

The internationalisation of environmental engineering education and its significance in creating the future of the environmental engineering profession

D.Q. Nguyen & Z.J. Pudlowski

World Institute for Engineering and Technology Education & Monash University
Melbourne, Australia

ABSTRACT: In this article, the authors attempt to address the reality of internationalisation and its impact on education, with particular attention being paid to environmental engineering education. There is an urgent need for engineering institutions around the world to respond to the rising challenges presented by internationalisation, through the establishment of a shared global education or curriculum. The process of internationalisation is by no means perfect as it comes with both positive and negative points. Nevertheless, it is recognised as an important process and engineering institutions cannot choose to ignore it if they are to remain future key players in this competitive global education market. The authors also discuss the status of engineering education in this rapid era of internationalisation and report on some of the changes happening at engineering institutions around the world. Finally, the authors analyse the employment outlook of the environmental engineering profession, the importance of the internationalisation of environmental engineering education and what it means for the future of the environmental engineering profession.

INTRODUCTION

It has been observed in recent years that our world is becoming an interconnected place. This has occurred because of the effect of internationalisation – more commonly referred to as a globalisation process. Internationalisation not only affects the political, cultural, economic, social and environmental aspects of a country, but also the educational aspect. There is no doubt that the challenges presented by this process have had a significant impact on our education and universities around the world are realising the importance of global education, if they are to remain strong competitors and survivors of this global market. Internationalisation/globalisation is well defined by Kiely and Marfleet [1] and Giddens [2].

INTERNATIONALISATION AND ITS IMPACT ON EDUCATION: WHY THE NEED FOR EDUCATION TO GO GLOBAL?

The effect of internationalisation is already forcing many institutions in Germany to modernise and implement new curricula. Detert believes that those who fail to meet this new challenge will be missing out in the highly competitive global education market. One very important aspect of globalisation of education is the establishment of common standards [3]. More details on internationalisation and its impact on education are presented elsewhere by the authors [4].

Universities increasingly will compete in two major areas. The first is in the quality of education – the quality of their graduates – because the opportunities for graduates will become global. Large corporations will be hunting worldwide for the best graduates to incorporate them into their organisations. Secondly, competition will be in research and development (R&D). Research engineers and scientists increasingly will be involved in competing for R&D, for quality research that has a target. In order to prepare them for this competitive market, it is vital that university education addresses the reality of globalisation and directs its students towards an internationally comprehensive approach that creates bridges to cultures throughout the world. This is where the internationalising of curricula becomes necessary [5].

Pudlowski envisions that, because of the effect of internationalisation, there is a distinct need for the development of a global curriculum, in other words a move towards global education, in order to overcome some of the difficulties that are being faced by developing countries in coping with the recent advancements in technology and production processes. Pudlowski agrees with Detert on the modernisation of engineering education, which would then have an overall positive effect on the process of globalisation. Pudlowski also suggests that a global curriculum should be structured in a modular way and should consist of a large number of subjects (modules), both core and optional. This would then form a so-called *bank of subjects*. Core subjects would be recommended for the standard global curriculum, while the optional subjects may be selected by individual universities in order to satisfy their local and individual

requirements [6]. An example of a global model in environmental engineering education is proposed and discussed by Nguyen [7].

ADVANTAGES AND DISADVANTAGES OF INTERNATIONALISATION AND GLOBALISATION

Now that it is understood what internationalisation means and how great its impact on education is, the next step is to examine some of the benefits and disadvantages of internationalisation. Hence, it is worthwhile to present a summary of the advantages and disadvantages resulting from this process [8][9]:

The advantages of internationalisation include:

- Helping the developing world to trade more easily by removing trade barriers and restrictions.
- Opening of trade business for all countries to trade freely in the global market.
- Creating more competition, thus keeping inflation down.
- Increasing the sharing and dissemination of information and ideas between nations.
- Increasing foreign investments to developing nations, which in turn help boost the economy of developing countries.
- Increasing the speed of transfer of information through globalised media.
- Benefiting the developed world in getting access to a cheap labour workforce.
- Breaking the communication barriers between countries.
- Broadening the understanding of different cultures through better communication between countries.

The disadvantages of internationalisation include:

- Greater chance of the spreading of disease between countries as people travel abroad more frequently (e.g. Bird flu and Swine flu).
- Increasing of corporate investments from the developed countries will lead to further polluting of the environment in developing countries because of the lack of, or non-strict, regulations and policies being implemented.
- Negatively changing or spoiling the cultural values of developing countries.
- Leading to exploitation of workers in developing countries.
- Leading to loss of local employment as more work is being outsourced to developing countries where labour is cheap, e.g. parts of Asia.
- Depreciation of the quality of goods and services through outsourcing.
- Developing nations being empowered by developed nations.

As with anything else, the process of internationalisation is not perfect; it comes with negatives and positives. How a country decides whether the process will hinder or prosper the country depends on the individual situation of the country. It is nevertheless an important process that certainly cannot be ignored.

ENGINEERING EDUCATION IN AN ERA OF RAPID INTERNATIONALISATION

Engineering education, in general, has done very little to promote global awareness, and many engineering institutions have yet to touch on the issue of global education. It would seem that many engineering subjects, irrespective of the disciplines, are mostly taught in isolation with no or little reference to the economic, environmental, political, cultural, technological systems (the five components that make up our global system) so that it will enable students to appreciate and understand how engineering is related to the five interconnected systems, as well as to the global society.

A study of faculty members from a number of schools in the USA revealed that very few people had an understanding of what global education was and an even smaller number did anything to globalise their curricula. Moreover, it was found that there were no examples of international studies and no one really spoke about problems or issues that cut across national boundaries [10]. It appears from this study that there is confusion and very little is understood about global education and globalising the curricula among educators.

The engineering profession, as most of the other global professions, is going to be submitted to a global evaluation in terms of the qualities required of what a universally accepted engineer should possess from an educational point of view, and also as seen by a provider of professional services (e.g. industry) [11]. With many countries having various legal frameworks, requirements, local codes and procedures to govern the practice of engineering, this makes for an enormous task in defining specific rules for each case to be considered [11].

The Importance of Recognition and Comparison of Engineering Programmes in an Era of Rapid Internationalisation

In the light of the increased mobility of highly educated workers on a global level, educational institutions in many parts of the world will have to prepare them for a future in which they will, to an increasing degree, be compared not only to

their own country's institutions, but also to institutions in other nations [12]. The internationalisation of degree programmes can ease the transferability of academic credits for courses taken abroad and also may become a way to open doors for students from abroad [12].

Tilmans also expressed the importance of developing the mechanisms and articulation for the recognition of degrees and coursework on an international basis. For example, he gave three primary reasons for this need in the USA, namely:

- The great number of foreign students wanting to study engineering in the USA or transferring credits from a foreign university to an institution in the USA;
- The increase of US students wishing to study abroad;
- The increase of diploma mills [13].

Vroeijenstijn expressed his view that an international comparison is more important today than ever before because of the following reasons:

- Comparisons between universities: a university must assess its quality and the value of its degree;
- Student exchanges and student mobility necessitate a deeper insight into the programmes of other universities;
- Employers will ask questions about the equivalence of degrees [14].

In this era of rapid internationalisation, engineering institutions cannot choose to ignore addressing such critical issues.

ENGINEERING – A GLOBAL PROFESSION

Increasingly, engineers conduct their work in more than one country and in countries other than where they received their education. Those countries have different laws, cultures, procedures and standards concerning their education and practice of engineering. It is anticipated that the growth of major trading blocs, such as the European Union (EU), the Pacific/Asian area and the Americas, will intensify this process of mobility. Also, instant worldwide communication is a strong catalyst for the development of global practice of engineering and engineering education. It is appropriate for the world's engineering profession to recognise this developing situation and to take steps to ensure the orderly transition into the worldwide practice of engineering, and the education of engineers in particular [15].

Yeargan suggested that one method by which this can be accomplished is through the establishment of international accreditation of engineering educational programmes, the recognition of academic equivalency between institutions, and reciprocal agreements between engineering licensing agencies [15]. Nguyen suggested the establishment of one common or so-called global engineering curriculum, which can be used globally, as an alternative. Such a curriculum would eliminate the need for any recognition and accreditation of courses between countries, and would eliminate many problems [7].

OUTLOOK OF THE ENVIRONMENTAL ENGINEERING PROFESSION

An outlook on the employment of environmental engineers indicates that this profession is expected to increase at a faster rate than the average for all occupations through 2010. This growing figure suggests there will be more demand for environmental engineers in the future to design methods to prevent and solve the increase in environmental problems such as air pollution, water contamination, waste disposal, etc. The paradigm shift is now towards prevention rather than solving environmental problems of today. The demand for environmental engineers also has been the result of increasing public awareness and concern. Environmental engineers today are not only concerned with solving local problems, they are also concerned with solving global environmental problems [16]. Hence, this must be reflected in the education of environmental engineers and this further reiterates the importance of globalising environmental engineering education.

The political aspect also plays a major role in the job outlook for environmental engineers more so when compared to the other types of engineers. It was assumed that strict environmental regulations and policies would enhance job opportunities for environmental engineers, whereas weak environmental regulations and policies would have the opposite effect. It was also reported that environmental engineers are less likely to be affected by economic conditions when compared to other types of engineering. However, an economic downturn may reduce concern over the environment, thus reducing employment opportunities [16].

INTERNATIONALISING ENVIRONMENTAL ENGINEERING EDUCATION

As a result of internationalisation, widespread environmental problems, as well as increased growing concern by the public have sparked greater interest in the environment among engineering educators and a greater demand for environmental engineers in the future. It has become clear that engineering educators need to take a more proactive role by responding to the challenges presented by internationalisation, looking at ways of greening engineering curricula and addressing the changes to existing curricula that are urgently needed in recognition of the environment. How

engineering schools respond to these challenges plays a crucial role in creating the future environmental engineering profession.

Various approaches have been adopted by engineering schools to incorporate the environment into engineering curricula. Many have started integrating the environment into traditional engineering subjects, offering more specialised environmental subjects as optional units in engineering curricula and developing environmental engineering undergraduate programmes.

To many, these new approaches and actions may be seen as positive initiatives by engineering schools to make the environment a common part of engineering curricula, in particular, with the increasing numbers of environmental engineering programmes that have eventuated over the past decade. However, there are problems with existing environmental engineering programmes that still need to be resolved. Some of the problems have been addressed and presented by the authors in a separate article [17].

Due to the impact of internationalisation, as the world slowly transforms into a global economy, the authors believe that the best solution is to move towards global education to be realised through the establishment of one common or so-called global engineering curriculum, which can be used internationally. The authors propose that one common curriculum, initially for environmental engineering, should be implemented on a global scale. The principal idea was to develop a curriculum within an environmental and global perspective. It is not an easy transformation and one would expect some rejection and opposition from a number of engineering educators. Many would prefer to have their own programmes, particularly developed within the local milieu and context.

It is the researchers' contention that, in the long term, this would be much more feasible from an economic perspective. A common curriculum would also help overcome the serious problems of recognition and accreditation, which vary both within and between individual countries.

Environmental engineering is different from any classical engineering discipline because it is multidisciplinary in nature, covering a broad range of topics from engineering and science to economics and humanities, etc. It is not enough to take existing engineering curricula and add on environmental units, and then call it environmental engineering, which has been a common approach adopted by many engineering schools. This way may appear to be the quickest and most economical and productive way of developing a new programme, but it has resulted in many problems and failures.

CONCLUSION

Environmental engineering has grown, expanded and evolved into a unique area of engineering over the past few decades. However, it still lacks identity as a discipline and as a profession within engineering in this rapid era of internationalisation. Without a doubt, the challenges presented by the process of internationalisation will have a significant impact on education both at a negative and positive level. However, in spite of the negatives, it is an important process and engineering institutions cannot choose to ignore it if they are to remain competitors in this global education market. Having said that, there are also many benefits of internationalisation, and engineering institutions around the world should take full advantage of the benefits resulting from this process.

The authors propose the establishment of one common or so-called global environmental engineering curriculum with the fundamental body of knowledge being identified and developed strongly in this future curriculum that may be utilised on a global scale. Such a curriculum would address the issue of offering an internationally recognised programme, as well as eliminate the need for any accreditation and recognition of courses between countries. In a comparative study of engineering educators and environmental engineering educators, it was found that there is a general support for the development of such a global curriculum [18].

Research concerning problems and challenges that developing nations experience in engineering education indicates there is an urgent need for such a curriculum and that would be particularly beneficial there, where resources are obviously scarce and substantial costs of higher education would have been reduced by sharing the developed courseware, software, laboratory procedures, methodologies, etc, already available. The education of today will help shape and determine the future of the environmental engineering profession, so it is important that a proper investment is made in the internationalising of environmental engineering education.

REFERENCES

1. Kiely, R. and Marfleet, P., *Globalisation and the Third World*. London: Routledge (1998).
2. Giddens A., *Modernity and Self-Identity*. Cambridge: Polity (1991).
3. Detert, K., New engineering curricula in Germany: an attempt to modernise and globalise engineering education. *Global J. of Engng. Educ.*, 3, 2, 85-93 (1999).
4. Nguyen, D.Q. and Pudlowski, Z.J., Environmental engineering education in an era of globalisation. *Global J. of Engng. Educ.*, 9, 1, 59-68 (2005).

5. Kuhnke, R.R., The training of tomorrow's engineers – challenges of change. *Global J. of Engng. Educ.*, 4, 3, 257-261 (2000).
6. Pudlowski, Z.J., The role, aims and objectives of the 1st CCEE Conference on Life-Long Learning for Engineers, under the theme Work-Based Learning and Continuous Professional Development. *Global J. of Engng. Educ.*, 3, 3, 189-194 (1999).
7. Nguyen, D.Q., Searching for a global model for environmental engineering education. *World Transactions on Engng. and Technol. Educ.*, 1, 1, 51-57 (2002).
8. About globalization: advantages and disadvantages, 26 December 2009, http://about.infocrystals.com/globalization_advantages.asp
9. Pros and cons of globalization, 1 January 2010, <http://lifestyle.iloveindia.com/lounge/pros-and-cons-of-globalization-3507.html>
10. Tye, B.B and Tye, K.A, *Global Education: A Study of School Change*. New York: State University of New York Press (1992).
11. Ryan-Bacon, W. and Delisle, G.Y., Canadian approach to global evaluation of engineering education and services. *Inter. J. of Engng. Educ.*, 16, 2, 109-116 (2000).
12. Jensen, H.P., Quality management: Danish engineering education. *Inter. J. of Engng. Educ.*, 16, 2, 127-135 (2000).
13. Tilmans, A.L., Articulation model for engineering education on the international scene. *Inter. J. of Engng. Educ.*, 3, 2, 153-159 (1987).
14. Vroeijsenstijn, A.I., In search of international standards: the case of the international programme review – electrical engineering. *European J. of Engng. Educ.*, 19, 3, 275-289 (1994).
15. Yeargan, J.R., International accreditation of engineering and technology programs. *Inter. J. of Engng. Educ.*, 7, 6, 464-466 (1991).
16. Environmental engineers, 22 December 2009, <http://www.careerfitter.com/reports/2000reports/az/ocos263.htm>
17. Nguyen, D.Q. and Pudlowski, Z.J., Achieving global standards with a global curriculum in environmental engineering education. *Proc. 6th UICEE Annual Conf. on Engng. Educ.*, Cairns, Australia, 315-318 (2003).
18. Nguyen, D.Q. and Pudlowski, Z.J., A comparative study on the perceived level of support by general engineering educators versus environmental engineering educators for the development of a global curriculum. *Proc. 4th Asia-Pacific Forum on Engng. and Technology Educ.*, Bangkok, Thailand, 191-194 (2005).