A Functional Curriculum for Engineering Education in Nigerian Universities

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Abstract— The demand for competent engineering graduates from Nigerian Universities is high and the solution to a large extent depends on the effectiveness of their curriculum. This paper therefore proposes a functional engineering curriculum which is anchored on the key interacting elements of a curriculum. These elements include: what to learn, how to teach it, the means of instruction, the feedback on what has been learnt, the implementers and the learners. In the paper, areas that need review were pointed out and possible suggestions were made. To make it more realistic and implementable, a schematic diagram representing the sequential and practical steps to follow in accomplishing this proposal was formulated. Applying insight from this paper will surely enhance the quality of Nigerian engineering graduates and can possibly trigger off a review of engineering curriculum to suite the present realities in the country.

Index Terms— Curriculum Review, Engineering Curriculum, Engineering Education, Nigerian Universities

1 INTRODUCTION

There are many definitions of curriculum, while some are very broad others are very narrow. A proper definition of curriculum should be simple and comprehensive, while at the same time sufficiently specific so that its key interacting elements and unique roles are clearly conveyed. Taking cognizance of this, Olaitan[1] defines curriculum as the planned and guided learning experiences and intended learning outcomes formulated through the systematic reconstruction of knowledge under the auspices of the school for the learners' continuous growth and competence. Hence, the nature of this type of curriculum consists of the contents (what to learn), the method of instruction (how to teach it), materials (means for instruction), evaluation (feedback on what has been learnt), the implementers (lecturers/instructors) and learners (students). Therefore, a functional and viable curriculum must consider and include all the above enumerated aspects. Curricula for engineering studies in Nigerian Universities need a serious review. The UNESCO report observed that most engineering facilities in Africa are established by colonial governments and various curricula and engineering education system were modeled as such[2]. This has possibly affected the appropriate structuring of the curriculum to meet the immediate growing need of the people in Nigeria. In this paper, a proposal of a functional curriculum for engineering education is handled in sections using the key interacting elements that have already been stated.

2 THE FUNCTIONAL CURRICULUM

Fig. 1 paints a picture at a glance of the network for the proposed curriculum where the various links, relationships and sequences can be clearly seen. The diagram guided the formulation of the curriculum.

2.1 What to Learn

This is the foundation in the development of a curriculum. Therefore, input must be gotten from the key people directly involved with engineering curriculum. From Fig. 1, it can be seen that the industry (those working in relevant industries), the society (those that enjoy engineering products and services), implementers (lecturers and instructors) and graduate engineers (fresh graduates from existing curriculum) must contribute in determining what to learn. A situation where curriculum is imposed to the system by few individuals (even if they are curriculum specialists) should be discouraged. The curriculum specialists can help in harmonizing the views and experiences of the four key players but should not take over their place. It must be emphasized that serious consideration of the society in which the curriculum will be used is very important. In fact, for a curriculum to be functional, it should be society sensitive. It must foster worthwhile ideals and values of a society and should enable that society to progressively attain its social, economic and political goals. Therefore, in developing engineering curriculum for Nigerian engineering students, the environment in which the products (Engineers) and services will be applied must be taken into account. Some of the researchers have indicated that this has not been the case. For instance, Onwuka [3] in his paper submitted that it has been lamented by many Nigerian engineering graduates that they find little or no relationship with what was taught in school and what is obtainable in the job market. Similarly, Olorunfemi et al [4] complained of a missing link between the institutions and industries as a result of lack of appropriate practical skill acquisition in engineering training. It is not claimed in this paper that a functional engineering curriculum must contain all that is needed in practice, but when the gap becomes too wide a reappraisal of what to learn in the curriculum becomes necessary.

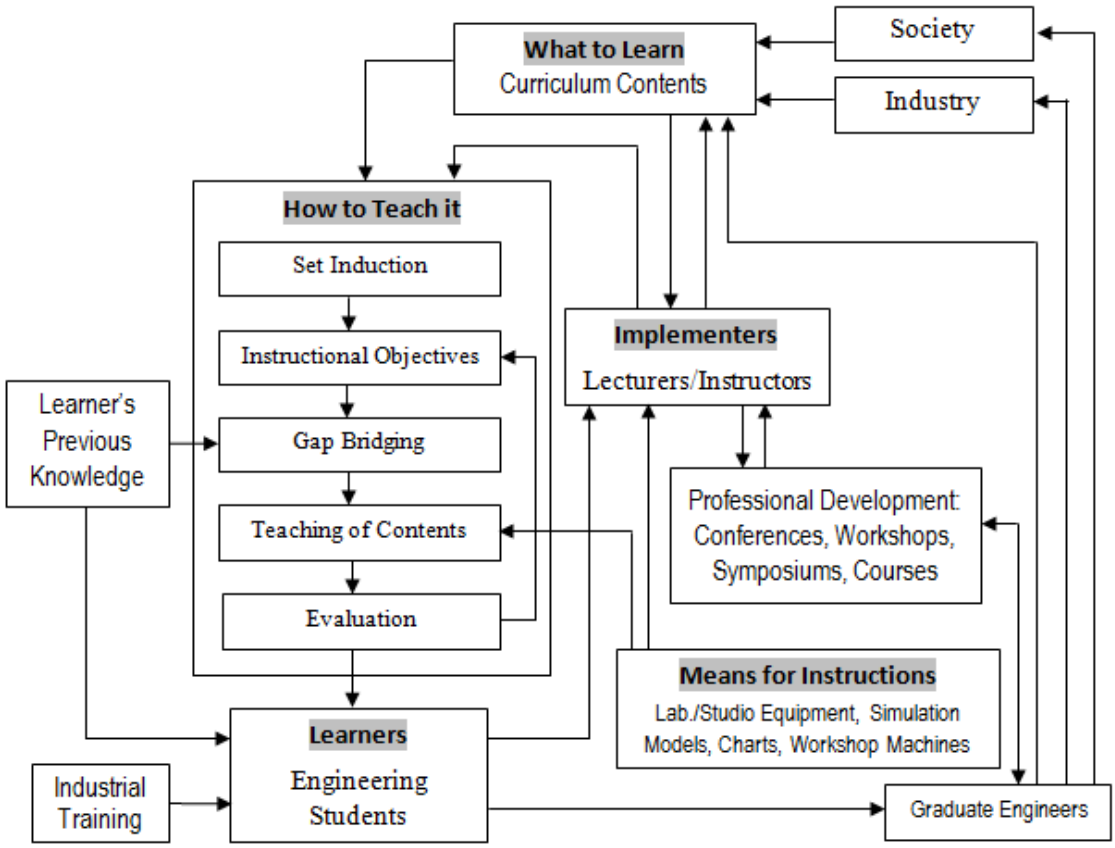

Fig 1: A Schematic Diagram for Functional Engineering Education

The point raised by Olorunfemi et al.[4] is critical as far as Nigeria is concerned. Many countries of the world have a functional collaboration between their academia (universities) and Industries [5][6]. Collaboration between the University and the Industry can come in form of industry-sponsored research and grants, exchanges of researches, direct hire of students and graduates, joint research and conferences, short courses, etc. Unfortunately, in Nigeria, this is not the case; the level of partnership between the two parties is insignificant. Societal problems that require engineering solutions are not static, they are dynamic and time variant. Hence, as technologies obtainable in the industries change, the contents of curriculum obtainable in our academia should as a necessity change. The implication of the above is that the curriculum should not be rigid, unlike what is obtainable in most of Nigerian Universities. It should be examined and necessary modifications effected. Even developed countries modify their curriculum in line with changes and problems from time to time [6][7]. In view of the above, a recommendation for review of the contents of all engineering curricula in Nigerian Universities should be done to ensure that each curriculum has proper contents.

2.3 How to Teach It

In this section, a proposal of methods to be used in teaching the contents of the curriculum and the sequence that it will follow are handled.

Set Induction: Engineering courses are considered hard to learn and most lecturers jump into explaining the concepts and solving the equations without any form of set induction because they consider it trivial, a waste of time or even meant only for students studying education. It must be noted that an engineering student can be likened to as an engine which when you want to operate it, requires that you put it on and allow a given time for it to warm up. Therefore, an engineering lecturer should start his lecture with a set induction. He may start by giving one exciting but related quotation relevant to what is to be taught so as to prepare the students for the course. This requires that the lecturer must prepare on time on how to introduce the topic so as to arouse the interest of the students. For instance, a lecturer that wants to teach a topic "Corrosion of Iron" may start with this quotation "*Anything that can go wrong can go wrong and anything that has been put together will fall apart sooner or later*". He may then ask the students to relate it with the topic of the lecture. After listening to

two or more students and commenting on the quotation he may launch into the lecture proper.

Instructional Objectives: After stimulating the students on the lecture of the day, the next thing is for the lecturer to state clear instructional objectives. Instructional objectives are clear statements of what students should be able to do to show that they have mastered what has been taught and this includes the time that the mastery should happen and the expected behaviour to demonstrate the mastery. Unfortunately, in many if not all the Engineering Faculties (even other Faculties) in Nigerian Universities, what we usually have is Academic Programme which is not really a curriculum because it does not contain detailed instructional objectives and evaluation procedure. With the instructional objectives, those course topics that are most important, those that require moderate attention and those that should be removed from the curriculum can easily be identified. Similarly, deficiencies and redundancies are easily revealed which is very helpful for lecturer's evaluation and curriculum review. It is also helpful to the students which has prompted Ramsden et al[9] to state that course objectives make ideal study guides for the students: the more explicit you are about what you want the students to be able to do, the more likely they will be to succeed at doing it. For functional teaching, Engineering lecturers should state instructional objectives for every of their lectures. It is a fact that one broad objective may take three or more lectures to be accomplished. Therefore, it may be broken down to sub-instructional objectives. So it is recommended that lecturers should state at least one sub-instructional objective at every lecture.

Gap Bridging: Many Lecturers are only concerned with their own course contents without trying to relate it with the previous knowledge or previous related course(s) that the students have done, thereby neglecting the fact that the study of engineering is a continuum. The major aim in teaching is to do it in such a way that it will be retained for long in the memory and teaching engineering as a continuum is helpful in this regard. This was supported by many researchers [10][11] as they found out that people learn new material contextually, fitting it into existing cognitive structures. To help in this situation therefore, courses may be divided into broad areas so that the lecturer that is taking Engineering Design for instance will handle it for various levels. If another lecturer must take it, it is recommended that he must get the lecture note that the previous lecturer has used for the lower level so as to carry the students along, effectively. This was depicted in Fig. 1, in which the learners (engineering students) knowledge is called up and integrated with what is presently being taught, thereby bridging the gap.

Relate with Professional Practice: The joy of engineering courses as compared with other pure science courses is its applied nature. However, most of the engineering courses in Nigerian are taken just like any other science course without relating how they can be applied in practice. This is probably because some of our industries are importation-based. It must be noted as observed by some authors [12][13][14] that Students tend to study hardest and learn best what they are interested in and believe they have a need to know (possibility of encountering it in practice). When the relevance of new material is established in the course of lecture, it provides the concrete justification on the essence of the knowledge.

Participatory Learning: An old adage says: If you tell me, I will forget. If you show me, I might remember. If you involve me, I will learn. There is a need to involve most if not all the students during lectures, if the lecturer's intention is to improve long time retention of what has been learnt. In Nigerian Universities, it is rarely possible because of excessive population and poor and grossly inadequate facilities. Research has proved that students retain information when they are involved [15][16]. For instance, Lecturers can pose questions from time to time or give short (about three minutes) exercise that is interesting but require brainstorming or even use students to demonstrate an engineering process being learnt. It is always good for Lecturers to think in advance on how to involve the students in their lectures, it is worth it. Situation where the lecturer dispenses his lecture or even reads it from the beginning to the end without integrating the students in the course of the lecture should be discouraged.

Evaluation: Evaluation is an important aspect for a functional curriculum. The function of evaluation is to motivate students to learn what they have been taught and enable the lecturer to assess the extent to which they have succeeded in doing so. It should effectively address the instructional objectives set out for the study, so instructional objectives must be condidered while evaluation is made as depicted in Fig. 1. Majority of the students study because they know that they will be evaluated eventually, hence it is a major compelling factor. As such, evaluation must be prepared to give maximum benefit. Felter et al[10] submitted that the burden is on the instructors to make the tests sufficiently comprehensive and challenging to push each student to learn to the greatest extent of which he or she is capable. Lecturers should give challenging but fair evaluation. This is because, in as much as tests can compel students to learn, they can also demoralize students from learning and may possibly make them hostile especially if they perceive that the evaluation is unfair. Lecturers should be careful in springing up tricky surprises during examination. When majority of students understood what they have been taught properly but cannot unravel one trick or the other embedded in the question so as to solve what they know, it becomes quite discouraging. This does not however mean that what should be set must be very easy and straight forward. In addition, Lecturers should in advance, solve the questions they want to ask the students so as to make necessary modifications and determine adequate time to be allocated.

2.4 Means for Instruction

Most of engineering courses are nowadays tilting towards theoretical. They are more of abstract than concrete (practical). In fact Felder et al [10] in support of this said that the movement from concrete to abstraction has proceeded to an extent that has negative consequences for many students. Visual information, like charts and computer simulation, is very helpful because a picture is worth a thousand words as usually said. Similarly laboratory and studio learning equipment, computers and workshop machines are of great help in practical work. It is worthy to note that students comprehend and retain more from visual information than from a verbal or written one. In Nigeria, means of transmitting engineering education has been our great problem. As we are now in computer age, an instructional approach based on computer assisted instructions and simulations is very necessary because it will make many engineering concepts clearer to the students and less tedious for the lecturers to pass across. Besides it makes remembering what has been done easier and encourages self paced learning. Therefore, the challenge is to Government and Industries in Nigeria to provide the needed fund or materials that will help the lecturers and instructors in the learning of engineering concepts. On the other hand the lecturers should think out ways of improvising instructional materials/equipment to facilitate in concretizing their lectures.

2.5 Implementers

The implementers (lecturers/instructors) of curriculum in our universities are very important for the overall success of the curriculum goals. In the course of this paper, some of their roles have been highlighted. At this juncture, it is worthy to emphatically state that a good engineering lecturer should be a student all his life. Engineering teaching fails when the teacher fails to learn continuously, no matter how old he may be. This is true whether we are merely learning new engineering facts or whether we are thinking out new ways of teaching engineering courses. It should be embedded in the curriculum that it is mandatory for the lecturers to attend at least two good conferences or workshops in a year, sponsored by the institution for their professional development. It is only in this way that the engineering lecturer can catch up with this fast changing technological world. Unfortunately, this is not so and that is why a lecture note produced 20 years ago can be used by a lecturer without any form of modification whatsoever. A change on this ugly trend is very necessary and urgent.

2.6 Learners

In curriculum development, the learner is the first central focus and that is why in this paper, the focus has been to improve the overall benefit that the learner will get. Beyond that, majority of the engineering students in our universities do not have adequate foundational knowledge to study engineering as a course in the university. In some cases, entrance examinations leading to admission into a Nigerian University are subjected to various forms of examination malpractices. Besides, it is important to reiterate here that the number of students being admitted to study in engineering departments should be reduced to a manageable number to enable learning to take place properly. In this regard the Nigerian Universities Commission (NUC) should be very strict on the staff student ratio during their accreditation visitations.

3 Conclusion

Have the goals of engineering educational curriculum been achieved? To what level have they been achieved? These pertinent questions are necessary because when a format has existed for decades without achieving its set goals, the first logical step to finding a solution is what has made it not to function. Brembeck once said that 'Education can heal or kill, build up or tear apart, lift up or deprave, much depends on how some of these basic issues are handled". This paper therefore has x-rayed these basic issues as they concern the engineering curriculum in Nigeria with simultaneous recommendations that will make it functional. It is critical because if we fail it will not even remain as it is, but will go worse. However, it is not claimed that this paper has done an exhaustive job to the functionality of engineering curriculum in Nigerian Universities. But the ideas proffered can give a sense of direction and can possibly trigger off a symposium for engineering educational curriculum reform for the entire engineering body in Nigeria.

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