IMPROVING TEACHING METHODS IN NIGERIAN UNIVERSITIES AND “INVENTING” THE FUTURE

May 3, 2017

DR. EMEKA JOACHIN OKAFOR
MIT-ETT FELLOW AND LECTURER
UNIVERSITY OF PORT HARCOURT (UNIPORT), CHOBA, NIGERIA
Emeka J. Okafor

PhD in Petroleum Engineering – Imperial College London, United Kingdom.
M.Sc. in Mechanical and Process Engineering – Technische Universitaet Darmstadt, Germany.
B.Eng. In Chemical Engineering, Enugu State University of Science and Technology, Nigeria.

- Lecturer in Petroleum and Gas Engineering Department at UNIPORT since February 2014.
- ETT Fellow of the Massachusetts Institute of Technology (MIT) from February 2016 to May 2016.
- Research/Staff Scientist at RWTH Aachen University, Germany, from September 2004 to September 2007.
- Visiting Research Scientist at Imperial College London from September 2007 to December 2007.
- Research Interests in Gas and LNG production, processing, utilization and safety.
OUTLINE

- Introduction (background and rationale)
- The “quality” and “teacher” gaps in Nigerian Universities
- What could be done about it:
  - “Invention” of the future by Nigerian Universities.
  - MIT/Total Empowering the Teachers Program.
  - Developing, reviewing and improving curriculum and/or teaching methods in Nigerian Universities.
- Concluding Remarks
Background and Rationale

- Science and engineering education and training are key to economic diversification and employment creation, …,

- Evidence from Newly Industrialized Countries (NICs) Compelling

- Precise Area of Weakness of Nigeria

- Weak linkages between academia, industry and governmental policy.
Nigeria’s Higher Education

Nigeria-HE where it is now!

- 46 Federal Universities (147 Universities total)

- Nigeria: has only ~39 scientists and engineers engaged in R&D/million persons
  (while 710 in Brazil, 1,020 in China, 160 in India, and 3,979 in USA; World Bank -2015 World Development Indicators: Science and Technology)
Consequences for Economy

- Lack of trained personnel capable of turning Nigeria companies into fast followers similar to Asian Tiger companies.
  - Unable to source innovation and hence did not add value to primary products

- Nigerian economy still based on primary products and commodities
  - Value is NOT added and hence the economy has NOT diversified
The Quality Gap: What Type of Education

- **Primary Education**
  - Learn to read, write and manipulate numbers

- **Secondary Education**
  - Learn how to learn (using all sources – books, interviews and internet), become fluent in all forms of communication (writing, oral, mathematical and computational)

- **University Education**
  - Undergraduate: Learn how to think critically and how to solve structured problems
  - Graduate: Learn how to ask the right questions and how to create knowledge
The Quality Gap: Undergraduate Education

- Educational system focuses too much on information transfer and examinations
  - Students often asked to restate facts
- What should done?
  - Develop ability to use and manipulate information
  - Develop skills to solve structured and unstructured problems
- Curriculum needs reform & modernization
The Quality Gap: Where to Start?

- We believe changes should be made at every level of the Nigerian Educational System.
- Preferably, it should proceed at all levels simultaneously.
- If the process must start somewhere, it should begin at the undergraduate level and propagate the reform to the lower levels with better quality teachers.
The Quality Gap: Undergraduate Education

- Educational system focuses too much on information transfer and examinations
  - Students often asked to restate facts
- What should done?
  - Develop ability to use and manipulate information
  - Develop skills to solve structured and unstructured problems
- Curriculum needs reform & modernization
Goals for Undergraduate Education: Engineering Example

- Develop extensive problem solving skills and ability to think critically
- Go beyond restatement of known facts
  - Approach to examination should change
- Go beyond understanding how systems work but know how to design them
  - Critical to learn how to make design choices
- Prepare students for adding value
The “Teacher” Gap: Staffing of Engineering Department

- The EEE Dept. at the University of Ife had \( \approx 15 \) faculty members in 1975
- Student population was 40 / year with a total of 160 in the department
- Today the same department has \( \approx 30 \) faculty members
- Today the same department has about 1000 students
Science and Engineering Graduate Projections

- Nigeria needs to produce \( \approx 200,000 \) science and engineering graduates / year
- Current rate is about \( \approx 1/3 \) of the rate required and the quality is not at world competitive standard
- Limited by lack of resources & infrastructure
- Limited by availability of lecturers
Staff Requirements

- Need to make extensive use of internet technology and resources
  - EdX, OCW and iLAB from MIT for example
- Need to make extensive use of teaching assistants and graders
- Even with all the above, the same EEE Department at OAU requires 30 additional staff members to bring the department to standard & sufficient quality level
Staffing Science and Engineering Departments

- Assume the number of universities offering science and engineering is 25.
- Assume that each of these universities has 10 science and engineering depts.
- Nigeria will need to produce 5,000 – 7,500 Ph.Ds in the next ten to fifteen years.
  - Excluding the impeding retirement of very high quality staff from the 1970s.
# Doctorate Degrees

## Table 27: Graduate Turn-out of Doctorate Degree

<table>
<thead>
<tr>
<th>Discipline</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>Administration</td>
<td>27</td>
<td>6</td>
<td>13</td>
<td>4</td>
<td>14</td>
<td>3</td>
</tr>
<tr>
<td>Agriculture</td>
<td>47</td>
<td>17</td>
<td>90</td>
<td>19</td>
<td>104</td>
<td>27</td>
</tr>
<tr>
<td>Arts</td>
<td>67</td>
<td>11</td>
<td>125</td>
<td>13</td>
<td>93</td>
<td>40</td>
</tr>
<tr>
<td>Education</td>
<td>103</td>
<td>60</td>
<td>130</td>
<td>54</td>
<td>102</td>
<td>71</td>
</tr>
<tr>
<td>Engineering Technology</td>
<td>32</td>
<td>1</td>
<td>34</td>
<td>4</td>
<td>36</td>
<td>3</td>
</tr>
<tr>
<td>Environmental Science</td>
<td>63</td>
<td>13</td>
<td>12</td>
<td>2</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Law</td>
<td>11</td>
<td>0</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Medicine</td>
<td>6</td>
<td>1</td>
<td>22</td>
<td>6</td>
<td>13</td>
<td>11</td>
</tr>
<tr>
<td>Pharmacy</td>
<td>4</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Science</td>
<td>74</td>
<td>20</td>
<td>87</td>
<td>19</td>
<td>76</td>
<td>11</td>
</tr>
<tr>
<td>Social Science</td>
<td>97</td>
<td>15</td>
<td>42</td>
<td>16</td>
<td>93</td>
<td>28</td>
</tr>
<tr>
<td>Dentistry</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Veterinary Medicine</td>
<td>6</td>
<td>0</td>
<td>15</td>
<td>2</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Others</td>
<td>6</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>543</td>
<td>147</td>
<td>578</td>
<td>143</td>
<td>553</td>
<td>199</td>
</tr>
<tr>
<td>Grand Total</td>
<td>690</td>
<td>721</td>
<td>752</td>
<td>794</td>
<td>428</td>
<td></td>
</tr>
</tbody>
</table>

Source: National University Commission
Science and Engineering Staff Requirements

- Nigeria needs to train more than 500 PhDs/year in science and engineering
  - Allow for some to work in industry or work in other capacities
- How do we do this without breaking the bank?
- How do we do this while establishing a knowledge creation infrastructure?
Higher Degrees

- A good graduate education leading to a Ph.D. takes at least 5 years
- Total training cost abroad would be high
  - $125K/year for an experimentalist
  - $80K/year for a theorist
- Cannot train the numbers required outside
  - Some will be trained outside
  - A majority will be trained partly internally and partly outside
Empowering the Teachers

What is “Empowering the Teachers”?  

- Program for developing young African faculty leadership in science and engineering education  
  - Partnership between MISTI, Total and Schlumberger  
- Program invites outstanding young faculty from the disciplines of Science and Engineering in African universities to spend a Semester@MIT

- Observe instruction in own discipline
- Develop courses based on problem solving approach
- Interact with the MIT faculty teaching in area
Empowering the Teachers Program

- Young faculty (*Lecturer I*) from Nigerian universities recruited/selected as ETT Fellows
  - Disciplines: electrical engineering, computer engineering, computer science & mechanical engineering (& pet. eng.)
- 40 Fellows spent a Semester@MIT
  - observe instruction in home disciplines and subjects
  - interact with the MIT faculty teaching in that area
  - develop new courses for home department based on problem solving inspired by equivalent course at MIT
  - discuss & explore curricular enrichment and reform
- Engagement with fellows after returning to Nigeria
  - build and consolidate networks of faculty working in allied areas in African & American universities
ETT Fellows’ Activities during Semester @ MIT

- Audited 2 EECS Courses
- Teaching Science & Engineering
- Effective Communications Courses
- Curriculum / Syllabus Development
- MIT Faculty Seminar Series "MIT Culture"
- ETT Seminar Series
New Course Development: Intended Learning Outcomes

- **Create**: Desired course assessment practice, problem definition, solving and design
- **Evaluate**: Current course assessment practice, memorization and regurgitation
- **Analyze**
- **Apply**
- **Understand**
- **Remember**
Curriculum Review – OAU-EEE

- Focused on what students should be able do on graduating
  - Digital focus (robots and cell phones)
- Buy in from faculty and staff
- Working groups consisted of
  - Core faculty members
  - Alums in academia
  - Alums in industry
- Multiple revisions & will pilot new courses first
- Share courses with CSE
Undergraduate Education

- Merit-based Admissions
- Curricular review & reform
- Tracking of graduates & benchmarking
- Entrepreneurship / Technology Park
- Examinations
- Educational Technology
  - EdX, Coursera, iLABs & OCW
Graduate Education

- Link tightly research expenditure & graduate education (Ph. Ds)
- Careful Problem Selection
- Significant external input to graduate committees
  - Consulting / Adjunct Professorships
- Benchmarking with respect to top univ.
- Technology Park & Consulting
Creation of a Viable Sign And Engineering Infrastructure

Vision

- To create a science and engineering infrastructure that is tightly coupled to graduate education and to industry for the purpose of producing a science and engineering research and development manpower using existing universities.
Objectives

- Develop a research infrastructure that will address Nigerian problems, promote scholarship, create world-class institutions with research programs that are competitive with the rest of the world.
- Create intellectual property that Nigerian industry can leverage, transfer technology to industry and sow the seeds for future economic development.
- Conduct research that is relevant to the Nigerian, African and world contexts delivering value-added information, knowledge and wisdom.
- Develop a knowledge creation infrastructure that will also train potential lecturers.
Goal

- Put Nigeria in the category of the first twenty nations in science and engineering output within the next 20 years
Establishment of the NNSEF

- Establish a Nigerian National Science and Engineering Foundation (NNSEF) that will fund competitive and merit based basic science, applied science and engineering research.
  - Limit initially to a few selected universities with demonstrated capacity
- This body will function like the American National Science Foundation (NSF) or the British Engineering and Physical Science Research Council (EPSRC).
- The principal mechanism for research funding would be through peer reviewed competitive grant process based on proposals written by principal investigators.
Cost (Concentrate on a Few Universities)

- Estimate at least $300M/year for 15 years
  - Inflation adjusted
  - Competitive research grants
  - Competitive equipment grants for teaching & research infrastructure and provide access to industry
  - Graduate fellowships
  - Travel grants
  - Conferences & Summer programs
Summary

- The proposed reform will take time and a lot of patience and long term commitment.
- The three most important ingredients required for success are:
  - Patience
  - Merit (patronage will **NOT** work)
  - Excellent leadership
Conclusions

- There are numerous challenges facing higher education and knowledge creation.
- Opportunity for Nigerian universities to address some of the challenges that are "doable".
- Potential to transform Science & Engineering into faculties that can compete with the very best.
END