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Engineering Education in Nigeria for Engineering Graduates: Issues and Strategies

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Authors' contributions

This work was carried out in collaboration between all authors. Author NCI designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors HCG and CMUD managed the analyses of the study. All authors read and approved the final manuscript.

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ABSTRACT

This conceptual paper presents a review of the developing trends in engineering education in Nigeria for engineering graduates in the 21st century. A case study approach was used for this study, chronicling several issues that impact quality engineering education presently in Nigeria. However in dealing with the issues this paper recommends that there is a need for Nigeria to become signatory to the international engineering alliance to ensure consistency in standards and the mobility of engineering graduates, encourage university/industrial linkage through the creation of technological parks, and to adapt the system of endowment to gain financial independence.

Keywords: Collaboration between academia and industry; engineering education; endowment systems; international engineering agreements.

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1. INTRODUCTION

Across the globe, national economy, national security, and indeed our everyday lives are progressively more reliant on scientific and technological innovation. Engineering is a key component of innovation and our emerging global technological society. A strong educational base in engineering that produces superior graduates has a direct impact on the economic growth, prosperity and development of any nation [1]. Thus, quality engineering education stimulates the technical capacity of the workforce leading to competent engineers to support economic growth and development. Once there is a cadre of qualified local engineering graduates available, a country can attract technically oriented multi-national companies, which will invest effectively in the developing country. In addition, that country can, more effectively utilize foreign aid funds, thus providing a legacy of appropriate infrastructure projects and technically competent engineering graduates to operate and maintain the project. In addition, competent engineering graduate entrepreneurs will start small business start and stimulate the economy [2].

There is an increasing demand for graduate engineers as industry, government and other service sectors are seeking professionals who are able to work anywhere in the world, who have the skills to work on global engineering projects and who can provide solutions to engineering problems.

In this rapidly growing technological society, engineering graduates in the 21st century must be technically adept, multilingual, commercially savvy, innovative and entrepreneurial, able to understand world markets, be professionally flexible and mobile.

Engineering education can prepare these engineers with the knowledge and technical skills that will enable them to meet with this increasing demand. Engineering graduates must not only be knowledgeable about science and technology but also have the skills, competencies and values to address global problems and opportunities in effective and creative ways [3]. In general, [4] submitted that the need for engineering education for engineering graduates is:

- To propagate scientific and technological knowledge;
- To provide society with graduates for the engineering profession who are equipped to respond to the engineering and technological challenges now and in the future;
- To increase the girth and profundity of the technological understanding of society;

2. ENGINEERING EDUCATION IN NIGERIA

The future of any nation depends not only on the natural resources available but must be able to harness these natural resources through specialized engineering skills acquired by its engineering graduates [5].

According to several authors [6,7], the Nigerian government from the mid 80's has made frenetic efforts to promote engineering education in Nigeria. The government has diversified and specialized the universities with a goal of increasing their scientific, technological and agricultural contribution to the transformation of the country. This is as part of its Millennium Development Goals to encourage economic growth and development.

In achieving this objective, engineering education in Nigeria can be obtained through two distinctive routes. First is the trade apprenticeship education where the graduate of the local trade program study to advance their practical and hypothetical comprehension of their various trades [8]. This mode of education is usually obtainable from technical colleges in Nigeria awarding ordinary national diploma (OND) and higher national diploma (HND) in engineering. The second route can be traced through the college or university awarding bachelors of engineering degrees [8].

For both routes, the federal government through the ministry of education instituted regulatory bodies to ensure quality and standardization of engineering graduates in Nigeria. The National Universities Commission (NUC) is in charge for accreditation and delivery of quality for all university education in Nigeria, while the Council for the Regulation of Engineering in Nigeria, (COREN) is in charge of accreditation and delivery of quality for only engineering education in Nigeria. They are responsible for planning, organizing, managing, funding, monitoring and supervising of activities and development of the tertiary institutions in the country in order to

ensure an effective and efficient control of Nigeria's higher education higher education [8].

The Council for the Regulation of Engineering in Nigeria carries out the accreditation of engineering education in Nigeria. Section 1 (1b) of the Decrees 55 of 1970 and 27 of 1992 (amendment), now an Act of the National Assembly, Engineers (Registration etc) Act CAP E11 of 2004 empowers COREN to "determine what standards of knowledge and skills are to be attained by engineering graduates seeking to be registered as engineering personnel and to raise those standards from time to time as circumstances may permit" [9].

For this purpose, the Act provides that COREN shall conduct visitations to Engineering Institutions in Nigeria or elsewhere for the purpose of:

(a) Accrediting their courses (sections 7 and 8 of the Decrees);
(b) Withdrawing any previous approvals, if so warranted and as prescribed in sub-sections (3)–(5) of section 7.

Similarly, educational institutions training graduates for the engineering profession are expected to submit syllabus of its programme, content and minimum facilities to the Council for approval before a course approved by the National Universities Commission or the National Board for Technical Education, or any other engineering body, is commenced [9].

Therefore the accreditation visit by COREN to Universities, Polytechnics (and Monotechnics), and Technical Colleges serves as a quality assurance mechanism to ensure that Engineering programmes meet the minimum requirements in:

- Academic Structure (Curriculum)
- Staffing (Academic, Technical and Administrative)
- Physical Facilities (Laboratories, Workshops, Classrooms, Office accommodation, Environment, etc)
- Library Facilities
- Information and Communications Technology
- Management and Funding

Table 1 shows that from the accreditation exercise carried out by the Council for the regulation of Engineering in Nigeria, (COREN), a total of thirty one (31) engineering disciplines from forty seven (47) universities were accredited, with 83% having full accreditation, 16% securing an interim accreditation and 1% failing accreditation. As illustrated in the following Fig. 1, it is evident that there are enough engineering disciplines approved to have met the required standard for a graduate engineer in the 21st century. Thus accreditation approval is not a barrier to Nigerian engineering education. However, serious barriers to exist.

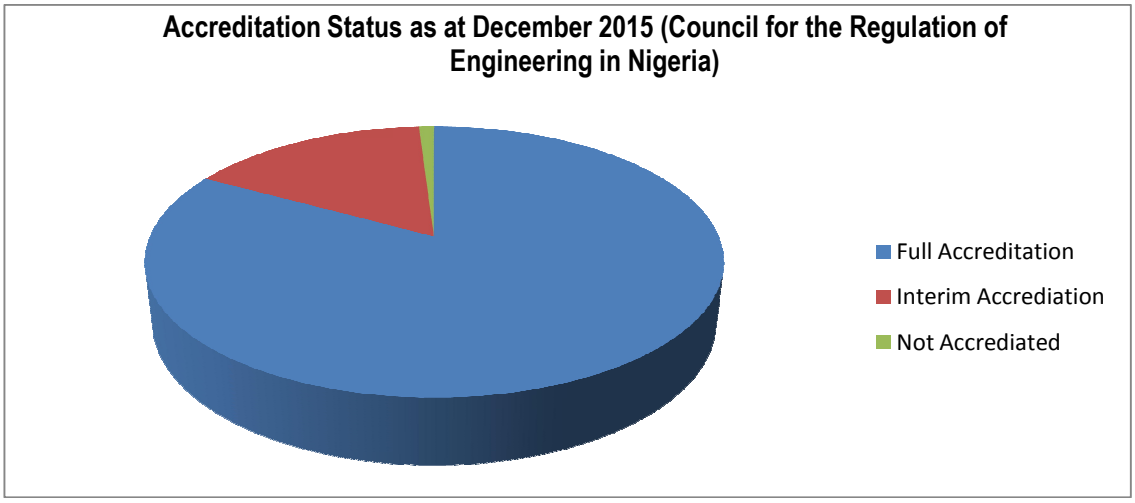

Fig. 1. Accreditation Status as at December 2015 (Council for the Regulation of Engineering in Nigeria)

Table 1. Shows the accreditation status as at December 2015 of existing engineering programmes in Nigeria as conducted by COREN [9]

S/No	Engineering disciplines	No of universities	Accreditation status				
			Full	Interim	Passed pre	Not accredited	Failed accreditation
1	Aeronautics & Astronautics Engineering	1	-	-	1	-	-
2	Agricultural Engineering	22	20	1	1	-	-
3	Agricultural & Bioresources Engineering	1	-	-	1	-	-
4	Agricultural/Environmental Engineering	1	-	-	1	-	-
5	Automobile Engineering	1	1	-	-	-	-
6	Biomedical Engineering	2	2	-	-	-	-
7	Chemical Engineering	23	18	1	4	-	-
8	Civil Engineering	36	-	-	2	-	-
9	Civil & Environmental Engineering	1	1	-	-	-	-
10	Civil &Water Resources Engineering	1	1	-	-	-	-
11	Computer Engineering	19	16	-	3	-	-
12	Electrical & Electronics Engineering	40	37	-	3	-	-
13	Electrical Engineering	4	3	1	-	-	-
14	Electronics Engineering	3	3	-	-	-	-
15	Food Engineering	3	3	-	-	-	-
16	Food, Agriculture and Bioresoucres Engineering	1	-	-	1	-	-
17	Industrial Engineering	1	1	-	-	-	-
18	Industrial/Production Engineering	1	1	-	-	-	-
19	Marine Engineering	3	2	-	1	-	-
20	Mechanical Engineering	43	38	1	4	-	-
21	Mechatronics Engineering	3	1	-	2	-	-
22	Metallurgical & Material Engineering	9	8	-	1	-	-
23	Metallurgical Engineering	1	1	-	-	-	-
	Mining Engineering	1	1	-	-	-	-
24	Petroleum Engineering	12	11	-	1	-	-
25	Polymer & Textile Engineering	1	1	-	-	-	-

S/No	Engineering disciplines	No of universities	Accreditation status				
			Full	Interim	Passed pre	Not accredited	Failed accreditation
26	Production Engineering	2	2	-	-	-	-
27	Systems Engineering	1	1	-	-	-	-
28	Structural Engineering	1	-	-	1	-	-
29	Telecommunications Engineering	4	2	-	2	-	-
30	Water & Environmental Engineering	1	1	-	-	-	-
31	Wood Engineering	2	2	-	-	-	-

3. ISSUES IN ENGINEERING EDUCATION

Without increased technological skills, nations will decline in competitiveness, and economic growth will diminish. However with increased technological skills, nations can be world leaders in economy and technology [10]. Nigeria has implemented a policy document called vision 2020, with the aim of becoming one of the top twenty global economies, consolidating her leadership role in Africa and becoming a significant player in the world [11]. One of the keys to achieve this is having the technical skills required to meet the increasing demand in infrastructure development as infrastructure development is listed as critical in the policy document.

However there are issues in engineering education that limits this objective and they are discussed as follows:

3.1 Funding Structures and Limited Infrastructure

Most universities in Nigeria are government (federal and state) owned, although some universities are also owned by private individuals in their personal capacity or missionary capacity. Universities owned by the federal or state government basically rely on government for funds, while private universities obtain their funds from the high amount of school fees charged on students [11]. An investigation carried out by [12] revealed that the Nigerian budgetary allocation was below twenty six percent recommended by the United Nations Educational Scientific and Cultural Organisation (UNESCO), and this has limited educational sector's ability to perform to its potentials (See Table 2). The study also discovered that the funds allocated were not properly implemented by the agencies concerned. Nigeria's meagre eight percent falls far short of UNESCO's recommendation.

Table 2. Meeting UNESCO'S Target Annual Budgetary Allocation (26%) to Education by 12 Selected Countries [13]

S/No	Countries	Budgetary allocation to education	Position
1	Ghana	31%	1st
2	Cote d' Ivorie	30%	2nd
3	Uganda	27%	3rd
4	Morocco	26.4%	4th
5	South Africa	26%	5th
6	Swaziland	24.6%	6th
7	Kenya	23%	7th
8	Botswana	19%	8th
9	Tunisia	17%	9th
10	Lesotho	17%	10th
11	Burkina Faso	16.8%	11th
12	Nigeria	8%	12th

Most infrastructures and facilities available on the Nigerian university campuses are out dated as they were provided during inception. These obsolete facilities impact the pre-service engineers' learning environment and their performance in core engineering disciplines as noted by Godwin and Okere [1].

A study by Hannington [14] observed that these universities have acute shortage in laboratory equipments and supplies therefore making teaching and research difficult, thus leaving the engineering students ill-equipped and ill-prepared to meet the challenges for technical and economic development.

3.2 Collaboration between Academia and Industry

With great importance attached to the development creativity by engineering graduates,

and with significant need for practical engineering education, the need for collaboration with the industries cannot be underestimated. Collaboration between academia and industry is a vital instrument for the development of an engineering graduate. According to Morakinyo [15] the specific objective of such strategic partnership is to ensure that:

- Technological skills acquired by engineering graduates are required by the industry
- Engineering graduates are not only more readily employed and up to date but can stand in their own right
- Industry can provide a practical training environment in which engineering graduates gain hands on experience before they leave school
- Industry can fund academic research or endow chairs in relevant engineering disciplines

But a survey by Obanor and Kwasi-Effah [16] revealed that there is a very low level of technology transfer and collaboration between most industries and universities in this region, due to the following observations:

- It was discovered that there are no research teams working as a body in various engineering departments.
- Technology transfer is not taught specially as a general or compulsory course in science and engineering faculties in most universities.
- Most of the multinational companies get their technology from their source country and not really concerned about developing our own local technology.
- Some academics that are aware of the universities formal linkage have negative thoughts concerning the linkage.

3.3 International Engineering Alliance

The rapid growth of international markets for nearly everything (products, raw materials, resources, manpower, services, and ideas) directly affect business and the university preparation. Students with the competencies to move beyond traditional definitions of jobs and skills are becoming more important [17]. Mobility is becoming a key professional development factor. Internationalizing engineering practices and engineering education programmes can enable engineering graduates to move and adapt anywhere.

Engineering graduates move about, working across borders, multinational companies move engineering personnel from one location to another, rendering skills and services, hence necessitating the need for a clear standard of competence for practitioners in the engineering profession [18].

The Washington (for accreditation of qualifications in professional engineering, normally of four years in duration), Sydney (for accreditation of qualifications in engineering technology, normally of three years in duration) and Dublin accords (for accreditation of qualifications in technician engineering, normally of two years duration.) are engineering accords aiming at ensuring consistency across engineering institutions and the mutual recognition of these accord signatories is intended to preserve consistency across national and global boundaries, advance benchmarking and mobility of the engineering discipline in member signatories [18].

Unfortunately, Nigerian engineering institutions are not signatories to these accords (See Table 3) thus making the mobility of engineering graduates difficult. The purpose of these agreements is that a person having been accessed to have met the international standard in engineering practice and competence by a member signatory and as a result of mobility will be accepted for registration as a competent professional in another member signatory.

4. STRATEGIES FOR ENGINEERING EDUCATION IN THE 21ST CENTURY

Beyond funding received by universities from the Federal government which is not up to the benchmark set out by United Nations Educational Scientific and Cultural Organisation (UNESCO), funding can also sourced from private investors and endowments.

Endowment systems, more pronounced in the United States and Canada are used to support the financial health of education institutions and are distributed to faculties, research projects and student funding. Harvard University is one of the leading institutions in its endowments. The following graph explains the sources and distributions of Harvard are external funding.

(See Fig. 2). Large endowments help universities sustain financial independence from insufficient or lack of government funding.

In Africa, South African universities lead in endowment drives to sustain scholarly institutions and programs, infrastructure development, research teams, and research journal productions. In Nigeria there is no record of any university endowment systems in place hence the dependence on the federal government for basic funding. There is a need to mobilize development partners to invest in sustainable educational initiatives which will enable the formation of research teams to encourage rejuvenation acts whereby, industry and University academia collaborates in order to solve problems faced in industry hence creating mutual benefits for the engineering graduate and the development of the economy.

Table 3. International engineering alliance membership as at December 2015 [18]

Country-Engineering organisation	Washington accord	Sydney accord	Dublin accord
Australia — Engineers Australia	1989	2001	
Canada — Canadian Council of Professional Engineers	1989		
Canada — Canadian Council of Technicians and technologist		2001	2002
Ireland — Engineers Ireland	1989	2001	2002
New Zealand- Institute of professional Engineers New Zealand	1989	2001	2006
United Kingdom — Engineering Council of United Kingdom	1989	2001	2002
United States of America — Accreditation Board for Engineering and Technology	1989	2007	2007
Hong Kong — Hong Kong Institute of Engineers	1995	2001	
South Africa — Engineering Council of South Africa	1999	2001	2002
Japan — Japan Accreditation Board for Engineering Education	2005		
Singapore — Institute of Engineers Singapore	2006		
Chinese Taipei/Taiwan — Institute of Engineering Education Taiwan	2007		
Korea — Accreditation Board for Engineering Education Korea	2007		
Malaysia — Board of Engineers Malaysia	2003		
India — All Indian Council for Technical Education	2007		
Russia — Association of Engineering Education Russia	2007		
Sri Lanka- Institute of Engineers Sri Lanka	2007		

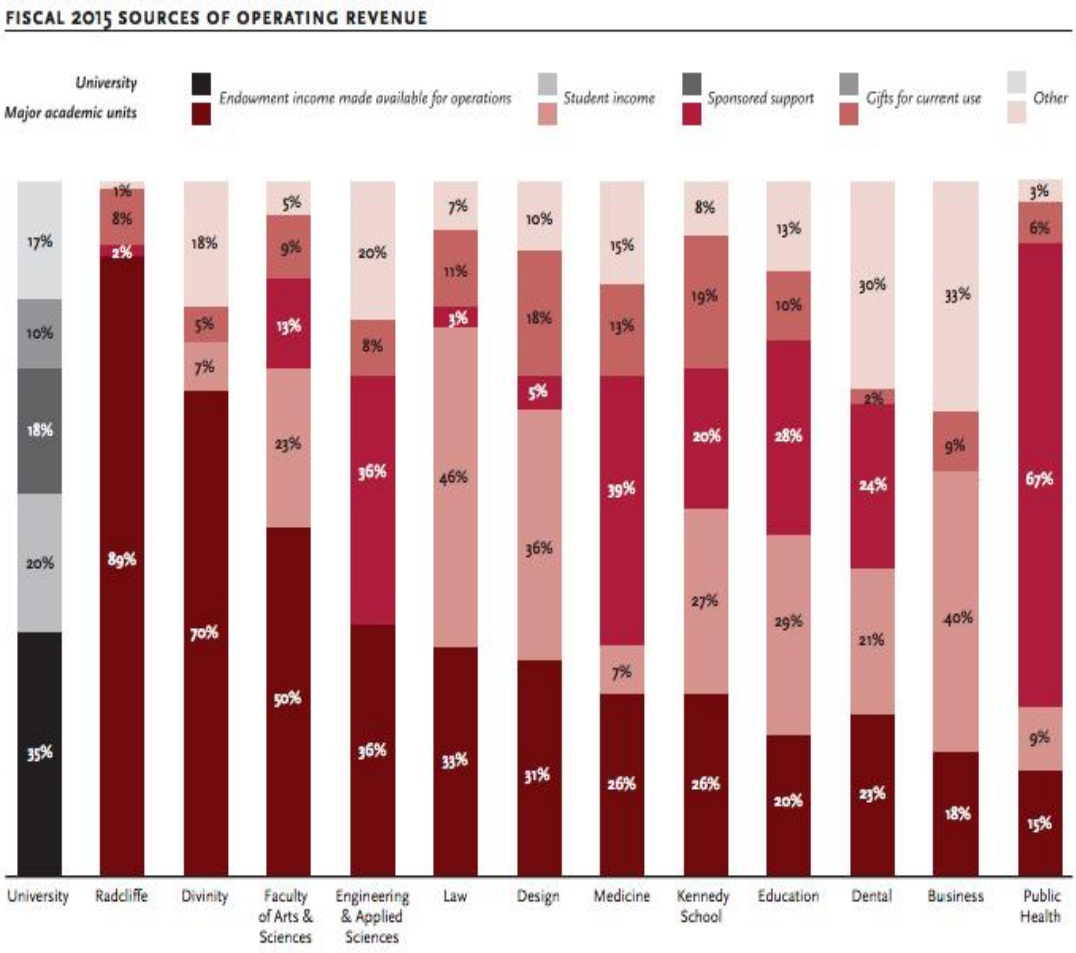

Fig. 2. Sources of operating revenue Harvard University in 2015 [19]

5. CONCLUSION

There is a need to sustain quality engineering education as it serves as bedrock for economic development and growth. Current trends and technological development has resulted in issues needing to be addressed. This paper looked at the issues facing engineering education in Nigeria in terms of insufficient funding, non-existent university, industry relation, linkages and technology transfer, limited infrastructure and facilities for engineering education and the mobility of engineering graduates in Nigeria. It is obvious that an alternative means of funding and generating revenue needs to be explored in order to improve the financial health of academic institutions, sponsor and fund research team and projects and lead to infrastructure development. There is also a need to ensure the internationalization of engineering practices and engineering education programmes in Nigeria to achieve global relevance, encourage consistency and mobility.

6. RECOMMENDATION

Producing engineering graduates that are competitive and can adapt anywhere in the 21st century requires that the gaps and issues be addressed in other to create the right environment for which professional and academic development is acquired. To address these issues, an attempt should be made to:

- Create technological parks with the necessary infrastructure provided to encourage innovation, commercialisation and collaboration between engineering graduates/students, the academia and the industry thus ensuring that the required technological knowledge and skills are gained.

- Popularize and create an understanding of the idea of endowment systems, organizing a major conference on endowing Nigerian universities would be a crucial action. Such a conference would need to bring together major development partners, such as agencies, foundations, Non-Governmental Organisations, major multinational corporations, private businesses, and representatives of Diaspora communities.
- Become signatories to the international engineering alliance to ensure consistency in standards and the mobility of engineering graduates produced.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Godwin HC, Okere CJ. Critical analysis of the recent poor performance of engineering students in engineering mathematics: A case of Nnamdi Azikiwe University, Awka, Nigeria. International Journal of Engineering Research & Technology (IJERT). 2013;2(9):2587-2601.
2. Jones RC. Engineering capacity building in developing countries. In 3rd African Regional Conference on Engineering Education; Pretoria, South Africa. 2006;1-5.
3. Morell L. Engineering engineering education for economic development. Boston; 2008.
4. Miszalski W. Engineering: Issues challenges and opportunities for development. New York; 2010.
5. Booth S. Engineering education and the pedagogy of awareness. In Brown S. Effective Learning and Teaching in Higher Education. London: Taylor & Francis e-Library. 2004;9-23.
6. Ajimotokan HA, Ajao KR, Adebiyi KA, Dainkeh A. Challenges of sustainable development in Nigeria: Need for effective engineering education and training. In 1st Joint International Conference of the University of Cape Coast, Ghana and the University of Ilorin, Nigeria; Ghana; Accra. 28th-30th September; 2009.
7. Ekeh JC. Reinvigorating engineering education in Nigeria for sustainable development. In Proceedings of the 18th COREN Engineering Assembly, Abuja, Nigeria. Abuja: COREN. 2009;7-21.
8. Ali Idris, Muhammad Rajuddin. The trend of engineering education in Nigerian Tertiary Institutions of learning towards achieving technological development. In International Conference on Teaching and Learning in Higher Education (ICTLHE 2012) in conjunction with RCEE & RHED, Johor, Malaysia: Elsevier. 2012;730-737.
9. COREN. COREN education-training. [Online]; 2016.
   Available:http://www.coren.gov.ng/council/council-committees/education-training
10. Royal Academy of Engineering. Educating Engineers for the 21st Century. London: The Royal Academy of Engineering; 2007. Report No.: ISBN 1-903-496-35-7
11. Owolabi RU, Rafiu LM. Chemical engineering education in Nigeria: Challenges and prospects. Journal of Engineering and Applied Science. 2010;5(4):246-251.
12. Azi AS. An assessment of Nigerias budgetary allocation to the educational sector: Implication for tertiary education in Nigeria. Journal of Educational Foundations. 2011;1(2):10-15.
13. Franklin A, Sanubi Akpotu, Nelson E. The Nigeria education system and vision 2020: A critical development planning perspertive. International Journal of Educational Admistration and Policy Studies. 2015;7(2):26-38.
14. Hannington O. State of research and teaching resources available for basic sciences in universities of Uganda. In 1st Africa Region Conference of Vice-Chancellors, Provosts, and Deans of Science, Engineering and Technology; Accra, Ghana. 2005;46-54.
15. Morakinyo JA. African universities: Linkages with the productive sector. Lead Paper at the Discussion Forum on the Occasion of African University Day Celebration. University of Ilorin; 2009.
16. Obanor AI, Kwasi-Effah CC. Assessment of university- industry collaboration and technology transfer in schools of engineering and sciences in Nigeria. Nigerian Journal of Technology (NIJOTECH). 2013;32(2):286-293.
17. Michel J. Mobility of engineers: The European experience. in engineering:

Issues challenges and opportunities for development. Paris: UNESCO Publishing. 2015;355-360.

18. Greenwood P. Washington Accord, Engineers Mobility Forum, APEC Engineer. In Engineering: Issues, challenges and opportunities for development. Paris: UNESCO Publishing. 2015;367-376.

19. Harvard University. [Online]; 2016. Available:http://www.harvard.edu/about-havard

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