

Chapter 4

Creating a Department of Biomedical Engineering and an Undergraduate Programme – The University of Lagos Experience

O.P. Popoola, N.K. Irurhe, O.J. Balogun & A.A. Osuntoki

Background

The University of Lagos (UNILAG) Nigeria was established in 1962. It is located in the southwestern part of Nigeria with a student population of over 40,000 and approximately 3,365 academic, non-academic and technical staff. It has three campuses namely Akoka (main campus), Idi-araba (College of Medicine) and Yaba campuses. There are currently 12 faculties with 9 at the Akoka campus namely: Engineering, Law, Arts, Social Sciences, Education, Environmental Science, Pharmacy, Science, and Management Science, while the College of Medicine at Idi-araba campus houses Basic Medical Sciences, Dental Sciences, Clinical Sciences. All faculties have both undergraduate and postgraduate degree programs. The University also has a Distance Learning Institute.

A Biomedical Engineering Unit was set up at the College of Medicine, University of Lagos in 1974. The purpose of this unit was to maintain laboratory and medical equipment in the College and at Lagos University Teaching Hospital as well as to train biomedical technologists for the nation. The University of Liverpool in the United Kingdom assisted in the creation of the unit, donated equipment, and was involved in the initial training.

The capacity to maintain equipment and ensure functionality is central to the successful provision of healthcare, medical education and biomedical research. The production of this capacity was a key deliverable of the Biomedical Engineering unit, and of its aims was to train technicians to cater for the West African sub-region. Nearly a hundred personnel were trained until government policy on education interrupted the program. During the early period of the unit, it was equipped with state-of-the-art equipment for medical diagnosis and research.

The unit became an academic department under the Faculty of Basic Medical Sciences in the 2009/10 academic session. The department now trains students at undergraduate, postgraduate diploma and master's levels in biomedical engineering (BME). The BME undergraduate programme in the University of Lagos had its first intake of students in the 2017/2018 academic session.

The Department of Biomedical Engineering

Location

The process of starting an undergraduate degree programme in the Department of Biomedical Engineering (which operated only at postgraduate level in the Faculty of Basic Medical Sciences, College of Medicine, until 2017) generated a debate on the domiciliation of the programme and the Department. This is quite understandable. The arguments were along the lines of the definitions implied by “biomedical” or “engineering”, special interests e.g. ownership of programmes, and the nuances of individual preferences. In an attempt to objectively resolve the debate some questions were considered:

- a. What effects will proximity to lecture halls and laboratories have on the students (especially where they have to take courses at locations that require inter-campus commuting)? *The main campus and Idi-araba campus are only about 5.5 km apart however traffic between them can sometimes be chaotic.*
- b. What is the likely effect of the location of the programme on the professional identity of the undergraduate students? *At UNILAG, all engineering programmes were in the Faculty of Engineering.*
- c. Which is/are the appropriate body/bodies responsible for licensing, accrediting and regulating the practice of BME in the country? *Engineering programmes are regulated by COREN in Nigeria.*
- d. Where are the majority of teaching resources for this programme (such as personnel, labs etc.) located?
- e. How best will the domiciliation of the programme enhance the interaction between students, their professional peers, and lecturers from the different faculties and departments in the medical school?
- f. How can administrative bureaucratic bottlenecks be minimised or eliminated in managing multidisciplinary faculty members so as not to be counterproductive?

It was resolved by the university Senate that the undergraduate biomedical engineering programme be domiciled in the Faculty of Engineering but co-located in the College of Medicine for student training.

What should the Department be called?

There is a diversity of nomenclature, focus and scope of BME around the world. In some climes, the ‘bio’ is separated from ‘medical’ to make a distinction between biological engineering and medical engineering. Quite often, the term biomedical engineering was used interchangeably with bioengineering. The usage of these terms often suggested the application of engineering principles to biology, medicine or both. While the former deals with engineering applications in medical sciences and clinical practice, the latter deals with applying biological engineering techniques to understand and control biological organisms. In our own case, there was a debate over the

appropriate name for the programme at the level of seeking of University Senate approval for the undergraduate programme. One school of thought felt it should be “Biomedical Sciences and Engineering” while another felt it should retain the existing “Biomedical Engineering”. The University Senate resolved to retain the existing name.

The undergraduate BME program

Why an undergraduate degree programme in BME?

University of Lagos has offered a post-graduate diploma (PGD) in BME since the 2012/2013 academic session, and a master’s degree (MSc) in BME since 2013/2014. Applicants were admitted from a broad range of disciplines namely sciences, engineering, and medicine. Those with first degree in engineering, mathematics, physics and computer science are admitted directly to the MSc programme while others are required to go through the PGD program.

Our experience is that while those without an engineering background lacked the basic numerical and computational skills required for BME, the engineering students lacked the basic knowledge in biological and medical sciences. Lecturers had to go back to basics (the undergraduate curriculum in the relevant subject areas) in order to make up for the knowledge gap. This made it difficult for most students to attain the desired learning goals within the stipulated time. It also affected the quality of research output. These challenges underscore the critical need to introduce an undergraduate BME program. It is expected that these identifiable difficulties at the postgraduate level will be taken care of at the undergraduate level, so that students entering the master’s programme will be adequately prepared.

Moreover, opportunities abound locally and globally in both the private and the public sectors for biomedical engineers. From medical device manufacturers, hospitals, educational and research institutions, to government and non-government agencies there is an ever-increasing demand to employ engineers who can provide solutions to health challenges. Expensive medical equipment is often either grounded or moribund in many health facilities in Nigeria because they were not originally designed for this climate. Over-dependence on imported medical devices leads to prolonged downtime, loss of revenue and poor patient management in the health sector.

The aim of the programme is to offer comprehensive interdisciplinary training in biomedical sciences and engineering that will position our graduates for innovation in the healthcare industry and research. We endeavour to produce graduates that are resourceful, creative, knowledgeable and able to perform the following functions:

- design and supervise the implementation of biomedical engineering projects;
- design and create products with suitable production techniques for the healthcare industry;
- install, maintain, and optimize the performance of, complex biomedical engineering systems in our environment;
- adapt and adopt foreign technology in solving local biomedical engineering challenges;

- inspire original thought and sound professional judgment in the execution of biomedical engineering tasks;
- manage people of diverse skills and interests, machines, materials and funds;
- boost local problem-solving capability by improving indigenous technology; and
- develop a research culture towards sustainability of healthcare solutions.

Design of the curriculum

In 2011, the University applied to the National Universities Commission (NUC) for approval to commence with an undergraduate degree programme in biomedical engineering. Resource verification was done that year but approval was “put on hold” because there was no existing Benchmark for Minimum Academic Standard (BMAS) for biomedical engineering. This became a challenge which the Department of Biomedical Engineering took up on behalf of the University.

In 2014, UNILAG submitted a draft BMAS to the NUC which was a significant contribution to the development and adoption of a national standard which to be used by NUC for the approval of biomedical engineering programs in Nigeria. Official approval from NUC to commence the programme in UNILAG came in October 2017 and thus the Joint Admission & Matriculations Board (JAMB) gave admission in the 2017/2018 academic session to 27 pioneer students.

The question of what model of curriculum to design was resolved after a global survey of BME curricula, and adaptation of some components of the existing curricula of the University of Liverpool and Northwestern University to suit local needs. Programme contributions and appraisal came from the Council for Regulation of Engineering in Nigeria (COREN) – the professional regulatory body for engineering in Nigeria, and other experts in academia, industry and health at home and abroad.

The curriculum was predominantly developed to meet local needs but applying international best practices. It was tailored to equip our graduates with competence, skill and possibly specialisation in any of the following core areas: biomedical devices, biomechanics and biomaterials (prosthetics design and fabrication), and biomedical modelling. These are in demand both locally and internationally.

Figure 1 shows the distribution of courses in the 5-year programme across basic sciences, engineering, medical sciences, general studies, languages and industrial work experience (the students’ industrial work experience scheme – SIWES).

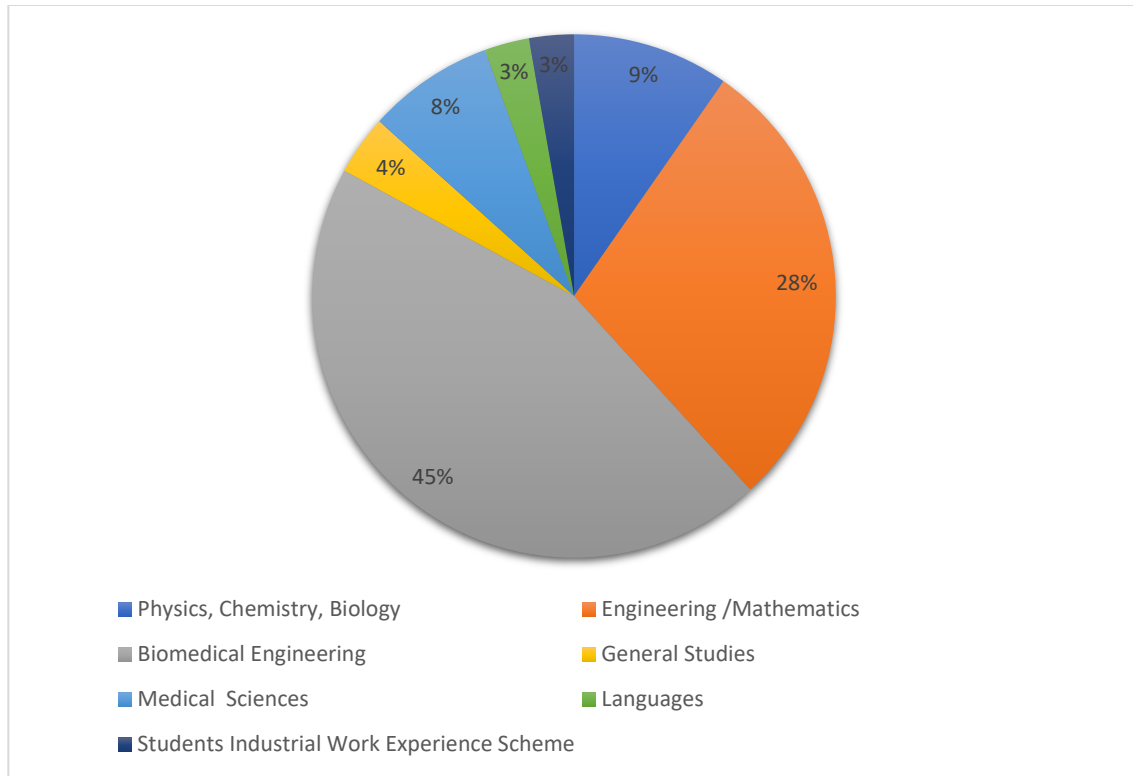


Figure 1: Curriculum distribution for the undergraduate programme

Laboratories

The Department of Biomedical Engineering believes that apart from the shared laboratories with other departments, it should have small units of the following labs:

- *Wet Lab*: where experiments are designed to acquaint students with the methods for acquisition, treatment, and reporting of quantitative information that describes the state of living systems.
- *Design and fabrication labs*: where students have access the tools of a prototyping lab and machine shop. They need to fabricate with various materials ranging from metals to wood, glass and plastic as they design new products and devices. A 3-D rapid prototyping facility is desirable.
- *Computational teaching laboratory*: where students have access to computational workstations installed with design software and integrated videoconferencing capabilities. Modelling and simulation training can be done in this lab.

The Department is hoping to add these facilities to the existing labs in the near future.

Teaching staff

The existing postgraduate programmes have provided the Department with lecturers able to teach the undergraduate courses. However, to reduce the burden on existing lecturers from collaborating departments (from the Faculties of Engineering and Basic Medical Sciences), more lecturers are being trained and recruited to teach BME undergraduate courses.

Research

There is a paradigm shift in UNILAG from the traditional silos to a more robust interdisciplinary collaborative research culture. BME has been a flagship platform that has popularised collaborative research within the University and also with external partners, especially through the National Institutes of Health (NIH)-funded programme “Developing Innovative Interdisciplinary Biomedical Engineering Programs in Africa”, in collaboration with Northwestern University, the University of Ibadan, and the University of Cape Town. This funding support lasted for 5 years. It afforded the academics involved in the BME programmes and others the opportunity for training visits to the Department of Biomedical Engineering at Northwestern University and other established BME programmes in the United States, as well as for training and project visits to the Division of Biomedical Engineering at the University of Cape Town. It is worthy of mention that the capacity building and training opportunities provided by this project to the benefit of academics from diverse faculties, has largely contributed to motivation for BME and commitment to building the Department of Biomedical Engineering.

The department is also part of the African Biomedical Engineering Consortium¹ and is participating in the African Biomedical Engineering Mobility (ABEM)² project which is funded by the Education, Audiovisual and Culture Executive Agency of the European Commission. ABEM grants scholarships to students to undergo postgraduate programmes and credit-seeking visits to partner institutions. It also facilitates staff exchanges between partner institutions. These will strengthen intra-Africa BME cooperation with the inherent benefits of partnership across institutions.

The BME programme is also being enhanced through NIH support under the Medical Education Partnerships Initiative (MEPI 2) grant, “Building Research and Innovation in Nigeria’s Science” (BRAINS), which supports training and mentored research projects and junior faculty development.

At UNILAG’s Department of Biomedical Engineering, our undergraduate training is aimed at producing engineers who are masters of integration, who know enough about different aspects of medicine and engineering to be able to bring the different knowledge areas and skills together in a practical manner. Although each lecturer has the academic freedom to research in their areas of

¹ <https://abec-africa.org>

² <https://www.africanbmemobility.org>

interest, the following are the core areas in which we are building capacity and developing core competencies at the undergraduate level, with the intention that postgraduate research in these areas will flourish: biomedical devices, biomechanics, biomaterials, and biomedical modelling.

Some of the factors that were taken into consideration in arriving at the departmental research focus were: needs that are of significant local and national relevance; the achievable short and long-term goals for biomedical engineering in Africa; global technology trends in biomedical engineering; and resource availability in the immediate or short term.

Our vision

It is the vision of BME at UNILAG to:

- improve and extend the technological capabilities of medical personnel in healthcare delivery;
- operate a department which serves as solution hub for research, medical device manufacturers and clinicians;
- train highly skilled biomedical engineers capable of meeting local needs and global challenges in the biomedical technology space; and
- become the foremost centre of excellence for BME in Africa.

Conclusion

We have discussed our experiences, the motivations and challenges in starting up an undergraduate biomedical engineering programme at UNILAG, and how the challenges have been handled. The experience has helped to form strong interdisciplinary relationships between stakeholders. We believe that the BME programme at UNILAG will be a guiding light in Africa.