The Role of Higher Education Institutions in the Development of ICT Professionals for Innovation in Nigeria

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Abstract – This paper presents the role of Higher Education Institutions (HEI) in the development of Information and Communication Technology related professionals in Nigeria. The paper identifies the prerequisites to producing graduates who have skills to create, manage and deploy contemporary world-class and innovative software solutions. Furthermore the paper presents the gradual but revolutionary steps the universities in Nigeria are taking towards producing high quality graduates for the Nigerian Software Industry in the shortest time. The paper discusses the need for definition of ICT related discipline, the demand and supply of ICT professionals in the Nigerian market. Highlighting the demand-supply imbalance the paper concludes by proffering solutions to meet the gap in the nearest possible time.

Keywords – Software Development, Computing, Academia, Collaboration, Higher Education, Institutions, Innovation.

I. Introduction

1. The Need for Software Development in Nigeria

The Nigeria's software industry has been disappointingly neglected despite Nigeria's size and both economic and political importance in Africa. Paradoxically, Nigeria is producing some of the world's best, most renowned and skilled Software experts and solutions of the 21st Century. Recognising this great potential, a Presidential initiative on outsourcing was made in 2005 by the ertswhile President and Commander-in-Chief of the Federal Republic of Nigeria, Chief Olusegun Obasanjo, GCFR to share Nigeria's locally-abundant human capital with the rest of Africa and the world, and to diversify into non-oil revenue sources.

This initiative had the vision "to position West Africa as a key player in the Information Society (IS) – producing some of the world's best, most renowned and skilled Software experts and solutions of the 21st Century and a mission of ensuring that a few years from now, West Africa innovates, develops and applies indigenous software for its governance, security and economic growth and also becomes the first address for global quality Software, solutions and Human Resource demand - by the knowledge industry"[1]

Nigeria, today, has 129 Universities (Federal 40, State 39, Private 50) (NUC, 2013), with almost all running some form of courses on Information and Communication Technology courses and producing well over 10,000 graduates with academic training on ICT[2].
It is always mentioned that to be successful in the ICT market, a country must have the following four characteristics among its population.
- English speaking
- Talented and hard working
- Relatively Cheap wages
- Relevant and high proficiency in Computers

Nigerians fulfil the first three requirements adequately. But the fourth requirement, a highly proficient ICT work force, is an area of great concern for the Institutions of Higher Learning especially the Universities.

Drawing from experience in mechatronics education from several emerging countries, it is vital for HEIs[3] to be very clear of the level of proficiency and capacity they need to build. In his study, (Akpinar, 2006), presents situation of mechatronics education in Turkey and its development process. Although it started late, there is mechatronics education from high school level to graduate level today. In China (Chen, et al, 2012), shows that as one of the typical and innovative teaching modes in mechatronics in China, mechatronics teaching in Beihang University has formed a ''One main line, Two links, Three practical points'' mode and methodology, which emphasizes on the links and mapping relationships between theoretical teaching and practical teaching. After 6-year practicing and exploring, the course has made fundamental and systematic innovation achievements in the field with respect to class materials, teaching mode, teaching system. Also (Wang et al, 2009), discusses the need for a focused laboratory environment to be as close as possible to the real world situation to apply and absorb mechatronics concepts, and to assist students in the development of ''hands-on'' skills. (Ersoya et al, 2010), in their paper documents a new methodology for teaching of Automotive Mechatronics course for innovation and (Rojko et al, 2011) also describes a novel E-training developed for teaching mechatronics.

This paper presents the role of Higher Education Institutions in the development of innovative ICT related professionals in Nigeria. It identifies the prerequisites to

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[1] The Presidential Committee on Capacity Building for Outsourcing under this program held a one day stakeholder consultation meeting on Wednesday, October, 19, 2005

[2] Information and Communication Technology
[3] Higher Education Institutions

producing graduates who have skills to innovatively create, manage and deploy contemporary world-class software solutions. Furthermore the paper presents the gradual but revolutionary approach Nigerian universities are taking to produce high quality graduates for the Nigerian Software Industry in the shortest time. The paper discusses this issue as follows: The need for definition of ICT discipline is discussed in section 2 while the demand for ICT professional in the Nigerian market is covered in section 3 and the supply by both degree-awarding institutions and vocational institutes are discussed in section 4. Highlighting the demand-supply imbalance the paper concludes by proffering solutions to meet the gap in the nearest possible time.

II. THE ICT DISCIPLINE

2.1 Defining the ICT Discipline

Like all science disciplines in the computer related fields, it is very important that institutions of Higher Learning adhere to discipline definition that has national, regional and international recognition. This assures employers that their graduate have minimum skills required by Industry. In Nigeria, there appears not be clear definition of the computing discipline. For example, National Board for Technical Education in creating the Vocational and the Innovative Enterprise Institutions has used the following discipline definitions:

- Software Engineering Technology
- Computer Hardware Engineering Technology
- Networking & Systems Security
- Computer Software Engineering Technology
- Multimedia Technology
- Telecommunications Technology

The Nigerian Universities run the computer related degree programmes under over three dozen names as shown in Table 1.

Table 1: ICT Related Course Names in Nigerian Universities

Computer Engineering	Computer Science	Information Systems	Information Technology	Software Engineering	Mechatronics Engineering
Communication Technology	Education, Mats, Stats & Computer Science	Office & Management Information	Information & Communication Technology	Software Engineering	Mechatronics
Computer Engineering	Education & Computer Science	Management Information System	Information Technology	Management software Development	Mechatronics Engineering
Computer Science & Engineering	Computer Science	Computer Education	Computer Science & Information Technology		
Electronics & Computer Engineering	Computer Science with Economics	Science & Computer Education	Information Technology		
Electrical/ Computer Engineering	Computer Science & Mathematics	Library & Information Science	Telecommunication Management		
Computer/ Electronics	Statistics with Computer Science	Computer & Information System	Information Science Technology		
Electrical/ Electronics		Information System & Economics			
Electronics		Computer & Information Science			
Computer Electronics		Information Science Management			
Computer Science with Electronics		Information System			
		Computer with Statistics			
		Bioinformatics			
		Information Resource Management			
		Communications			
		Business Computing			

Source: Analysis from Joint Admissions and Matriculation Board Publications, 2007-2010, Council for the Regulation of Engineering in Nigeria (COREN), 2013

The ACM[4] recommends the following skills requirement:

a) Computer Engineers who should be able to design and implement systems that involve the integration of software and hardware devices
b) Computer Scientists who should be prepared to work in a broad range of positions involving tasks from theoretical work to software development
c) Information Systems specialists who should be able to analyse information requirements and business processes and be able to specify and design systems that align with organizational goals
d) Information Technology professionals who should be able to work effectively at planning, implementation, configuration, and maintenance of an organisation's computing infrastructure
e) Software Engineers who should be able to properly perform and manage activities at every stage of the lifecycle of large-scale software systems

2.2. Employability of University Graduates in the Software Industry

The 21st Century will be marked by increasing reliance on technology to address growing concerns about diminishing resources and sustainable development. The economic crisis in 2008-2010 has heightened the need for competent human resources to help recover the losses. As repositories of valuable human capital, universities face great challenges in contributing to economic development in times of such economic downturns. Furthermore, the rapid rate of change and development of new technologies means that education programmes must keep pace with the knowledge and skills demanded by employers. The kind of skills needed and how universities can help to foster these skills has not been fully addressed by policy makers. With a forecast of increasing unemployment, unless the economy rebounds soon, it is crucial that universities equip their students with appropriate knowledge, skills and aptitudes to be more competitive in a shrinking labour market.

III. SOFTWARE DEVELOPMENT: DEMAND SIDE

3.1 Job Vacancy Adverts in Nigeria

Table 2 and 3 shows the analysis of job vacancy adverts in the Nigerian print media over a period 2006 to 2010 and reveals disappointing results for the software development industry but presents a very interesting pattern and trends.

The demand for software developers was least in earlier years but becoming of some importance recently, the low level notwithstanding. This corroborates the fact that local software development is beginning to show up. The demand for Desktop Computing such as Microsoft Office Productivity skills is definitely slowing down as the populace is becoming more computer literate. It is very interesting that requirement for Database administrator and Enterprise Resource Planning professionals are taking the centre stage. This of course points to the apparent demand for software and mechatronics engineering skills. Software sales pattern[5] in Nigeria can be identified with the industry segmentation. Multiple drivers are pushing market growth and adoption of integrated life-cycle and enterprise change management tools. Some of the drivers are:

a. Regulatory compliance demands and audit
b. Emergence of global complex sourcing
c. Open source methodology
d. Need to create governance across the life cycle of projects
e. New Information System security awareness in Nigeria
f. Technology and development shift with the evolution of Service Oriented Architecture

This trend will augur well for the Nigerian Software market if the supply side is more focused in producing graduates of high quality with computing skills needed by the private sector and other potential employers[6]

Table 2: Newspaper adverts for jobs in Guardian newspaper, 2006 AD

Technologies/Areas	%
Operating Systems & Networking	10.00%
Client/Server & RDBMS	12.00%
MIS/Software Engineering	8.00%
Desktop Computing	45.00%
Graphics/Web Designing	15.00%
Teaching	10.00%
TOTAL	**100.00%**

Table 3: Jobs Advertised in Nigeria Print Media (Guardian, Punch, Vanguard)

JOBS	Importance
Systems Administrator	29.34%
Database Administrator	16.53%
Communications Engineer	13.64%
Hardware Engineer	11.57%
Enterprise Resource Planning	8.26%
Computer Aided Design	7.44%
Software Developer	4.55%
Systems Analyst	3.72%
Web Administrator	3.72%
Desktop Operator & Others	1.24%
TOTAL	**100.00%**

3.2 ICT Job Content

A closer look at the ICT content of advertised jobs also reveals a clear direction where the Universities should focus and how urgently they must re-engineer the curriculum to meet the need of the Nigerian Software Industry.

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[4] ACM accessed www.acm.org, 12 September 2009

[5] Unpublished Market Intelligence Report, (Bolu, 2008)
[6] Tom Wanyama et al

It is important to note the increasing demand by employers of Computer Engineering skills such as VSAT/Wireless Technologies, UNIX Operating Systems skills and once again the diminishing explicit demand for Desktop Application skills (see Table 4).

Table 4: Specific Skills Requirement by Employers

Job Specific Skills	Importance
UNIX Operating System	28.10%
Database Administration	15.70%
VSAT/Wireless Technologies	13.22%
Windows Operating Systems	8.68%
Enterprise Resource Planning	7.44%
Computer Aided Design	7.44%
Internet Technologies	6.20%
Java Programming	5.37%
Others: NET Programming, Desktop applications, etc	7.85%
TOTAL	**100.00%**

The Technology Vendors for Jobs advertised shows increasing demand for Software and Information Technology skills such as Java Programming and CISCO certifications. The results are shown in Table 5 below.

Table 5: Technology Vendors for Advertised Jobs – 2009

Technology Vendors	Importance
Microsoft	34.55%
CISCO	25.13%
Oracle	20.42%
Macromedia	7.85%
SAP AG	5.76%
Others: Autodesk, CompTIA, etc	6.29%
TOTAL	**100.00%**

When we look at the programming languages used by the Nigerian Software Industry in 2006-8, it appears that the Java Programming and Visual Basic are predominant. Table 6 shows these details.

Table 6: Programming Languages used by Software Companies in Nigeria: 2005-2007

Programming Language/Tools/Databases	Importance
Programming Languages/Tools	
Visual Basic	1
Java Programming	2
Crystal Report	3
Visual FoxPro	4
Databases	
Microsoft SQL	1
Oracle	2

Source: Software Companies in Nigeria - Nigeria Software Development Initiative. Accessed Sept 11, 2009. http://www.nsdi.org.ng/ Book2.htm

IV. SOFTWARE DEVELOPMENT: SUPPLY SIDE

4.1 Supply Capacity

Nigeria has huge capacity for producing ICT related professionals not only for the Nigerian Market but also for the regional and global market. Today there are close to 130 universities/degree awarding Institutions and almost all offer some form of ICT related courses at degree levels. What is disappointing is the lack of programmes to produce graduates of high quality with computing skills needed by employers of labour and the entrepreneurs for the software market.

From Tables 7 and 8 as at 2009, we can see that of the 83 universities listed no Federal nor State universities that have awarded degrees programmes on Software Engineering. Only 3 Private Universities have started or about to start.

Although virtually all universities are offering Computer Science courses, the content of the programmes is far cry from the domestic and international demand. While the older universities are strong in traditional Engineering and by extension basic computer engineering, the newer State and particularly private universities are emphasising Information Technology and Information systems. For Mechatronics Engineering no university in Nigeria has graduated a Mechatronics Engineer although 5 have started (JAMB, 2013).

It is understandable that the ease to change curriculum is much longer in the older universities especially the Federal-owned universities, however, universities must respond to the needs of the market so that their graduates are relevant and employable. Moreover the export-oriented information services sector provides tremendous opportunities for developing countries like Nigeria. Developing countries are outsourcing coding jobs to developing countries where labour cost are relatively lower and in larger quantities than the developed countries.

4.2 Courses Run by HEIs

A closer look at the courses run by degree-awarding HEIs shows a major gap in the Industry demand. Their curricula need to have the following characteristics:
- Cover the six areas identified as contemporary components of ICT related training. They are:
  - Computer Engineering
  - Computer Science
  - Information Systems
  - Information Technology
  - Software Engineering
  - Mechatronics Engineering
- They should reflect the International Certification of major software Technology Vendors
- They must be dynamic with provision for skills on the changing technologies
- Areas of emphasis must be very focused although not necessarily Vendor specific

Table 7: ICT Related Degree-Awarded Institutions in Nigeria (2009)

Institution Types	Institutions	Computer Engineering	Computer Science	Information Systems	Information Technology	Software Engineering	Mechatronics Engineering	COURSES
Federal Universities - General	17	16	17	5	0	0	0	38
Federal Universities - Agriculture	3	3	5	1	1	0	0	10
Federal Universities - Technology	7	7	6	2	3	0	0	18
Total Federal Universities	**27**	**26**	**28**	**8**	**4**	**0**	**0**	**66**
State Universities - General	23	11	23	8	1	0	0	43
State Universities - Technology	5	7	3	2	1	0	0	13
Total State Universities	**28**	**18**	**26**	**10**	**2**	**0**	**0**	**56**
Total Private Universities	**29**	**17**	**25**	**14**	**19**	**3**	**0**	**78**
Total Universities	**83**	**61**	**79**	**32**	**25**	**3**	**0**	**200**
Degree Awarded Institutions	19	0	1	4	0	0	0	5
TOTAL DEGREE ICT COURSES (2009)	103	61	80	36	25	3	0	205

Table 8: Universities Offering ICT Related Courses in Nigeria (2009)

Institution Types	Institutions	Computer Engineering	Computer Science	Information Systems	Information Technology	Software Engineering	Mechatronics Engineering	COURSES
Federal Universities	27	39.39%	42.42%	12.12%	6.06%	0.00%	0.00%	100%
State Universities	28	32.14%	46.43%	17.86%	3.57%	0.00%	0.00%	100%
Private Universites	29	21.79%	32.05%	17.95%	24.36%	3.85%	0.00%	100%
TOTAL	**84**	**30.50%**	**39.50%**	**16.00%**	**12.50%**	**1.50%**	**0.00%**	**100%**

V. SOFTWARE DEVELOPMENT: FILLING THE GAP

5.1 Actions required by HEIs in Nigeria

The following actions need to be taken by HEIs.

- Discipline Definition: Presently the names under which ICT courses are run are well over 40 in the Nigerian universities. This must be streamlined with the internationally accepted definitions. Professional bodies and Quality Assurance agencies play a very important role in the definition of ICT disciplines[7]

- Curriculum Development: Universities, especially the older universities must review their curriculum in line with domestic and international demand. The academia needs to work closely with professional bodies such as the Nigerian Society of Engineers, Computer Professional of Nigeria, Nigerian Computer Society, etc. Universities must reflect as far as possible courses that embody major skills required by the ICT employers and market. For example, Oracle Certified Professional, Sun Microsystems (Oracle) Java programming, and e-Business.

- Short Courses: In order to ensure that the software market obtains the required software skills, academia must supplement the conventional programmes in the defined disciplines with a range of short courses. Such skills must cover skills that are known to be lacking in the conventional programs and required by the ICT industry. Some of the short courses are:

- o Cisco Certified Associate
- o Cisco Certified Network Professional
- o Microsoft Certified Information Technology Professional
- o CompTIA Certifications such as A+, N+, Linux+, Security+
- o Java Certified Developer
- o Microcontroller Programming

5.2 Actions required by Private and Public Sectors in Nigeria

The private sector has huge responsibility in directing the quality of graduates turned out from the HEIs by doing the following:

- Industry-Academia Collaboration: HEIs not only provide Industry with the skilled manpower but also support the sector in many other ways such as research and development. The ICT industry in Nigeria shies away from collaborating with the Nigeria academia preferring overseas collaboration. This must be reversed.

- Infrastructure Development: The ICT training infrastructure in the HEIs requires modernizations. Assistance such as Servers, High Performance Computing facilities and License-free developer software are necessary to enable the HEIs produce high quality ICT professionals.

- The Government has obligations to use the academia in designing and implementing software and ICT projects. Some countries such India and Mauritius[8]

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[7] Wanyama et al, 2006.

[8] The Government of Mauritius uses the University of Technology in the design of the Cyber City project.

use the academia in major ICT project design and analysis.

5.3 Software Entrepreneurship Programme at some university in Nigeria

Some Nigeria universities such as, the University of Nigeria, Nsukka, Federal University Oye-Ekiti, Covenant University, Ota, etc, in a modest beginning, are addressing this issue as suggesting above. Some of these initiatives are:

- Six-months Java Programming by partering
- A two-month Entrepreneurship Training by the University of Nigeria Centre for Entrepreneurship and Development. The training materials or modules contain all the basic knowledge that could help the trainee start and manage sustainable businesses. The key components of the module include; Entrepreneurship Development, Basic Business Management, Leadership and Business Development Services.
- SAP University Alliances are partnering with universities to provide access to SAP NW AS Java Server including SAP NetWeaver Portal at the SAP University Competence Centre in Magdeburg, Germany for Java programming and Enterprise Portal development.
- Code Camp with Capstone Project on Education, Hospital and Hotel Industry by partnering with NIIT Ltd of India

VI. Conclusion

Nigeria today has close to 130 Universities with almost all running some form of courses on Information and Communication Technology courses and producing well over 10,000 graduates with academic training on ICT[9].

The following actions need to be taken by HEIs.

- Discipline Definition: Presently the names under which ICT courses are run are well over 40 in the Nigerian universities. This must be streamlined with the internationally accepted definitions. Professional bodies and Quality Assurance agencies play a very important role in the definition of ICT disciplines[10]
- Curriculum Development: Universities, especially the older universities must review their curriculum in line with domestic and international demand. The academia needs to work closely with professional bodies such as the Nigerian Society of Engineers, Computer Professional of Nigeria, Nigerian Computer Society, etc. Universities must reflect as far as possible courses that major skills required by the ICT employers and market. For example, Oracle Certified Professional, Sun Microsystems (Oracle) Java programming, and e-Business.
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- Java Certified Developer
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- Infrastructure Development: The ICT training infrastructure in the HEIs requires modernizations. Assistance such as Servers, High Performance Computing facilities, License-free developer software are necessary to enable the HEIs produce high quality ICT professionals.
- The Government has obligations to use the academia in designing and implementing software and ICT projects. Some countries such India and Mauritius[11] use the academia in major ICT project design and analysis.

This paper has presented the role of Higher Education Institutions in the development of Information and Communication Technology professionals in Nigeria. The paper also identified the prerequisites to producing graduates who have skills to innovatively create, manage and deploy world-class software solutions. Furthermore the paper presented the gradual but revolutionary steps Nigerian universities are taking to produce high quality graduates for the Nigerian Software Industry in the shortest time.

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[9] Information and Communication Technology
[10] Wanyama et al, 2006.

[11] The Government of Mauritius uses the University of Technology in the design of the Cyber City project.

REFERENCES

[1]   Akpinar, B., (2006), Mechatronics education in Turkey, *Mechatronics,* 16 (2006) 185–192.

[2]   Bolu, C. A., *ICT Training Demand in Nigeria*, Unpublished Market Intelligence Reports on ICT Demand in Nigeria (2006-2010), International Data Management Services Ltd, Ikeja Lagos, Nigeria

[3]   Chen, D., Li, X., Li, Z., Wang, T., A., (2012), mechatronics control engineering class at Beihang University, China: Practicing and exploring, *Mechatronics,* 22 (2012) 881–889

[4]   Ersoya, S., Küçük, H., (2010), The effect of a new teaching methodology on learning performances of automotive - mechatronics students, *Procedia Social and Behavioral Sciences,* 2 (2010) 310–316

[5]   Federal Ministry of Education, (April, 2009), Brochure: Vocational & Innovative Enterprise Institutions, Abuja, Nigeria

[6]   Joint Admissions and Matriculation Board, JAMB, UME/DE Various Brochure 2007-2012 Academic Sessions.

[7]   National Universities Commission, (2013), *Nigerian Universities-Federal, State and Private Universities in Nigeria*, http://www.nuc.edu.ng: accessed December 24, 2013.

[8]   Nigerian Newspapers (various editions), – Guardian, Punch and Vanguard Newspapers, 2008-2010

[9]   Nigerian Universities Curricula on Computer Science, (various), 2007-2010.

[10]   NSDI, (2009), Software Companies in Nigeria - Nigeria Software Development Initiative. Accessed Sept 11, 2009 http://www.nsdi.org.ng/Book2.htm

[11]   Potgieter, C., & Herselman, M., (July 2003), *Using ICT in Tertiary Education – Do We Dare To Compare?* Proceedings of the 16th Annual NACCQ, Palmerston North New Zealand, Mann, S., & Williamson, (eds), accessed from http://www.naccq.ac.nz

[12]   Rojko, D. Hercog, K. Jezernik, E-training in mechatronics using innovative remote laboratory, *Mathematics and Computers in Simulation,* 82 (2011) 508–516,

[13]   SAP Education, (2011), Participant Handbook-Unit 13: Human Capital Management, SAP ERP-Integration of Business Processes. Material No: 50100105, SAP AG.

[14]   Wang,Y., Yu, Y., Xie, C., Wang, H., Feng, X., (2009), Mechatronics education at CDHAW of Tongji University: Laboratory guidelines, framework, implementations and improvements, Mechatronics, 19 (2009) 1346–1352

[15]   Wanyama, T., & Baryamureeba, V., (2006), *The Role of Academia in Fostering Private Sector Competiveness in ICT Development*, Faculty of Computing and Information Technology, Makerere University, Uganda.

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