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Current Issues in Engineering Education Quality

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It appears that engineering educators agree that achieving quality in education is a worthy undertaking. Nevertheless, there is no such agreement on the definition of quality, let alone how to achieve or measure it. This paper examines some views about engineering education quality that have been expressed in recent literature. Issues discussed include the concept of quality in engineering education, products vs students, customer vs students and employers, ISO standards, life-expectancy of education, and non-technical courses in engineering curricula. The objective is to have a holistic view of engineering quality, to reconcile views that appear contradictory, and to examine the dangers of extending models beyond their range of applicability.

INTRODUCTION

Defining the quality of engineering education is not easy. One needs to address various current related issues such as the introduction of ISO standards to education, the way to view students and employers, the role of non-technical courses, the use of technology in the classroom, and the life-expectancy of education in order to have a holistic view of engineering education quality. In this paper, some views on quality and closely related issues are examined along with the limits of applicability of various related models.

DEFINITION OF QUALITY

Based on the Oxford Dictionary quality is *degree, especially high degree, of goodness or worth.* The Webster's Dictionary defines it as *grade of excellence*. Various researchers, however, have put forward their own definitions of engineering education quality. For example, Crosly stated that quality has to be defined as conformance to requirements, not as goodness [1]. Others defined it as fitness for purpose, effectiveness in achieving institutional goals, meeting customers' stated or implied needs, degree to which education prepares students to be personally effective and capable within the circumstances of their life and work [2-4]. Holifield *et al* approved of the definition *fitness for purpose* and concluded that quality is actually the minimum they would expect [5]. Vroejenstijn, on the other hand, suggested that it is a waste of time to try to define quality in an academic context [6]. The concept of total quality management avoids the direct definition of quality; its focal emphasis is client satisfaction and continuous improvement [7]. This, however, leads back to the requirement of defining the clients and their needs. Defining quality as fitness for purpose confuses the term *quality* with *adequacy* or *salesmanship* Further, Guptal and Rae pointed out that such a definition is limited in practice because of the difficulty of measuring results of higher education with any kind of precision [8]. They proposed that quality in higher education is possible only if the quality of the following is maintained: student intake, staff, teaching, assessment, courses, research, and facilities. They did not however define the term quality with regard to any of these mentioned aspects.

Since there is so much difficulty in finding a globally acceptable definition of quality in education, one may ask why do we need a definition? The need arises because of the desire to communicate that a particular institution provides quality education with the consequence of attracting more students, more funds, more job offers for the graduates, and more recognition. One may suggest that the assurance of quality can be communicated globally by adopting internationally accepted standards such as the ISO standards.

ISO STANDARDS FOR EDUCATION

The International Organisation for Standards (ISO) formed an international team, that included the American National Standards Institute (ANSI), that developed the ISO 9000 series of standards in response to the need to harmonise dozens of national and international standards then existing throughout the world [9]. Registration (or certification) is the formal recognition of an organisation's ISO 9000 quality management system by a qualified third party. It is possible, however, for organisations to self-declare conformity with ISO 9000 standards [11].

The motivation for industry to accept ISO 9000 standards varies widely and includes the desire to obtain marketing advantage, to improve operations, to create quality assurance systems recognised globally, to improve the quality of products or services, and to satisfy the requirements of major customers.

Some universities and colleges followed the path of industry and adopted the ISO 9000 standards and probably more will follow. The reasons include:

- Increased internationalisation.
- Desire to increase mobility of students.
- Desire to attract industry, solicit more funds from politicians, and impress society at large.
- Lack of convenient peer-review for new institutions in some countries.
- Discomfort with current accreditation system.

Nevertheless, several concerns surround the process; these include:

- The possibility of confusing the public; accreditation and conformity with ISO 9000 standards are not the same, nor are they mutually exclusive.
- Forcing the customer model on education.
- Destruction of the traditional meaning of higher education through non-academic strict formalism.
- Creation of a burden on the budget and staff.
- ISO standards need interpretation to be used in education.

PRODUCTS VS STUDENTS

In trying to use industrial standards in education, it becomes inevitable that education is modelled as a manufacturing process and students, or rather the graduates, are viewed as products [12][13]. Stetiu and Stetiu, and Karapetroveic *et al* accepted that model and pointed out similarities between education and manufacturing [12][13]. Although such a model may have its uses, one has to be aware of its limitations, for example:

- A student is a human being with rights and values.
- One may simply discard a defective product.
- A manufacturer guarantees and maintains its products.
- A quality educated individual is expected to appreciate, rather than depreciate, with time.
- The model may lead to apparent short term gain to industry, but it will certainly lead to long term loss to both industry and society.

CUSTOMER VS STUDENTS AND EMPLOYERS

Most of the definitions of quality discussed earlier require an explicit identification of the customers and their needs. If we define customers in an educational sense, it must be in terms of different attributes compared to those of manufacturing. A customer of education is to be educated, trained and corrected, not only listened to and satisfied. The customer here is not always right and a full or partial refund or exchange of unsatisfactory *goods* is impractical.

The customers of education are the students, industry and society at large. Modelling students as customers has the advantage of emphasising that to achieve quality, one has to listen to students and be sure they are satisfied. It is interesting, however, to observe that some commercial enterprises, with traditional customers, are now using terms such as members, guests, family of, etc rather than customers to convey the idea that they offer more quality services or products. It would be ironic if educators were to abandon the term student, with all its well-established history, in favour of the term customer. The use of the term appears to deprive education of its humanistic nature and reduce it to a mere commodity; it also implies less commitment to life-long learning. Modelling employers as customers may be useful if it implies considering the current needs of industry. One should keep in mind that employers also need to be educated and informed of the needs of students, society and other employers. Modelling society at large as a customer of education is particularly important. It is mainly society, not industry, that pays for education, enjoys its outcomes, and bears its consequences in both the short and long terms.

NON-TECHNICAL COURSES IN ENGINEERING CURRICULA

It has been suggested in the past that:

> *Any curriculum that is not developed systematically and as per the demands of the society becomes irrelevant and will soon have*

an adverse effect on all those who come in contact with it [14].

Is there a demand for non-engineering courses in engineering curricula? Do society, industry and engineers see that education quality is enhanced by the inclusion of such courses? Ruprecht stated that the need for humanities in technical curricula can be explained in part by the impact technology has on our society [15]. Engineers are the class of people who contribute most, and most directly, to the changing face of the earth. So they should have at least an idea of the context they are working in. Jelen argued that the history of scientific and philosophical ideas is an exciting and thrilling story with an open end, and that it contributes to educating the whole and balanced engineer [16]. Engineers should not let decisions concerning technological achievements remain in the hands of politicians and economists. Bissell and Bennett stated that the inclusion of the history of technology can give students a vital broader perspective on their subjects and improve the attractiveness of technology to those who would not normally consider it as an object of study [17].

Monk defended the case of literature, stating that it is literature, especially in the form of the novel and the tragedy, that highlights how people cope with ethical dilemmas and that there are many relevant tragedies and novels with a technological flavour that can be compared, contrasted and debated by students and professionals [18]. Mingxure *et al* analysed the role of humanities and social science, concluding that 20% of class hours for such topics is necessary in a broad-based engineering course to maintain quality [19]. Florman viewed non-technical courses as preparation for engineers to become leaders and an instrument to enhance the respect of society for engineers [20]. To show the deteriorated status of engineers in the USA, he stated that *even in industry - even in technology-based industry - engineers routinely take orders from business school types*.

Based on the previous views, one may become tempted to conclude that numerous non-technical courses have to be included in a quality engineering curricula. But there are still a few points to ponder:

- More non-technical courses implies fewer technical courses; would this enhance the quality of *engineering* education?
- What non-technical courses need to be included? How is this determined?
- Who teaches non-technical courses? Would it defeat the purpose if these courses are taught by non-technical individuals?
- What if industry, in spite of praising the concept of well-rounded engineers, employs only narrowly-focused graduates?
- An engineer is expected, as any other good citizen, to visit museums and theatres, to read newspapers and magazines, to listen to music and parliamentary debates, etc; should such activities be included in engineering curricula?
- Indeed there is more to the making of a good engineer than engineering, but should we distinguish between engineering education and engineers' education?

USING TECHNOLOGY IN THE CLASSROOM

It is in vogue to correlate the use of current technology, particularly the Internet and multimedia, in the classroom with quality of education. The results reported on using technology in the classroom indicate both an enhancement in learning in certain cases and no measurable effects in some other cases [21][22]. It is important to realise that technology offers tools; there is no particular advantage in ignoring them, but the mere use of these tools is not a guarantee of quality. Tools may even be misused, leading to inferior results; the Internet and multimedia are no exceptions. It is advantageous to use technology to overcome budget constraints, to save time, etc. Quality should be judged by the outcome of using the tool, not by the tool itself.

LIFE-EXPECTANCY OF EDUCATION

The purpose of engineering education, as stated by various institutions, was reviewed by Mingxure *et al* [19]; one of the common themes was *to have students prepared for continued learning*. Continued learning is an essential ingredient in any quality engineering education. It sets apart education from training. An educated individual needs no re-education, but such an individual never stops learning.

The demand from industry for individuals who can be put to work immediately has influenced engineering education. Some individuals preach that the lifetime of an engineering degree is about five years. They incorrectly attribute that to the rapid change in technology. An educated individual is a long-term investment; the individual can grow with the company through a commitment and *ability* for life-long learning. A trained individual who appears productive from day one on the job will require retraining sooner or later, a process that can be quite expensive. It is not only paid for by society and the individuals involved, but also by industry.

CONCLUDING REMARKS

It may be difficult to define quality of engineering education, but one can describe its results in terms of ability to satisfy the current and future needs of industry, mobility, and life-long commitment to learning. It is the duty of educators to communicate to industry and society the meaning and value of quality education. A balance has to exist between ignoring the demands of industry and society and catering to these demands indiscriminately without considering the consequences.

Models such as those of customer, production, etc may be of use, but one has to be aware that these models may convey inappropriate messages and should not be extended beyond their range of applicability. There are many useful and interesting things an engineer should know, but the main emphasis of a quality engineering curriculum has to be on science, engineering and technology.

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BIOGRAPHY

Dr Ibrahim has a BSc (EE) degree from Ain Shams University in Cairo, and MEng and PhD degrees from McMaster University in Hamilton, Ontario. He is a senior member of the Institute of Electrical and Electronics Engineers (IEEE), a member of the Association of Professional Engineers of Ontario (APEO), the Materials Research Society (MRS), the American Philatelic Society (APS), and the International Banknote Society (IBS).

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Computers in Electrical Engineering Education - Research, Development and Application

by Zenon J. Pudlowski et al

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