

The need for the modernisation of environmental engineering education: a response to current problems and challenges

Duyen Q. Nguyen & Zenon J. Pudlowski

Monash University
Melbourne, Australia

ABSTRACT: A study on environmental issues, reported in the *Global Environment Outlook 2000*, predicts that the current environmental problems facing humanity today will remain problems of the future. This suggests that not enough human or financial resources have been invested in solving the environmental problems of today, and that more applications of sustainable solutions are needed to prevent and eliminate current problems. Some of the major problems highlighted in this report include climate change, freshwater scarcity, deforestation/desertification and freshwater pollution. Due to the persistent global environmental problems, a crucial document, called *Agenda 21*, was adopted in 1992. It addresses the importance of education in bringing about changes to current developments so that they become sustainable. Also, it has encouraged many institutions to include environmental subjects in their curricula. In response to the problems mentioned above, as well as taking into account the impact of globalisation, a global environmental engineering education curriculum is advocated for, and discussed in, this article. Such a curriculum needs to be urgently designed, developed and implemented in order to remedy the present critical situation.

INTRODUCTION

The findings of current literature and comprehensive analysis of the content of existing environmental engineering curricula show that there are still problems and deficiencies that need to be resolved. Some of the problems relating to the content and structure are reported elsewhere [1].

In this article, the researchers strongly advocate for change and for the modernisation of environmental engineering education. The ultimate objective of this study is to develop a global curriculum, with the initial focus on environmental engineering, to be implemented. It should be emphasised that the fruition of such a development may take some time before it can be properly implemented and used globally. There are many benefits from having a global curriculum as opposed to each institution developing their own programmes. The need and benefits of a global curriculum are outlined here [1].

With the world becoming more globalised, it would be ideal if engineering institutions around the world collaborate in formulating and building a standard curriculum as a so-called global curriculum that could be utilised by the global engineering education community.

Since the increase of globalisation, there has been much debate and discussion about activities for the worldwide recognition of engineering qualifications. An example of such an activity is the harmonisation of educational systems in many institutions in Turkey, since the first attempt to join the European Union in 1991, along with other countries. In selecting a university to study, many students in Turkey will base their decision largely on internationally recognised accreditation institutions. For this reason, Turkish universities are facing immense pressure from students to obtain international accreditation. Turkey is potentially seeking accreditation of their engineering

programmes through professional bodies such as ABET and FEANI [2].

It seems that those engineering institutions, which offer engineering programmes that are not recognised internationally and do not meet global standards, will soon find that their programmes will slowly become outdated and perhaps even obsolete when students are seeking more internationally recognised programmes.

A similar situation can also be observed in Japan. Many institutions in Japan are also trying to establish an accreditation system suitable for Japan, in parallel and harmony with other systems abroad, as they too have found problems with the existing conventional system in place. In addressing this issue, one of the planned fundamental policies of the Japan Accreditation Board of Engineering Education (JABEE) is to develop a system that consists of the following: quality assurance and continuous improvement of engineering education, so that graduates are able to work worldwide, having international mutual recognition and educational quality assurance for professional engineers [3].

From the two examples presented, it is important that institutions recognise that engineering is truly a global profession, with multinational and transnational corporations employing engineers around the world. Therefore, it is essential that engineering educators teach future engineers and prepare them for an increasingly international workplace [4].

In the context of the globalisation of any human activity, particularly engineering, it is essential that well-developed countries undertake very serious efforts and adopt an open-minded approach in order to establish such parameters that will permit the ultimate objective of international recognition of their courses to be achieved [5].

Environmental Education

Agenda 21 and the subsequent declarations stress the critical role of education in instilling greater understanding of the concept of sustainability in the next generation [6].

In line with this new principle, and with the ever-increasing environmental problems, it is important to encourage and force many learning institutions around the world to introduce and integrate environmental subjects into a formal educational system.

Sadly, progress in this respect appears disappointing. It is difficult to introduce new subjects into school curricula, and limited change is visible in most university curricula, although there has been a rapid growth in the specialised environmental courses now offered by universities throughout the world. Overall, the general coverage of environmental issues still remains superficial and scattered [6].

One of those specialised environmental courses, which have dramatically increased in numbers in engineering schools, is environmental engineering. However, there are still problems with the existing courses, which still need to address fundamental issues. One of the objectives of this study has been to develop a global curriculum that would try and remedy some of these problems with existing courses. Moreover, it is important to develop a curriculum that would also take account of the impact of globalisation and, as such, to become a more modern curriculum for environmental engineering.

Accreditation Standards

There have been great discussions and debates about the problems that arise from various different standards, accreditation, recognition and diversity of engineering programmes across the globe. These problems would not be an issue if all engineers, after graduation, would find work and remain earning a living in their local countries; but the reality of the issue is that engineering is becoming a global profession due to the impact of globalisation. This provides a great opportunity for many engineers to gain first hand experience in working overseas. The other obvious reason is that many are forced to travel abroad to seek employment due to the shortages of jobs in the local environment.

In order to overcome this problem, engineering educators need to close up this gap of different educational standards and accreditation that exist between nations and provide some form of standardisation in engineering education.

In this article, the authors suggest one way of achieving standardisation, which is through a so-called global curriculum, with the initial focus on environmental engineering. Should this project become successful, the idea can be extended on to other engineering specialities.

ENGINEERING BECOMING 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 the education and practice of engineering. It is anticipated that the growth of major trading blocs, such as the European Community, 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 the 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 [7].

Yeargan, suggests 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 [7]. The alternative, which is put forward in this article, is through the establishment of one common or so-called global engineering curriculum, which can be used globally. Such a curriculum would eliminate the need for any recognition and accreditation procedures between countries.

GLOBAL CURRICULUM

For engineers to move freely beyond national settings and to venture into other countries, the above problems need to be resolved and there needs to be some form of standardisation established in the education system so that it fits into the global education standards. One way of achieving these global standards is through the use of a global curriculum.

A common curriculum could avoid the problems of a multiplication of course offerings and would also reduce substantial administrative overhead costs attributable to departmentalisation. The other advantage noted of a common curriculum is that it does not restrict graduates' choices and opportunities upon entering the workforce [8].

The overall challenge in developing a global curriculum for environmental engineering includes, but is not necessarily limited to, the following:

- Removing problems found in traditional environmental engineering programmes;
- Identifying core features for inclusion;
- Building a curriculum suitable for global application with minor adjustments to suit local conditions;
- Creating a curriculum that is globally transferable and marketable;
- Providing subjects that will enhance students' knowledge and skills required for solving environmental problems;
- Avoiding overcrowding of the curriculum with unnecessary subjects;
- Ensuring that the key environmental subjects are strongly visible in the curriculum;
- Avoiding overspecialisation and repetition of any one particular field in environmental engineering;
- Avoiding inclusion of too much subject matter from the civil and chemical engineering discipline currently found in traditional programmes;
- Including more subjects that will enhance those knowledge and skills that have been identified earlier;
- Providing a broad coverage of subjects from all of the disciplinary areas (eg engineering, science, humanities, etc).

ENVIRONMENTAL STATUS

A global survey on emerging issues, which was conducted on 200 environmental experts in more than 50 countries, suggests that many of the major environmental problems expected in the next century are problems that exist now or have been present for quite some time, but which are not receiving enough policy attention [6]. Some of the emerging environmental issues that were highlighted from the survey were climate change (51%), freshwater scarcity (29%), and deforestation/ desertification (28%) and freshwater pollution (28%). This was followed by environmental problems stemming from poor governance (27%), loss of biodiversity (23%), and the two social issues of population growth and movements (22%) and changing social values (21%). Figure 1 shows the major emerging environmental issues obtained from this survey [6].

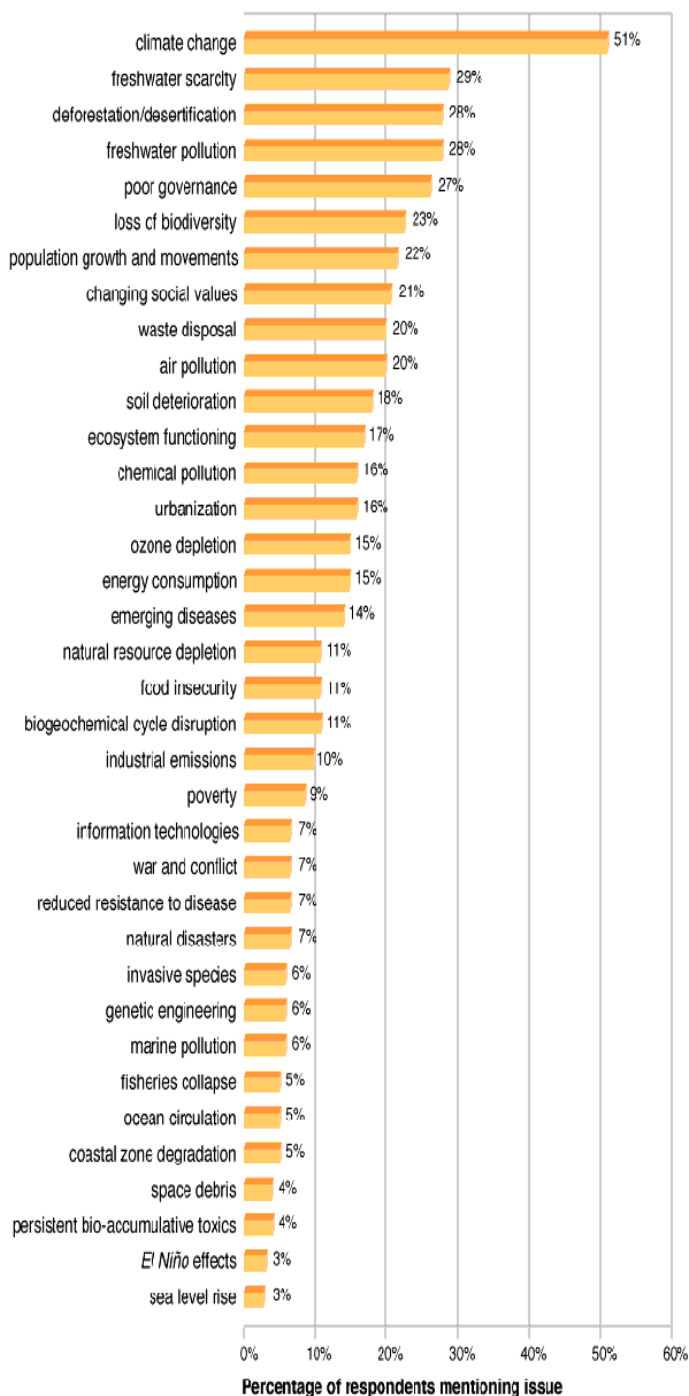


Figure 1: Emerging environmental issues.

The main environmental problems and policy focus of each region, found in the regional-specific alternative policies studies, is summarised in Table 1 [6].

Table 1: Environmental problems and regional policy focus.

Region	Environmental Focus	Policy Focus
Africa	Land and water resources management	<ul style="list-style-type: none"> • Constitutions & institutions • Planning • Promotion of new technologies • Environmental information & education • Public participation • Market-based incentives • Capital flows • Trade policies • Social policies • Regional cooperation
Asia and the Pacific Region	Air pollution (mainly emissions of sulphur dioxide and nitrogen oxides)	<ul style="list-style-type: none"> • Constitutions & institutions • Planning • Promotion of new technologies • Market-based incentives (eg taxation, subsidies)
Europe and Central Asia	Energy-related issues (mainly due to transport and electricity use)	<ul style="list-style-type: none"> • Promotion of new technologies (eg cleaner vehicles) • Environmental information & education • Voluntary action by private sector • Market-based incentives • Capital flows • Regional cooperation
Latin America and the Caribbean	Use and conservation of forests	<ul style="list-style-type: none"> • Constitutions & institutions • Planning • Market-based incentives • Capital flows • Trade policies
North America	Resource consumption Greenhouse gas emissions	<ul style="list-style-type: none"> • Constitutions & institutions • Voluntary action by private sector • Market-based incentives
West Asia	Land and water resource management	<ul style="list-style-type: none"> • Constitutions & institutions • Planning • Command & control • Promotion of new technologies • Environmental information & education • Enforcement monitoring • Market-based incentives • Trade policies

It appears that every region has their own distinct problems to deal with and the adoption of strict policies is necessary in order to control the problems in focus. It is the researchers' strong belief that introducing strict policies might be one way to control regional problems. However, education is the key to solving global problems and achieving a better future for future generations to come.

It is important that educational institutions recognise the various regional problems and, from this, they can provide more education on specific environmental topics affecting the region. This is where the global curriculum on environmental engineering can be useful as its flexibility allows for institutions around the world to adopt and adjust the curriculum to suit local environmental needs.

The problems may be local in scale, but it requires a global solution to really make a difference in solving problems such as climate change.

CONCLUSION

Environmental engineering education, which is an important area of engineering, has a particular relevance in an era of advancing technologies and globalisation, as it comprises a multitude of scientific concepts, ideas, principles, methods and technologies used for the benefit of humankind. It is, therefore, particularly important that environmental engineering education curricula address the most pressing issues and challenges, as well as demonstrate effective scientific solutions to those environmental problems, which the world faces today.

The need for a global curriculum in environmental engineering education has been discussed in this article, showing the benefits that would emerge from such a curriculum. Furthermore, it is believed that such a curriculum would facilitate grossly the process of accreditation of international degree programmes and the recognition of foreign qualifications on a worldwide basis.

Research concerning problems that developing countries currently face in engineering education indicates that there is a

tremendous need for such a curriculum and that it would be particularly beneficial there, where resources are scarce and substantial costs of higher education would have been reduced by sharing the developed courseware, software, laboratory procedures, methodologies, etc. Such a curriculum, although appearing uniformed, would still permit the introduction of local and regional issues, and would also allow the inclusion of environmentally sound policies and local programmes.

It is hoped that the work presented in this paper, which involves comprehensive research, design and development of such a global curriculum in environmental engineering education, will meet a positive climate and response from the global engineering education community. Therefore, the paramount objective of this article is to elicit support from international academics for this important and timely endeavour.

REFERENCES

1. Nguyen, D.Q. and Pudlowski, Z.J., Achieving global standards with a global curriculum in environmental engineering. *Proc. 6th UICEE Annual Conf. on Engng. Educ.*, Cairns, Australia, 315-318 (2003).
2. Akduman, I., Özkale, L. and Ekinci, E., Accreditation in Turkish universities. *European J. of Engng. Educ.*, 26, 3, 231-239 (2001).
3. Ohnaka, I., Introduction of an accreditation system in Japan. *European J. of Engng. Educ.*, 26, 3, 247-253 (2001).
4. Phillips, W.M., Peterson, G.D. and Aberle, K.B., Quality assurance for engineering education in a changing world. *Inter. J. of Engng. Educ.*, 16, 2, 97-103 (2000).
5. Ryan-Bacon, W. and Delisle, G.Y., Recognition of substantial equivalence of engineering competence: the Canada-France mutual recognition agreement. *European J. of Engng. Educ.*, 26, 3, 219- 230 (2001).
6. <http://www.grida.no/geo2000/english/index.htm>
7. Yeagan, J.R., International accreditation of engineering and technology programs. *Inter. J. of Engng. Educ.*, 7, 6, 464-466 (1991).
8. Beeckmans, J.M., Viewpoint: general practice engineering. *Inter. J. of Engng. Educ.*, 12, 6, 396-400 (1996).