



Educational initiatives

Implementing a holistic process for embedding sustainability: a case study in first year engineering, Monash University, Australia



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ABSTRACT

While there is clear recognition of the need to incorporate sustainable development into university curricula, there is limited research that examines how to achieve that integration or evaluates its impacts on student learning. This paper responds to these knowledge gaps through a case study of curriculum renewal that involved embedding sustainability into a first year engineering curriculum. The initiative was guided by a deliberative and dynamic model for curriculum renewal that brought together internal and external stakeholders through a structured sequence of facilitated workshops and meetings. That process identified sustainability-related knowledge and skills relevant for first year engineering, and faculty members teaching in the first year program were guided through a process of curriculum renewal to meet those needs. The process through which the whole of curriculum renewal was undertaken is innovative and provides a case study of precedent in the field of education for sustainability. The study demonstrates the contribution that can be made by a web-based sustainability portal in supporting curriculum renewal. Learning and teaching outcomes were evaluated through 'before and after surveys' of the first year engineering students. Statistically significant increases in student's self-reported knowledge of sustainability were measured as a result of exposure to the renewed first year curriculum and this confirmed the value of the initiative in terms of enhancing student learning. While applied in this case to engineering, the process to achieve integration of sustainability into the curriculum approach is likely to have value for other academic disciplines. Considering student performance on assignments and exam questions relating to sustainability would provide a stronger basis for future research to understand the impact of initiatives like this on student learning.

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1. Introduction

Redressing the imbalance in environmental, social and economic outcomes that characterise contemporary, unsustainable, societal systems presents a formidable challenge and one in which education plays a central role. The importance of education in this context was recognised by the United Nations in their declaration of the Decade for Education for Sustainable Development (DESD) (2005–2014). As the DESD draws to a close, assessments are emerging that Higher Education Institutions are changing teaching,

learning and research in ways that can contribute to sustainable living. Wals (2014) suggests the strongest engagement with Education for Sustainable Development (ESD) tends to be by universities focussed on education as opposed to research. While not offering a clear distinction between the two types of universities, Wals implies the latter may be more likely to rate highly in university league tables which focus on research performance and while they may engage in research related to sustainability they are less interested in curriculum change. A range of substantial barriers exist to realising sustained ESD in universities, spanning budget and resourcing, cultural inertia, and champion-based efforts that are susceptible to institutional disruption (Holmberg and Samuelsson, 2005; Desha and Hargroves, 2009; Lozano, 2010). However maintaining pre-existing approaches exposes institutions to risks associated with tightened legislation and regulation, increased accreditation requirements and shifts in industry

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demands of graduate capabilities (Desha et al., 2009). As noted by Watson et al. (2013, p 107) “In spite of the recognized need to incorporate SD into curricula, change has been little and slow, and there is still limited research explaining the incorporation of sustainable development into university curricula”.

Engineering has long been recognised as a key discipline, obliged to contribute to a sustainable future (Velazquez et al., 1999; Davidson et al., 2010; Karatzoglou, 2013). Yet a number of international reviews and assessments have found engineering students' knowledge and understanding of sustainable development to be lacking (Ashford, 2004; Azapagic et al., 2005; Byrne et al., 2013) and there is growing global concern with the lack of sustainability content in engineering curriculum (Desha and Hargroves, 2009). There has been a plethora of articles over the last decade in particular, documenting and in some cases evaluating, individual and institutional efforts in curriculum renewal ranging from initiatives targeting an individual course (Lundholm, 2004) or whole programs (Svanstrom et al., 2012) to design of entirely new degrees (Lozano and Lozano, 2014). Part of the challenge is that there are substantial time lags in curriculum renewal. Traditional curriculum renewal can take 15–20 years (three to four program accreditation cycles) and consequently rapid curriculum renewal approaches need development and testing (Desha et al., 2009). This presents an opportunity for organisational learning in the long term-transformation of individual, professional and organisational norms and practices towards sustainability (Jha-Thakur et al., 2009).

Australia is in a strong position to advance sustainability in the context of engineering education because of the role of Engineers Australia (EA) as the professional accreditation body for engineering in Australia. EA's strong commitment to sustainability, is reflected in the Stage 1 competency requirements (Engineers Australia, undated) that underpin engineering course accreditation. This clarity of expectation highlights the need for Australian institutions to address quite explicit sustainability related graduate attributes, and embed these within the undergraduate experience.

This paper presents a case study of an initiative to develop and trial a holistic approach for integrating sustainability into the engineering curriculum at Monash University in Melbourne, Australia. While Monash is a young institution (it admitted its first students in 1958) it has developed to be Australia's largest research-intensive university (ranked in the top one per cent of world universities and 91st in the world according to the Times Higher Education World University Rankings 2013–2014). As a research-intensive university, Monash represents an important case in the context of advancing ESD given that research-intensive universities have had less engagement with ESD to date (Wals, 2014). Annually, Monash University contributes approximately 6% of all engineering graduates in Australia and 15% of engineering graduates from research-intensive universities in Australia.

Supported by a grant from Sustainability Victoria, Monash University undertook an initiative to embed sustainability in the first year of the Bachelor of Engineering program. Since the Bachelor of Engineering begins with a combined first year, it is an ideal entry point to maximise the reach and impact of integrating sustainability into the curriculum. The aims of this paper are to examine the process of curriculum renewal to embed sustainability and evaluate its impact on learning outcomes.

The paper begins by reviewing insight from the literature on the integration of sustainability in curricula. The following section introduces the model which guided the curriculum renewal initiative, detailing the approach that underpinned the design and implementation of the initiative, including key outcomes. Attention then turns to results from student surveys conducted before and after exposure to the renewed curriculum. Those surveys were used

to measure changes in student's knowledge of sustainability and their perceptions of its importance. The discussion section places the results into perspective against existing knowledge while the final section presents the conclusions and identifies research directions.

2. Integrating sustainability in the curriculum: insight from the literature

This section addresses three key questions:

- How is sustainability integrated into curricula?
- What are the differences in terms of education design (learning outcomes, curriculum, pedagogy and assurance of learning)?
- What does it achieve?

In addressing the first of those questions there are two dimensions of ‘How’ which are relevant: ‘How’ in terms of different approaches to incorporating sustainability into the curriculum; and ‘How’ in terms of the process employed to undertake the curriculum renewal.

A range of approaches have been identified for how sustainability can be integrated into the curriculum. Strategic options can be distinguished based on whether they emphasise vertical or horizontal integration (Watson et al., 2013). Vertical integration involves adding a specific sustainability course to the curriculum whereas horizontal integration can range from providing some coverage of sustainability issues in an existing course, intertwining sustainability in existing courses, offering a sustainability specialisation within an existing program or designing a specialist sustainability degree. The risk with vertical integration is that it may not provide an adequate counter to ‘unsustainability’ which may be reflected in other courses in the program or that the isolated nature of the sustainability content will not enable students to incorporate it into their professional practice (Peet et al., 2004).

In terms of the process of curriculum change there is limited insight in the literature. Desha and Hargroves (2011, 2014) developed a dynamic and deliberative model for embedding sustainability in university education systems, which addresses the need for a multi-faceted, systemic approach. Their model draws on curriculum renewal theory, case study literature and more than 70 colleagues' curriculum renewal experiences in Australia and overseas. While the Desha and Hargroves' model emphasizes both internal and external collaboration, many of the initiatives described in the literature have an internal focus with faculty members being the prime contributors to curriculum renewal (Hyde and Karney, 2001; Fenner et al., 2005; Biswas, 2012). That internal focus is also inherent in the individual interaction method employed at a number of European Universities to embed sustainability in the curriculum (Holmberg et al., 2008).

While the process of curriculum renewal is rarely explicitly described, the literature does highlight a range of tools including concept maps and syllabus benchmarking tools which have been employed to support curriculum renewal to integrate sustainability. Concept maps can help to map the underlying structure and complexity of concepts related to sustainability (Lozano and Lozano, 2014). STAUNCH is one syllabus benchmarking tool, which rates the extent to which social, environmental and economic and cross cutting themes are addressed in course descriptors or syllabi, (Watson et al., 2013; Lozano and Lozano, 2014).

A number of differences emerge in terms of education design (learning outcomes, curriculum, pedagogy and assurance of learning) when sustainability is incorporated into the curriculum. An emerging area of the literature focuses on articulating sustainability competencies (Wiek et al., 2011), which have a potentially

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