ProSPER.Net Working Paper

Integrating sustainability education into existing and built environment curriculum

Assoc. Prof. Usha Iyer-Raniga and Dr. Mary Myla Andamon
School of Property, Construction and Project Management, RMIT University

Abstract

This working paper is one outcome of a project entitled *Integrating sustainability education into engineering and built environment curriculum* that operates under the auspices of the Promotion of Sustainability in Postgraduate Education and Research Network (ProSPER.Net) at the United Nations University Institute of Advanced Studies (UNU-IAS). The project is being undertaken under the leadership of the School of Property, Construction and Project Management, RMIT University. It is carried out in collaboration with academics from ProSPER.Net member institutions and other universities. The project also benefitted from the inputs of industry representatives who participated in the project's activities.

In summary, the aim of the project is to integrate sustainability thinking and practice into engineering and built environment curricula through a professional development programme for university academics. The primary output of the project is the development of a guide for university academics and curriculum developers in built environment disciplines, such as engineering and architecture at undergraduate and postgraduate levels. The wider aim is to ultimately expand and develop further courses and offerings to students within this rapidly changing built environment sector. Wherever possible, this applied research project draws on links with industry, creating opportunities for networking and creating close links with academia and industry.

This working paper seeks to inform the process of developing the framework for the curriculum guide and is organized as follows:

- In Section 1, an overview of the project is discussed, with emphasis on the approach adopted for the project;
- In Sections 2 and 3, as background work undertaken for the project, a review of the issues and the state of sustainability education in the engineering and built environment disciplines is reported;
- In Section 4, discussions of the educational responses for the integration and innovation of sustainability education in built environment are offered;
- In Section 5, a discussion of the development of the framework for the proposed Guide is presented; and
- In Section 6, insights on the challenges and themes for further exploration are posed.

1. Project Overview

Buildings and cities are measures of economic health in most developed and developing economies across the globe. The built environment is constantly changing, reflecting

government policies, legislative changes and community expectations. Strategies to deliver low carbon, resilient, built environments require a range of different stakeholders to work effectively. Government targets, both voluntary and mandatory, are putting pressure on new graduates to be fully abreast of relevant global and local issues. Increasing globalization is finding graduates and senior professionals working on projects away from their home bases. This is putting additional pressure on graduates to understand not just the requirements for meeting the local regulatory minimum but also best-practice requirements for sustainability in these regional centres.

Education has long been recognized internationally as fundamental to addressing the global challenges society faces (ARIES 2009). The unique features and issues of sustainability have a profound effect on the way academic curricula are structured. The general direction of education for sustainability is moving increasingly toward integration and innovation. However, the slow progress of the integration of sustainability in the built environment curricula may have been due in part to the practice-led approach, which is a hallmark of the discipline, and by the assumption that sustainability already permeates the curricula by its nature.

This ProSPER.Net Project is primarily aimed at developing a guide for university academics and curriculum developers that integrates sustainability thinking and practice into built environment disciplines, such as engineering and architecture at undergraduate and postgraduate levels. The project is tasked with drawing from the experiences of academics in built environment programmes. Furthermore, the project espouses a collaborative inquiry process wherein the role of the industry is considered to be vital in achieving outcomes and ensuring that sustainability goals of building projects are met. A survey of literature demonstrated that this inquiry process will not only help build the capacity of institutions but also maintain enthusiasm and interest in change and sustainability issues through partnerships and networks, which in turn further enhance opportunities for collaborative action (Lyth, Nichols & Tilbury 2007).

This project adopts a regional approach to focus on the main issues around applying the principles of sustainability in the built environment and the tensions with regulatory and best practice approaches. This regional approach took account of international, national, sub-regional and local concerns in relation to sustainability teaching and learning, and the expectations of both graduates and the industry. A review of literature was undertaken which formed the background work for the project. This included desktop research, which laid the foundation for the workshop, followed by discussions and insightful inputs from the participating universities and institutions to understand the current programmes and course offerings in the built environment curricula. The literature review focused on understanding the elements of sustainability currently being integrated into curricula, both from programme level and course development perspectives. The desktop investigation also canvassed the academic training and professional development of built environment practitioners in sustainability education.

The core activity of the ProSPER.Net project was a workshop that brought participants together to share knowledge and experiences, with the objective of recommending practical approaches for integrating sustainability issues whilst understanding and interpreting the theoretical dimensions of sustainability and sharing experiences about the best approaches for all stakeholders. The colloquium contextualized the current state of sustainability integration in the existing built environment curricula in the Asia-Pacific region and established

opportunities for networking and building close links within and between academia and industry.

Participation in the project and workshop was not restricted to just ProSPER.Net member institutions; other universities expected to benefit from the workshop and broader project outcomes were also invited to participate. The three-day workshop was conducted at RMIT University Vietnam in Ho Chi Minh City, Vietnam from 20 to 22 April 2012. There were nine teaching academics who participated in the workshop. These academics were invited by the ProSPER.Net Board and their representatives. The core group of three universities (Asian Institute of Technology, University of the Philippines and Tongji University) were identified by the ProSPER.Net Board and the remaining universities were selected through discussions with the Board. The aim was to select a mix of universities from the Asia-Pacific region because growth in the building and construction sector is expected to occur most in this region, with attendant growth in population (World Bank 2012). The invited industry participants were selected from a mix of international and national Vietnamese-based participants.

The universities/institutions who participated in this project were:

- Asian Institute of Technology (Thailand)
- Tongji University (China)
- University of the Philippines (Philippines)
- National Institute of Advanced Studies in Architecture (India)
- Universiti Sains Malaysia (Malaysia)
- Universitas Gadjah Mada (Indonesia)
- International University, Vietnam National University – HCM (Vietnam)
- University of Tokyo (Japan)
- RMIT University (Australia)

Industry participants included:

- World Green Building Council
- Vietnam Green Building Council
- Sino-Pacific Construction Consultancy Co. Ltd (Vietnam)
- Vietnam Centre for Research and Planning on Urban and Rural Environment (CRURE)/Vietnam Institute for Architecture and Urban-Rural Planning (VIAP)/Ministry of Construction (MOC)

Arising from the literature review, the content and key priorities for inclusion in the workshop were identified. The planning and activities based at the workshop were guided by the following activities:

Table 1: Workshop Activities (see Figure 1)

Activity	*Description*
A1	• Understanding sustainable development concepts
A2	• What content needs to (can) be used? • General agreement on content and integration of content amongst participants
A3	• Investigating adequacy, appropriateness and effectiveness of integrating into current modules of curricula
A4	• Ideas for development of new programmes/subjects or streams of integration
A5	• Developing linkages and networks, monitoring the integration into existing courses,

Activity	*Description*
	creating new courses and sharing experiences
A6	• Industry / academic partnerships – what are the results?

To achieve the objectives of the research project and guided by these overarching workshop activities, an action research framework was adopted. The workshop functioned as a participatory action research process, whereby progressive problem solving (in this case, curriculum development) occurred with participants working with others in teams or as part of a "community of practice" to improve the way they address issues and solve problems. Using participatory action research (Argyris 1993) in collaboration with industry practitioners, the workshop identified how best to integrate sustainability thinking and practice into curricula. It identified the key priorities for inclusion, within global and local policy commitments. The final workshop programme was kept flexible to take account of specific needs of the workshop participants and planning of events leading up to the workshop. The action research approach used for the workshop required planning, processes and delivery needs to evolve to maximize outcomes. The workshop structure was designed such that there was a clear link between the various segments leading to outcomes (Figure 1, refer to Table 1 for the activity codes).

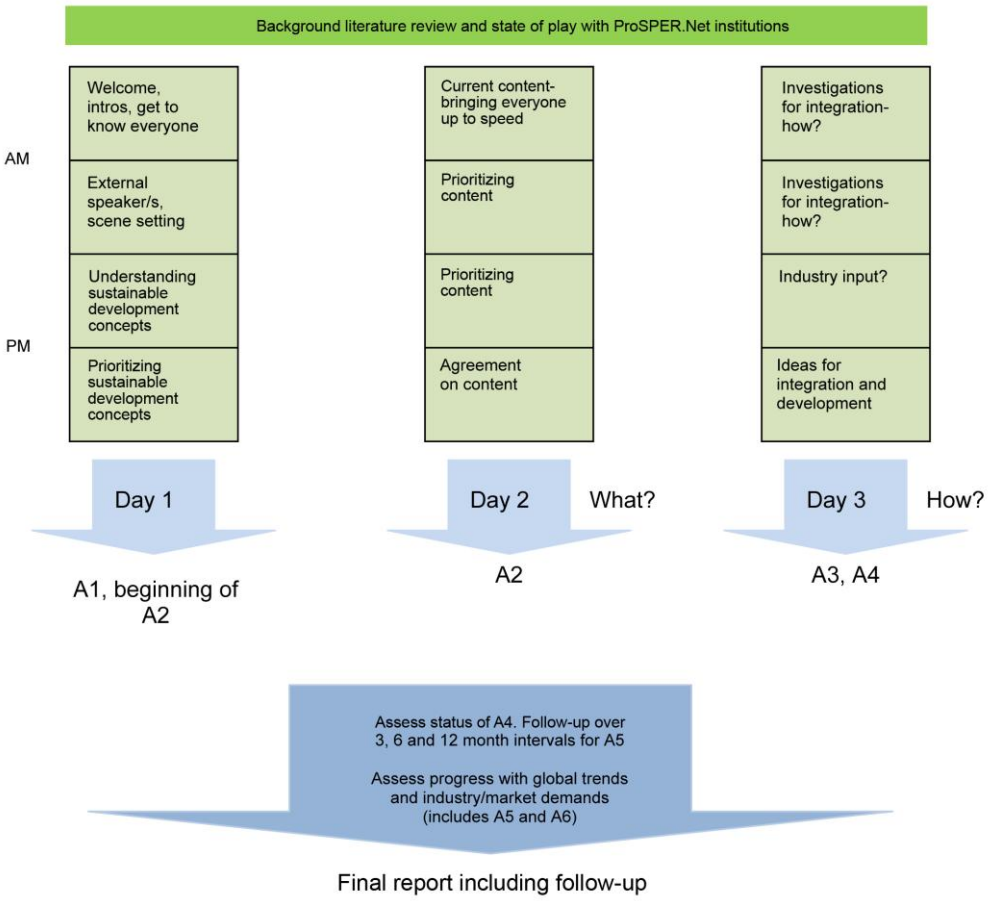

Figure 1: Workshop Outline
(ProSPER.Net Project Proposal, September 2011)

Feedback was sought after each main segment of the workshop. The feedback was collected using a feedback form over the three days of the workshop. Using informal feedback from the participants during the workshop and reviewing formal feedback provided in the feedback

forms, the workshop facilitator was able to adjust the workshop content over the three days to maximize outcomes. This ensured that the framework of action research was implemented in practice.

The information collected throughout the workshop and the subsequent post-workshop survey informed the development of the guide for curriculum developers, programme/course coordinators and teachers in the engineering and built environment discipline. It is expected that the guide will catalyze change in existing curricula. The education framework informing the guide has been set within an industry context where possible. The guide outlines key priorities to be included in the built environment curricula of participating institutions, with attendant suggested content information. Monitoring these priorities for a whole year and seeking academic, student and industry feedback will determine which of these priorities have the best impact from academic, industry and student perspectives.

2. Education for Sustainability and Sustainability Education

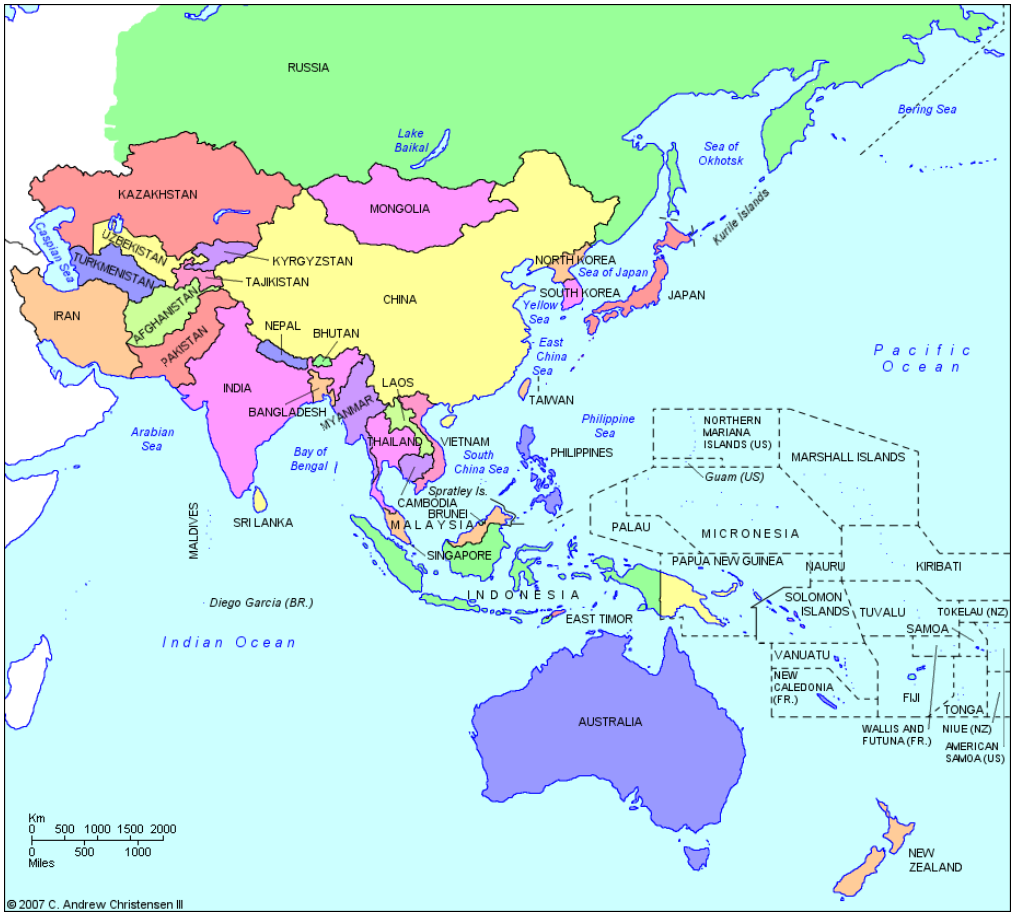

Figure 2: Political Map of Asia-Pacific Region
Source: World Monitor. Info (Christensen III 2007)

The United Nations declared the decade from 2005 to 2014, the Decade of Education for Sustainable Development (DESD). The *UNESCO International Implementation Scheme* (2006) outlined the strategic focus of the implementation of the Decade; leading the international agenda are the themes of Climate Change Education for Sustainable Development and Education for Sustainable Development. In the Asia-Pacific region, the strategy to address the needs and priorities of stakeholders in the region is identified in the *UNESCO Working Paper for the Asia-Pacific Regional Strategy for Education for*

Sustainable Development (2005). These strategies strongly advocate for partnerships in the Decade's implementation and argue the need for collaboration and networking as key elements in enhancing participation, ownership and commitment to the success and maximum impact of activities for the DESD (Tilbury & Cooke 2005).
The further and higher education sectors have acknowledged the importance of learning for sustainability through various declarations (Centre for Environment Education 2007; UNESCO - Education Sector 2006; University Leaders for a Sustainable Future (ULSF) 1990). In particular, the Talloires Declaration (1990) includes a 10-point plan that commits universities to curriculum change and professional development for sustainability. To equip all sectors of the society to actively engage in change for sustainability, curriculum change is recognised as urgently needed across all programmes of study offered by higher education and not just those programmes focusing on sustainability issues (Tilbury, Adams & Keogh 2005, p19).

In Australia, education for sustainability has evolved over the past 30 years, shifting in focus from knowledge of natural ecosystems to equipping all people with the knowledge, skills and understanding necessary to make decisions based on environmental, social and economic implications (ARIES 2009; Tilbury & Cooke 2005). Sustainability education initiatives from Australia and New Zealand have been widely published (Sherren 2006; Sterling, Stephen; 2004; Thomas & Nicita 2002; Tilbury 2004a; Tilbury, Adams & Keogh 2005; Tilbury & Cooke 2005). Developments from other regions have received less consideration (Ryan et al. 2010).

In the Asia-Pacific region, the demand for higher education has risen in tandem with overall population growth and increasing affluence, which adds urgency to the pursuit of sustainability (World Bank 2012). In a review of the contributions of the region to leading practice in sustainability in higher education, Nomura and Abe (2011) and Ryan et al (2010) show that the Asia-Pacific region offers many creative initiatives and has made considerable progress in education for sustainable development (ESD) and in understanding the learning dimensions of sustainability. Nomura and Abe (2011) highlighted that initiatives of higher education institutions in Asia and the Pacific region have been propelled by government policies and agencies as well as several regional and subregional efforts. Region-wide efforts saw the emergence of several networks such as the Promotion of Sustainability in Postgraduate Education and Research Network (ProSPER.Net) and the Regional Centres of Expertise in ESD, both developed by the United Nation University's Institute of Advanced Studies, and the United Nations Environment Programme (UNEP) Asia-Pacific Regional University Consortium (RUC) initiated by UNEP's Regional Office for Asia and the Pacific (UNEP-ROAP) (Nomura & Abe 2011; UNU-IAS 2013).

Ryan et al (2010) contend that the higher education initiatives for sustainability across the region have, in many respects aligned with global trends and, furthermore, the region has arguably made greater progress with its trajectory on education and learning for systemic change. Ryan et al (2010) further observed that the global trend of neglect for the learning processes for sustainability within the education sector is also mirrored in the Asia-Pacific. However, "the region has directed considerable attention to pedagogy and learning for sustainability and shows a stronger overall trajectory in this respect" (Ryan et al. 2010, p111). The Association of South East Asian Nations (ASEAN) has recently proposed a new ASEAN agenda – a roadmap to introduce sustainability education into universities by 2015 (Sharma 2012). With the growth of ASEAN countries, the increased focus on sustainable development requiring a "balance between economic growth, social development and environmental

protection" would need to "filter down to academic research and teaching … as universities are taking on a more important role in tackling global and regional challenges" (Sharma 2012).

Educational Responses

To foster environmental literacy and build awareness of sustainability issues, the predominant trend in higher education curricula has largely been towards learning *about* sustainability (Benn 1999; Page 2009). **Education *about* sustainability** focuses on developing key knowledge and understanding about natural systems and environmental issues as opposed to learning that engages and equips for change towards sustainability (Tilbury 2004a). **Learning *for* sustainability** moves beyond education *in* and *about* the environment to focus on equipping students with the conceptual frameworks necessary to develop skills to effectively enact change towards sustainability (Tilbury, Adams & Keogh 2005; Tilbury & Cooke 2005).

Addressing sustainability in the curriculum requires more than the addition of content (Sterling, Stephen; & Thomas 2006; Tilbury, Adams & Keogh 2005). From the 1990s, the implications of the *'for' approach* to sustainability education were more widely understood and consequently, a consensus has been formed that education for sustainability should not be viewed as 'one more subject' to be added to curriculum. Instead, the focus should be as a wholly integrative approach, where sustainability is seen as a context for delivering the aims of education and not as a competing priority (UNESCO - Asia and Pacific Regional Bureau for Education 2005, p9).

Sterling (2004) suggested that the significant learning challenge of higher education in the transition towards a more sustainable society is not just in terms of **student learning** (**'*designed learning*'** as a result of curricula and pedagogy) but also learning within the wider community including senior management, academics and support staff **('*attendant learning*'**). Fien et al (2000) contend that **teacher education** is an especially important area of action in the reorientation of education towards sustainability where reforms would require new attitudes and skills among teachers. Sterling and Thomas (2006) further illustrated a model of staged learning responses to sustainability from the perspectives of societal change and educational change (Table 2).

The learning responses to sustainability from the perspective of societal change and educational change follow a staged process (Table 2) (Sterling, Stephen; 2004; Sterling, Stephen; & Thomas 2006). It is in the fourth level that the defining transformation takes place (Figure 3):

1. Where value is placed on the quality of learning (being creative, reflexive, participatory process); and
2. Where inter- and trans-disciplinary approaches are embraced and developed in relation to an emphasis on real-life issues.

Table 2: Levels of Social and Education Responses to Sustainability

	Sustainability Transition	*Response*	*State of sustainability (societal change)*	*State of education (educational change)*
1	Very weak	Denial, rejection, or minimum change	No change (or token)	No change (or token)
2	Weak	'Bolt-on'	Cosmetic reform	Education *about* sustainability
3	Strong	'Build-in'	Serious greening	Education *for* sustainability

	Sustainability Transition	*Response*	*State of sustainability (societal change)*	*State of education (educational change)*
4	Very strong	Rebuild or redesign	Wholly integrative	Sustainable education

Source: Sterling & Thomas (2006, Table 2, p355)

This model of staged learning responses illustrates the emphasis of **sustainability education** "not on desired outcomes as in the term 'education *for* [sustainability]', but on the qualities of education itself through which sustainability is manifested as an emergent property" (Sterling, Stephen 2004, p55). This emphasis on the quality of learning is recognition of the need to build the individual's capacity, among others, to think critically, systematically and reflexively – "a shift from content and predetermined learning outcomes towards the nature of learning experience" (Sterling, Stephen 2004, p52).

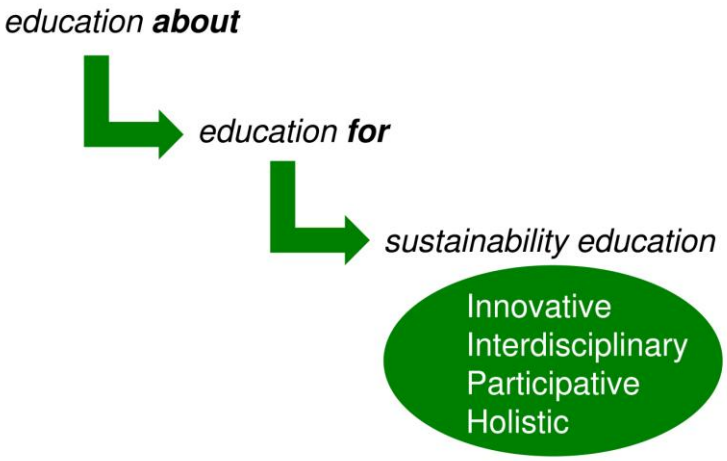

Figure 3: Stages of Learning (educational) Responses to Sustainability
Adapted from Sterling and Thomas (2006)

Affirming Sterling's call for transformation, Tilbury (2004a) has argued that innovation and not integration is required to enable curriculum change for sustainability. Tilbury posits "Education for sustainability is an innovative and interdisciplinary process requiring participative and holistic approaches to the curriculum…it has a transformative agenda that requires and often leads to professional, curriculum as well as structural change" (Tilbury, Adams & Keogh 2005, p15). Tilbury (cited in Tilbury & Cooke 2005, p16) illustrates the traditional 'about' approach versus the critical 'for' approach to sustainable education (Table 3).

Table 3: Traditional versus Critical Approaches to Sustainable Education

Traditional ('about' approach)	*Critical ('for' approach)*
• Passing on knowledge and raising awareness of issues	• Understanding and getting to the root of issues
• Teaching attitudes and values	• Encouraging values clarification
• Seeing people as the problem	• Seeing people as agents of change
• Single actions	• Learning for Change
• More focus on individual and personal change	• More focus on structural and institutional change
• Integration	• Innovation
• Problem-solving	• Creating alternative futures
• Sending messages	• Creating opportunities for reflection, negotiation

Traditional ('about' approach)	*Critical ('for' approach)*
	and participation

Sources: Tilbury & Cook (2005, Box 1.22, p16)

Sustainability Curriculum

The literature on sustainability curriculum is rich with suggestions of how higher education should be delivered (Blewitt & Cullingford 2004; Corcoran & Wals 2004) and elements of the curriculum have been outlined (Holdsworth & Thomas 2012; Holdsworth et al. 2008; Tilbury 2004b; Tilbury, Adams & Keogh 2005). However, as Sherren (2005) suggests, the literature contains little about disciplinary content.

A survey of environmental and sustainability coursework activities at Australia's 41 public and private universities indicates that the discipline focus varies considerably between undergraduate and graduate programmes; moreover, the idealized curriculum differs considerably in both programme levels (Sherren 2005). This is illustrated in Figure 4 where the Australian aggregate core programmes are depicted by broken lines, by level of programme. Interestingly however, the environmental and sustainability core content in the built environment, engineering and technology programmes are shown to be marginally half (50%) of elective and other subjects (Figure 4). The stacked areas of the different disciplines in Figure 4 are ordered according to the degree of difference of core and elective subjects. For the built environment, engineering and technology programmes, the figure illustrates the 50% proportion of core and elective subjects with environmental and sustainability content.

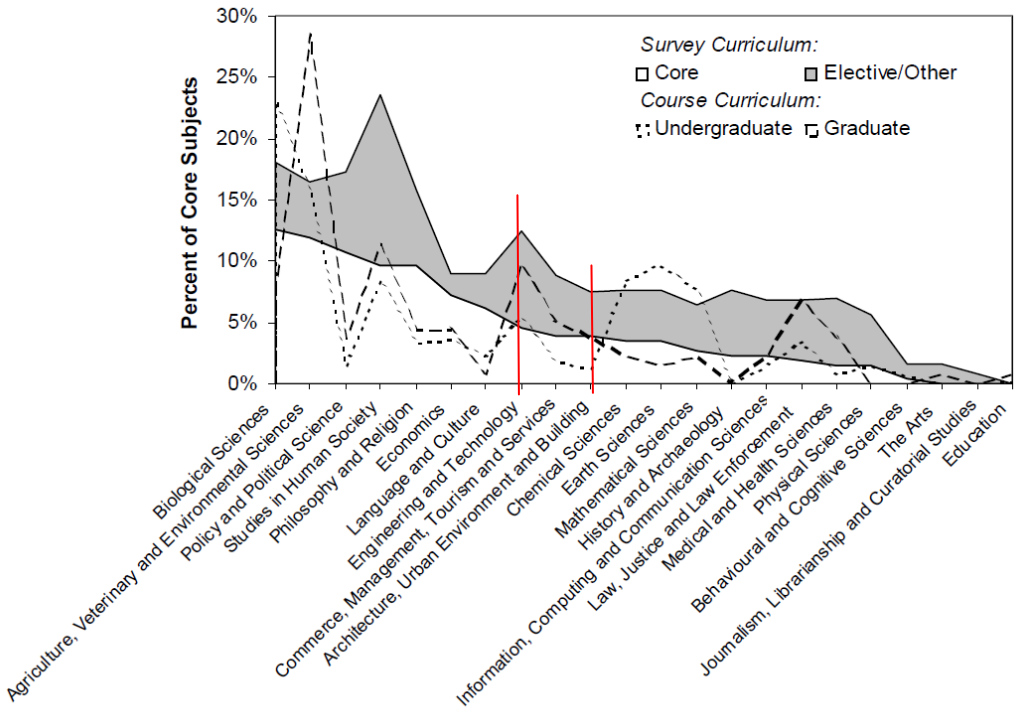

Figure 4: Curriculum Survey – Environmental and Sustainability Programmes in Australian Universities, itemized by Core and Elective Subjects (Sherren 2005, p100)

Sherren's (2005, 2006) findings further indicate that the programmes in the Sciences (*Biology*, *Chemistry*, *Earth Sciences* and *Mathematics/Statistics*) as well as in the applied fields of *Environmental Sciences* including *Engineering and Technology* are emphasized in

Australian programme cores (Figure 5). Clearly underrepresented are the pragmatic disciplines such as *Policy and Political Science*, *Economics*, *Management* and the *Built Environment*. Whilst these disciplines "clearly contribute to education for sustainability, they are shown to be overlooked in curriculum design" (Sherren 2005, p101) further exemplifying the primacy given to science over society and the dominance of education about the environment, and scientific and applied theory. Sherren (2006, p405) further suggests that this strong biology and environmental science bias in core curriculum around environment and sustainability shows that despite the human origins of sustainability problems, solutions are clearly seen to lie in better technology, not in behavioural change.

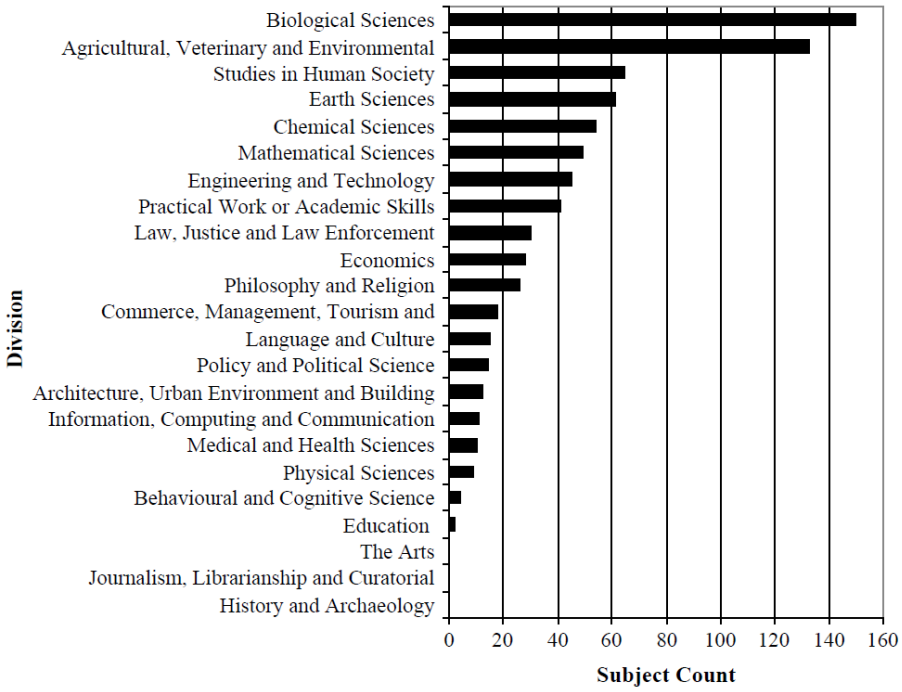

Figure 5: Popularity of Discipline Levels by Core Subject Count (Australian Universities)
(Sherren 2006, p406)

Sustainability has no well-established home in academia (Sherren 2006) and this is an advantage if the aim is to mainstream sustainability across disciplines. Broadly, however, sustainability is not thoroughly or uniformly integrated across Australian universities and the commitment to sustainability education varies widely (Fien 2002; Sherren 2006; Thomas 2004; Thomas & Nicita 2002). Findings of Thomas and Nicita's (2002) survey of Australian universities show sustainability to be owned largely by one discipline and subjects with sustainability content tend to be clustered in one faculty. Among these disciplines are the biological and environmental sciences; science and technology faculties; and architecture, planning, engineering and property degrees; (Benn 1999; Edwards 2004; Iyer-Raniga, Arcari & Wong 2010; Page 2009; Sherren 2005, 2006).

A quick and cursory review of the literature also suggests a similar trend in universities overseas. The concentration of sustainability content is also found in science, technology, engineering and mathematics (STEM) discipline areas in the United Kingdom (Edwards 2004; Fenner et al. 2005; Hopkinson & James 2010), the Netherlands (Peet, Mulder & Bijma 2004), Sweden (Svanström et al. 2012), Japan (Kitamura & Hoshii 2010) and in the United States (Lozano-García et al. 2008; Wright 2003).

There is also the view that sustainability content in the courses may be tokenistic. In a study of sustainability coursework programmes in Australian universities, the degree to which sustainability is tokenistic may be evaluated by examining where sustainability is mentioned in the programme (Sherren 2006). If the term appears in the course subjectname, it could be there to fulfil the letter of rather than the intent around integrating sustainability content (Sherren 2006, p404). If the term appears in the description or subject topics, integration of the sustainability concepts may be assumed.

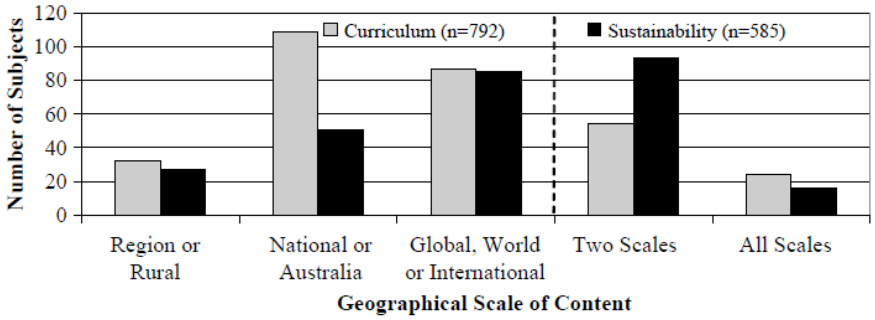

Figure 6: Scale of Curriculum Content in Australian Universities (Sherren 2006, p 409)

Moreover, Sherren's (2006) findings also suggest the value of considering the spatial scope of subjects with sustainability content. Whether viewed as beneficial or detrimental, the globalization of education has promoted the trend for homogenized subject content to make them suitable for overseas delivery and application. In Australian universities, a national focus was most dominant in core curriculum subjects, whereas the sustainability subjects cut across both national and international scales (Figure 6).

The review of key literature thus far shows that sustainability programmes and courses have placed emphasis and remain more concerned with understanding the environment, rather than its interaction with humankind. The demand for marketing skills, specialized degrees and flexible programme designs have increased the increasingly standardized approaches and utilitarianism of university offerings (Sherren 2005, 2006). It is argued that sustainability courses "should be more liberal, prescribed, [and] educate the citizens as well as the practitioner, and give historical, cultural and spatial context to choices and actions" (Sherren 2006, p410).

Ryan et al (2010) reviewed the educational responses from within the higher education sector in the Asia-Pacific region and reported that one of the key challenges that emerged is the need to "build sustainability progress not on generic approaches but on the specific local features of the region and the academic strengths of particular higher education institutions" (p114). The special issue of the International Journal of Sustainability in Higher Education presented the distinctive efforts to accelerate sustainability innovation within the Asia-Pacific context (Ryan et al. 2010). Perspectives from Japan, the South Pacific Islands, India, Taiwan, China and the Philippines were reported (Chhokar 2010; Corcoran & Koshy 2010; Galang 2010; Niu, Jiang & Li 2010; Nomura & Abe 2010; Su & Chang 2010) and highlighted the growing prominence of the sustainability agenda in the higher education sector.

In the profile and review of significant developments of ESD in higher education in Japan, Nomura and Abe (2010) reported that government initiatives have played a substantial role in

developin sustainability education programmes at undergraduate and postgraduate levels. Education policies and programmes in the context of sustainable development were re-oriented with a "focus on awareness-raising/information sharing and emphasis on community-level practice" (Nomura & Abe 2010, p5). Sustainability science research has also been supported. However, Nomura and Abe (2010) also report that despite the positive initiatives, "there have been relatively limited developments in the field of ESD research and institutional change geared to sustainable development" (p126). There is also the lack of "whole institutional thinking about learning opportunities and long-standing environmental management practices still tend to be implemented separately from *education for sustainable development* efforts." In the case of South Pacific Island nations, the prospects of sustainability are promising with the widespread realization of the need to take action and the recognition of the urgent need to take up these issues in higher education (Corcoran & Koshy 2010). However, Corcoran and Koshy (2010) report that little analysis of sustainability in higher education has been done in this geographical region and the enormous challenges of distance, funding, cultural traditions, globalization, and adaptation for the effects of climate destabilization make progress difficult (p130). The review of Corcoran and Koshy (2010) points to the relative newnessof higher education in the Pacific Islands as a constraint on higher education for sustainable development. There is a lack of capacity at all levels (individual, institutional, and systemic) and a lack of a critical mass of university graduates to advance the sector's potential benefits to society. Moreover, "most small island developing states do not possess the economies of scale that allow a national infrastructure of scope required to address national sustainability needs" (p133) and educational policy development in the South Pacific is generally initiated at the regional level and then adapted at the country level into national policies.

In India and Taiwan, significant national developments in higher education for sustainable development were initiated and funded by government as national projects and have been reported by Chhokar (2010) and Su and Chang (2010), respectively. In India, environmental education is mandated at all levels of formal education, which includes a compulsory undergraduate course. However, Chhokar (2010) reported that effective implementation is hampered "by the lack of inter-disciplinary competence among staff and students, and traditional methods of assessment in higher education" (p141). Su and Chang (2010) reported that in Taiwan, the most critical challenge and constraint on a speedy progression is the lack of qualified, well-trained and enthusiastic personnel (p170).

A review by Niu et al (2010) of the significant developments in China in the field of education and learning for sustainable development (SD) shows that teaching about SD has been "integrated into technical fields, especially at universities at major cities, and research has been undertaken to develop economically effective and environmentally friendly innovations" (p153). However, Niu et al (2010) highlighted that resources and capacity are still very limited. The key barriers to capacity building in China are mainly due to the country's size and scale, which result in regional differences. Niu et al (2010) reported that a significant challenge for promoting learning and change for sustainability is that of closing the gap between present research and educational materials, and the development issues and social needs that have arisen due to China's economic growth (p158).

Galang (2010) reports on an innovative programme in the Philippines which promotes change across whole institutions for environmental education for sustainable development (EESD). EESD has been accepted in policy documentation in the Philippines and a general framework in the higher education curriculum is in place, with many universities and colleges offering

undergraduate and graduate degree programmes with an environmental focus. Yet Galang (2010) contends that the country "has a long way to go to reach beyond the provision of specific courses and to actualize the lofty goals of the protocol outlined in its policy statements and its intentions for EESD in higher education (p176).

Much as the emphasis of understanding the environment is prevalent in programmes and courses in the Asia-Pacific, there seems to be a lack of clarity on what is the core knowledge for sustainability. A case in point are the findings of Iyer-Raniga et al (2010) involving the survey of construction management students in Melbourne and Singapore where the students indicated that whilst sustainability consideration for the future is important, there is lack of understanding of the tools currently available to achieve sustainability goals. A discussion on these tools (pedagogical methods and learning outcomes) is provided in Section 4.

Furthermore, a completed ProSPER.Net project spearheaded by Universiti Sains Malaysia examined sustainability education challenges particularly in Asia (Sanusi et al. 2011). A working handbook was developed which functions as an ESD resource and may assist in obtaining a better understanding with regard to the implementation and inclusion of sustainability in diverse areas such as business, education, health and technology. The manual is generic in nature and was not meant to be an exhaustive reference. But it provides introductory level material to lay the foundations for teaching academics from any discipline. It also outlined a collection of diverse case studies (curricula examples) of integrating ESD from different academic areas and programmes.

Defining Sustainability Knowledge

Sustainability has been defined in many different ways. The popular and often quoted definition of sustainability is from the 1987 Report of the Brundtland Commission, "Our Common Future" (Brundtland 1987). Put simply, sustainability refers to our own human society being capable of continuing indefinitely. The development that will move our society in that direction is what we call sustainable development. However, the concept of sustainability becomes relevant only when we understand the *unsustainability* inherent in the current activities of society. "Sustainability is a term that arises in response to a potential environmental and human disaster … and cannot be separated from that other great concept …*globalization*"(Cullingford 2004, p19).

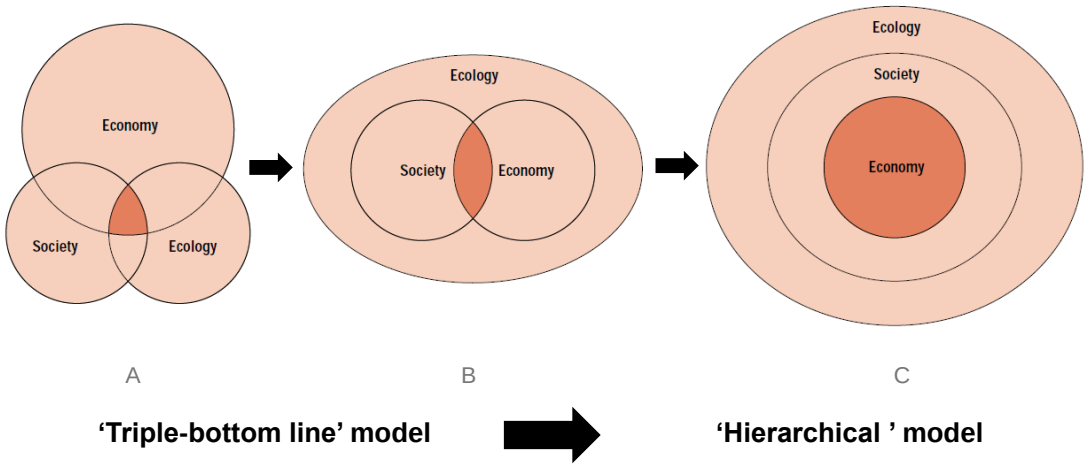

Figure 7: Framework for Sustainability and its Transition
Source: Image adapted from Lowe (1996)

Predominant models of sustainability include the triple bottom line (TBL), a phrasing coined by Elkington (1997) in which the environmental, social and financial outcomes are taken into account (Model A, Figure 7). This was the predominant model of decision-making in Australia until the 1980s (Lowe 1994). It gives primacy to economic decisions and assumes that the environmental problems can always be solved if the economy is sound (Lowe 1996). Sustainability thinking (Lowe 1996) has been expanded further to include:

1. A progressive variant of the TBL framework (Model B, Figure 7) characterized by a piecemeal approach to ESD (ecologically/environmentally sustainable development).
2. A further variant recognizing that the economy is a sub-set of society, since many important aspects of society do not involve economic activity. Similarly, human society is totally constrained by the natural ecology of our planet. As nesting systems, it requires integration of ecological thinking into all social and economic planning (Model C, Figure 7).

Sustainability, however, is not a relativistic concept because the biophysical limits to sustaining life on Earth are not absolute (Fischer et al. 2007). Lowe's (1994) model of the nested hierarchy of three pillars or considerations of sustainability is in contrast to the widely held notion of the triple bottom line, which treats the considerations as parallel rather than nested concepts (Fischer et al. 2007). With societies not able to exist without a functioning life support system, and economies only able to flourish within a functioning social system with effective institutions and governance structures, Lowe's hierarchical conceptualization of sustainability (Model C, Figure 7) is deemed to be more appropriate than a balancing framework such as the triple bottom line. Furthermore, it has been argued that cultural vitality should be added as the fourth pillar (Figure 8) in any public planning process, as any transformation of change needs to be rooted in values set by society (Hawkes 2001; Yencken & Wilkinson 2001).

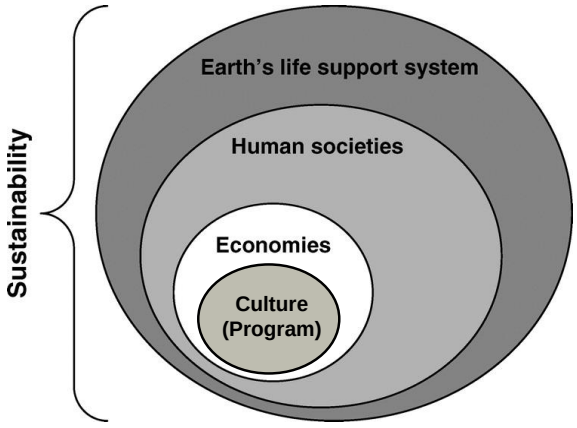

Figure 8: Key Considerations for Sustainability – the Quadruple Bottom Line
Source: Image adapted from 'Hierarchical Model' (Lowe 1994).

Other definitions and approaches include a systems perspective – where sustainability exists when no elements of the system are overloaded (Brown 2003). An ecosystem perspective to sustainability considers sustainability to be the capacity to create, test, and maintain adaptive capability (Holling 2004). Holling's (2002) **panarchy framework**, outlines a theory of adaptive change that draws on ecological theory to develop principles for sound human ecological relationships. The central tenet of this theory is the ability to adapt to change, which is conceptualized through the adaptive renewal cycle.

This cycle (Model A, Figure 9) is based on the **traditional ecological concept of succession** moving from exploitation (where numerous species quickly populate a disturbed area) to conservation(where certain species have gained a dominant role); the area has reached a climax state. The adaptive cycle also includes the more contemporary attention to **ecological resilience** through the functions of release and reorganization. Release follows the conservation phase, when systems have become over-connected, rigid and ripe for disruption. This creative destruction phase is in turn followed by reorganization, where innovation and restructuring occur, setting the foundation for the subsequent exploitation phase (Higgins & Duane 2008; Holling, Gunderson & Peterson 2002). The panarchy framework outlines the three dimensions of change for the adaptive cycle (Model B, Figure 9):

1. Along the X-axis: **Connectedness** increases as the cycle slowly moves from exploitation to conservation, until it reaches a point of internal over-connectedness, when the system becomes impenetrable to outside influences.
2. Potential for change can be tracked along the Y-axis: **Potential**, such as potential productivity, social capital, or economic potential, increases as the cycle moves from exploitation to conservation. When a disturbance leads to a release, this is temporarily reduced until reorganization takes place (when some as aspects of the accumulated potential from the previous cycle resurface to set the stage for subsequent cycles).
3. **Resilience** (Model B, Figure 9) is the third dimension of the adaptive cycle (Holling 2004).

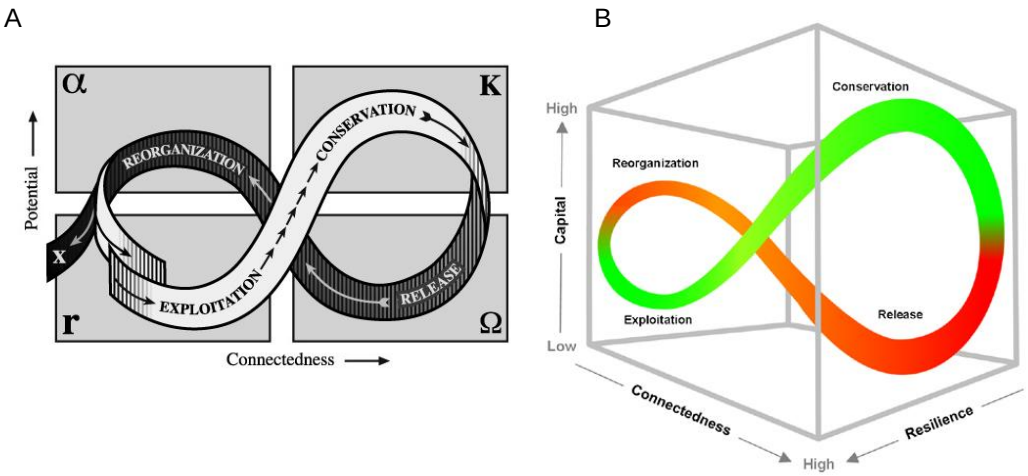

Figure 9: Panarchy Framework – Theory of Adaptive Change
(Holling, Gunderson & Peterson 2002) (Holling 2004)

Curriculum Design and Structure

Since the 1970s, environmental education and its transition to sustainability education has developed a reasonably clear view of goals and the material and information available to support educators (GUNI 2011; Sanusi et al. 2011; Thomas, Kyle & Alvarez 1999; Tilbury & Cooke 2005). The underpinning frameworks of sustainability knowledge show that elements of sustainability (including problems) could fit comfortably into different disciplinary approaches, such as those of ecology, physics, chemistry, geography, history, sociology, government and economics (Miller, Munoz-Erickson & Redman 2011).

In defining education for sustainability, Thomas (2004) suggests that, as identified by Dyer (1996) and Woods (1994), the broad pedagogical models for the incorporation of sustainability have been worked out as follows (Thomas 2004, p35):

- The inclusion of the coverage of some environment [sustainability] issues and material in an existing course of the programme;
- Having a separate course that deals specifically with environmental matters; and
- Integrating environmental [sustainability] issues and discussion into all courses so that environmental [sustainability] understanding is developed in the context of the discipline, the programme, and the course material.

A report on embedding sustainable development at the engineering department of the University of Cambridge (Fenner et al. 2005) emphasizes that educators must understand the process of change in order to successfully introduce sustainability concepts into course and curricula. The typical barriers to incorporating sustainability in any organization, such as a university, is presented by Lozano (2006) (Table 4) and highlights the notion that capacity building of educators must be considered the cornerstone of transforming universities to become effective in empowering students to become change agents for sustainability (Lozano-García et al. 2008).

Table 4: Levels of Barriers to Change in Sustainability Education

	Typical barriers to change
Level 1: Resistance to the idea of sustainability itself	• Generally produced by a lack of information, disagreement with the idea, lack of exposition and confusion in the application of examples and case studies
Level 2: Resistance to involving deeper issues	• Usually produced by feelings of loss of control or power, status loss, respect or separation of the individual from the others
Level 3: Deeply embedded resistance to change	• Makes a serious contrast with the organization; the individual might be in accordance with the idea of change, but nevertheless takes the situation to a personal dimension

Source: Adapted from Lozano (Lozano 2006, p790)

Hinged on the task of capacity building for educators in a multi-disciplinary course about sustainable development developed for the faculty at ITESM Monterrey Campus in Mexico, the course structure was based on the premise that certain drivers have directed society down an unsustainable path (Lozano-García et al. 2008). The purpose of the course was to educate teachers on how to incorporate the full range of sustainable development in their courses, with a special emphasis on the triple bottom line. This is an exemplary case of how a framework of relevant, interconnected sustainability concepts and elements, with the use of concept maps, was used to attract and engage educators to become well-versed in sustainable development and empowered to teach it (Figure 10). Throughout the duration of the course, participants processed and refined their individual concept maps, and expanded the concepts related to sustainable development.

Based on the results of the course, Lozano-Garcia et al (2008) suggest that a multi-disciplinarily developed and delivered course is an effective vehicle for educating teachers on sustainable development. The interconnected structure of the framework showed resonance with the triple bottom line definition of sustainability as well as many other dimensions linked with sustainable development. Furthermore, the structure increased the course participants' comprehension of sustainability.

From the framework of interconnected sustainability concepts and elements (Figure 10), Lozano-Garcia et al (2008) have identified some sustainability concepts and tools and that are relevant for helping educators achieve sustainability literacy and understanding. The list is

not exhaustive but based on a desktop review of the built environment programmes and courses offered in universities in the Asia-Pacific region and on information provided by ProSPER.Net workshop participants; the relevance of these concepts to engineering and the built environment curriculum can be inferred (Table 5).

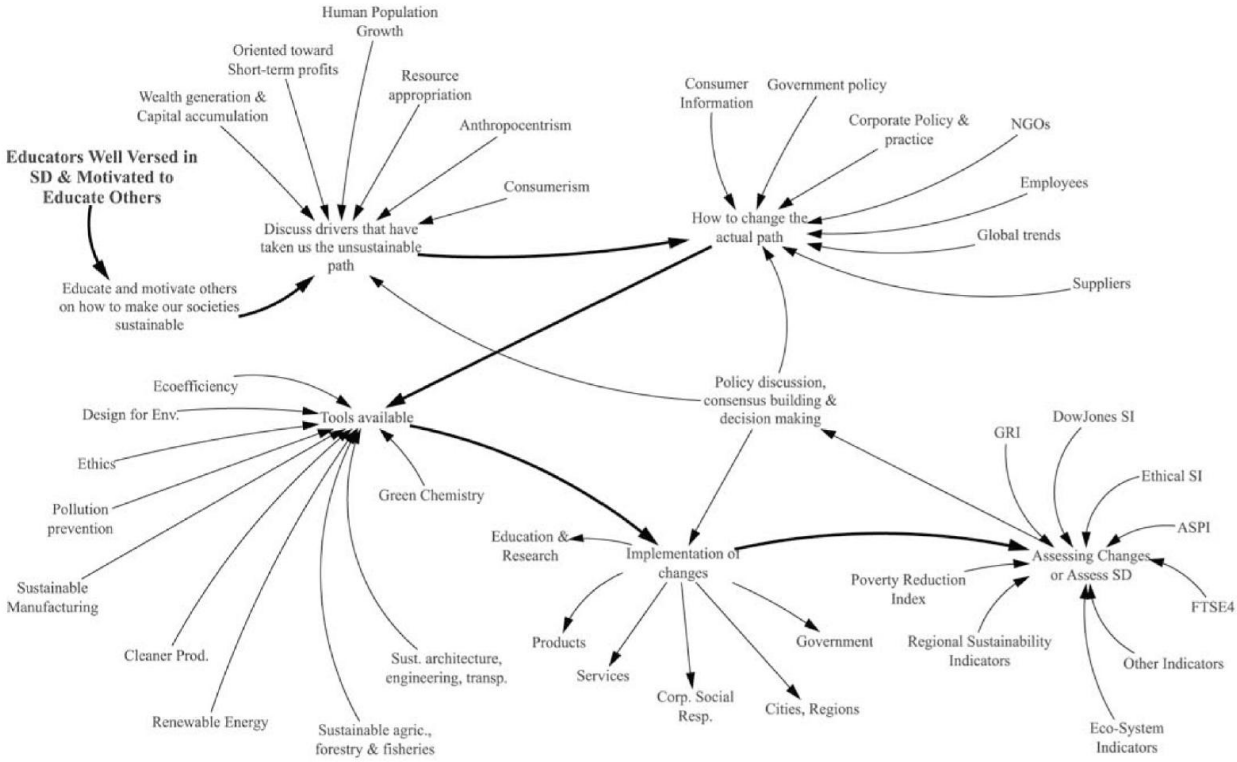

Figure 10: Interconnections among sustainability concepts and elements
(Lozano-García et al. 2008, p261)

Table 5: Sustainability Concepts, Tools and Knowledge

Sustainability concepts, tools and knowledge	*Relevance to engineering and built environment curriculum*	
	Direct	*Indirect*
• Climate change	●	
• Eco-efficiency	●	
• Green and sustainable chemistry		●
• Sustainable, green engineering	●	
• Design for the environment	●	
• Sustainable manufacturing		●
• Sustainable architecture, construction and project management	●	
• Sustainable mobility (personal and public)		●
• Sustainable agriculture, forestry and fisheries		●
• Ecologically sustainable resource management	●	
• Cleaner production and sustainable consumption		●
• Renewable energy and energy efficiency	●	
• Pollution prevention and integrated product policy		●
• The polluter pays principle		●

Sustainability concepts, tools and knowledge	*Relevance to engineering and built environment curriculum*	
	Direct	*Indirect*
• Ethics	●	
• Ethical investment		●
• Ethical employment		●
• Corporate social responsibility		●
• Human population control		●

Adapted from Lozano-Garcia et al (2008, p262-263)

Transforming Sustainability Knowledge

The findings of the course on capacity building for educators (Lozano-García et al. 2008) highlight the ways in which the unique features and issues of sustainability profoundly affect the way academic curricula are structured. Miller et al (2011) contend that building sustainability knowledge requires a fundamentally different approach to the ways academic institutions organize education and research and relate to society. The concepts outlined in Table 5 point to **sustainability knowledge** being defined as knowledge that (Miller, Munoz-Erickson & Redman 2011, p179):

- Recognizes the complexity of system dynamics;
- Is socially robust;
- Is acknowledged by multiple epistemic cultures; and
- Incorporates (contextualized) normative criteria.

This approach of looking at organizational change as necessary in developing education for sustainability is endorsed by Thomas (2004) as a strategic approach. Miller et al (2011) further suggest that currently generated knowledge is too static for such a complex adaptive world and as knowledge is an emergent property of social systems, the focus is thus on knowledge-processing instead of just knowledge-sharing or transfer (McElroy 2006 cited in Miller, Munoz-Erickson & Redman 2011). Miller et al (2011) emphasize that academic institutions must break with the more traditional, disciplinary structure of science to remain adaptive to changing societal needs, able to co-produce knowledge for sustainability with society. The key conditions of *epistemological pluralism* and *reflexivity* are necessary if academia is to produce such knowledge and become a key player in sustainability transition (Miller, Munoz-Erickson & Redman 2011, p178).

The School of Sustainability at Arizona State University is an experiment in producing sustainability knowledge and contributing to the solution of real world problems at the local and global scales (Miller, Munoz-Erickson & Redman 2011). Using the premise that sustainability is not a smooth, cumulative, or linear process or a single desired end state, as previously exemplified in the framework of interconnected concepts and elements by Lozano-Garcia et al (2008), but instead one that requires social transformations that are complex and continuously changing, an adaptive approach to learning and producing knowledge is then necessary to face and respond to these changes (Miller, Munoz-Erickson & Redman 2011).

Drawing on the experiences at the School of Sustainability, the resilience theory's adaptive cycle (Holling, Gunderson & Peterson 2002) was employed as a heuristic device (Model A, Figure 9 and Model A, Figure 11) to conceptualize the relationship between the academic institution and the individual, and the dynamic nature of the knowledge production process. The adaptive cycle has been used as a tool in the context of resource management

organizations and social innovation (Holling & Gunderson 2002). Miller et al (2011) suggest that it is likewise useful in understanding the operation of academic institutions as the departure from the traditional structure is essentially social innovation in academia. Specifically, the re-conceptualized model illustrates the centrality of the key conditions in producing sustainable knowledge (*epistemological pluralism* and *reflexivity*) in the processes and strategies that might build adaptability into knowledge production (Model B, Figure 11).

Miller et al (2011) elucidate that in order to remain adaptive, *epistemological pluralism* involves promoting the use of all relevant knowledge, perspectives and viewpoints in a structured, rigorous manner and *reflexivity* must be encouraged both from within (*internal reflexivity* – by challenging conventional wisdom and espousing systems dynamics thinking) and outside (*external reflexivity* – by working with society to frame problems) the academic institution. This framework "encourages institutions and individuals to exploit the opportunities presented by changes and transformations in approaches to producing knowledge" (Miller, Munoz-Erickson & Redman 2011, p189).

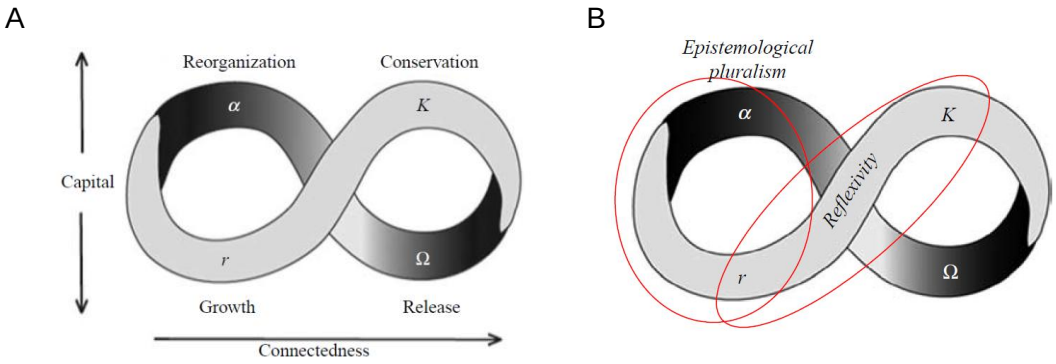

Figure 11: The adaptive cycle framework – reflexivity and epistemological pluralism in the knowledge production process (Miller, Munoz-Erickson & Redman 2011, p183)

In the development of sustainability education, Sterling (2004) contends that sustainability is "likely to arise depending upon the degree which attention shifts from 'things' to relationships, and from a segregated and dualistic view of the world towards an integrative and participative perspective". Sterling further argues that sustainability education is "at heart, an epistemological issue" (p56). Sterling (2004) provided a concise summary of what sustainability knowledge, and thus sustainable education, requires (p57-58) which demonstrates resonance with the adaptive cycle (panarchy) framework:

- Implies a **fundamental change of purpose** or, at very least, an additional key purpose of education.
- Implies embedding, embodying and exploring the nature of sustainability as intrinsic to the **learning process**. This is education 'as' sustainability – nurturing **critical, systemic and reflective thinking; creativity; self-organization; and adaptive management** – rather than education 'about' sustainability, or education 'for' particular sustainable development outcomes.
- Is not prescriptive, but **indicative and purposeful**.
- Affirms liberal humanist traditions in education, but goes beyond them through **synergy with systemic and sustainability core values, concepts and methodologies**.

- Challenges the limiting effects of characteristics of the dominant mechanistic paradigm, such as top-down control, centralization, managerialism, instrumentalism and the devaluing of humanities and arts.
- Is based on 'systemics' rather than 'systematics' – that is, the **emphasis is on *systemic learning* as change**, rather than *systematic control* in response to change.

Echoing the necessity for "capacity building for educators", the change of educational culture requires a deep learning process by educational actors. If higher education institutions are to play a constructive part in the transformation of sustainability knowledge and transition of sustainable education to provide transformative learning experiences, these institutions and educators need to go through a transformative learning experience themselves (Blewitt 2004; Sterling, Stephen 2004, 2010). Sterling (2004) succinctly pointed to the implications of a sustainable education paradigm (Table 6). At its core, "it entails an extended and participatory epistemology, a connective ontology and integrative praxis (p57).

Table 6: Key Characteristics of a Sustainable Education Paradigm

Fundamental Orientations	*Characteristics*
Ontology	Realist/idealist (rational)
Epistemology	Participatory
Theory of Learning	Participative/systemic
Function of Education	Remedial /development/transformative
Main Emphasis	Towards transformative learning experiences
Focus	Meaning-making appropriate to context
Seeks	Wholeness and sustainability
Reflects	Intrinsic and transformative values
Pedagogy	Transformative
Desired Change	Contextually appropriate balance between autonomy and integration (i.e. healthy, sustainable relationships) in and between systemic levels)

Source: Sterling (2004, Table 4.2, p57)

3. Engineering and Built Environment Sustainability Education

In this carbon-constrained world, the importance of the built environment places a high level of responsibility on those professionals who plan, design, construct, manage and maintain that environment (Figure 12). Educators in the built environment have become increasingly aware of their environmental responsibilities and the impact of buildings upon the quality of life, health and resource consumption (Edwards 2004; Graham 2009).

The findings of the Australian Research Institute in Education for Sustainability (ARIES) scoping study conducted by Macquarie University on the state of play of education for sustainability in the built environment sector in Australian university programmes (Lyth, Nichols & Tilbury 2007), indicated there was clear recognition that professional education in the sector for climate change adaptation and mitigation was limited and urgently needed. Professionals in the sector generally understand the need for climate change adaptation and mitigation, but not its practical implications (Snow & Prasad 2011). Similarly, in a review of schools of architecture in the UK, Edwards (2004) noted that most architecture courses pay little regard to sustainability as a holistic concept and although low-energy design is widely understood, the notion of social sustainability, life-cycle costing and alternative technology is given little timetable space (p137).

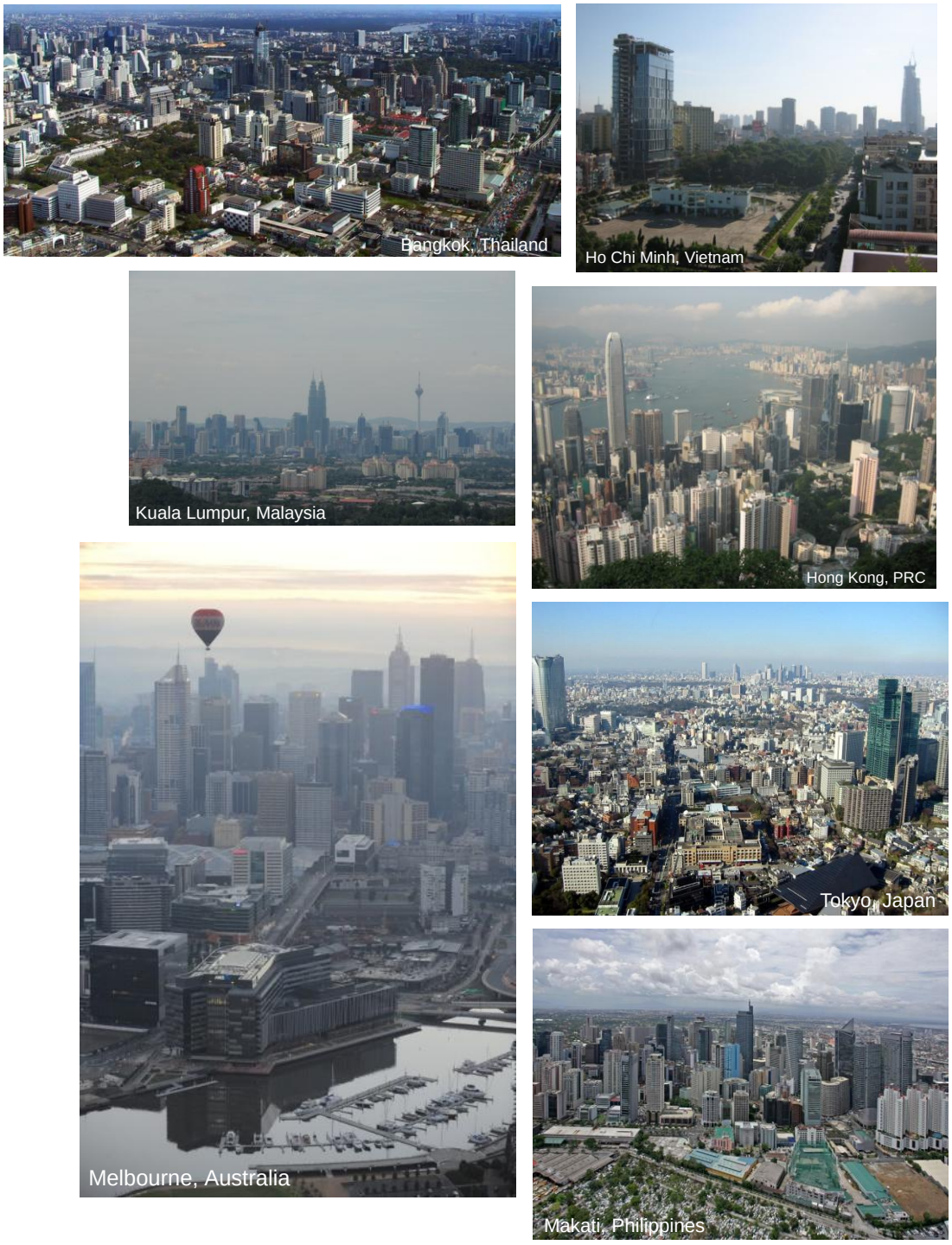

Figure 12: Skylines of Major Cities and Centres in the Asia-Pacific Region

The unique features and issues of sustainability have a profound effect on the way academic curricula are structured. For the ProSPER.Net project, to contextualize the current state of sustainability integration in existing built environment curricula in the Asia-Pacific region, ProSPER.Net workshop participants provided a list of programmes and attendant courses currently taught in their respective universities and institutions. This preliminary information formed part of the desktop literature review. The final information collated from the

participants underpinned the framework of the workshop and demonstrated the need for the definition and resolution of issues identified in the literature review on:

- Curriculum design and structure;
- Capacity building for academics in transforming sustainability knowledge;
- Learning outcomes – student experiences;
- Sustainability pedagogies;
- Pedagogical implications in the engineering and built environment disciplines;
- Industry input – students as employable graduates; and
- Challenges to professionals in the field of built environment, their institutional structures and boundaries.

Built environment programmes and courses

In evaluating and reviewing the university programmes and courses at undergraduate and postgraduate levels, the template provided to the workshop participants streamlined the information and allowed for ease in comparing schools, programmes within schools, courses offered, and the subject topics covered in the courses. To quickly and simply analyze the information, the frequency of keywords describing template content was reviewed. Using the language of visual design, tag clouds or word clouds [1] were generated as graphical representations of word frequency for the following:

1. Name of schools, departments within the discipline area of engineering and built environment (Figure 13);
2. Common names of programmes offered within these schools and departments (Figure 14);
3. Course names (subjects) offered within the programmes (Figure 15); and
4. Subject topics covered in the different courses (Figure 16).

Understandably and as expected, the schools, departments and institutes in the discipline area of built environment were predominantly within the schools of engineering and architecture (Figure 13). Interestingly, among the nine participating universities, only RMIT University (Australia) indicated having a school in construction and project management. This perhaps, could have a bearing on how the discipline generally relates to the industry and marketplace in a particular country and the professional accreditation requirements needed to practice in that profession.

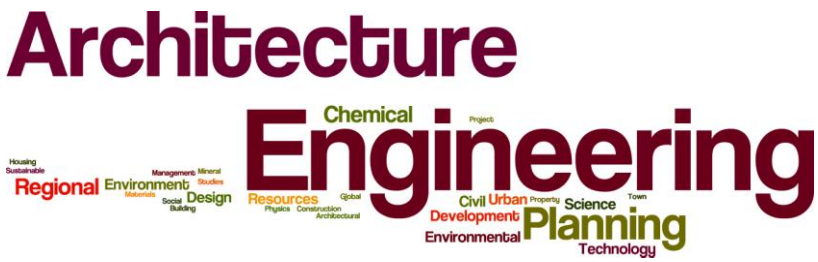

Figure 13: Schools, Departments and Institutes within the discipline area of Engineering and Built-Environment (ProSPER.Net Workshop participants)

[1] Tag clouds (or word clouds) are visual representations of text data. These clouds give greater prominence to words that appear more frequently in the source text. *Wordle* (http://www.wordle.net/) was the online tool used to generate the word clouds for this working paper which was also presented in the ProSPER.Net workshop.

Figure 14: Common Names of Programmes Offered
(ProSPER.Net Workshop participants)

Architecture and engineering also weighed heavily with regard to common names of programmes offered within the schools, departments and institutes (Figure 14). However, key terms such as *environmental*, *management*, and *planning* have also emerged as qualifiers for programme names.

Within the programmes, the courses were much more specific and indicated sustainability content (Figure 15). Keywords gleaned from the course and subject topics also reflected and supported the predominant terminologies in the course names (Figure 16).

Figure 15: Courses (subjects) Offered within the Programmes
(ProSPER.Net Workshop participants)

Figure 16: Keywords and Subject Topics outlined within the Course Contents
(ProSPER.Net Workshop participants)

As Sherren (2006) posited, the degree to which sustainability is tokenistic may be evaluated by examining where sustainability is mentioned in the programmes. In the ProSPER.Net

review of university programmes and courses of the participating institutions, for purposes of pre-work and information for the workshop, dominance of certain terminologies in the course names was taken as an indicator of how sustainability concepts are integrated. If sustainability terminologies appeared in the description or subject topics, the integration of sustainability concepts was assumed. This was then included as one of the issues to be reviewed in the workshop discussions on framing the curriculum design and structure. During the workshops, the participants validated these assumptions in their own review of the programmes and courses and provided more in-depth clarification. The presentations of the academics revealed an extensive and diverse spread of programmes and courses both in breadth and depth. Similarities and differences in the different programmes and courses were also highlighted.

The scope of this project was confined to programmes and courses within the built environment disciplines, and attendant discussions and shared experiences of the workshop participants highlighted the similarities and alignment of the programme objectives as well as the design of the courses. The engineering and built environment programmes are predominantly professionally accredited courses and thus have a strong need to respond to external influences through the reframing of curricula, so as to produce graduates equipped to work in an evolving and challenging context. The strong links with professional and industry bodies, reinforced through the use of practitioners to deliver and support subject areas, need to ensure that graduate entrants to the professions are appropriately equipped. Many schools, departments and institutions within universities have strong industry-based research and consultancy links, operating at the forefront of the discipline. However, it has been identified that the skills based in the sector remain insufficient to meet the needs of the new sustainable communities' agenda (ILO 2012; Lyth, Nichols & Tilbury 2007).

4. Integration and Innovation in Sustainability Education

There have been a growing number of studies on how to integrate sustainability in higher education, and broad and general frameworks for its integration into curricula have been presented, as follows:

1. An incremental approach whereby small groups can start out and if successful can be expanded throughout the university (Lozano 2006);
2. The need to think strategically about integrating sustainability into higher education (Lidgren, Rodhe & Huisingh 2006; Scott & Gough 2006);
3. The need for a broad and general approach (Sammalisto & Lindhqvist 2008).

The literature indicates that many core principles of integrating sustainability into higher education require substantial shifts in thinking and practice. Some may be out of reach of the individual lecturer and more challenging for some disciplines. Table 7 illustrates the magnitude of change and transformation required in teaching sustainability.

Sterling (2004) argues that moving towards a sustainable education paradigm is not a choice between these opposites (Table 7), but a "change of weighting that moves away from the dominance of the old paradigm" and the transformation and conservation of "some of the characteristics rather than abandoning them in their entirety" (p57). Sterling (2004, 2010) further contends that sustainability education implies a transformation in educational thinking and practice through which education becomes more *transformative learning*. This indicates a paradigm that is holistic, systemic and participative. The approach espouses the "emphasis on contextualized knowledge; different ways of knowing (in addition to scientific

approaches); real-world local issues as a focus of learning; the active role of the learner; and the need for participatory methodology" (Sterling, Stephen 2004, p54).

Table 7: Integration of Sustainability in Higher Education

Integration of sustainability within higher education implies shifts	
From	*To*
• Transmissive learning	• Learning through discovery
• Teacher-centred approach	• Learner-centred approach
• Individual learning	• Collaborative learning
• Learning dominated by theory	• Praxis-oriented linking theory and experience
• Focus on accumulating knowledge and a content orientation	• Focus on self-regulative learning and a real issues orientation
• Emphasis on cognitive objectives only	• Cognitive, affective, and skills-related objectives
• Institutional, staff-based teaching/learning	• Learning with staff but also with and from outsiders
• Low-level cognitive learning	• Higher-level cognitive learning

Source: Sterling (2004, Table 4.3, p58)

Drawing from the literature on sustainability education, Rusinko (2010) extended the studies and perspectives and developed a generic matrix of options (Figure 17) for integrating sustainability in higher education (SHE). The matrix outlines the use of a broad, non-discipline specific perspective – including delivery and focus considerations – so that faculty and administrators can make appropriate and strategic choices with respect to integrating sustainability into higher education, relative to their particular goals, desired outcomes, resource constraints and environment (Rusinko 2010).

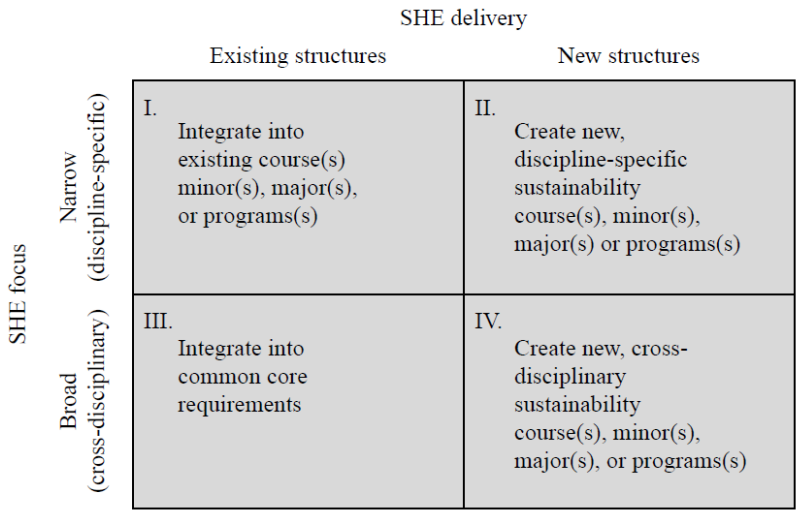

Figure 17: Generic Matrix to integrate Sustainability in Higher Education (SHE), Rusinko (2010, p253)

Pedagogical Methods

In investigating the issues involved in establishing a green curriculum at RMIT University in Australia, Thomas et al (1999) considered a number of models and approaches and the corresponding methods and associated resource requirements were identified (Table 8), focusing on the integration of waste minimisation principles in the four diverse course areas of Accountancy, Architecture, Building and Construction Economics and Nursing. It was

apparent that more multi-dimensional understandings of waste minimization required more sophisticated models of integration (Thomas, Kyle & Alvarez 1999).

Table 8: Approaches for Integration of Sustainability into Higher Education Curricula

Approach	*Method*	*Resources*
1. Modular approach	• Addition of a section dealing with some aspect of the project/topic material to an existing subject • Addition of interdisciplinary group work • Reconfiguring an existing element in current subject • Developing a new subject • Visiting speakers	• Academic and professional contacts • Guest speakers • Written resources • Sharing with colleagues/staff; use of frameworks • Practical examples of application and outcomes • E-learning/online forums
2. Intra-disciplinary framework	• Connections across subjects • Project work • Making issues explicit • Reconfiguring existing material	• Guest speakers • Forums for staff discussion • E-learning/online forums • Examples/case studies used • Practical examples of application • Sharing of outcomes • Seminars
3. Inter-disciplinary framework	• Common subject or shared component in subjects – shared speakers • Project work • Exploring links with other courses • New shared module	• Written resources (text books, reports, etc.) • Case studies • Industry contacts • Guest speakers • Forums for discussions between staff and students • E-learning/online forums • Seminars
4. Exploring course culture	• Orientation activities • Faculty handbook • Questioning responsibility • Student association • Course learning outcomes between staff members within and across courses • Professional codes	• Teaching and learning strategies • E-learning/online forums • Seminars • Written resources (text books, reports, etc.) • Student orientation • Activities • Industry contacts • University policies
5. Professional practice	• Links with relevant professional associations for development and incorporation of new graduate attributes	• Industry contacts • Guest speakers • Forums/meetings • Conferences • Work placement, on-the-job training, etc.
6. Experiential learning	• Site visits/field trips • Exploring the project/topic in a material and spatial context	• Places/contacts • Written materials (reports, etc.) • E-learning/online forums • Seminars
7. Flexible learning resource	• Individual lecturers incorporate multiple entry points in a manner they see fit	• Case study • Project kit • Guest speakers • Written resources (text books, reports, etc.) • E-learning/online forums

Source: Adapted from Thomas et al (1999, p327)

In a later study on the extent to which concepts of environmental literacy and sustainability education have been adopted and how they have been introduced in Australian Universities,

Thomas and Nicita's (2002) findings show that a range of approaches were used, with some indicating the use of multiple approaches (Table 9).

Table 9: Approaches for Presenting Environmental Literacy/Sustainability Education

Approach	*Method*	*Modes for delivery*
1. Addition	• Introduction of new subject or modules which deal with environmental / sustainability issues relevant to the host discipline	• Seminars • Work placement • Guest speakers • Projects • Group work • Field/site visits • E-learning/online forums • Lectures/tutorials • Participation in relevant voluntary groups
2. Incorporation	• Integration of environmental/sustainability themes into existing subjects	
3. Engagement	• Integration of an environmental/ sustainability component into most or all subjects within a course/programme	

Source: Adapted from Thomas and Nicita (2002, p483)

Based on the prioritized expectations on the learning outcomes and the marketplace requirements for built environment graduate attributes discussed in the workshop[2], the ideas and suggestions for the integration of sustainability into the curricula (Table 10) interestingly echoed those approaches and models outlined by Thomas et al (1999) (Table 8) and Thomas and Nicita (2002). Furthermore, drawing from the workshop discussions and insights offered by both the teaching academics and industry representatives, and in order to address and effect targeted learning outcomes, it was imperative that multiple approaches be employed.

Table 10: Development and Changes to Built Environment Curriculum (ProSPER.Net Workshop)

Development and changes to built environment curriculum	
How educators will make the change	*How to engage industry*
• Change teaching content	• Continuing professional education
• Research collaboration	• Open lectures/seminars open to all in the university rather than just within the programme
• Sharing/networking lessons learned	• Research collaboration
• Best practice examples/case studies used where possible	• Form partnerships: students and industry through conferences such as with Green Building Councils, etc.
• Dialogue/discussions with industry	• Getting industry speakers
• Invite industry to: student presentations, faculty presentations	• Accreditation considerations
• Dialogue/discussions with other university staff/ officials	• Organize activities with industry (e.g. conferences, seminars, etc.)
• Keep looking for funding	• Send graduates to individual companies
• Lobbying politicians	• Mentoring
	• Alumni tracking – surveys
	• Advisory boards
	• Adjunct professors
	• Feel good stories/testaments

[2] Day 3 activities of the ProSPER.Net Workshop were focused on developing a curriculum representing an existing built environment curricula wherein the following measures were explored: (1) What changes are needed to the existing built environment curricula?; (2) What will it take to make the change?; (3) How will you make the change?; and, (4) How will you engage with the industry?

Learning Outcomes

Learning outcomes are the point at which education principles and other principles meet (Thomas, Kyle & Alvarez 1999); these are the pivotal links between teaching intentions and the assessment of student learning (Biggs & Tang 2011). As the literature review for this project uncovered, the workshop discussions similarly revealed that sustainability pedagogies are rife with the need for different approaches to teaching and navigating the difficult transformative changes to higher education curricula. There is, however, limited parallel discussion on the learning outcomes associated with these different approaches (Fenner et al. 2005; Hopkinson & James 2010).

In the RMIT University study on integrating waste minimization principles in four course areas (Thomas, Kyle & Alvarez 1999), a categorization of learning outcomes was developed in parallel with the discussion of the associated approaches (Table 8). Thomas et al (1999) developed a set of learning outcomes that reflected the possibility of different levels of sophistication and engagement with sustainability issues (Table 11) based on how the integration of an understanding on waste minimization adds to the students' learning. Designated as lower, transitional and higher learning outcomes, each of the three levels required more advanced and enhanced understandings and more complex interventions by the academic staff of the course.

Table 11: Student Learning Outcomes

Student Learning Outcomes	
Lower outcomes	• Understand what environmental/sustainability issues and concepts mean in various contexts (e.g. personal, professional, etc.) • Identify strategies/opportunities for sustainability in these contexts. • Demonstrate awareness of environmental/sustainability issues and concepts and opportunities
Transitional outcomes	• Familiarity with agencies, regulations and organizations • Understanding of the change processes (e.g. political, etc.) involved – to course structure and content, work practices and professional culture
Higher outcomes	• Engagement with issues through practical application of principles in a variety of different contexts • Initiate projects • Critical thinking about sustainability concepts and understanding of how it is changing • Inter- and cross-disciplinary collaboration

Source: Adapted from Thomas et al (Thomas, Kyle & Alvarez 1999, p328-329)

Academic and industry participants outlined their expectations on the learning outcomes and anticipated attributes of graduates during the workshop discussion on what would be the educational responses and focus of a curriculum in the built environment that espouses sustainability education (Table 12).

Table 12: Learning Outcomes and anticipated Student Attributes (ProSPER.Net Workshop)

Learning outcomes and anticipated attributes		
	From academics	*From industry*
1	• Genuine concern	• Motivation to make change
2	• Discipline/competence/sustainability	• Life-cycle thinking
3	• Good team player	• Open to other disciplines
4	• Right attitude	• Environmental/social/economic implications of their work

For the learning outcomes that weighed heavily for academics, it was interesting to note that while professional competence was considered to be important, so also were softer skills. This is aligned to trends observed in Australia (Iyer-Raniga, Arcari & Wong 2010; Sterling, Stephen; & Thomas 2006; Thomas & Nicita 2002). From the expectations of what industry identified as key needs and attributes of the graduates who would address the requirements of the marketplace, the responses show that learning outcomes are not all about professional competence.

Perhaps learning outcomes would have to be dealt with individually in specific programmes and courses. Sterling and Thomas (2006, p363) argue that "the principles of sustainable development are ideally best explored with students where these principles are infused in the curriculum that is currently used in the discipline area". Sterling and Thomas (2006) contend that taking the discussion on education for sustainability forward necessitates knowing what students desire as learning outcomes – what are the capabilities, abilities or competencies to be achieved. Some examples of studies on crafting capabilities have been outlined by Sterling and Thomas (2006, pp359-366). Parker et al (2004) identified three categories of capabilities as being requirements of education for sustainability (Table 13). These capability requirements resonate well with the academics' expectations on the learning outcomes and anticipated attributes of graduates and correlate with industry requirements (Table 12).

Table 13: Capability Requirements for Education for Sustainability

Knowledge and understanding of	*Skills in:*	*Values and attitudes:*
• Social justice and equity • Diversity • Globalization and interdependence • Sustainable development • Peace and conflict	• Critical thinking • Ability to argue effectively • Ability to challenge injustice and inequalities • Respect for people and things • Cooperation and conflict resolution	• Sense of identity and self-esteem • Commitment to social justice and equity • Value and respect for diversity • Concern for environment and commitment to sustainable development • Belief that people can make a difference

Source: Parker et al (2004) cited in Sterling and Thomas (2006, p361)

Whilst the debate on what the capabilities of students should be is taking hold in parallel with the sustainability pedagogies, Sterling and Thomas (2006) argue that only a minority of higher education institutions have looked at curriculum change in this light, either within disciplines or in terms of whole institutional approaches.

Challenges and Barriers

Educators must understand the process of change to successfully introduce sustainability concepts into course and curricula (Fenner et al. 2005). The typical barriers to incorporating sustainability in any organization, such as a university, is presented by Lozano (2006) (Table 14) and highlights the notion that "capacity building of educators" must then be considered to be the cornerstone of transforming universities to become effective in empowering students to become change agents for sustainability (Lozano-García et al. 2008).

Table 14: Levels of Barriers to Change in Sustainability Education

Typical barriers to change	
Level 1: Resistance to the idea of sustainability itself	• Generally produced by a lack of information, disagreement with the idea, lack of exposition and confusion in the application of examples and case studies
Level 2: Resistance to involving deeper issues	• Usually produced by feelings of loss of control or power, status loss, respect or separation of the individual from the others
Level 3: Deeply embedded resistance to change	• Makes a serious contrast with the organization; the individual might be in accordance with the idea of change, but nevertheless takes the situation to a personal dimension

Source: Adapted from Lozano (Lozano 2006, p790)

The workshop discussions on the extensive and diverse programmes and courses taught in the participating institutions revealed that the issues, challenges and barriers for implementation in sustainability education were similarly not divergent among the different programmes and courses. These issues, challenges and difficulties in the educational responses to change in sustainability education is summarized as follows:

- Rigidity of institutional structures;
- Rigidity of people and disciplines;
- Lack of facilities, resources, etc.; and
- Lack of or perception of lack of empowerment to make changes.

The academics strongly advocated for the following (Table 15) to further explore the insights and address the key messages discussed in the workshop:

Table 15: Issues and Challenges (ProSPER.Net Workshop)

Information	*Resources*	*Implementation and Review*
• What is the state of sustainability education in ProSPER.Net member institutions and beyond (wider community) • Organize forum for industry/academics/stakeholders to understand the best practice/case study examples; online chat forums, etc. • Establish a repository of best practice models • Survey of industry in countries to examine what is required in research and education • Build close relationship with research and education, and continuously close feedback loops	• Textbooks for learning modules on sustainability education • Resources for teaching need to be development both in breadth and depth • Detailed curriculum development • Support at high level of university for promotion of innovativeness in curriculum, e.g., meeting senior management at the university such as the Vice-Chancellor, Rector, etc.	• Monitoring (medium- and long-term) • Follow up with students post-graduation to determine if concepts are applicable in industry and whether learning media are appropriate

Curriculum Design: Interdisciplinary versus Discipline-based

Sustainability represents a set of conditions whereby human and natural systems are inextricably interlinked with social, economic and cultural values (Holling & Gunderson 2002). In higher education, disciplines largely form the organizing framework for learning, teaching and research. However, the many interrelated dimensions of sustainability defies containment and easy compartmentalization into disciplinary silos (Selby 2006). *Interdisciplinarity* is any approach that goes beyond a single discipline and the logic of

interdisciplinary approaches to sustainability issues derives from the consensus that these issues cannot be sufficiently understood in isolation (Blewitt & Cullingford 2004; Parker, Jenneth 2010; Tilbury 2004a). Jones et al (2010a) define interdisciplinarity as disciplines working collaboratively, sharing their insights and methods in an attempt to go beyond their own boundaries to address issues or questions. On the other hand, *multidisciplinarity* is largely recognized in the literature as being the least integrated form of interdisciplinarity, where "disciplines might work together cooperatively but without sharing ideas, assumptions and methodologies and without being influenced or changed by the other" (Jones, Selby & Sterling 2010a, p24).

A major driver for more interdisciplinary approaches to teaching and learning is the sustainability agenda. Jones et al (2010b) explored the relationship between sustainability and interdisciplinarity and suggest that sustainability has primarily ontological dimensions and normative dimensions (Figure 18). Interdisciplinarity on the other hand is an approach to knowledge and inquiry, and has both epistemological and methodological qualities. Thus, sustainability presents an overarching and complex socio-economic-ecological context wherein interdisciplinarity – as a holistic mode of understanding and organizing knowledge and inquiry – seems appropriate (Jones, Selby & Sterling 2010a, p19).

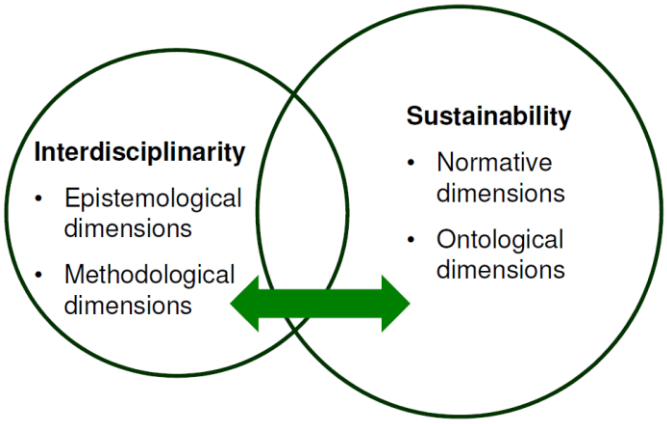

Figure 18: Linking Sustainability and Interdisciplinarity
Adapted from Jones, Selby & Sterling (2010b, p20)

The complex nature of sustainability-related issues requires commensurate approaches to knowledge, research, teaching and learning. There appears to be an emerging consensus that sustainability issues cannot be sufficiently understood or addressed without a primary recognition of **interrelationships**, and therefore also an assumption of the need for interdisciplinary approaches (Jones, Selby & Sterling 2010a; Parker, Jenneth 2010). However, educational structures and practices are widely characterized by disciplinary compartmentalization. While there is expertise and experience in interdisciplinarity in higher education institutions, it still appears on the margins of the mainstream, which remains dominated by discipline-based practices and structures.

5. Development and Framework of the Built Environment Sustainability Education Curriculum Guide

Informed by the literature review and the workshop outcomes, the formulation of the framework of the curriculum guide drew on the following seminal and foundational reports and key text references which focus primarily on the built environment and construction sector and point to sustainability education in the built environment:

- Guidelines on Education Policy for Sustainable Environments (Graham & Booth 2010)
- Shifting Towards Sustainability: Education for climate change adaptation in the built environment sector (Lyth, Nichols & Tilbury 2007)
- AGENDA 21 on Sustainable Construction (CIB 1999; du Plessis 2002)

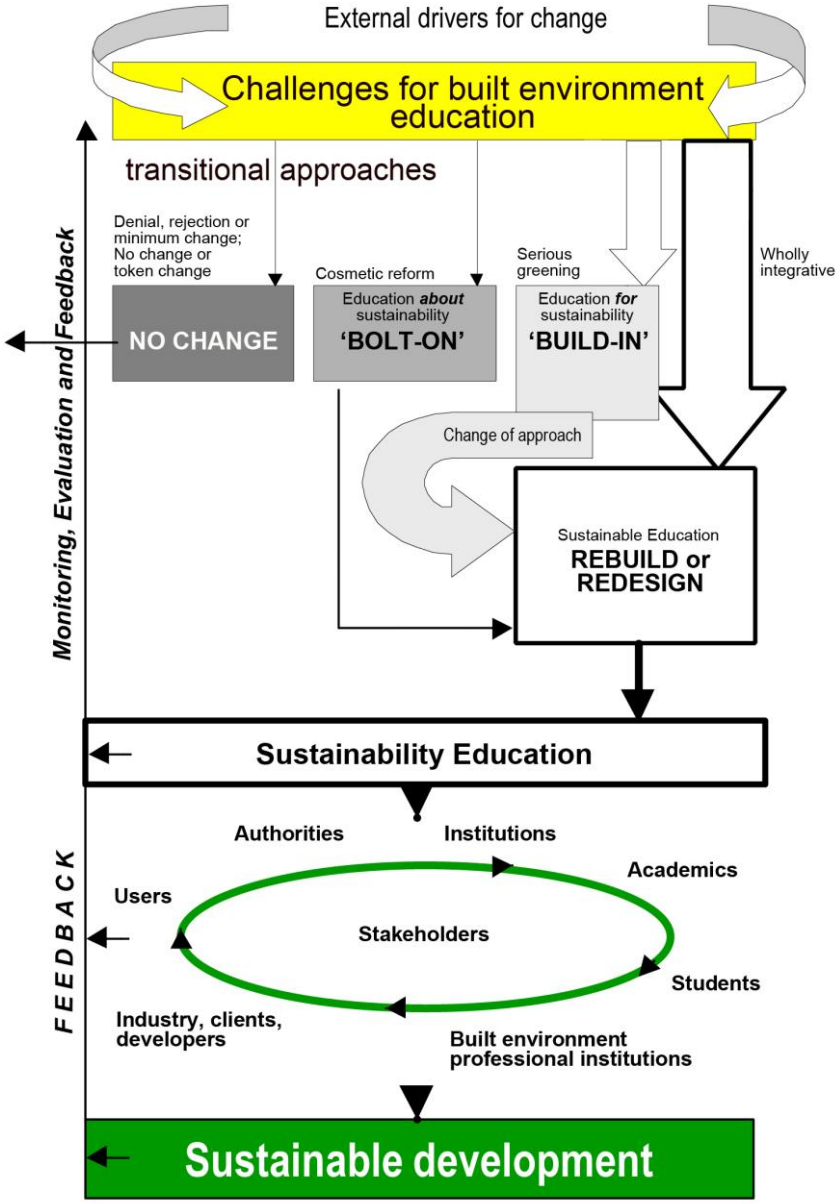

Figure 19: Learning Process to Sustainability Education
Adapted from Strategies and Actions for Sustainable Construction (CIB 1999, p21)

Drawing insights from CIB – Agenda 21's (CIB 1999; du Plessis 2002) strategies and actions for sustainable construction that outlines the "process of continual improvement in the built environment sector from unsustainable practices to positive ones" (Graham & Booth 2010, p13), the guide for university academics and curriculum developers in the built environment disciplines emphasizes the process of integrating sustainability thinking and practice into the built environment curricula and the key role the professions play in the creation of sustainable built environments. This iterative and continual learning process is described in Figure 19 and

hinges on addressing the key challenge of building sustainability progress in the local and regional contexts and the academic strengths of particular higher education institutions (Ryan et al. 2010), rather than on generic approaches.

In summary, the guide is structured in four sections with a view of facilitating rather than directing change in an interactive format to capture feedback and experiences:

- Section 1 – A framework, which outlines the priorities in the professional development programme; contextualizing these priorities and strategies for capacity building for different stakeholders is presented.
- Section 2 – The broad framework established and developed in Section 1 will provide a rationale for the guiding principles for teaching and learning issues, identifying learning aims and developing learning outcomes; transformative sustainability approaches and methods; repository of references and useful resources; presentation of best practice and case study example and monitoring and closing of feedback loops.
- Section 3 – This section provides a template of programme and curriculum content, sustainability pedagogies for built environment courses and references and useful resources. The outline of the themes for the curriculum content and the list of references and resources are not exhaustive but provide general guidance for curriculum design and structure.
- Section 4 – Platform for curriculum dissemination and distribution, best practice models of curricula and case study examples. This section outlines the available knowledge networks for faculty development and will provide a platform for reporting and monitoring of progress and evaluation.

6. Directions and Imperatives

Taken overall, the general direction of education for sustainability is moving increasingly toward integration and innovation (Lyth, Nichols & Tilbury 2007; Snow & Prasad 2011). However, the slow progress of the integration of sustainability in the built environment curricula maybe have been due in part to the practice-led approach which is a hallmark of the discipline and by the assumption that sustainability already permeates the curricula by its nature (Bradley, Sayce & Lewis 2010; Wright 2003). In looking across built environment education, Bradley et al (2010) posit that sustainability is being addressed at four levels:

1. Sustainability as knowledge;
2. Sustainability as process;
3. Sustainability as practice; and
4. Sustainability as paradigm.

The diverse experiences of the academics and industry representatives in the ProSPER.Net workshop point to these issues, which are key to professional education for sustainability:

1. Pedagogical implications in the built environment discipline – transformative learning;
2. Learning outcomes – student experiences;
3. Interdisciplinary rather than discipline-based;
4. Industry input – students as employable graduates; and
5. Challenges to the professionals in the field of the built environment, their institutional structures and their boundaries.

To successfully introduce sustainability concepts into course and curricula, educators must understand the process of change (Fenner et al. 2005) and "capacity building of educators" must then be considered the cornerstone of transforming universities to become effective in empowering students to become change agents for sustainability (Lozano-García et al. 2008).

This working paper has benefited from input from the ProSPER.Net Board, contributions from academics from participating institutions and feedback from industry representatives. It sets the direction for the development of the built environment curriculum guide and for a potential second phase wherein the project will be used as a case study to develop a community or network of practice. As well as being an outcome of the project, this paper will be used to communicate the nature and scope of the project and be instrumental in getting feedback from the collaborators and the broader academic community. The next phase of the project will involve the potential application and trial of the guide in context, which would allow development of resources, implementation, monitoring and evaluation.

7. Acknowledgements

This ProSPER.Net project is funded by the Ministry of the Environment of Japan through its contribution to the United Nations University – Institute of Advanced Studies (UNU-IAS) and is supported by RMIT University School of Property, Construction and Project Management. The authors acknowledge the contributions of the academics and industry representatives who collaborated in the project and participated in the workshop.

8. References

Argyris, C 1993, *Knowledge for action : a guide to overcoming barriers to organizational change.*, Jossey-Bass, San Francisco. CA.

ARIES 2009, *Education for Sustainability: The role of education in engaging and equipping people for change*, The Australian Research Institute in Education for Sustainability (ARIES), Sydney, NSW, <http://aries.mq.edu.au/publications/aries/efs_brochure/>.

Benn, S 1999, *Education for sustainability - Integrating environmental responsibility into curricula: A guide for UNSW faculty*, Institut e of Environment al Studies, The University of New South Wales, Sydney, NSW.

Biggs, JB & Tang, C 2011, *Teaching For Quality Learning At University: What the Student Does*, 4th edn, McGraw-Hill Education, Maidenhead.

Blewitt, J 2004, 'Sustainabilitry and Lifelong Learning', in J Blewitt & C Cullingford (eds), *The sustainability curriculum : the challenge for higher education* Earthscan Publications, London, pp. 24-42.

Blewitt, J & Cullingford, C (eds) 2004, *The Sustainability Curriculum: The Challenge for Higher Education*, Earthscan Publications, London.

Bradley, JF, Sayce, S & Lewis, A 2010, 'Sustainability and Built Environment Professionals: A Shifting Paradigm', in P Jones, D Selby & S Sterling (eds), *Sustainability Education : Perspectives and Practice across Higher Education* Earthscan Publications, London; Sterling, VA, pp. 257-72.

Brown, AD 2003, *Feed or Feedback: Agriculture, Population Dynamics and the State of the Planet*, International Books, Utrecht.

Brundtland, GH (ed.) 1987, *Report of the Brundtland Commission: Our Common Future*, Oxford University Press, Oxford.

Centre for Environment Education 2007, *The Ahmenabad Declaration 2007: A Call to Action, 4th International Conference on Environmental Education, 28 November*

2007, International Conference on Environmental Education (ICEE), viewed 24 February 2012 <http://www.tbilisiplus30.org/Ahmedabad%20Declaration.pdf>.

Chhokar, KB 2010, 'Higher education and curriculum innovation for sustainable development in India', *International Journal of Sustainability in Higher Education*, vol. 11, no. 2, pp. 141-52.

Christensen III, CA 2007, *World Monitor. Info: Asia and the Pacific Region.*, World Monitor Info, viewed 03 August 2012 <http://www.worldmonitor.info/regions/asiapacific.html>.

CIB 1999, *CIB Report Publication 237: AGENDA 21 on Sustainable Construction*, International Council for Research and Innovation in Building and Construction (CIB), Rotterdam, The Netherlands.

Corcoran, PB & Koshy, KC 2010, 'The Pacific way: sustainability in higher education in the South Pacific Island nations', *International Journal of Sustainability in Higher Education*, vol. 11, no. 2, pp. 130-40.

Corcoran, PB & Wals, AEJ (eds) 2004, *Higher education and the challenge of sustainability : problematics, promise and practice*, Kluwer Academic Publishers, Dordrecht.

Cullingford, C 2004, 'Sustainability and Higher Education', in J Blewitt & C Cullingford (eds), *The sustainability curriculum : the challenge for higher education* Earthscan Publications, London, pp. 13-23.

du Plessis, C 2002, *Agenda 21 for Sustainable Construction in Developing Countries: A discussion document*, The International Council for Research and Innovation in Building and Construction (CIB) and United Nations Environment Programme International Environmental Technology Centre (UNEP-IETC), Pretoria.

Dyer, C 1996, *Moving from Rhetoric to Reality: An Initial Exploration of Theories and Approaches to Curriculum Greening Appropriate to the Faculty of Environmental Design and Construction*, RMIT University, Melbourne.

Edwards, B 2004, 'Sustainability and Education in the Built Environment', in J Blewitt & C Cullingford (eds), *The sustainability curriculum : the challenge for higher education* Earthscan Publications, London, pp. 129-40.

Elkington, J 1997, *Cannibals with Forks: The Triple Bottom Line of 21st Century Business*, Capstone Publishing Limited, Oxford, UK.

Fenner, RA, Ainger, CM, Cruickshank, HJ & Guthrie, PM 2005, 'Embedding sustainable development at Cambridge University Engineering Department', *International Journal of Sustainability in Higher Education*, vol. 6, no. 3, pp. 229-41.

Fien, J 2002, 'Advancing sustainability in higher education: Issues and opportunities for research', *International Journal of Sustainability in Higher Education*, vol. 3, no. 3, pp. 243-53.

Fien, J, Abe, O & Bhandari, B 2000, 'Towards education for a sustainable future in Asia and the Pacific', *Prospects*, vol. 30, no. 1, pp. 41-56.

Fischer, J, Manning, AD, Steffen, W, Rose, DB, Daniell, K, Felton, A, Garnett, S, Gilna, B, Heinsohn, R, Lindenmayer, DB, MacDonald, B, Mills, F, Newell, B, Reid, J, Robin, L, Sherren, K & Wade, A 2007, 'Mind the sustainability gap', *Trends in Ecology & Evolution*, vol. 22, no. 12, pp. 621-4.

Galang, AP 2010, 'Environmental education for sustainability in higher education institutions in the Philippines', *International Journal of Sustainability in Higher Education*, vol. 11, no. 2, pp. 173-83.

Graham, P 2009, *Building Ecology: First Principles For A Sustainable Built Environment*, Blackwell Science (UK), viewed 05 December 2011, <http://RMIT.eblib.com.au/patron/FullRecord.aspx?p=238366>.

Graham, P & Booth, P 2010, *Guidelines on Education Policy for Sustainable Environments*, United Nations Environment Programme Sustainable Buildings & Climate Initiative (UNEP-SBCI) & Faculty of the Built Environment, University of New South Wales, Australia, Sydney, NSW.

GUNI 2011, *Higher Education in the World 4: Higher Education's Commitment to Sustainability: from Understanding to Action*, Global University Network for Innovation (GUNI), Barcelona.

Hawkes, J 2001, *The fourth pillar of sustainability : culture's essential role in public planning*, Cultural Development Network (Vic.) in association with Common Ground Publishing, Melbourne.

Higgins, TL & Duane, TP 2008, 'Incorporating Complex Adaptive Systems Theory into Strategic Planning: The Sierra Nevada Conservancy', *Journal of Environmental Planning and Management*, vol. 51, no. 1, pp. 141-62.

Holdsworth, S & Thomas, I 2012, 'Academic Development and Sustainability Education within Higher Education: Case Studies of Practice', *Athens: ATINER'S Conference Paper Series No: CON2012-0233*, p. 19.

Holdsworth, S, Wyborn, C, Bekessy, S & Thomas, I 2008, 'Professional development for education for sustainability: How advanced are Australian universities?', *International Journal of Sustainability in Higher Education*, vol. 9, no. 2, pp. 131-46.

Holling, CS 2004, 'From Complex Regions to Complex Worlds', *Ecology and Society*, vol. 9, no. 1, p. Article 11.

Holling, CS & Gunderson, LH (eds) 2002, *Panarchy : understanding transformations in human and natural systems* Island Press, Washington

Holling, CS, Gunderson, LH & Peterson, GD 2002, 'Sustainability and panarchies', in CS Holling & LH Gunderson (eds), *Panarchy : understanding transformations in human and natural systems*, Island Press, Washington, pp. 63-102.

Hopkinson, P & James, P 2010, 'Practical pedagogy for embedding ESD in science, technology, engineering and mathematics curricula', *International Journal of Sustainability in Higher Education*, vol. 11, no. 4, pp. 365-79.

ILO 2012, *Study of occupational and skill needs in green building: final report*, International Labour Office (ILO), Skills and Employability Department (EMP /SKILLS), Geneva.

Iyer-Raniga, U, Arcari, P & Wong, J 2010, 'Education for Sustainability in the Built Environment: What are the students telling us?', paper presented to 26th Annual Association of Researchers in Construction Management (ARCOM), Leeds, UK, pp. 1447-56.

Jones, P, Selby, D & Sterling, S 2010a, 'More than the Sum of their Parts? Interdisciplinarity and Sustainability', in P Jones, D Selby & S Sterling (eds), *Sustainability Education : Perspectives and Practice across Higher Education*, Earthscan Publications, London; Sterling, VA, pp. 17-37.

---- (eds) 2010b, *Sustainability Education : Perspectives and Practice across Higher Education* Earthscan, London; Sterling, VA.

Kitamura, Y & Hoshii, N 2010, 'Education for sustainable development at Universities in Japan', *International Journal of Sustainability in Higher Education*, vol. 11, no. 3, pp. 202-16.

Lidgren, A, Rodhe, H & Huisingh, D 2006, 'A systemic approach to incorporate sustainability into university courses and curricula', *Journal of Cleaner Production*, vol. 14, no. 9–11, pp. 797-809.

Lowe, I 1994, 'Performance Measurement', paper presented to Fenner Conference on the Environment (November 1994), Canberra, Australia.

---- 1996, 'Towards ecological sustainability', in State of the Evnironment Advisory Council (ed.), *Australia State of the Environment 1996 (SoE 1996)*, CSIRO Publishing, Melbourne, pp. 10-30.

Lozano-García, FJ, Gándara, G, Perrni, O, Manzano, M, Hernández, DE & Huisingh, D 2008, 'Capacity building: a course on sustainable development to educate the educators', *International Journal of Sustainability in Higher Education*, vol. 9, no. 3, pp. 257-81.

Lozano, R 2006, 'Incorporation and institutionalization of SD into universities: breaking through barriers to change', *Journal of Cleaner Production*, vol. 14, no. 9–11, pp. 787-96.

Lyth, A, Nichols, S & Tilbury, D 2007, *Shifting Towards Sustainability: Education for climate change adaptation in the built environment sector. A Report for the Australian Government Department of the Environment, Water, Heritage and the Arts (DEWHA)*, The Australian Research Institute in Education for Sustainability (ARIES), Sydney, NSW.

Miller, TR, Munoz-Erickson, T & Redman, CL 2011, 'Transforming knowledge for sustainability: towards adaptive academic institutions', *International Journal of Sustainability in Higher Education*, vol. 12, no. 2, pp. 177-92.

Niu, D, Jiang, D & Li, F 2010, 'Higher education for sustainable development in China', *International Journal of Sustainability in Higher Education*, vol. 11, no. 2, pp. 153-62.

Nomura, K & Abe, O 2010, 'Higher education for sustainable development in Japan: policy and progress', *International Journal of Sustainability in Higher Education*, vol. 11, no. 2, pp. 120-9.

---- 2011, *Sustainability and Higher Education in Asia and the Pacific*, Global University Network for Innovation, viewed 30 July 2012 2012, <http://www.guninetwork.org/resources/he-articles/sustainability-and-higher-education-in-asia-and-the-pacific>.

Page, G 2009, 'Sustainability in Undergraduate Property Courses', paper presented to 15th Pacific Rim Real Estate Society Annual Conference (18-21 January 2009), Sydney, Australia, p. 13, <http://www.prres.net/papers/Page_Sustainability_In_Undergraduate_Property_Courses.pdf>.

Parker, J 2010, 'Competencies for interdisciplinarity in higher education', *International Journal of Sustainability in Higher Education*, vol. 11, no. 4, pp. 325-38.

Parker, J, Wade, R & Van Winsum, A 2004, 'Citizenship, and community from local to global: Implications for higher education of a global citizenship approach', in C Cullingford & J Blewitt (eds), *The Sustainability Curriculum: The Challenge for Higher Education*, Earthscan Publications, London, pp. 63-77.

Peet, D-J, Mulder, KF & Bijma, A 2004, 'Integrating SD into engineering courses at the Delft University of Technology: The individual interaction method', *International Journal of Sustainability in Higher Education*, vol. 5, no. 3, pp. 278-88.

Rusinko, CA 2010, 'Integrating sustainability in higher education: a generic matrix', *International Journal of Sustainability in Higher Education*, vol. 11, no. 3, pp. 250-9.

Ryan, A, Tilbury, D, Corcoran, PB, Abe, O & Nomura, K 2010, 'Sustainability in higher education in the Asia-Pacific: developments, challenges, and prospects', *International Journal of Sustainability in Higher Education*, vol. 11, no. 2, pp. 106-19.

Sammalisto, K & Lindhqvist, T 2008, 'Integration of Sustainability in Higher Education: A Study with International Perspectives', *Innovative Higher Education*, vol. 32, no. 4, pp. 221-33.

Sanusi, ZA, Steele, R, Khelghat-Doost, H, Jegatesen, G & Rosli, H (eds) 2011, *Education for Sustainable Development: Issues, Principles and Practices for Global Application*, United Nations University - Promotion of Sustainability in Postgraduate Education and Research (UNU-ProSPER.Net).

Scott, W & Gough, S 2006, 'Sustainable Development within UK Higher Education: Revealing Tendencies and Tensions', *Journal of Geography in Higher Education*, vol. 30, no. 2, pp. 293-305.

Selby, D 2006, 'The catalyst that is sustainability: bringing permeability to disciplinary boundaries', *Planet (Journal of GEES, the Geography, Earth and Environmental Sciences Subject Centre)*, vol. No. 7, no. December 2006, pp. 57-69.

Sharma, Y 2012, *Roadmap for sustainability education and research in ASEAN universities*, 22 April 2012 edn, University World News, 30 July 2012, <http://www.universityworldnews.com/article.php?story=20120420090606838>.

Sherren, K 2005, 'Balancing the Disciplines: A Multidisciplinary Perspective on Sustainability Curriculum Content', *Australian Journal of Environmental Education*, vol. 21, pp. 97-106.

---- 2006, 'Core issues: Reflections on sustainability in Australian University coursework programs', *International Journal of Sustainability in Higher Education*, vol. 7, no. 4, pp. 400-13.

Snow, M & Prasad, D 2011, 'Climate Change Adaptation for Building Designers: An Introduction', no. EDG 66 MSa, p. 11, viewed 06 February 2012, <http://environmentdesignguide.com.au/media/EDG_66_MSa.pdf>.

Sterling, S 2004, 'An analysis of the development of sustainability education internationally: evolution, interpretation and transformative potential', in J Blewitt & C Cullingford (eds), *The sustainability curriculum : the challenge for higher education* Earthscan Publications, London, pp. 43-62.

Sterling, S 2004, 'Higher education, sustainability, and the role of systemic learning', in PB Corcoran & AEJ Wals (eds), *Higher Education and the Challenge of Sustainability: Problematics, Promise, and Practice*, Kluwer Academic Publishers, Dordrecht, pp. 47-70.

Sterling, S 2010, 'Transformative Learning and Sustainability: sketching the conceptual ground', *Learning and Teaching in Higher Education*, no. 5, pp. 17-33.

Sterling, S & Thomas, I 2006, 'Education for sustainability: the role of capabilities in guiding university curricula', *International Journal of Innovation and Sustainable Development*, vol. 1, no. 4, pp. 349-70.

Su, HJ & Chang, T-c 2010, 'Sustainability of higher education institutions in Taiwan', *International Journal of Sustainability in Higher Education*, vol. 11, no. 2, pp. 163-72.

Svanström, M, Palme, U, Wedel, MK, Carlson, O, Nyström, T & Edén, M 2012, 'Embedding of ESD in engineering education: Experiences from Chalmers University of Technology', *International Journal of Sustainability in Higher Education*, vol. 13, no. 3, pp. 279-92.

Thomas, I 2004, 'Sustainability in tertiary curricula: what is stopping it happening?', *International Journal of Sustainability in Higher Education*, vol. 5, no. 1, pp. 33-47.

Thomas, I, Kyle, L & Alvarez, A 1999, 'Environmental Education across the Tertiary Curriculum: a process', *Environmental Education Research*, vol. 5, no. 3, pp. 319-37.

Thomas, I & Nicita, J 2002, 'Sustainability Education and Australian Universities', *Environmental Education Research*, vol. 8, no. 4, pp. 475-92.

Tilbury, D 2004a, 'Environmental Education for Sustainability: A force for change in higher education', in PB Corcoran & AEJ Wals (eds), *Higher Education and the Challenge*

of Sustainability: Problematics, Promise and Practice, Kluwer Academic Press, Dordrecht, pp. 97-112.

---- 2004b, 'Rising to the Challenge: Education for Sustainability in Australia', *Australian Journal of Environmental Education*, vol. 20, no. 2, pp. 103-14.

Tilbury, D, Adams, K & Keogh, A 2005, *A National Review of Environmental Education and its Contribution to Sustainability in Australia: Further and Higher Education*, Australian Government Department of the Environment and Heritage (DEH) and Australian Research Institute in Education for Sustainability (ARIES), Canberra, ACT.

Tilbury, D & Cooke, K 2005, *A National Review of Environmental Education and its Contribution to Sustainability in Australia: Frameworks for Sustainability*, Australian Government Department of the Environment and Heritage (DEH) and the Australian Research Institute in Education for Sustainability (ARIES), Canberra, ACT.

UNESCO - Asia and Pacific Regional Bureau for Education 2005, *Working Paper: Asia-Pacific Regional Strategy for Education for Sustainable Development*, United Nations Educational Scientific and Cultural Organisation (UNESCO), Bangkok.

UNESCO - Education Sector 2006, *United Nations Decade on Education for Sustainable Development (2005-14): International Implementation Scheme*, United National Educational, Scientific and Cultural Education (UNESCO), Paris.

University Leaders for a Sustainable Future (ULSF) 1990, *Talloires Declaration*, Association of University Leaders for a Sustainable Future (ULSF), viewed 24 February 2012 <http://www.ulsf.org/pdf/TD.pdf>.

UNU-IAS 2013, *ProSPER.Net: Developing a New Generation of Leaders (2008-2013)*, United Nations University - Institute of Advanced Studies (UNU-IAS), Yokohama, Japan.

Woods, S 1994, *The Environmental Agenda, Taking Reponsibility, The Built Environment*, Pluto Press, London.

World Bank 2012, *Putting Higher Education to Work: Skills and Research for Growth in East Asia (The World Bank East Asia and Pacific Regional Report)*, The International Bank for Reconstruction and Development / The World Bank, Washington, D.C.

Wright, J 2003, 'Introducing sustainability into the architecture curriculum in the United States', *International Journal of Sustainability in Higher Education*, vol. 4, no. 2, pp. 100-5.

Yencken, DGD & Wilkinson, D 2001, *Resetting the compass : Australia's journey towards sustainability*, CSIRO Publishing, Collingwood, Vic. .