DEVELOPING ENGINEERING SKILLS FOR TECHNOLOGICAL BREAKTHROUGH IN NIGERIA

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Abstract

Technology is the making, modification, usage, and knowledge of tools, machines, techniques, crafts, systems, methods of organization, in order to solve a problem, improve a *preexisting solution to a problem, achieve a goal or perform a specific function. Technology in this context requires specific engineering skills to thrive. This paper examines the ways engineering skills help to transform technology. It identifies different skill areas in our society especially in Nigeria and discusses the several avenues of skill acquisition. The study identified skill to be classified into three: cognitive, non-cognitive and technical skill and went further to draw a synergy in relation to the three classes.*

Introduction

The use of the term technology has changed significantly over the last 200 years. Before the 20th century, the term was uncommon in English, and usually referred to the description or study of the useful arts (George, 1823). Technology rose to prominence in the 20th century in connection with Second Industrial Revolution. In 1937, the American socialist Read Bain wrote that technology includes all tools, machines, utensils, weapons, instruments, housing, clothing, communicating and transporting devices and the skills by which we operate and use them (Read, 1937). But equally prominent is the definition of technology as applied science, especially among scientist and engineers (Donald, 1999). The word technology can be used to refer to a collection of techniques. In this context, it is the current state of humanity's knowledge of how to combine resources to produce desired products, to solve problems, fulfill needs, or satisfy wants. It includes technical methods, skills, processes, technique, tools and raw materials.

From the above definitions of technology it is evident that the phenomenon cannot thrive without skills, specific engineering skills. The development of

indigenous skills and techniques of pre-colonial Nigeria is a pre-requisite to sound technological growth rather than depending on foreign inputs, which must be properly monitored and developed to set the pace for Nigeria's industrialization (Kayode, 2010). Development is the gradual growth of skill to become more advanced or process of producing more advanced product (Hornby, 2002). Consequently technology development is the transformation of ideas to practical skills, which are concerned with the transformation of ideas to practical skills, which are concerned with the transformation of raw material into finished goods (Kayode, 2010).

According to Onipede (2003) technological development pertains to development witnessed through industrial activities; he went further to state that these activities involves the processing of manufactured goods on a large scale using extensive plant and equipment which were all products of technology. Therefore technological transformation entails the paradigm shift in a nations technology. This according to Kayode (2003) entails a process of mobilizing resources and harmonious integration of modern and traditional technologies organized and fitted into feasible project designed for specific purpose. The process of skill development to meet up with the technological need of a society is called human capital development. Human capital development presupposes investments, activities and processes that produce vocational and technical education knowledge, skills, health or values that are embodied in people (Enyekit, Amaehule and Teerah, 2011). It implies building an appropriate balance and critical mass of human resource base and providing an enabling environment for all individuals is an effort in human capital development (Erhurua, 2007). The critical position of engineering in national development, the need to release the productive capacity of the engineer into our economy cannot be over-emphasized. To achieve this, a lot of technical skills are required of an engineer. The German engineer comes out theoretically sound with an equally do-how knowledge to match. Nigeria's situation shows a sharp contrast hence the need for greater attention to engineering skill development to achieve the desired technological transformation.

The Concept of Skill

Skill consists of cognitive, non-cognitive and technical skills as explained below:

1. Cognitive Skills: These are the basic mental abilities we use to think, study, and learn. They are the tools with which technical and life skills are acquired. Cognitive skill according to David (2011) is defined as the ability to understand complex ideals, to adapt effectively to the environment, to learn from experience to engage in various forms of reasoning, to overcome obstacle by taking thought. Examples of cognitive skills are: literacy, numeracy, and ability to solve abstract problems.

2. Non-Cognitive skills: these refer to personal traits and behaviours (Arvil, 2011). Non-cognitive skills characteristics across multiple domains (social, emotional, personality, behaviors, attitudes etc) not included under cognitive skills (David,

2011). Examples include: work habits such as discipline, effort, determination, behavioral traits such as self confidence, sociability, and emotional stability, physical characteristics such as strength, dexterity and endurance.

3. Technical Skills: which according to David (2011) is the combination of cognitive and non-cognitive skills used to accomplish specific task. They can be acquired through informal training on the job, apprenticeship, enterprise-based training, off-the job training in government and non governmental training institutions and internship (Arvil, 2011).

Skill Expectations of an Engineer

According to Maddocks, Dickens and Crawford (2002), a graduating Engineer should be skillful in the following areas

1. Knowledge and Understanding: That is the Ability to Demonstrate

i. Specialist (Discipline) knowledge
ii. Understanding of external constraints
iii. Business and management techniques
iv. Understanding of professional and ethical responsibilities
v. Understanding of the impact of engineering solutions on society
vi. Awareness of relevant contemporary issues

2. Intellectual Abilities: Which is the Ability to Demonstrate

i. The ability to solve engineering problems; design systems etc. through creative and innovative thinking.
ii. The ability to apply mathematical, scientific and technological tools
iii. The ability to analyze and interpret data and, when necessary, design experiments to gain new data.
iv. The ability to maintain a sound theoretical approach in enabling the introduction of new technology.
v. The ability to apply professional judgment, balancing issues of cost, benefits, safety, quality etc
vi. The ability to access and manage risk.

3. Practical Skills: That is the Ability to

i. Use a wide range of tools, techniques, and equipment (including software) appropriate to their specific discipline.
ii. Use laboratory and workshop equipment to generate valuable data.
iii. Develop, promote and apply safe systems of work.

4. General Transferable Skills: The Ability to:

i. Communicate effectively, using both written and oral methods.
ii. Use information technology effectively.
iii. Manage resources and time.

iv. Work in a multi-disciplinary team
v. Undertake lifelong learning for continuing professional development.

Avenues of Engineering Skill Acquisition/Development

1. Vocational and Technical Education

The term vocational and technical education is a comprehensive term referring to the educational process when it involves, in addition to general education, the study of technologies and related sciences and the acquisition of practical skills and knowledge relating to occupations in various sectors of economy and economy and social life (Enyekit, Amaehule and Teerah, 2011).

In UNESCO study (as cited in Enyekit, Amaehule and Teerah, 2011), the broad educational goals of vocational and technical education distinguished it from "vocational training" which is directed to developing the particular skills and related knowledge required by a specific occupation or group of occupations. Vocational and technical education is a vehicle upon which the skills of work force are built. Without the implementation of vocational and technical education, we cannot hope for a future self reliant graduate with the required skills and flexibility for sustainable human capital development in the global age (Enyekit, Amaehule and Teerah, 2011). Vocational and technical education is an instrument for change and development and a provider of service oriented skills, which plays significant role in economic revival for sustainable human capital development. It is on the recognition of these needs that the National Policy on Education places on technical and vocational skills at the secondary and tertiary institutions in Nigeria (Enyekit, Amaehule and Teerah, 2011). The examination of the statistics as released by UNESCO Institute of Statistics (2007) shows distinct regional pattern for how vocational skills are acquired (Arvil, 2011). The study according to Arvil (2011) revealed that technical and vocational education plays large roles in Europe and Oceana than in North America. In Denmark and the Netherlands over a quarter of secondary students are enrolled in technical and vocational education (Arvil, 2011). And that in UK, this percentage rises to over half of secondary students. In Australia, it is over 40% but in Canada the percentage drops to under 5%. This pattern does not imply marginalization of skills in countries like Canada. In these countries, skills are often being acquired in other ways, including tertiary education. One of the trend noted in UNESCO data according to Arvil (2011) is the tendency of countries to push vocational specialization later in the curriculum of formal education. Thus with rising access to general education taking place, vocational and technical education is being pushed later in the curriculum from lower to upper secondary to tertiary education (Bishop, John and Ferran, 2005). This method, if adopted in Nigeria education curriculum and implemented shall culminate in the desired technological transformation.

2. Student Internships

Internships which found its origin in the U.S. in the early 19oos are work-based educational experiences, that relate to specific jobs, positions, occupations or

professions (http://www.ebscohost.com/upload/imported/thisTopic-dbTopic-1072.pdf). Students are placed as interns with a wide variety of sponsoring organizations based on their individual fields of interest. They can serve internships in the arts, education, health, communications, business and industry, technology and many other areas. Students are released from school for the part of the school day or school year; work a variable number of required hours on a part-time basis for a designated period. In Nigeria, a total period of one year is usually used for internship at a stretch or bit by bit within the student's undergraduate life.

During this period, the student is mandated to retire completely to the industry. Internship is synonymous with students of Engineering and Engineering technology in Nigeria that is not to say that students of other disciplines do not pass through the programme. Student interns receive on-the-job, one-on-one training in a work setting from skilled professionals, who provide the knowledge and expertise of their field. Students learn by doing in actual situations through, hands-on experiences. They are evaluated and assessed by both their school internship coordinator and their onsite professional supervisor or mentor using an authentic, competency and performance base model, portfolios and exhibitions (hppp:www.ebscohost.com/uploads/imported/thisTopic-1072.pdf). Among the many positive educational outcomes of internship are practical experiences, new skills and improved attitudes and behaviours. Intern projects include a range of practical experiences that emphasize real work and independent activities (Hendrie, 2004; Littke, 2004). Typical activities designed by Student Industrial Work Experience Scheme (SIWES) coordinators for student interns include conducting site interviews; keep an observation diary using the LOGBOOK and personal evaluations. At the end of the program the student is expected to present a technical report to the department where he originated. In Nigeria, student internship is sponsored by the Industrial Training Fund (ITF).

3. Apprenticeships

These are largely private contracts between a master craftsman and parent or student whereby the master agrees to provide training for a fixed period of time to the student in exchange of labour and small fees (Arvil, 2011). Nigeria has no provision for artisanship and apprenticeship training in its engineering curricula (htt://go.engineering-ng.net/forum/topics/). And this in no doubt has made traditional apprenticeship the dominant practice in Nigeria. The most populous apprenticeship areas as practiced in Nigeria include: auto-mechanic, wood work, bricklaying, electrical installation, welding and metal works. Others include electronic repairs, generator mechanic, computer hardware repairs etcetera. Recently in Nigeria, the federal ministry of finance has flagged off the Graduate Apprenticeship Scheme christened SUREP which is first of its kind. A country like Ghana reports less than 1 % of its secondary enrolments in technical and vocational education. In Kenya the figure is two percent. Yet both countries have much large members engaged in

traditional apprenticeships achieved less for women in terms of entry rates and occupational access. Therefore according to Arvil (2011) women should venture into newer areas such as information technology where employment has not yet had time to form gender-specific patterns.

4. Government Training Centres

These are non-formal training outfits established by government or offered by technical ministries such as ministry of science and technology. One good example of such centres in Nigeria is the Common Facility centre (CFC) in Aba, Abia State. The CFC has evolved from multiple projects addressing the leather and the garment/textile sectors in the region. The CFC is a shared facility for the improved production and knowledge of the leather and garment clusters also located in Aba. Located in close proximity to the clusters, the CFC provides training aimed at improving the skills of the entrepreneurs in the clusters and thus contributes to improving the production quality (http://www.unido.org/index.php!id=1002556). The specific objectives of the project include:

i. Establishment of institutional mechanism for training of CFC staff and the installation of equipment.
ii. Training the staff/trainers and up-grading existing entrepreneurs technical and management skills in ready-made garment.
iii. Improving capacity of support institutions and providing services in entrepreneurial, technical and management training.

5. Enterprises Training through Pivate Sector

A good example of this is the UNIDO-Hewlett Packard (HP) Cooperation for Entrepreneurship and Technology Education.

This partnership consummate in 2008 to implement a global program for entrepreneurship and IT education (htt://www.inido.org/index.php?id=1002556). The major aim has been to equip aspiring and existing entrepreneurs in developing countries with hands-on business and IT skills. The GET-IT/LIFE initiative has benefited from close alignment and synergies with national entrepreneurship development programmes.

The Place of Artisans

An artisan is a skilled manual worker who makes items that may be functional or strictly decorative, including tools and machines. An artisan is therefore a person engaged in or occupied by the practice of craft, who through experience and sometimes, talent reach the expressive level of an art in his work and what he creates. An artisan gain expertise mainly from constant hands-on-job exposure (htt://go.engineer-ng.net/topics). Artisans were the dominant producers of consumer products prior to the industrial revolution (htt://go.engineer-ng.net/topics/. For Germany, artisanship is a hangover from the 19th century, making them a name almost synonymous with state-of-the art technology (htt://go-engineer-

ng.net/from/topics/. In Nigeria, apprenticeship is given the least of attention neither is the engineering curricula designed to feature the acquisition of outwardly menial skills like welding and plumbing. Nigeria imports artisans such as electricians, tillers and plumbers, which should not be the case because the country should be looking to developing areas of comparative advantage and link that to industrialization (htt://go.enginer-ng.net/forum/topics/.

Engineering Processes for Technological Transformation:

1. Basic Engineering Research

There have been genuine attempts by many engineering researches in universities and research institutions to develop machineries for agricultural and industrial production. The results of many of these efforts are rarely known to the public and most are not commercialized (Adeyemi, 2000).

2. Development of Indigenous Technology

While admitting that the adaption of Western Technology as mandatory for our technological take off, it behoves on us to apply western science and technology to improve on some indigenous technology such as textile production (aso-oke), blacksmith, foundry works etc (Adeyemi, 2000). In adaption of western technology and the development of our indigenous technology, Adeyemi (2000) opined that advantage must be taken of latest development in computer aided design and manufacturing, robotics, information technology such as internet, etc.

3. Design and Development of Machineries and Equipment:

The design of production machineries requires a detailed knowledge of technical procedure for converting raw materials into finished products. The professionals are to also utilize existing standards and technical brochures for this design activity. Although this is the conventional method but for Adeyemi (2000), our nation can avoid the trial and error and costly requirement of product development that trails the method. It is now obvious that the industrialized world is not prepared to divulge her technical secret with the less developed nations as this will affect their leadership position in the world (Adeyemi, 2000). As a way out Adeyemi (2000) suggested that Nigeria should purchase machines of proven performance from across the world, dismantle and copy the technology. This referred to as reverse engineering strategy. He also cited that Japan employed the reverse engineering method for development of her local technology in some fields.

Recent Government Efforts

The Nigeria Minister of Trade and Investment, Olusegun Aganga in February, 2012 expressed his discontent with state of the country's Gross Domestic Product saying "the cement industry is growing exponentially with a direct impact on the construction industry which is growing at the rate of 12% per annum in the country, but sparingly less than 0.4% contribution to GDP". The reason he said, was informed by the fact that the country Nigeria imports large parts of its technical workforce. To

arrest the ugly trend, the federal government in partnership with Cement Manufacturer of Nigeria (CMAN) are presently to establish a Cement Technology Institute, an institute where core practical cement manufacturing skills are acquired. Government is also planning to put in place a practical vocational skill development programme, like it is done in Brazil where they turned out between two to four million graduates every year.

Conclusion

The shortage of engineering skill manpower has remained a major setback to Nigeria's technological breakthrough. This shortage is linked with the imperial educational system that give little or no consideration to the technological need of rapidly changing industrial economy. It is therefore suggested in the paper that technical and vocational education be integrated in the engineering curricula. Also apprenticeship and artisanship culture should be embraced by all in order to produce skill manpower for the desired technical transformation.

Recommendations

Having x-rayed the place of engineering skills for technological transformation, the following recommendations are eminent:

1. The Nigeria engineering curricula should include apprenticeship and artisanship programme.

2. The student's internship programme (SIWES) should be goal oriented. Every student must be sent to companies where they can get the required hands-on practical experience.

3. Schools should open windows of partnership with technically oriented companies.

4. Existing technical colleges should be revitalized by employing qualified skillful teachers and equipping the workshops with modern training models, tools and kits.

5. Technical secondary education should be made compulsory for aspiring engineering students.

6. Government should establish more training centres which should be operated through public private partnership.

7. Engineering research should be redirected towards technological transformation instead of career progression.

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