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How much do engineering students know about sustainable development? The findings of an international survey and possible implications for the engineering curriculum

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This paper addresses the issue of engineering education for sustainable development. In an attempt to facilitate a better integration of sustainability teaching into the engineering curriculum, it seeks to provide answers to the following fundamental questions: (1) How much do engineering students know about sustainable development? (2) What are the knowledge gaps? (3) What could be the best approach to educating engineering students for sustainable development? Some answers to the first two questions have been provided by carrying out a world-wide survey of engineering students on their level of knowledge and understanding of sustainable development. The survey results suggest that, overall, the level of knowledge is not satisfactory and that significant knowledge gaps exist. However, an encouraging result is that students believe that sustainable development is important for engineers, although they often have difficulties in making a direct link between the theory of sustainable development and engineering practice. To address the third question, the paper then discusses the implications of these findings for the engineering curriculum. It also illustrates an approach to teaching sustainability that could help to stimulate students' interest in this subject during their studies and to ensure their commitment to practising sustainable engineering later as professionals.

Keywords: Sustainable development; Sustainability education; Engineering education; Engineering curriculum; International survey

1. Introduction

Agenda 21, a global action plan for delivering sustainable development accepted at the Earth Summit in Rio de Janeiro in 1992, stated that 'education is critical for promoting sustainable development and improving the capacity of the people to address sustainable development issues' (UNCED 1992). Ten years later, the World Summit on Sustainable development in Johannesburg highlighted once more the importance of education as one of the key elements required for sustainable development (WSSD 2002a). The summit recommended 'adopting a decade of education for sustainable development, starting in 2005' (WSSD 2002b).

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There is evidence that some progress in sustainability education has been made in the last decade, but much more remains to be done. This appears to be true for undergraduate engineering education too. For example, an inquiry into the state of engineering higher education in the UK conducted in 2000 found that, among other institutions, universities were failing to train the new generation of engineers effectively in sustainable development (Forum for the Future 2000). Following the finding that, despite the fact that good engineering is essential to sustainability, engineering solutions are often unsustainable, the inquiry urged practical action. One of its key recommendations was that by 2005 universities should integrate sustainable development into all undergraduate engineering courses. However, the follow-up to this report, published in February 2003, found that progress was patchy and slow (Forum for the Future 2003). One of the key findings of this new report was that the engineering profession has so far failed to embrace the positive role engineers have to play in securing a sustainable future. This is unfortunate, to say the least, since the challenge of sustainable development is an excellent opportunity for the profession to show how vital its contribution is to improving quality of life for everyone. Given some of the profession's major concerns, such as negative public image and the falling numbers of engineering students in countries such as the UK, this appears to be an opportunity missed.

There is therefore an urgent need to address the issue of engineering education for sustainable development. This will inevitably require redesigning the engineering curriculum to enable incorporation of sustainability teaching and learning. However, to effect these changes in the most appropriate and successful way, it is first necessary to provide answers to the following questions:

(1) How much do engineering students already know about sustainable development and are they interested in this topic?
(2) What are the knowledge gaps?
(3) How to teach this subject to further stimulate students' interest in learning about sustainability but also to cultivate their commitment to practising sustainable engineering?

In an attempt to answer these questions, two of the authors of this paper (Azapagic and Shallcross) carried out a world-wide survey of undergraduate engineering students to find out how much they know about sustainable development. This paper presents the results of that survey which, as far as the authors are aware, is the first of its kind and scope. This is followed by the specific recommendations on the topics that could be included in the engineering curriculum to bridge the knowledge gaps and raise students' awareness and the level of knowledge about sustainable development. The final part of the paper illustrates an approach to teaching sustainability to engineering students, tried and tested over the years by the (first two) authors of this paper.

Prior to attempting to provide some answers to the above questions, the following section describes the survey, its objectives and students' responses to the questionnaire.

2. The survey

The main aim of the survey was to help answer the first two questions posed in this paper. The main objectives of the survey were to:

(i) assess the level of students' knowledge and understanding of sustainable development;
(ii) identify if and how different variables, including the type of engineering programme and level of study, influence the level of knowledge;

(iii) find out whether students are interested in sustainable development and if they find it relevant to the engineering profession;
(iv) identify knowledge gaps.

The survey, which was carried out in the period from October 2000 to June 2002, covered students studying general, chemical, mechanical, civil and environmental engineering as well as design and manufacturing. The intention was to cover as many regions world-wide as possible and to include both developed and developing countries. Around 40 universities based in Europe, North and South America, the Far East and Australia were approached to participate in the survey. Out of these, 21 universities responded, with a total of 3134 students completing the questionnaire. Table 1 lists the universities by country and gives the total number of questionnaires returned by each university.

The survey was carried out either by posting the questionnaires to the universities or, directly, by visiting some of the universities. To ensure that students whose mother tongue is not English fully understood the questions, the questionnaire was translated into the native languages of the participating universities.

The questionnaire, which is included in the Appendix, was divided into four parts:

(1) Information about students;
(2) The level of knowledge and understanding of the environment and sustainable development;
(3) Importance of sustainable development as perceived by students;
(4) Previous environmental/sustainability education.

The first part was included to enable analysis of the influence of a number of variables on the level of knowledge and understanding of sustainable development, including student gender,

Table 1. Breakdown of the survey participants by country and university.

Country	University	Engineering discipline	Study years included	Number of questionnaires
Australia	1. University of Melbourne	Chemical engineering	1–5	315
Australia	2. University of Newcastle	Chemical engineering	1–3	21
Brazil	3. Fundãçao Universidade Estadual de Maringá	Chemical engineering	1–5	296
France	4. Université de Pau–ENSGTI	Engineering	3–5	24
Germany	5. University of Stuttgart	Chemical engineering	1–5	27
Italy	6. University of Padova	Chemical engineering	4–5	76
Sweden	7. Chalmers University of Technology	Chemical engineering	1–5	71
Thailand	8. University of Prince Songkla	Chemical engineering	2–4	85
USA	9. Georgia Institute of Technology	Chemical engineering	2–4	30
USA	10. Oklahoma State University	Chemical engineering	1, 4, 5	35
UK	11. Aston University	Chemical engineering	1–5	58
UK	12. Bournemouth University	Engineering design	1–5	91
UK	13. Cambridge University	Engineering	1, 4	236
UK	14. University of Hertfordshire	Civil engineering	2, 3	42
UK	15. Loughborough University	Mechanical and manufacturing	1–5	305
UK	16. Imperial College	Chemical engineering	3, 4	63
UK	17. University of Oxford	Engineering	1–4	136
UK	18. University of Surrey	Chemical engineering	1–4	65
UK	19. UMIST	Chemical engineering	1–5	184
Vietnam	20. University of Hanoi	Chemical engineering	1–5	290
Vietnam	21. Ho Chi Minh University of Technology	Chemical engineering	1–5	684
			Total:	3134

the university and the country, type of degree (single or combined[1]), type of engineering programme and the year of study.

Part 2 was designed to provide information on the level of knowledge and understanding of sustainable development in general and about various specific topics related to sustainability. It was deliberately divided into two general areas: the 'environment' and 'sustainable development'. The 'environment' was singled out for two reasons. Firstly, based on the authors' experience, very few of the first-year engineering students have heard of the term 'sustainable development', while most know something about the environment, mainly through school education. Secondly, university teaching on sustainable development is still not widespread, while many engineering programmes include some teaching on the environment, particularly in relation to environmental engineering. Therefore, not to discourage students at the outset by confronting them with unfamiliar terms, the questionnaire was deliberately designed to start with the 'easier' questions, *i.e.* those related to the environment, and to keep the more 'difficult' topics, *i.e.* sustainable development, for the end.

Forty-five questions, grouped under the following four topics, were posed in part 2 of the questionnaire:

(i) environmental issues;
(ii) environmental legislation, policy and standards;
(iii) environmental tools, technologies and approaches;
(iv) sustainable development.

For each question, students had a choice of the following four answers:

- 'Not heard of';
- 'Heard of but could not explain';
- 'Have some knowledge';
- 'Know a lot'.

To find out if the students were truthful in answering the questions, a 'dummy' question was introduced in this part.

Part 3 of the questionnaire aimed to find out whether students were interested in sustainable development and how important it was for them personally and professionally, but also how important they thought it was for their country, society world-wide and for future generations. The four options that students could choose from were:

- 'Not important';
- 'Possibly important';
- 'Important';
- 'Very important'.

Part 4 consisted of two questions asking if students had any previous environmental or sustainability education

- in school;
- at the university.

These were simple 'yes' or 'no' answers. The aim was to establish a connection between their current level of knowledge with their prior education in this field and if and how that changed from the lower to higher years of study.

In designing the questionnaire several constraints had to be satisfied. One constraint was the maximum time that lecturers would be willing to give up of their lecture for students to complete the questionnaires. Similarly, the questionnaire could not demand too much time or effort from students if they were to reply to all questions. It was therefore concluded that 10

min would be an optimum time. Consequently, this limited the number of questions that could be included in the questionnaire. Nevertheless, the authors believe that the questionnaire is comprehensive and includes most of the sustainability issues and topics that are relevant for engineering students.

The collected data were analysed by software designed specifically for the purposes of this survey (Shallcross 2000). To translate the qualitative answers to the questions in parts 2 and 3 into quantitative measures needed for the analysis, a scoring system on a scale 1–4 was used. Thus, for example, the answers 'Not heard of' and 'Know a lot' in part 2 were assigned the lowest (1) and the highest (4) scores, respectively. Similarly, the answers on the importance of sustainable development in part 3 had score 1 for 'Not important' and score 4 for 'Very important'.

Table 2 shows the total number of responses and the breakdown of the respondents by gender, study year, degree type, engineering discipline and geographical region or country. To preserve confidentiality, the results are presented in an aggregated form for all the participating universities.

As noted in the previous section and shown in table 1, there were 3134 responses from 21 universities based in 10 countries, both developed and developing. The percentages of male and female students were 64.7 and 34.1%, respectively; 1.2% of students did not state their gender. The largest number of students participating in the survey were in their first year (26%), while the percentage of students in years 2–4 was approximately 20% in each year. The student population in year 5 was somewhat smaller (10%), mainly because there were few universities with 5-year programmes covered by this survey, but also because the number of students in year 5 is generally smaller than at the lower year of study.

The majority of students were enrolled on a single programme of study, with only 7.3% pursuing a combined degree. The majority of students surveyed studied chemical engineering (75%). As noted in the previous section, the other engineering disciplines included civil, mechanical, environmental and general engineering, and design and manufacturing. Geographically, the majority of responses came from the universities based in Europe (44%) and the Far East (33.8%). Of the European universities, the majority of the replies were from the UK universities (37.6%). Australia and Brazil each returned 9.4 and 10.7% of the questionnaires, respectively. The sample from the USA was small (2.1%), hence the conclusions of the survey related to this region should be interpreted with caution.

Table 2. Total number and breakdown of responses by different variables.

		Number	%
Total		3134	–
Gender	Male	2029	64.7
	Female	1070	34.1
	Not stated	35	1.2
Study year	1	820	26.2
	2	612	19.5
	3	639	20.4
	4	694	22.1
	5+	330	10.5
	Not stated	39	1.2
Degree	Single	2905	92.7
	Combined	229	7.3
Engineering discipline	Chemical engineering	2352	75.0
	Other engineering	782	25.0
Region/country	Australia	336	10.7
	Europe (France, Italy, Germany, Sweden, UK)	1378	44.0
	Far East (Thailand and Vietnam)	1059	33.8
	USA	65	2.1
	Brazil	296	9.4

The results of the survey are presented and discussed in the next two sections, in an attempt to provide answers to the first two questions posed in the Introduction.

3. How much do engineering students know about sustainable development?

The questions asked in part 2 of the questionnaire provided some answers to this question: the results of the survey aggregated for all students and across all topics indicate that the average level of knowledge and understanding of sustainable development and the related issues is just above 'heard but could not explain'. This corresponds to the average score of 2.23. The survey results suggest that students appear to be most knowledgeable about the 'environmental issues', with an average score of 2.78. They are least familiar with the 'environmental legislation, policy and standards', where the average score was 1.53, which is in between the answers 'not heard' and 'heard of but could not explain'.

Most students claimed that they 'have some knowledge' or 'know a lot' about the following six topics:

- acid rain;
- air pollution;
- deforestation;
- global warming;
- ozone depletion;
- water pollution.

In figure 1, this corresponds to a score between three and four on the scale from one to four. For the rest of the environmental issues, the students had 'heard but could not explain', *i.e.* the average score was between two and three.

It was interesting to observe that the level of knowledge about certain regional environmental issues was higher in the geographical regions where those issues were a particular problem. For example, it was found that, compared with the other regions, students in Brazil had the highest average scores for their knowledge about biodiversity loss, deforestation, desertification and ecosystems. Similarly, students in Australia and the Far East had the highest average scores for their understanding of salinity and water pollution, respectively. This finding is not surprising and is consistent with the findings of some other surveys of environmental knowledge and concerns. For instance, the latest 'Survey of public attitudes to quality of life and to the environment' in the UK found that the British people were more concerned about some largely domestic issues such as waste management and effects of livestock methods (including BSE) than global issues such as tropical rainforest destruction or climate change (DEFRA 2002).

With regard to the other topics addressed in part 2 of the questionnaire and shown in figures 2–4, there were no scores above three for any of the topics, which would indicate that the level of knowledge and understanding of these issues is relatively low. Furthermore, for 15 topics the students had a score below 2.0, indicating that they had 'not heard of' or had 'heard but could not explain' these topics. They are:

- EU EMAS;
- Intergovernmental Panel on Climate Change (IPCC);
- ISO 14001;
- Kyoto Protocol;
- Montreal Protocol on CFCs;
- Rio Declaration;
- Eco-labelling;

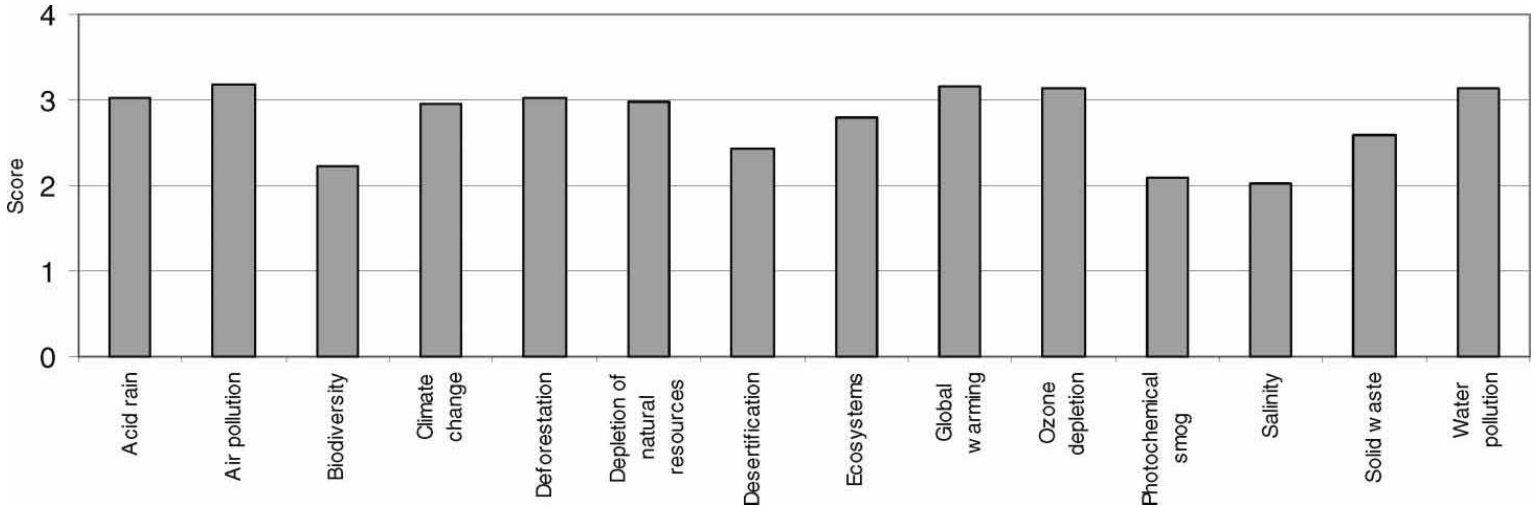

Figure 1. Questionnaire analysis for part 2: level of knowledge and understanding of 'environmental issues' (average score for all students and all questions on this topic = 2.78).

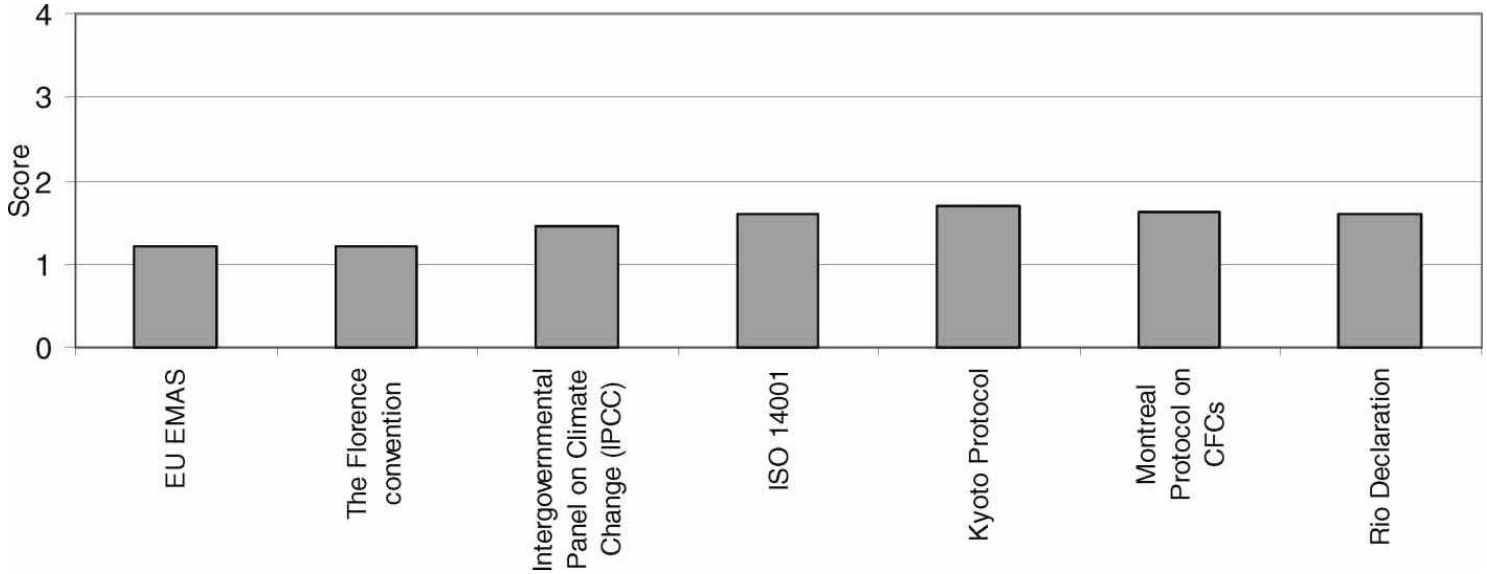

Figure 2. Questionnaire analysis for part 2: knowledge and understanding of 'environmental legislation, policy and standards' (average score for all students and all questions on this topic = 1.53).

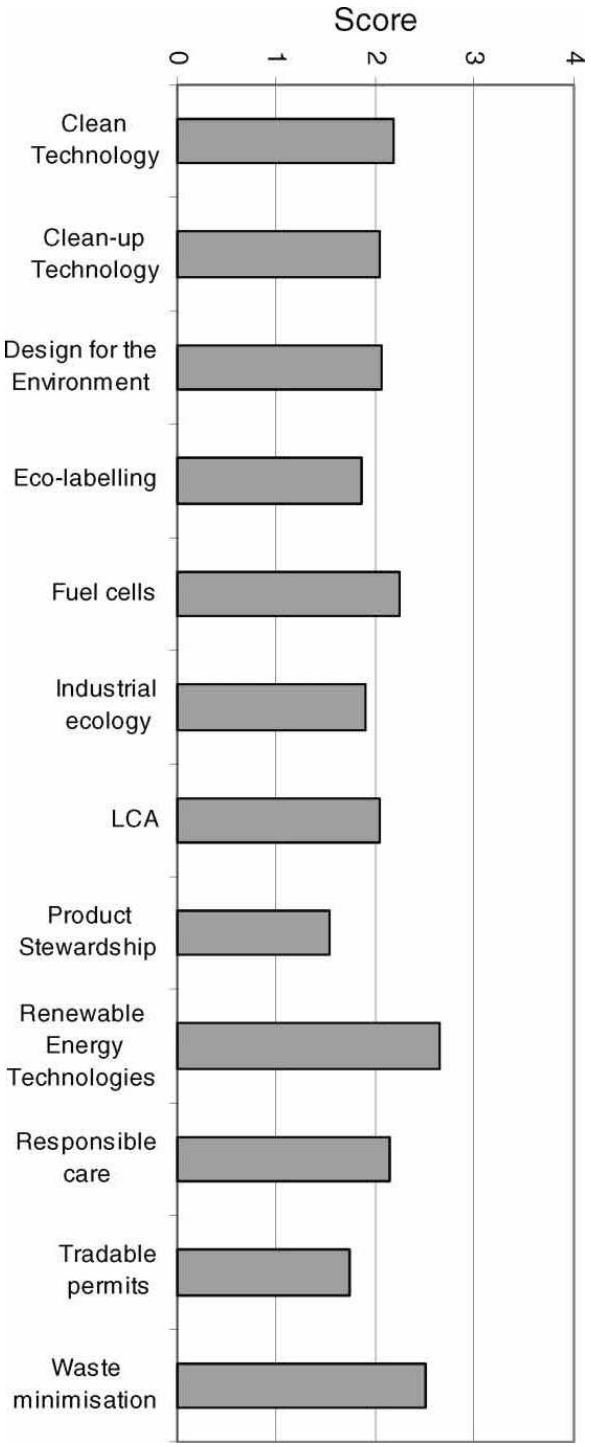

Figure 3. Questionnaire analysis for part 2: knowledge and understanding of 'environmental tools, technologies and approaches' (average score for all students and all questions on this topic = 2.11).

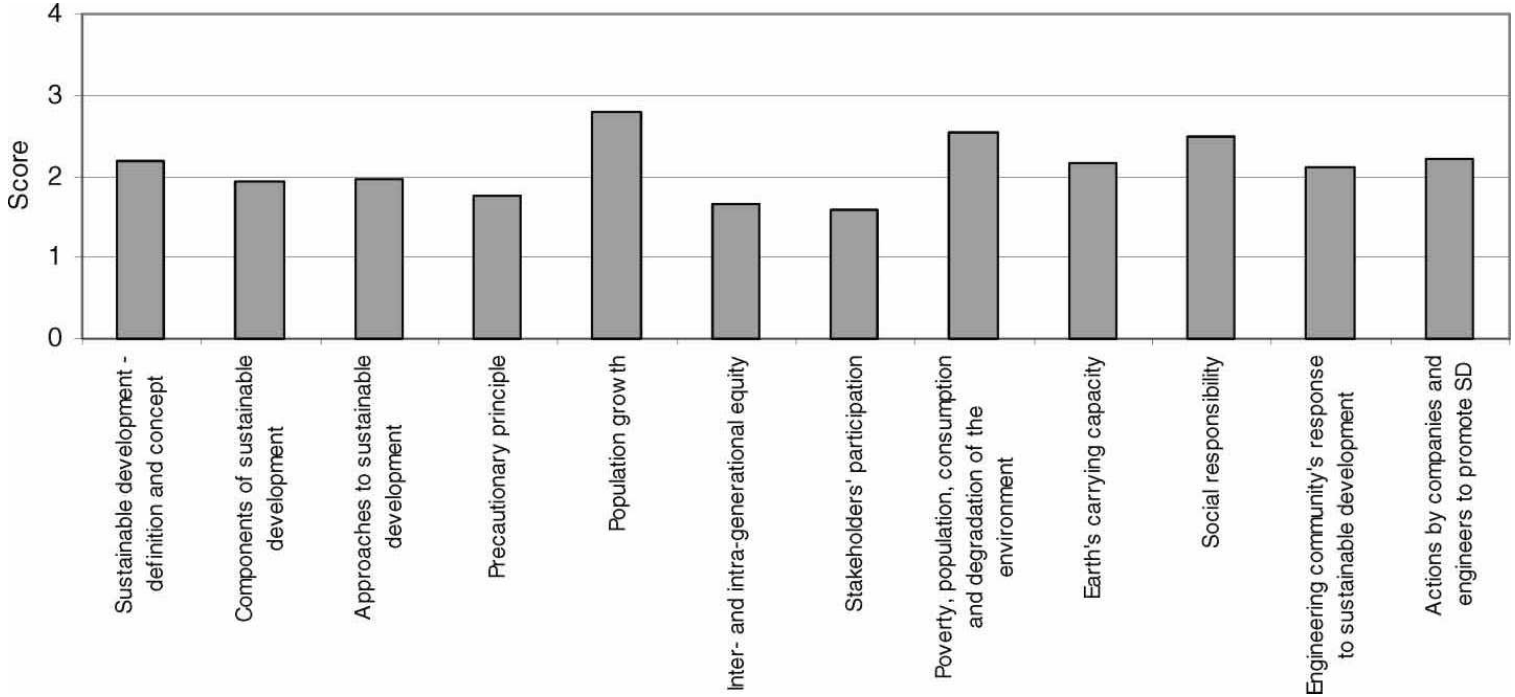

Figure 4. Questionnaire analysis for part 2: knowledge and understanding of 'sustainable development' (average score for all students and all questions on this topic = 2.13).

- Industrial ecology;
- Product Stewardship;
- Tradable permits;
- Components of sustainable development;
- Approaches to sustainable development;
- Precautionary principle;
- Inter- and intra-generational equity;
- Stakeholders' participation.

With regard to the influence of different variables on the level of knowledge and understanding of sustainable development and the related issues (part 1 of the questionnaire), the survey results suggest that neither the gender nor the level of study have an influence. The average difference between the knowledge of male and female students for all topics was only 2.7%, while the difference between years 1 and 5 was 3%. Similarly, small differences were observed between different types of degree (single or combined) and between the engineering disciplines covered by this survey. Therefore, given the relatively large size of the sample, it could be concluded that currently there is no statistically significant difference in the level of knowledge about sustainable development between the male and female students in different years of study and studying different engineering disciplines. However, as the sample was dominated by the chemical engineering students, the conclusion that students in different engineering disciplines have the same level of knowledge about sustainable development should be drawn with care. Nevertheless, this conclusion may hold at least in the UK, where engineering curricula follow a fairly similar pattern, currently with little or no teaching on sustainable development.

With respect to the geographical regions, students in the European and the Far East countries covered by this survey appear to have the highest level of knowledge and understanding of sustainable development. The difference between these regions and the USA, where on average students had the lowest level of knowledge about this topic, is around 13%. However, as already pointed out, the USA sample was statistically much smaller than the samples from the other countries, so these results must be interpreted cautiously.

The analysis by country shows that engineering students in Sweden, Germany and Vietnam have the highest level of knowledge about sustainable development. These results point to the conclusion that there is little difference in the level of knowledge and understanding of sustainable development between the students in the developed and developing countries, at least between the students of the countries included in this survey.

Nevertheless, despite a relatively low average level of knowledge and understanding, most students appeared to be interested in sustainable development and thought that it was either 'important' or 'very important' (part 3 of the questionnaire). These results are shown in figure 5. This is an important finding as it indicates that students could be engaged effectively in learning about sustainability. However, the authors' experience with teaching this subject to engineering students is that they need to see an immediate and direct relevance between the theory of sustainable development and engineering practice, even more than what they expect in other engineering subjects. One of the reasons for this is that sustainability is often perceived by engineering students as 'soft' science, whilst their interest lies in 'hard' engineering (Azapagic 1996–2003). This is particularly true for engineering students in the UK, who mainly study mathematics and physics during their secondary education, normally with little exposure to 'soft' subjects such as sociology and philosophy.

Another interesting finding of the survey was that most students thought that sustainable development was more important for future generations than for them personally. This could, of course, be interpreted in different ways. One of the explanations by some of the students

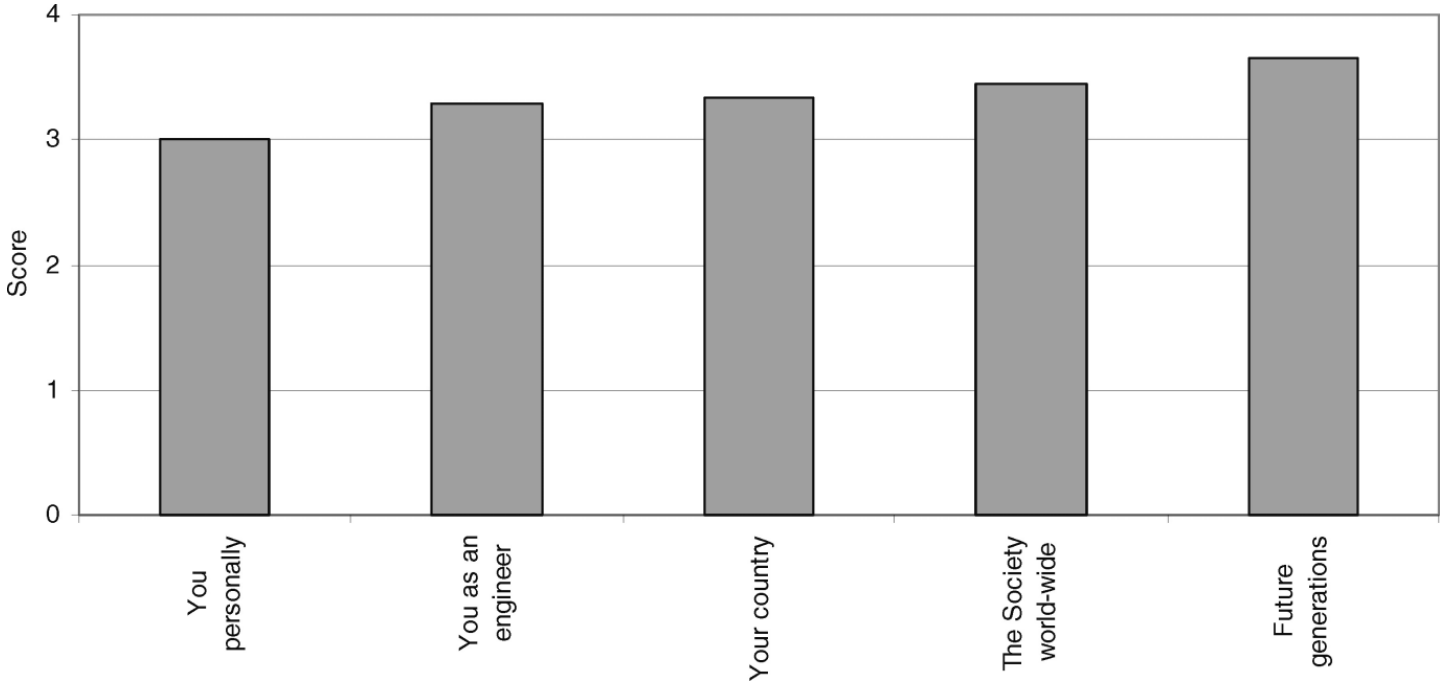

Figure 5. Importance of sustainable development as perceived by students (results averaged for all students).

(Azapagic, 1996–2003) was that they believed that during their lifetime the environment would still not be degraded so much as to affect their livelihoods but that the next and the future generations would be affected much more. This explanation gives a useful indication as to how to engage engineering students in this subject more effectively: if they can understand and anticipate the benefits (or otherwise) for future generations of what they are doing today, it may be possible to stimulate their interest in learning about sustainability while studying and to cultivate their commitment to practising sustainable engineering later as professionals.

4. What are the knowledge gaps?

The analysis of part 2 of the questionnaire has also provided answers to this question. While on average students appear to be knowledgeable about 'environmental issues', there are still issues about which the majority of students had not heard, including:

- biodiversity loss;
- salinity;
- photochemical smog.

Regarding 'environmental tools, technologies and approaches', students have little or no knowledge (score < 2) about:

- industrial ecology;
- product stewardship;
- tradable permits.

The largest knowledge gap is in the area of 'environmental legislation, policy and standards', as students appear not to be familiar with any of the issues grouped under this general heading.

Finally, the knowledge gaps related to 'sustainable development' have been identified for the following topics:

- components of sustainable development (economy, society and the environment);
- approaches to sustainable development;
- precautionary principle;
- inter- and intra-generational equity;
- stakeholders' participation.

To summarize, the survey results suggest that, overall, the level of knowledge and understanding of environmental and sustainability issues by engineering students is not satisfactory and that relatively large knowledge gaps exist. These findings are of concern, particularly as the analysis of part 4 of the questionnaire shows that most students have had some environmental/sustainability education in school (85%) and university (74%). That perhaps explains a relatively high level of understanding and knowledge of most of the 'environmental issues' addressed in the questionnaire. However, the finding that there is no difference in the level of knowledge between different years of study is also of concern as it suggests that environmental and/or sustainability topics are not taught adequately on engineering programmes. These findings confirm our belief that much more work is needed in educating students in this area. However, the fundamental question here is how to do that in a way that is most appropriate for engineering students and that captures their imagination most effectively. This question is addressed next.

5. How to teach sustainability to engineering students?

If engineers are to contribute truly to sustainable development, then sustainability must become part of their everyday thinking. This, on the other hand, can only be achieved if sustainable development becomes an integral part of engineering education programmes, not a mere 'add-on' to the 'core' parts of the curriculum. What is needed, therefore, is an integrated approach to teaching sustainable development which should provide students with an understanding of all the issues involved as well as raise their awareness of how to work and act sustainably (Perdan *et al.* 2000).

An approach to teaching sustainability to engineering students has been proposed by the UK Government Sustainable Development Education Panel (SDEP 1999). The panel has suggested that sustainability *concepts* and *solutions* should be two key areas of learning. The former includes an understanding of interdependence of natural, social and economic systems, the needs and rights of future generations and an appreciation for the need for precaution. Sustainability solutions are, among other issues, related to an understanding of the role of the engineering community in promoting sustainable development, a sense of social responsibility and an awareness of the tools and techniques for identifying sustainable solutions. The specification related to these areas is expressed in terms of *learning outcomes* that describe assessable changes in knowledge and skills development and behaviour that the engineering programmes, modules or learning materials are designed to bring about. The panel has also suggested that sustainable development education is best integrated into specialist courses through learning activities that are firmly set in the context of the specialism, and that different learning activities and learning materials will be needed to deliver the sustainability learning agenda to students from the different branches of engineering (SDEP 1999). A number of professional and engineering bodies in the UK have since expressed their support for integrating sustainability into engineering education and practice, including the Royal Academy of Engineering and the Institution of Chemical Engineers (IChemE).

At present, however, it is not yet clear how to achieve this goal at the practical level, particularly *how* and *where* in the curriculum to teach sustainability. Although many universities are starting to teach this subject, most approaches to teaching sustainability still seem to be *ad hoc* and dependent mainly on the expertise available at each university. In an attempt to contribute to a more systematic integration of sustainability into the engineering curriculum, an example approach developed by the University of Surrey is described in the next section.

5.1 *Redesigning engineering curriculum for sustainable development education: an example*

The University of Surrey developed a 'three-tier' approach to teaching sustainability (Azapagic 2001). The approach was first developed and implemented in the chemical engineering programme and after its successful implementation is now being rolled out to other engineering disciplines, including mechanical and civil engineering. As illustrated in figure 6, the 'three-tier' approach comprises the following elements:

(1) dedicated lectures and tutorials on sustainable development;
(2) specific case studies;
(3) integration of sustainability into the overall curriculum.

Following the SDEP (1999) recommendations, the first tier introduces students to sustainability concepts as one of the key learning areas through a series of lectures and tutorials. In the second tier, students are exposed to specific, practical case studies, to enable them to apply

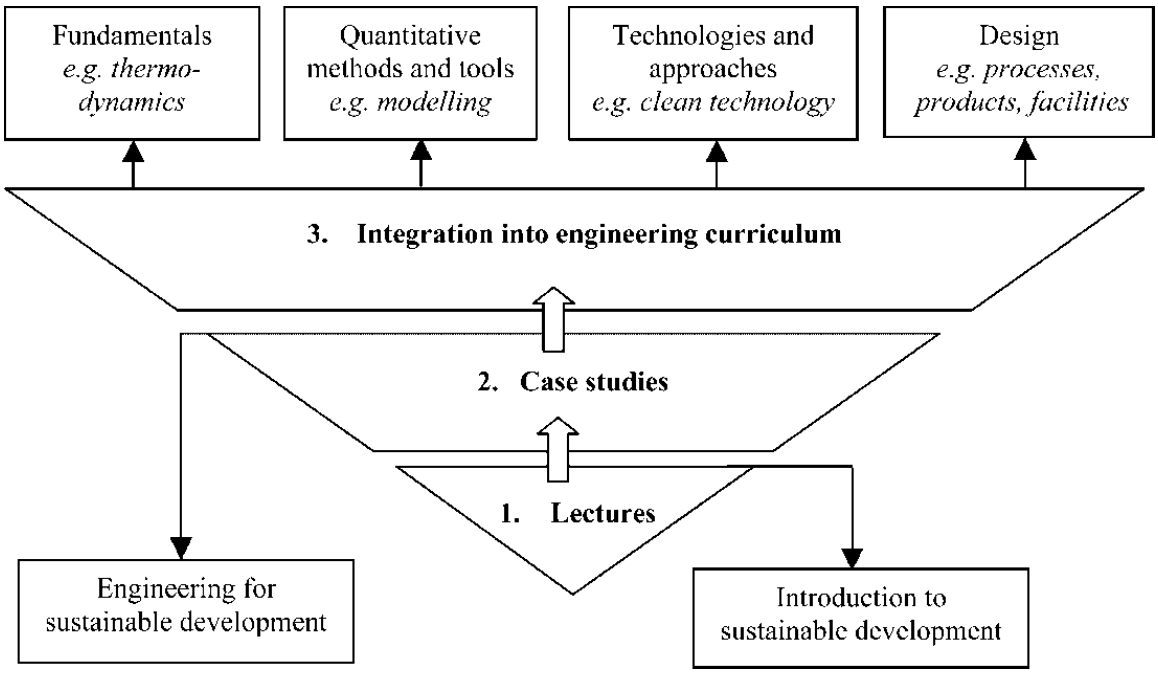

Figure 6. The three-tier approach to teaching sustainability developed by the University of Surrey (adapted from Azapagic, 2001).

the sustainability concepts and identify sustainable solutions. Taking a life cycle approach to address economic, environmental and social issues, a series of practical case studies have been developed from a range of industrial sectors including water, energy, waste, chemicals, glass and mining and minerals. For more details on case studies see Azapagic *et al.* (2004a) and Perdan and Azapagic (2003).

The third and final tier is integration of sustainability thinking into the overall curriculum, from the fundamentals (*e.g.* thermodynamics) through quantitative methods and tools (*e.g.* mathematical modelling) to the design projects (*e.g.* processing plants, facilities and products). This is probably the most challenging task, which is best facilitated through further, more complex case studies and multidisciplinary design projects. For instance, within a thermodynamics module, a combined heat and power (CHP) plant burning municipal solid waste could provide a plethora of interesting technical aspects (*e.g.* efficiency of incineration with and without heat recovery), and environmental (elimination of solid waste but also increased air pollution) and social considerations (*e.g.* public perception and objection to incinerators) (Kirkby and Azapagic 2004). Furthermore, students could learn how to integrate different sustainability criteria into the conventional design approaches by using, for example, life cycle thinking, industrial ecology approaches and appropriate ethical principles (Azapagic *et al.* 2004b).

Such an integrated approach enables a systematic introduction of sustainability criteria into the curriculum, starting with a lower level of complexity and progressing towards more complex considerations at the higher levels of study. It promotes learning outcomes that enable graduates to establish a clear connection between engineering and sustainable development and helps them in practising sustainable engineering.

More detail on this approach can be found in Azapagic (2001).

6. Conclusions

The world-wide survey of engineering students carried out by the authors suggests that, overall, the level of knowledge and understanding of sustainable development is not satisfactory and

that much more work is needed in educating engineering students in this field. While on average students appear to be relatively knowledgeable about environmental issues, it is apparent that significant knowledge gaps exist with respect to the other two (social and economic) components of sustainable development. The largest improvement in knowledge is required in the area of environmental legislation, policy and standards, as students appear not to be familiar with any of the issues under this general heading.

An encouraging finding of this survey is that all engineering students surveyed think that sustainable development is important for them personally and even more important for them as engineers. Hence, it should not be difficult to capture their imagination by teaching sustainable development so as to make it as relevant to engineering as possible. As shown by the three-tier approach developed by Surrey, this can be done through a series of lectures and tutorials, followed by practical examples and case studies integrated into the core modules of the engineering curriculum.

Another interesting finding of the survey is that all students think that sustainable development is more important for future generations than for them personally. Therefore, it is important that students can understand and anticipate future benefits (or consequences) of their activities today. This may stimulate their interest in learning about sustainability while studying and motivate them to practise sustainable engineering in their future professional life.

Acknowledgements

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Note

1. For the purposes of this survey, the combined degree includes study programmes that combine engineering with other disciplines, e.g. environmental engineering, chemical engineering and science, etc. These types of degree are common, for example, in Australia.

Appendix: The Questionnaire

International Survey: Environment and Sustainable Development

We are asking for your help in learning more about the level of understanding and knowledge that undergraduate students have regarding the environment and sustainable development. The results of this survey will help us to improve the existing and develop new teaching programmes related to this area. Please respond to the following items as honestly and carefully as possible.

Please put a cross in the appropriate box. ☒

1. Please tell us about yourself:

Gender: Female ☐ Male ☐

University or Institution: _____

Degree(s) enrolled in: _____

Year of study: 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

The country you come from: _____

2. How do you rate your knowledge of the following topics:

	Not heard of	Heard of but could not explain	Have some knowledge	Know a lot
i) Environmental Issues				
Acid rain	☐	☐	☐	☐
Air pollution	☐	☐	☐	☐
Biodiversity	☐	☐	☐	☐
Climate change	☐	☐	☐	☐
Deforestation	☐	☐	☐	☐
Depletion of natural resources	☐	☐	☐	☐
Desertification	☐	☐	☐	☐
Ecosystems	☐	☐	☐	☐
Global warming	☐	☐	☐	☐
Ozone depletion	☐	☐	☐	☐
Photochemical smog	☐	☐	☐	☐
Salinity	☐	☐	☐	☐
Solid waste	☐	☐	☐	☐
Water pollution	☐	☐	☐	☐
ii) Environmental Legislation, Policy and Standards				
EU EMAS	☐	☐	☐	☐
The Florence Convention	☐	☐	☐	☐
Intergovernmental Panel on Climate Change (IPCC)	☐	☐	☐	☐
ISO 14001	☐	☐	☐	☐
Kyoto Protocol	☐	☐	☐	☐
Montreal Protocol on CFCs	☐	☐	☐	☐
Rio Declaration	☐	☐	☐	☐

	Not heard of	Heard of but could not explain	Have some knowledge	Know a lot
iii) Environmental Tools, Technologies and Approaches				
Clean technology	☐	☐	☐	☐
Clean-up technology	☐	☐	☐	☐
Design for the environment	☐	☐	☐	☐
Eco-labelling	☐	☐	☐	☐
Fuel cells	☐	☐	☐	☐
Industrial ecology	☐	☐	☐	☐
Life cycle assessment	☐	☐	☐	☐
Product stewardship	☐	☐	☐	☐
Renewable energy technologies	☐	☐	☐	☐
Responsible care	☐	☐	☐	☐
Tradable permits	☐	☐	☐	☐
Waste minimization	☐	☐	☐	☐
iv) Sustainable Development				
Sustainable development—definition and the concept	☐	☐	☐	☐
Components of sustainable development	☐	☐	☐	☐
Approaches to sustainable development	☐	☐	☐	☐
Precautionary principle	☐	☐	☐	☐
Population growth	☐	☐	☐	☐
Inter- and intra-generational equity	☐	☐	☐	☐
Stakeholders' participation	☐	☐	☐	☐
Connection between poverty, population, consumption and the degradation of the environment	☐	☐	☐	☐
Earth's carrying capacity	☐	☐	☐	☐
Social responsibility	☐	☐	☐	☐
Engineering community's response to sustainable development	☐	☐	☐	☐
Actions that can be taken by companies and engineers to promote sustainable development	☐	☐	☐	☐

3. How would you rate the importance of sustainable development for:

	Not important	Possibly important	Important	Very important
You personally	☐	☐	☐	☐
You as an engineer	☐	☐	☐	☐
Your country	☐	☐	☐	☐
The society world-wide	☐	☐	☐	☐
Future generations	☐	☐	☐	☐

4. Did you have any environmental education in school ? Yes ☐ No ☐

5. Have you had any environmental education in your university course so far? Yes ☐ No ☐

Thank you for your help.

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About the authors

Adisa Azapagic is a Professor of Sustainable Engineering at the University of Surrey. She is a chemical engineer with research experience and interests in life cycle thinking, industrial ecology and corporate sustainable development. One of her professional interests is in engineering education for sustainable development. She has pioneered an interdisciplinary approach to teaching sustainability to undergraduate engineering students at Surrey, which was one of the first UK universities to integrate sustainable development teaching into the engineering curriculum. Her latest book, *Sustainable Development in Practice: Case Studies for Engineers and Scientists,* co-edited with Slobodan Perdan and Roland Clift, shows how the principles of sustainable development could be integrated into engineering curricula as well as into everyday engineering practice.

Slobodan Perdan is a philosopher with main professional interests and expertise in the areas of sustainable development, environmental and engineering ethics, and educational software development. He is currently working as a freelance consultant, having previously worked at the University of Surrey for several years.

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