

Quality Control and Assurance in Engineering Education in Nigerian Tertiary Institutions

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Abstract - There is no doubt that engineering is the only solid base and way forward for this country's technological development. This technological base can only be achieved through good technological education, good technical policies and proper technical manpower remuneration hinged on quality assurance and quality control in our engineering schools. Engineering education is the activity of teaching knowledge and principles related to the professional practice of engineering. Engineering Education is the process of training engineers for the purposes of initiating, facilitating and implementing the technological development in the society. The general philosophy of engineering education in the universities and Polytechnics is to produce graduates of high academic standard and of immediate value to the industry. The quality of engineering graduates and their engineering practices in any country are factors in determining the quality and extent of the economic/technological development and weaknesses of that country. This paper has looked at what was obtainable, what is currently practiced and what it ought to be. The way forward for technical education with quality control and quality assurance for this Country is also discussed in this paper. The paper among other recommendations, the introduction of fewer faculties of engineering, each designated as a centre of excellence in specific areas of specialization and for faculties of engineering boards in Nigeria to have industrialists as members who should also participate in engineering education curriculum review. The writer concludes the paper with the remark that high quality teaching staff and students in our universities will attract grants, endowments and fellowships needed to promote and sustain engineering education in Nigeria.

Key words: *Quality Control, Quality Assurance, Engineering & Education*

INTRODUCTION

Education is the key to creating, adapting and spreading knowledge upon which the wealth of any nation is based. In the early seventies, when most of us were entering the universities & polytechnics, and even up to the early eighties when some of us graduated out of the schools, we remembered parastatals such as Nigerian Airports Authority (NAA), National Electric Power Authority (PHCN), Nigerian Telecommunications (NITEL), United African Company (UAC), Paterson Zochonist (PZ), NESTLE etc were flooding the schools to recruit young prospective graduates into their establishments and parastatals for employment. Things started fizzling out from the mid-eighties and soon after, the quality of graduates started dwindling. This was probably preceded

with the non-availability of jobs for fresh graduates. Also, the interest of students then to register for courses in engineering especially Civil and Mechanical nose-dived probably because most of the young graduates then were not readily employed into the labour market. Soon after, the number of intakes into Engineering profession in higher institutions started reducing with an average engineering student in a class falling below fifteen (15) or even ten (10). At the end the full engineering study, the number would further fall, as all the students were not be able to graduate after all. This trend has continued and is even getting worse with the quality of the turned out graduates not being able to meet all national and international standards in parading themselves as engineering graduates. We are all aware of the proliferation of Universities, Polytechnics and so many engineering schools in Nigeria with the Nigerian University Commission (NUC) and NBTE (National Board for Technical Education) unable to control and monitor the required standards in those higher institutions. Also, Nigerian graduates in Engineering and any field of study do not rank in foreign countries thereby subjecting them to further academic studies or even degrading their certificates to be able to rank with graduates from other country. This has continued with the non-recognition of any Nigeria university in United Kingdom or United States of America. Before now, some Federal Universities such as University of Nigeria, Nsukka (UNN), University of Benin (UNIBEN), Obafemi Awolowo University (OAU), University of Ibadan (UNIBADAN) and Ahmadu Bello University, Zaria (ABU) were recognised in those countries with none of them in the list now. Every Nigerian graduate with the right frame of mind begins to get worried on the future of Nigerian engineering education with much worries coming from engineers. There is no doubt that engineering is the only solid base and way forward for this country's technological development. This technological base can only be achieved through good technological education, good technical policies and proper technical manpower remuneration hinged on quality assurance and quality control in our engineering schools.

Now, the questions are:

- ✓ What has engineering education been like in Nigeria?
- ✓ Has Engineering practice accelerated or retarded technology development and self-reliance in Nigeria?

- ✓ Are our engineering schools and the current engineering curricula enough for the growth of engineers, industrialization and development of the Country?
- ✓ Are there still hope for a rescue of our engineering training?

These questions will be systematically answered in this submission which has looked at the concept of engineering, concept of quality control and quality assurance, need for quality control and quality assurance in engineering in Nigerian tertiary institutions, challenges of engineering education in our tertiary institutions, recommendations and conclusion.

Concept of Engineering

The dictionary defines engineering as the profession in which a knowledge of the mathematical and natural sciences gained by study, experience and practice is applied with judgment to develop ways to use economically the materials and forces of nature for the benefit of mankind. It is also the application of science to the needs of humanity or the application of Science for the efficient utilization of natural resources to produce wealth. Perhaps, the most adopted definition is that given by Kiddle (1920):

“Engineering is the art or science of utilizing, directing or instructing others in the utilization of the SIX principles, forces, properties and substances of nature in the production, manufacture, construction, operation and use of the things ... or means, methods, machines, devices and structures...”

The only avenue to acquire this knowledge, experience and practice is through qualitative training of the individual in an engineering school. Anyone who has gone through this training in a University, Polytechnic or engineering-based institution comes out to be an engineer or a member of the engineering family. He or she begins to practice what he or she has studied and along the line garners experience in order to take higher responsibilities subsequently. This therefore defines the Engineer as one who acquires and uses scientific, technical and other pertinent knowledge and skills to create, operate or maintain safe, efficient systems, structures, machines, plant, processes or devices of practical and economic value. Engineering requires ingenuity, craftsmanship, and judgment in adapting knowledge to practical purposes. Smith lists major engineering functions as including research, development and design; construction, production, and operation; and application and sales, and management. Engineering is a wealth-creating profession and the art and science of harnessing scientific knowledge for the benefit of mankind.

Engineering education is the activity of teaching knowledge and principles related to the professional practice of engineering. Engineering Education is the process of training engineers for the purposes of initiating, facilitating and implementing the technological development in the society.

The general philosophy of engineering education in the university and Polytechnic is to produce graduates of high academic standard and of immediate value to the industry

Concept of Quality Control and Quality Assurance

Quality can be described as standards of something as compared to other things, that is, the degree of goodness or excellence. High quality teaching/instruction and examination can be regarded as the goodness or effectiveness in teaching which can result in the student learning and satisfaction. Quality teaching/examination ensures that candidates possess the knowledge, skills, and competences that are appropriate for their area of responsibility. These include standards that ensures teachers that know the subjects they teach and how to teach them to the students, understand how children learn and what to do when they are having difficulty, and that they will be able to use effective teaching methods for those who are learning easily, as well as those who have special needs. There is the need to have teaching standards and develop challenging examinations to document and recognize accomplished teaching. It is very clear that the overall goal in ensuring quality is to improve opportunities for high quality learning.

Quality can be achieved through the execution of the core functions of the University – namely teaching, research and community service. The indicators of declining quality include: high dropout rates and high academic wastage and inability of University graduates to perform well on the job. What is central to all these definitions is that quality is not some fixative, immutable, target to be attained but a dynamic target which attainment is facilitated by a set of strategies. Ekhuere (2000) believes that quality is a process involving many variables and activities which include: quality of staff, environment of instruction, content of instruction, students support services, culture of quality, continuous learning and improvement, quality of instruction and feedback from clients and consumers of product.

The terms "quality control" and "quality assurance" are not synonymous. There is a distinct difference between them both in meaning and purpose. While quality control detects any problems that occurs, quality assurance is meant to prevent problems.

Quality control can be described as the process of ensuring a certain set level of excellence in a service or product is met. Quality Control makes sure the results of what you've done are what you expected. Quality control can only be done by the person actually doing the work.

Quality assurance (Ayodel, 2007) entails the quality of teaching personnel; quality of available instructional teaching materials, equipment, school environment, students, and quality education delivery. It embraces all functions and activities that will ensure quality of the academic (teaching, curriculum, etc) and structures (buildings infrastructures etc.) which will allow an objective review of the quality of the programme/

instructional delivery. Quality assurance is a way of measuring, improving, and maintaining the quality of any human activity that has a value. It is noteworthy that quality assurance principles regulate both the external and internal activities of an educational institution. It is done by someone who has supervisory capacity over the person doing the work and can decide on means, methods, and materials.

Quality Assurance makes sure the right things are done the right way. The aim of the both quality control and quality assurance is to improve the quality of education for all students.

- ✓ What is the quality of students admitted into the private universities?
- ✓ What quality assurances are put in place to measure the quality standards?
- ✓ Which regulatory bodies have the responsibility of ensuring the quality content in the curricula?
- ✓ Who determines the quality of teachers in private universities whereas the aforementioned question bothers on control?

The above questions are central in determining the quality of education.

Need for quality control and quality assurance in engineering in Nigerian tertiary institutions

With the rapid globalization of higher education as well as related changes in social, political, economic, and other conditions over the last 25 years there have been ever increasing expectations for higher education, in general, and Engineering Education, in particular. These expectations are often expressed in terms of the need for Quality Assurance locally, regionally, and globally.

The quality of engineering graduates and their engineering practices in any country are factors in determining the quality and extent of the economic/technological development and weaknesses of that country. Nnadi (2000) said that the concept of qualitative engineering education and training should imply a rationalised, balanced and well-articulated sound academic programme carefully linked with a well-planned hands-on apprenticeship appropriate in all aspects".

Ojobo (2002) in his paper on "Engineering Education, Engineering Culture and the changing phases of sciences and Technology" to the NSE Enugu Branch on 21st February 2002, observed the following that "Some Engineering schools have degenerated to mimic level"; "The facility situation in our colleges of engineering is pathetic and must be addressed" and "Our universities are not well funded". Therefore, the future engineers of this country are being heavily handicapped. The emphasis of the various governments has been on other areas of mean importance to the country than Engineering.

However, the students themselves are not to be exempted from the entire debacle facing the engineering education in the country. Generally, the apathy of most students to technical subjects right from secondary schools is the basis of the whole problem since nobody can talk of studying engineering or any technical course without first obtaining credits in mathematics, Physics, and Chemistry in WASC or other allied certificates. Those of them who eventually read these subjects end up being lazy when studying engineering and engineering-based courses as they do not find time to visit the libraries or make use of the modern Information Communication Technology (ICT) available through the vast information on the internet. They rather dwell on cult activities and other social activities that deprive them of concentrating on their course of study. Again, instead of embarking on practically-oriented projects, most of the students now copy already existing projects or research works of other graduates thus recycling the already existing works in the system without adding any new idea or bringing any new innovation to the system even with the abounding technological growth world-wide.

The quality of technical or engineering education in the Nigerian education system, is defined as the totality of characteristics of a learning programme and of its provider, through which the expectations of the beneficiaries and the quality standards are met. In engineering or technical education, quality is directly related to the achievement of the learning outcomes (knowledge, skills and competence achieved at the end of the learning process) that fulfil the key stakeholders' expectations:

- ✓ the students
- ✓ the parents
- ✓ the employers and
- ✓ the community, in general

The implication of the above is that the university education should have quality assurance by the performances of the graduates. Unfortunately, concern has been raised about the decline in the quality of university education offered in Nigeria. Obya (1999) lamented that the quality of education offered by Nigeria universities have deteriorated substantially. As a result, there is high unemployment amongst graduates especially in fields of engineering.

Quality assurance for engineering schools or disciplines is carried out at different levels in the universities:

- On semester basis,
 - External examiner system in which experienced academic staff are invited from another university to vet question papers, marking schemes and final year students' projects.

- At Interval
 - The National Universities Commission (NUC), on regular basis, conducts accreditation exercise for all engineering programmes in the universities using experienced senior academic staff.
 - Statutory professional bodies e.g. Council for the Regulation of Engineering in Nigeria (COREN) also ensure maintenance of standards in tertiary institutions through a system of visitation, accreditation and re-accreditation of programmes.
 - Accreditation
 - Which promotes and fosters good quality post-secondary training for the production of high quality and skilled engineers;
 - Ensures parity of standards in all programmes offered by universities;
 - Certifies to the Nigerian community that the programme offered by an institution has satisfied the minimum educational requirements as laid down by the National Universities Commission; and
 - Provide counsel and assistance to the managers of institutions, where necessary.
 - Programme Approval
 - All Nigerian Universities require prior approval of NUC before establishing new programmes.
 - NUC has developed guidelines and application formats for this purpose.
 - Adequacy of preparedness is assured through resource assessment then granting of approval follows.
- Challenges facing engineering education in our tertiary institutions
- Lack of quality control and quality assurance is not only found in engineering education but in so many other professions. The problems of engineering education in Nigeria universities and polytechnics have been articulated by many stakeholders. The problems include but not limited to:
- The proprietary Logic: One of the challenges of quality control in private engineering schools in Nigeria is the critical concern that the most of the private school owners are owned by religious bodies. For instance Babcock is owned by Seventh Day Adventist Church; Covenant University is the property of Living Faith Church (Winners Chapel); Madonna University is a Catholic owned university; Redeemers University belongs to the Redeemers Christian Church, Benson Idahosa University is owned by the Church of God Mission, Tansian University, Caritas University, Godfrey Okoye University, etc. The challenge here is to strike a balance between the secular and ecclesiastical content of curricula activities, since most religious institutions use the universities to propagate their doctrines and beliefs.
 - The Profit-Logic: With profitability at the zenith of the establishment of most private Universities and Polytechnics, monetization of admission and the mercantile approach to issues of management, serious concerns are being expressed about the quality of such schools, their lecturers, students and academic programmes. In Nigeria, private engineering schools are perceived as demand-absorbing, where quality is compromised in favour of quantity.
 - The Peril of Academic Freedom: Academic freedom confers on teachers and students the right to express free and frank opinions, publish newsletters and to disseminate information without interference. If Nigerian universities are to fulfill their mandate of teaching, research, public service and public enlightenment, academic freedom is a necessary pre-requisite.
 - The Logic of He Who Pays the Piper Controls Quality: Most private engineering schools are funded by their owners and it will be extremely difficult for NUC to control the quality of education since funding largely determines education.
 - The Logic of Engineering schools paying the accreditation teams (COREN inclusive): Where the schools of engineering being visited for accreditation or approval pay for the visits (approval, logistics and accreditation of the team members) will not give the teams boldness to criticize or do proper quality control and assurance checks.
 - Universities of Technology and Engineering schools running other programmes: The common practice where universities established to run agricultural programmes or engineering programmes accommodate other programmes reduce the quality expected from them.
 - Quantity and Quality of Teachers: By far, the most serious factors eroding quality in the educational system are the quantity and quality of the teachers. Teachers are considered as the most important factor in student learning, a bridge between students and quality. Their deficiencies either in knowledge, pedagogical skills or motivation spells doom for the system. These are “among the sore points of basic education in Nigeria” (Tahir, 2001). At the inception of UPE and UBE, the Federal Government had to resort to crash teacher training to make up for the huge shortfall in teachers for the take-of of both programmes. This group of teachers have compounded the problem of quality in the system because the training is weak and no concrete programme was put in place at school level to improve them.
 - Dearth of suitably qualified teaching and technical personnel,
 - Low funding levels,
 - Inadequacy of equipment and infrastructural facilities for teaching and learning,

- Poor remuneration and low staff morale: The relatively unattractive remuneration package in the universities has been the main impediment to staff sufficiency in the institutions.
- Poor administration and supervision of technical education programmes
- Poor assessment Methods
- Low accreditation standards
- Engineering curriculum deficiencies
- Lack of promotion of the field

Recommendations

The need to improve engineering education should begin with giving greater attention to our nursery or preschool, elementary, secondary, and vocational schools. These areas are the building blocks of society's educational foundation since it is not everyone who needs a university education. Thus, the society must make meaningful use of the current Universal Basic Education (UBE) program, which is expected to provide free education to children between the ages of seven to seventeen (Umar and Adoba, 2001). In addition to the free primary education, the government should guarantee sponsor the needy students in order to achieve the MDG goal on education by 2020.

If Nigeria cannot give adequate and quality education to students at the elementary and secondary level, the tertiary institutions would continue to be populated by those who are least prepared to face the rigors of university education. And 'cultism,' 'intimidation of professors into better grades' and other vices will continue to blossom on the campuses across the nation.

To supplement the efforts of the government, the private sector should assist in the form of financial and material donations, and collaborate with institutions of higher learning to help the primary and secondary schools to improve their teaching standards, governance, and their community relations.

States and Federal governments should also device ways and means of helping financially handicapped students in higher institutions, in ways of making available affordable financial loans to enable needy students to complete their education. As in the United States (and other humane societies), 'merit-based' and 'need-based' approach policy could be adopted in the process of putting the loan policy in place (King, March 1999). And adequate machinery should be put in place to collect the loan from students as soon as they find employment. Nigeria has the resources to implement a good student loan program, but as always, her problems have been corruption and implementation.

Science-inclined students should be motivated by way of funding special science schools with adequate laboratories and workshops as founded on the 6-3-3-4 education system in existence in the late 80s in Nigeria.

Science and technical teachers should be encourage with special allowances to put more commitment and dedication in producing future engineers in the Country.

Also, engineers in the teaching profession should have special salary scales to encourage them train the young future engineers without looking elsewhere for greener pastures and also motivated by way of funding special science

Again, the engineers in practice should be encouraged by placing them on better salaries in their offices or parastatals and awarding them local contracts to make the profession a futuristic to be delved into and cherished by the upcoming engineers.

There is a need for greatly improved funding for engineering education, pivotal role in economic and industrial development on any nation.

Funding and resource capacity could be greatly improved in Nigeria with introduction of fewer faculties of engineering, each designated as a centre of excellence in specific areas of specialization. The example of Zimbabwe is useful. The second faculty of engineering in Bulawayo which was established in 1991 offers courses which are different from those offered by the University of Zimbabwe.

The engineering curricula in Nigeria needs to be restructured to include more subjects on management, entrepreneurship and technical report writing.

It should be mandatory for faculty boards of engineering in Nigeria to have industrialists as members who should also participate in curriculum review.

Teachers and trainers should be supported to spend short periods and sabbatical leave in industry.

Compulsory industrial internships should be scheduled for the fourth year by all faculties of engineering. Reports emanating from such visits should be graded on a pass or fail basis, in the same way student industrial reports are treated in most universities and polytechnics. The Student Industrial Work Experience Scheme programme in each country needs to be restructured to ensure better faculty-employer involvement in the design and supervision. Faculties of engineering should have strong industrial placement units, headed by experienced engineers (not allowing the students to search out for non-existing industries as is done presently).

There mandatory periodic evaluation and review of engineering curricula every five years, by teams comprising both academics and practicing engineers as already in Nigeria by the National Universities Commission (NUC) and the Council for Registration of Engineers (COREN) should be continued.

Deans of faculties of engineering should actively encourage departments to foster a close relationship with relevant industries. This is the trend in developed countries and substantial funds and equipment often emanate from industry to support research and consultancy problems of

interest to industry. This is already a requirement stipulated by NUC for every faculty Education and indeed, Engineering Education is one of the pillars for growth and certainly the strongest pillar in eradicating poverty and uplifting the standard of living of any nation.

In order to better prepare an engineer quality-wise, young engineering graduates should be made to undergo compulsory one-year internship training in an industry before proceeding on the compulsory one year National Youth Service programme.

Private Universities certainly have the challenge of quality control to contend with. Private universities should adhere to the principle of reciprocity of capacity and accountability. The NUC should be more determined to play its statutory role of enforcing minimum standards for private universities. Accordingly, NUC should enforce criteria such as quality of teachers, accreditation of courses/programmes, funding requirements, and other educational inputs to ensure that there is effective teaching and learning.

Quality control departments should be set up in all engineering-based Universities and Polytechnics with high caliber staff and good working conditions of service to recruit, retrain staff, inspect, monitor and audit faculties of engineering against the set standards and training programmes, curricula and other activities aimed at maintaining the quality assurance of engineering training.

Other recommendations are

- Use active learning in class
 - Most students cannot stay focused throughout a lecture. After about 10 minutes their attention begins to drift, first for brief moments and then for longer intervals, and by the end of the lecture they are taking in very little and retaining less. A classroom research study showed that immediately after a lecture students recalled 70% of the information presented in the first ten minutes and only 20% of that from the last ten minutes (McKeachie 1999).
 - Students' attention can be maintained throughout a class session by periodically giving them something to do.
- Use cooperative learning
 - Cooperative learning (CL) is instruction that involves students working in teams to accomplish an assigned task and produce a final product (e.g., a problem solution, critical analysis, laboratory report, or process or product design), under conditions that include the following elements (Johnson et al. 1998).
- Assessment and evaluation of teaching quality
 - Most institutions use only end-of-course student surveys to evaluate teaching quality. Current trends in assessment reviewed by Ewell (1998) include shifting from standardized tests to performance-based assessments and from teaching-based models to

learning-based models of student development, Measures that may be used to obtain an accurate picture of students' content knowledge and skills include tests, performances and exhibitions, project reports, learning logs and journals, observation checklists, interviews, and conferences (Burke, 1993).

- Emphasis on competency: Skill acquisition by technical teachers must be consistent.
- Training the trainers programme should be encouraged especially overseas.
- Adequate motivation and better welfare packages for teachers are needed.
- Prompt provision of infrastructural facilities must be made.
- Adequate funding of engineering and technical schools: The Federal Government should increase funding to the educational sector especially engineering sector.
- Administration and supervision of technical schools and colleges should be handled by technical personnel with the right administrative skills.
- Create high Quality Induction programmes for embryo teachers
- Private financing of higher education could contribute immensely to improving both the financial situations of the institutions and their quality of education.

CONCLUSION

It is important that if the nation wants to do well technologically, raise the standard of her engineering products and rank best among comity of nations, the quality control and quality assurance in our nation's engineering schools should be hiked. This can only be achieved by adapting most of the recommendations in this submission.

Where there is high quality teaching staff and students, universities will attract grants, endowments and fellowships needed to promote scholarship and sustain excellence in engineering schools in Nigeria.

Regulatory bodies in the education sector, viz: Federal ministry of Education, National University Commission (NUC), National Board for Technical Education (NBTE), Council for the Regulation of engineering in Nigeria (COREN0, the Nigerian Society of Engineers (NSE) and other affiliate bodies should wake up to their responsibilities by ensuring that the right steps are taken in training our children in engineering schools. This will not only assure quality in the system but will ensure that the engineering schools products meet the engineering standards locally and globally.

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