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Engineering education in sustainable development

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Major challenges to engineering education for sustainable development: what has to change to make it creative, effective, and acceptable to the established disciplines?

Nicholas A. Ashford

Keywords Sustainable development, Educational policy, Higher education

Scholars and professionals committed to fostering sustainable development have urged a re-examination of the curriculum and restructuring of research in engineering-focused institutions of higher learning. This article will address the following themes and questions: How can multi- and trans-disciplinary teaching and research coexist in a meaningful way in today's university structures? Does education relevant to sustainable development require its own protected incubating environment to survive, or will it otherwise be gobbled up and marginalized by attempting to instil it throughout the traditional curriculum? What roles can national and EU governments have in accelerating the needed changes? How can it be made safe for courageous students to take educational paths different from traditional tracks, even if technical options exist to do so? What can one learn from comparative analysis of universities in different nations and environments?

Advances in education transformation towards sustainable development at the Technical University of Catalonia, Barcelona

Didac Ferrer-Balas, Jordi Bruno, Mireia de Mingo and Ramon Sans

Keywords Sustainable development, Environmental management, Education

This paper presents methodological and strategic results of the first two years of the implementation of the second environmental plan (2002-2005) at the Technical University of Catalonia (UPC) and discusses the benefits and difficulties of new strategies adopted. Particularly, the focus is pointed to the introduction of environmental aspects into technical education, in the framework of an integral university approach that combines simultaneous actions in the areas of education, research, university life and communication in order to develop a consistent and synergetic model. The paper describes and discusses the strategies that have been adopted for accelerating the transformation of the university towards a sustainable university, which include: to create useful tools for decision making, particularly strategic planning indicators; to introduce environmental indicators into university mainstream processes; to assess the transformation potential through an environmental research map; and to work synergistically through "linking initiatives".

Implementing a program in sustainability for engineers at University of Technology, Sydney: a story of intersecting agendas

Paul Bryce, Stephen Johnston and Keiko Yasukawa

Keywords Sustainable development, Higher education, Curricula, Australia

Integrating sustainability into an undergraduate engineering program at the University of Technology, Sydney has been a challenging project. The authors of this paper have been participant observers of the integration process. In this paper, they have attempted an analysis of that process, focussing on the dynamics of the network of people and interests, which have shaped the process. Actor network theory was used to provide an analytical framework for the analysis. The interests and experiences of the authors in the process necessarily influence the analysis. All three authors have been active in positioning sustainability as a central theme for the critique and practice of engineering. Paul Bryce and Stephen Johnston have had long-standing involvement in technology transfer projects in development. Both have published on engineering as a social activity, critiquing the undue emphasis in engineering education on engineering science, at the expense of attention to engineering practice. Their experience and scholarship have given credibility to their efforts in the

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faculty to press for a new paradigm of engineering practice. Keiko Yasukawa is an educational developer in the faculty who has been working with staff and students to help them reflect on their idea of what engineering is about in their teaching and learning. She has taken a leading role in shaping the new curriculum.

Integrating SD into engineering courses at the Delft University of Technology: the individual interaction method

D.-J. Peet, K.F. Mulder and A. Bijma

Keywords Sustainable development, Higher education, Curricula, Case studies, The Netherlands

When sustainable development (SD) is only taught in specific courses, it is questionable if engineering students are able to integrate it into their engineering practices and technical designs. For this reason, sustainability should also be integrated into regular engineering courses, e.g. design courses, materials courses or processing technology. The SD education plan adopted by the board of Delft University of Technology (DUT) in 1998 was based on this philosophy. It consists of three interconnected activities for all engineering curricula: the implementation of an elementary course "Technology in sustainable development"; the development of a graduation program in sustainable development for students who want to specialize; and the integration of sustainable development in all regular courses, wherever applicable. This paper describes various activities that the project group carried out to stimulate and support the third strategy: SD integration. It turned out that top-down attempts to influence the content of courses often triggered resistance among lecturers, as they feared the intermingling of laymen into their scientific/engineering discipline. Interaction was important but was often impossible by lack of mutual understanding. Participation in a national project aimed to stimulate discussion by making disciplinary sustainability reviews of academic/engineering disciplines. This approach was promising as it created the base for serious discussions. However, the reports often ended in the bureaucracies of the departments. More positive results were achieved with a semi-consultant approach directed at discussing SD issues with individual lecturers. Many lecturers were willing to discuss their courses, and were interested in practical ideas to integrate sustainability. This interactive approach is promising because it does not conflict with academic culture and keeps the lecturer in charge of his own course.

A sustainable development course for environmental engineers in Kyrgyzstan

Igor Hadjamberdiev

Keywords Kyrgyzstan, Sustainable development, Higher education, Poetry

Courses on sustainable development (SD) are taught in several institutes of Kyrgyzstan. However, courses for the specialties "eco-technology", and "ecological exploitation of natural resources" are only offered by two institutes. There are two alternative courses: for students; and (two months) for decision makers. The theoretical-cognitive base of the courses includes Rio 92 documents, Club of Rome Reports, Brundlandt Report, Vernadsky biosphere-nooshere theory, and the Kyrgyzstani *Comprehensive Development Framework 2001-2010*. Three problems are also included: administrative apparatus reform; economy restoration (mining, water-soil-energy); and poverty alleviation. Philosophy, recent nature concept, regional and global problems are also included in the courses. A focus point in the courses is to restore balances between nature conservation and nature-using activities, especially in the energy field (oil, gas, coal, and alternative energy from sun and wind). Sun, including collectors for water, building heating and processes for drying crops and vegetables by sunlight, are also included in the course. Small hydroelectric power stations (1-22KW) might be used in the country's mountain range. The courses also deal with Central Asian ethnic problems (sharp divisions by ethnicity such as Turkish, Kazakh, Kyrgyz, Uzbek, Iranian,

Tadjik). There is also a course in emotional form, using poetry and (sometimes religious) verses. The courses have been taught since 1998. Thus far 400 students and 92 administrators passed the course. In this paper, the specific approach of the course, investigating SD at a conceptual as well as an emotional level, will be evaluated. Reflects on the question of how successful this approach might be for developing countries in general.

Learning about environmental issues in engineering programmes: a case study of first-year civil engineering students' contextualisation of an ecology course

Cecilia Lundholm

Keywords Ecology, Higher education, Sweden, Case studies

Describes how first-year civil engineering students interpreted the content and structure of an ecology course. Students' learning processes were analysed from an intentional perspective, i.e. a perspective that takes into account the students' educational aims and conceptions of the study situation. Interviews were carried out with six civil engineering students who had taken the ecology course. Classroom observations were carried out and the dialogue between the lecturers and the students recorded. Interviews were transcribed and analysed from an intentional perspective, i.e. meaning is ascribed to the students' actions and utterances in terms of intent. Students contextualised the content of the ecology course in different ways – within natural science, cultural, social and political, applied and professional, and existential contexts. Students found the content of the ecology course to be a question of value judgement. Also, among the students there were feelings of accusation on behalf of engineers as professionals. Learning processes among the students were analysed in terms of contextual awareness and contextual inconsistency. Students mainly enhanced their knowledge in the sense that they tended to elaborate concepts solely on an empirical level and learned more facts. Suggests that environmental issues can be seen and dealt with from natural science, social science and philosophical perspectives, and that it is important that these different perspectives are explicitly addressed on a meta-level. The tendency to enhance the amount of content matter to be taught without considering the meta-level issues can cause the students problems in their efforts to learn. Suggested that the premises for teaching certain content should be made explicit by the teacher. To know why certain content has been included in the teaching may be of considerable help for the students in formulating relevant learning projects.

Arsenic mitigation and social mobilisation in Bangladesh

Crelis F. Rammelt and Jan Boes

Keywords Bangladesh, Water pollution, Water supply, Sustainable development

For the people of Bangladesh, mostly in rural areas, a new disaster is emerging. Two-thirds of the deep tube wells installed over the last three decades – roughly 3 million in total – contain arsenic concentrations above the permissible levels set by the WHO. These wells were installed to contribute to a secure and reliable drinking water supply, and put an end to various contagious diseases from the use of surface water. In itself that goal has been reached. It is therefore a bitter observation that it is this very approach that has led to the widespread arsenic poisoning of drinking water. Most rural development programs cannot meet the demand of the community because of the absence of appropriate institutional mechanisms, and most programs simply cannot reach the large low-income groups. It is time to rethink the existing institutional set-up and redefine the roles of communities, the private sector, NGOs, local government institutions and the central government. An initiative from several Bangladeshi organisations has resulted in international co-operation – the Arsenic Mitigation and Research Foundation (AMRF). Participation of the local community is one of the guiding principles of AMRF. Local priorities will be a significant component in the decisions made regarding mitigation

activities. Given the institutional weakness of governmental bodies in solving problems within a reasonable time, it is natural to look for local solutions based on local experience, knowledge and capacity. Focuses on institutional development and community participation related to arsenic contamination in drinking water and broadly in sustainable development policy and practice in Bangladesh. Looks into possible comprehensive frameworks for the implementation of sustainable drinking water systems, facilitating a basic development strategy for people's participation. Discusses ways to ensure a greater role for the community in achieving a sustainable rural water management system, involving formal institutions as well as informal networks at village community level.