativeness and ability to provide solutions to real world challenges.

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