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METHODS FOR QUALITATIVE EDUCATION AND TRAINING OF ENGINEERS AND TECHNOLOGISTS IN DEVELOPING COUNTRIES

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ABSTRACT

The problems of technological underdevelopment in developing countries are ever-increasing, culminating into graduate unemployment, job insecurity, social and engineering infrastructures' collapse and so on. This is generating concerns especially when the implications are viewed from the economic and social aspects. This paper, therefore, looks at case studies from Nigeria and some African countries, to examine and trace this situation to the poor quality of educational training of engineers and technologists, responsible for bringing about innovative changes in the society, as the major factor inhibiting the engineering and technological development of developing countries. The paper then suggests a total review of our mode of engineering education and training, and adoption of new approaches, taking example from the training methods of other professional fields such as medicine, tailored towards effective performance of our engineers and technologists so as to bring about rapid engineering and technological growth. And consequently, economic and social development if developing countries are to be reckoned with in the advances in technological developments currently being experienced in other countries of Japan, America and the rest of Europe.

1. INTRODUCTION

The demands placed on engineers during their day-to-day life are quite enormous. These becomes obvious especially in many developing countries where problems of infrastructural developments pose great challenges to engineering professionals. The successful way that the professional engineer

meets these demands depend on the quality of education received and exposures or experiences that such engineer has acquired. In other words, the success of such engineer depends on how well- prepared he is for these challenges.

The expectations of the public from engineers and technologists are quite high, and these call for a training and educational requirements tailored towards the perceived needs of the society. The quality of engineering graduates from our institutions of higher learning (i.e. polytechnics, universities etc) in the recent times have been generally low especially when their performances, both at school and after graduation, are reviewed or compared with their counterparts from other well-developed nations. The poor performances of these engineering graduates have therefore revealed some inadequacies in the method or system of our engineering education and training. This seems to be lagging behind when compared with other advanced countries such as Germany, France, America, etc.

The development in engineering education and technological training in many advanced countries have reached great heights. And Nigeria as well as other developing countries of the world need to re-examine their system of engineering education with a view to focus on economic and industrial development so as to foster a sound future for commercial and industrial growth capable of attracting and maintaining a viable international market.

Therefore the Author of this paper examines the problem of poor quality of engineering graduates arising from the system of engineering education and training. This is with a view to develop in our engineering students relevant skills such as personal organization, communication and technical performance of our engineers and technologists at undergraduate, as well as graduate levels, in developing countries such as Nigeria.

2. THE DEVELOPMENT OF ENGINEERING EDUCATION AND PRACTICE –RITISH EXAMPLE AND EUROPEAN INFLUENCE

The development of engineering, and particularly civil engineering, in the United Kingdom stemmed from a base of sound practical skills leavened with an understanding of theoretical knowledge (1).

In Europe however, engineering education emerges from a theoretical base which was subsequently enhanced by sound practical experience.

Thorburn (1) said "the success of building and construction works in UK depended on practice developed within particular regions and related to climatic and environmental considerations", the master builders then place great dependence on their experience of behaviour instead of an understanding of the reasons for the behaviour. Thus, it could be concluded that most of the successes in the engineering construction development of the ancient empires relies on practical skills transferred from master builders to apprentices. This practical skills continued to influence the education and

training of engineers (or civil engineers) and technologists in the United Kingdom.

France, however adopts an educational system geared towards the economic and industrial development of their society, whilst German system is designed towards their strong industrial base with considerable emphasis on mechanical, electrical and chemical engineering.

The level of industrial growth in Europe and the need to continue to develop qualitative engineering education and training to sustain their industrial development necessitated the introduction of the concept of an European Engineer. This is an innovation in educational training of European Engineers which is geared towards establishing close links with member European states' Universities. This affords students from members states to pursue their degree courses in any university within the member state. Thus, producing a true European Engineer who is very proficient not only on technical aspect but also in language, culture and hospitable practices in the member states. And of course, he obtains a broad education and awareness of opportunities within the European community.

3. METHODS OF ENGINEERING EDUCATION AND TRAINING

Most developing countries of the world such as Nigeria are still grappling with the old methods of teaching practiced several years back. These methods have not yielded much in terms of the quality of engineering professionals produced from them. This is clear when the state of developments in developing countries are compared with the developed countries.

These methods have not been modified to reflect the changing needs of our society, and the technological challenges posed from other advanced nations. The engineering education is vital to any nation. And each nation must evolve a method of engineering education based on their level of development and their technological and economic goals. Some of the methods are discussed below:

3.1 Traditional Lecture Delivery

This is the method of learning through delivery of series of lectures to students. This method is usually based on strong theoretical background.

This often leaves students in poor understanding of what is taught, and so, there is little or not much that could be made of it in terms of practical application. The lectures are usually delivered in classroom environment with little or no practical backup which would have made the lectures more appreciated by students. The lecture-delivery mode need to be modified year after year to simulate current trends in engineering needs of the society, and the capabilities of the students. The practice of many teaching staffs is the use of the same lecture notes for students year-after-year (from 2 to 10

years or even more in some cases) is not helping matters. Because each year there is always new ideas emerging and students ought to be updated in their training so that the knowledge they acquire can be relevant in the current scheme of things after graduation.

The large army of unemployed graduate engineers in Nigeria, as well as other developing countries, and the collapse states of many engineering infrastructures are a few products of our poor engineering educational system.

Experiential Learning Techniques

The use of experiential learning technique has been demonstrated by Kolb (2) in which the theoretical knowledge gained is linked with experience through reflection and planning. Fig 1 shows the Kolb's experiential learning cycle.

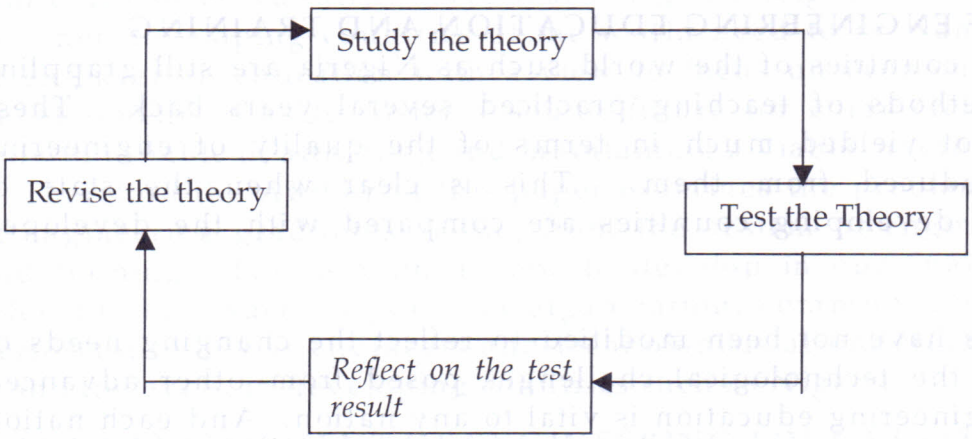

Fig 1: Kolb's Experiential Learning Cycle (2)

The interest of students in learning can be motivated when the teaching staff adopts a method of teaching which displays ability of a facilitator rather than an instructor. Personal experiences of the author in his professional development indicate that in civil engineering education, for instance, as well as engineering education in general, experiential learning through the use of real- life engineering projects, either in design or construction, proves very useful in understanding engineering better. And sometimes group design assignments to students have also been found to be a useful means to enable students to work together as a team. Also this provides logical development of engineering problem-solving skills and appreciation of theoretical knowledge acquired from lecture series. Thus, building self-confidence, team-working and communication (3).

3.3 Industry Based Training Method

The idea of training engineering undergraduates in the industry through the involvement of experienced engineers is also of great importance. In Nigeria for instance, the Students' Industrial Work Experience Scheme (SIWES) designed to assist engineering students in linking theoretical background with practical experience during their training has been on course for some years. A similar scheme devised at the Heriot-Watt University as reported by, Chrisp and Fordyce (4) is the Industrial Liason Scheme developed to encourage first year undergraduate students to develop skills such as personal organization, communication and engineering awareness and to apply them at the outset of their career in civil engineering. The performance of the SIWES in the engineering education of undergraduates in Nigeria is still fraught with problems such as lack of industries willing to give opportunities to students for industrial experience. The economic and political factors may have also contributed to the ineffectiveness of the program. The SIWES would have offered practical engineering education and training a boost as similar to practical exposure offered the medical students in training which makes students to go into the hospital wards, and in most cases, allowed to administer the patients.

Kersten (5, 6) reported Flexner's (6) argument that "there must be a dedicated, scientific and systematic method of observing and reflecting on problems of politics, economics and law (and engineering), just as there is a detached scientific and systematic method of reflecting on the problems of disease (medicine)".

Medical education has been greatly enhanced by the use of real-life practical training when student doctors are allowed in the hospital wards to observe and reflect on various cases of ailments read about in books. The method has offered a better appreciation of theory by students.

This approach will certainly enhance the productivity of engineers if such modes are inculcated into the curricula system of engineering and technological education in developing countries.

3.4 Education or Learning through Participation in Seminars, Conferences, Expositions and Courses

The active participation of students in relevant engineering conferences, courses and seminars is also a useful method that quality engineering education can be imbibed by our students. Many seminars have proved useful to the author in his professional development. Such attendances have brought about interaction between students and experienced professionals in the academics and in the industry. Such seminars and conferences are also useful means of bridging the gap between engineering educators and practitioners. These seminars have addressed the common problem of

Incompetent and Uncommitted Teaching Staff

In most of the institutions where engineering education are offered there have been experiences of poor quality teaching staffs who are teaching various engineering courses. This is either due to the fact that they have not been well-trained or have not acquired sufficient exposure in practical engineering to enable them foster good engineering practice to undergraduate students. The author in his personal professional practice while working with different graduate engineers in consulting engineering practices has observed variations in the qualities of engineering education imbibed by graduate engineers. This variation lies in the quality of performance in assignments given to the graduate engineers. The quality in the graduate engineers performances varies from institutions to institutions where they were trained. The performances of engineers from institutions where there are experienced engineering teaching professionals and where fairly substantial practical exposure have been obtained performed better than graduates from institutions where teaching personnels are not adequate and practical workshop or laboratory facilities are non-existent.

Although, the learning of engineering is very much the responsibility of the undergraduate, but the learning is however facilitated by the technical competence and practical experience of the teaching personnel involved in their undergraduate training.

5 CONCLUSIONS

The quality of engineering education in the developing countries such as Nigeria still require a lot to be done for any meaningful improvement. Members of the public and employers of engineering graduates have often expressed disappointments over writing skills and comprehension of graduate engineers, ability to express ideas verbally and on paper, technical competence and computer capability in engineering application.

"Engineering education brings about improvement in quality of life of the people, and improving the people's quality of life is not just providing land, housing, engineering services and facilities at whatever rate, but the provision of these by new and improved processes and at prices that allow people access to them" (10).

The role of the student Industrial Work Experience Scheme (SIWES) in engineering and technological education is vital, although there are perceived problems of lack of cooperation of many industries in Nigeria, as well as many developing countries, in realizing the objectives of the scheme. This is largely due to the economy of these industries.

The inadequate availability of qualified and experienced teaching personnel and engineering facilities in most engineering faculties of higher learning in Nigeria as well as other developing nations has significantly impacted on the quality of engineering education. Considering the various

factors inhibiting the quality of our engineering education and the performance of engineering graduates, the engineering teaching methods adopted in most developing countries have revealed some defects and this is reflected on the level of technological development in developing countries and our dependence on developed countries for assistance on developmental programs.

The impact of our engineering educational system is seen in the slow-pace of engineering development of most developing countries.

6 RECOMMENDATIONS

From the discussions and the conclusions made above the quality of engineering education determines the quality of life and technological development of any nation. And provision of infrastructures through new and improved processes such as being experienced in most developed countries is paramount. Therefore, for developing countries to come to a stage of being reckoned with among the technologically advanced nations, the followings on the need to improve the quality of engineering education are suggested:

(i) The quality of teaching staff in engineering departments in the higher institutions should be evaluated to determine the level of their contributions to the lower standard of engineering graduates and determine means of addressing them.

(ii) The various factors militating against student Industrial work Experience Scheme (SIWES) in fostering theoretical knowledge with practical experience should be identified with a view to bring about a realization of the noble objectives of the scheme.

(iii) The use of the traditional mode of lecture delivery should be modified by inculcating the experiential learning approach. This would involve taking engineering students through some rigorous practical engineering training to enhance their post-graduation performance as is done in the educational training of medical students.

(iv) In view of the lower standard of engineering education generally experienced in developing countries, the engineering registration requirements should make advanced postgraduate study a necessity. This is also being canvassed even in American Society of Civil Engineers.

(v) The institutions offering engineering courses should be streamlined in view of the low number of qualified teaching personnel and facilities available in many institutions, and the inadequate funding of engineering education by government of developing countries. The government should take as priority the funding of engineering education because it is the bedrock of economic and technological development.

(vi) The formation of African Union recently (in line with the idea of European Union) should not only be on bilateral cooperation on economic, politics and administration. But this should also be on technological education as well so as to foster economic and technological development in the African states capable of providing new and better future for Africa and create less reliance on the developed countries for technical assistance, thereby, conserve the foreign exchange of developing nations.

(vii) That the engineering education should be shifted from theoretical basis and geared towards practical aspect so as to help the students to be able to annex all the theoretical knowledge acquired into practical application. This would thereby boost economic development.

If these steps are taken there would be an improvement in the quality of our engineering degrees and our students would be adequately prepared to annex all their theoretical knowledge acquired at school to bring about opportunities to employ themselves and even generate employment for others after graduation. Thus, lessen the burden of government.

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