INTEGRATING BUILT ENVIRONMENT STUDIES THROUGH SUSTAINABLE DEVELOPMENT EDUCATION

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Abstract: The study sets out to crystallise the learning obtained from a pursuit to deliver 'education for sustainable development', in a higher education context and across eleven built environment professions, including the key engineering disciplines of civil, energy and environmental engineering.

This paper captures the key lessons, from a concerted ten-year drive to integrate sustainability thinking into the built environment disciplines at the University of Ulster, whilst building on international concepts. Funded initially by the Royal Academy of Engineers, this inter-disciplinary work required appointment of visiting professors, engagement with professional bodies, staff motivation and training, module design and development of appropriate pedagogy and assessment methods.

A continuum, involving evolution from Year 1 undergraduate sustainability awareness, through Year 2 sustainability application in technical modules, leading to final year sustainability integration across in-depth studies, design activity and research-focused dissertations, gave a structure and coherence to the work, with the need for a focused and broad-disciple staff team to maximise on the opportunity of success.

This integrative approach to 'sustainability education being both complex and complicated' was applied at Masters level. The challenge of sustainability thinking, in the context of international drivers, was embraced by students at all levels, with indications from students, module and professional surveys highlighting the benefits of multi-disciplinary projects and encouragement of complimentary ownership by all professions.

A focused staff sustainability group sought and obtained input and feedback from a Sustainability Visiting Panel, gave access to relevant case studies, allowed students and staff to engage in holistic challenges, while positive reports from external Accrediting Bodies added weight and content to a mature sustainability education.

Keywords: Sustainable Development, Pedagogy, Assessment, Module design; Embedding Sustainability

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1. INTRODUCTION

1.1 Education for Sustainable Development

This paper is set in the context of the UN International Decade of Education for Sustainable Development (DESD) 2005-2014. It is apparent that the various official DESD documents are consistent in outlining their vision for a world 'where everyone has the opportunity to benefit from education and learn the values, behaviour and lifestyles required for a sustainable future and for positive societal transformation' (UNESCO 2005). A mid-term review indicated: 'Anecdotal evidence suggests that the DESD has already started to make some difference in terms of influencing governments to establish DESD policies and strategies, engaging stakeholders and producing new tools and resources for ESD stakeholders. However, there is still a long way to go to achieve the ultimate goal of the DESD—a more sustainable global community.' (Mula and Tilbury 2009)

The United Nations University's Regional Centres of Expertise on Education for Sustainable Development (RCE) initiative recognised that RCE's are an evolving concept and drew attention to the RCE process as a promising example of 'social learning' and 'communities of practice', as well as a 'knowledge management system'. (Mochizuki 2008)

1.2 Non Statutory Professional Bodies

The UK engineering professions have sought to play a key role in the linking of sustainability to education in the context of their professional recognition of members and of under-pinning education programmes. The UK Engineering Council, as the professional qualification awarding body has guidance on the role of engineers in relation to sustainability. Six principles have been developed, to guide and motivate engineers, to achieve sustainable development (SD) in their work, and to meet professional obligations in achieving sustainability. These address the issues of building a sustainable society; professional and responsible judgments; exceeding legislative norms; resource management; adopting multiple views to solve problems; and managing risk. (Engineering Council 2009).

In support, the Royal Academy of Engineers, as a multi-discipline body introduced a 'Visiting Professor in Engineering Design for Sustainable Development' Scheme (1999 – 2008), and produced a set of Guiding Principles (Dodds & Venables, 2005), identifying the three mutually inclusive supporting elements of sustainable design as Eco-Centric, Techno-centric and Socio-Centric concerns.

As a key professional body, the Institution of Civil Engineers (ICE) has nine attributes for those who aspire to be professional members and chartered engineers; two sustainability-related attributes are shown in Fig. 1 (ICE3001A; 2009)

Group	Attribute
Engineering Application	A Ability to identify, review and select techniques, procedures and methods to undertake engineering tasks. B Ability to contribute to design & development of engineering solutions. C Ability to implement design solutions and contribute to their evaluation.
Sustainable Development	A Sound knowledge of sustainable development best practice. B Ability to manage engineering activities that contribute to sustainable development

Fig. 1. ICE 3001A (2009) Routes to Membership extract

1.3 University of Ulster Developments

The School of the Built Environment (SoBE) at the University of Ulster (UU), with 11 disciples, has been attempting to deliver environmentally related material and programmes in the 1990's, as a result of UK government directions (Toyne Report 1993). An interim review (Khan 1996) indicated that progress was slow across the UK; simultaneously UU developed an undergraduate programme in Environmental Engineering and consolidated environmental material in environmental health and civil engineering degrees. In 1999, SoBE, along with other UK Universities, obtained funding from the Royal Academy of Engineering to 'deliver SD across the built environment disciplines in the School' within its Visiting Professor scheme. The work was led by WA Strong (Project Leader); Dr Lesley Hemphill was appointed Project Officer in 2002 and two Visiting Professors assisted the work - Dr Jim McQuaid (1999 – 2002); Dr Brian Hanna (2003-2006)

2. SCHOOL OF THE BUILT ENVIRONMENT AT UNIVERSITY OF ULSTER

The traditional professions of civil engineering, architecture, construction and quantity surveying are central to the delivery of built environment design and construction phases, and have been well served by a comprehensive supply of educational programmes at undergraduate and post-graduate levels. Further development of built environment disciplines reflected the need for skills in other important themes and representing the breadth of the built environment processes across strategic and land planning, holistic and detailed design, procurement and construction, and facilities operation and maintenance.

<table>
<tr><td></td><td>Energy Institute</td><td>ICE</td><td>CIEH</td><td>CIAT</td><td></td></tr>
<tr><td>CIBSE</td><td>Energy & Building Services Engineering</td><td>Civil Engineering</td><td>Environmental Health</td><td>Architecture</td><td>RIBA</td></tr>
<tr><td>CILT</td><td>Transport Studies</td><td colspan="2">SUSTAINABLE DEVELOPMENT</td><td>Housing Studies</td><td>CIH</td></tr>
<tr><td>CIOB</td><td>Construction</td><td>Building & Quantity Surveying</td><td>Property & Investment Development</td><td>Planning & Property Development</td><td>RTPI</td></tr>
<tr><td></td><td>CIOB</td><td colspan="3">RICS</td><td></td></tr>
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Fig. 2. Built Environment Disciplines and Professional Bodies in SoBE

Figure 2 shows the wide-ranging built environment under and post-graduate education provision, allowing opportunity for creative and inter-disciplinary learning and teaching as well as unified research and development (UU 2009).

The vocational and professional nature of built environment professions necessitates regulation for both academic standards and in providing under-pinning education towards professional status such as chartered engineer, builder, surveyor, architect, planner, environmentalist or environmental health officer. These professional bodies play traditional roles, primarily as member organisations, in accrediting educational programmes and representing the body in advocacy and learned society functions, and also having 'royal charter' responsibility functions for statutory roles such as health and safety and for ethics - leadership and responsibility for SD falls within this latter category. Typically of others, the ICE, one of the oldest professions, has developed significant corporate SD strategies (ICE

2007). This new professional response to the sustainability agenda is reflected mainly in the objectives and education accreditation requirements of these built environment professional bodies, with some seeking more deeply embedded sustainability in degree programmes.

Graduates from the built environment courses have opportunity to develop fulfilling careers, to gain long-term employment and be agents for change in SD and ethics, at both home and abroad and in public and private sectors. These employability and influencer roles have been cited as key marketing tools to attract undergraduates, whilst the deeper role of professional leaders has been studied, confirmed and recorded by the Royal Academy of Engineering (Royal Academy 2006).

3. SUSTAINABLE DEVELOPMENT EDUCATION IN SoBE

3.1 Sustainable Development Group

The Sustainable Development Group (SDG) was formed in 1999 to deliver the Royal Academy of Engineering SD programme, observing at that stage that there were no other significant multi-discipline SD examples in UK Higher Education. It commenced its quest for SD integration from a low base, by carrying out a module audit to determine the explicit and implicit references to SD in all built environment module objectives. Whilst the new Environmental Engineering course rated satisfactory with 45% of modules including SD, this was contrasted by traditional Quantity Surveying and Civil Engineering courses, accredited by RICS and ICE respectively, scoring under 5%. This raw data presented a weak position which necessitated a Position Paper on SD integration, in which a new ROAMEF framework was applied:
Rationale – the purpose(s) that the teaching or case study is intended to fulfill;
Objectives – the project objectives that will ensure delivery of the pedagogy material;
Appraisal – the justification that the project will meet the Rationale purpose(s);
Monitoring – the arrangements for ensuring that the project proceeds to the plan;
Evaluation – the arrangements for post-examination of the utility in meeting its purpose(s);
Feedback - the application to subsequent projects of lessons learned in the execution

Little evidence existed in how to develop this sustainability in a large multi-disciplinary higher education school, so the SDG sought accountability and relevance in appointment a Sustainability Visiting Panel (SVP), drawn from external experts representing the economic, environmental ands social pillars of SD, and it met annually SVP to give advice and support.

The SDG, with its Visiting Professors, appraised the options for breadth and depth of SD teaching and learning, while communicating and feeding back to the Royal Academy Network. The broad approach applied to competencies in decision making, risk taking, design selection, materials choices and more across several themes issues in pursuit of balance of the competing demands of environmental, social, economic and resource management zones. A continuum for sustainability education was designed to provide a foundation of SD *Awareness* [Phase I], to support more detailed studies in lectures, and informed by *Case Studies* [Phase II], and to facilitate and underpin a range of SD *Integrative Projects* [Phase III], design teamwork and individual studies (Fig. 3). This continuum also facilitated an appreciation of how SD can influence the built environment phases of concept, design, construction and maintenance, and across typical themes such as planning, biodiversity, design, facilities management, construction, environment, social impact, waste management, water resources, transport systems and urban development.

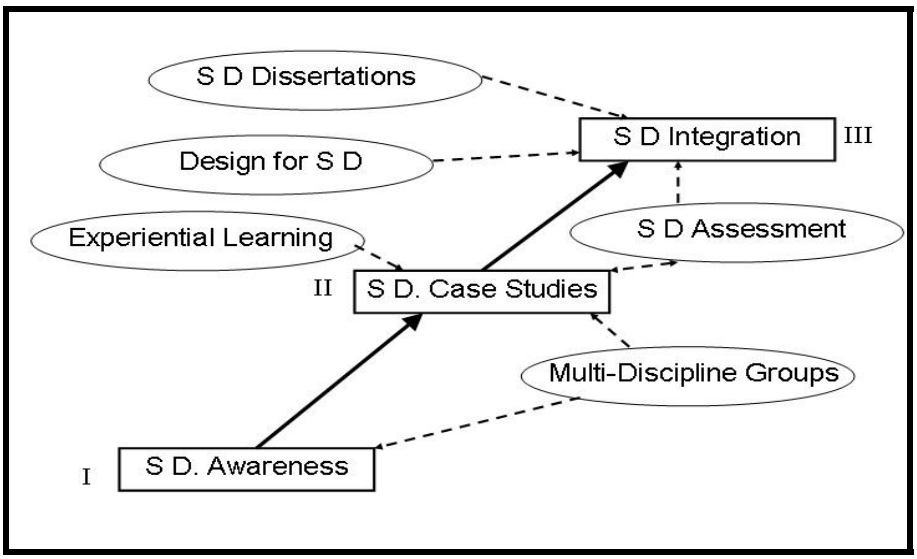

Fig. 3 UU Continuum for Sustainability in Curricula

3.2 Year 1 (Level 4) – Sustainability Awareness

The drivers for this new Year 1 'Communicating Sustainability' module for a range of built environment disciplines were: a. vocational courses meeting professional body requirements; b. simultaneous multi-discipline delivery to professional groups; c. sustainability awareness experience underpinning future studies; d. response to international & national trends in sustainability; e. challenging student social conscience; f. mobilising of motivated staff, and g. delivering rigorous assessment of sustainability information

The 10 credit point module was initially developed as a 'forced marriage' between teaching in Information Technology (IT) and SD [Model A], evolving to a partnership with SD material leading [Model B]; IT material was reduced, as students already had basic IT skills, and allowed the structuring of a 20 credit point module in which SD was integrated with new teaching on Geographical Information Systems (GIS) [Model C]. See Fig. 4.

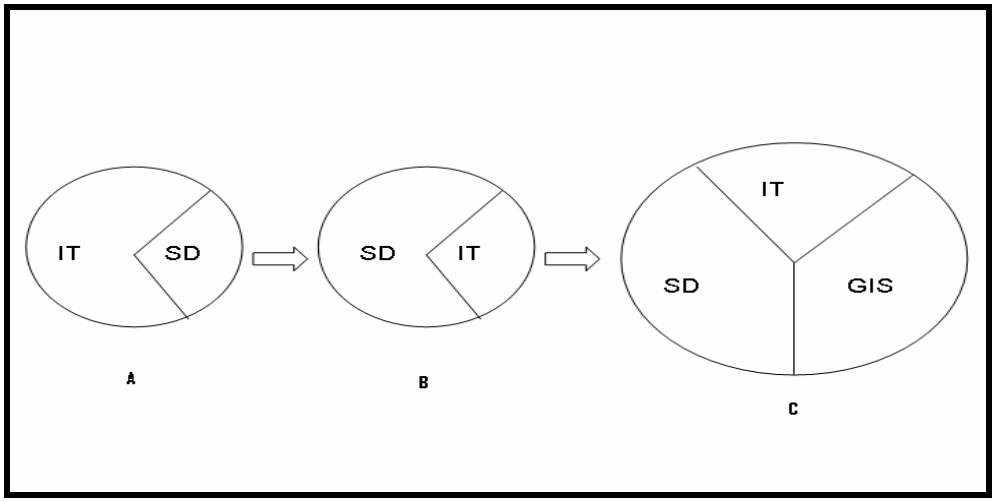

Fig. 4 Evolution of sustainability awareness module structure

This Model B module covered basic knowledge of proprietary software applications and oral and written skills, while addressing the SD themes of water, transport, energy, construction, planning, regeneration, sustainable communities and social issues. Inter-active lectures by motivated staff and visitors on SD themes, with emphases on Student-Centered Learning,

were supported by seminars and practical workshop sessions in the computer laboratory. The UU interactive learning environment ensured that material was accessible from a WebCT portal, and this was reinforced by substantial reading material via the UU Learning Resource Virtual Built Environment Library (VIBEL 2007). Module assessment included a purpose-built online SD test, using multiple choice, true/false and 'matching statements' questions, selected, against themes randomly from a bank of 120 questions.

3.3 Year 2 (Level 5) Activity

Each degree programme was encouraged to ensure that SD was embedded into its curriculum, with the SD thread strongly identified across teaching and learning. It was evident that this drive was dependent the motivation and ability of staff members, some of whom had been traditional lecturers in delivering fundamental science and engineering, while other staff had the opportunity to integrate SD into vocationally oriented topics. The SDG provided three types of support: a. development of 2 major Case Studies on i. Regeneration of Mossley Mill development (with Newtownabbey Borough Council); ii. Sustainability in the development of a Community Treatment Care Centre (with N Ireland Health Estates); lectures, documents and display material were made available; b. development of mini SD Case studies, to be used in class as a means of integrating SD into current taught material; c. Advice and support for staff in developing SD content and studies for existing modules.

3.4 Year 4 (Level 6) Activity

In this phase, the major SD thrust was:

a. Applied module delivery in which SD assignments provided a vehicle for integrated studies – Civil Engineering, Environmental Health and Planning & Property Development were highly active in this approach, while the suite of Renewable Energy studies across several disciplines gave significant input to the 'Energy and Climate Change' debate;

b. Design modules where SD monitoring and appraisal greatly assisted in decision making and whole life analyses – Building Services and Civil engineering degrees fully engaged;

c. Dissertation studies in which SD thinking gave greater understanding; the SD requirement gained considerable momentum, with up to 30% of all final year Dissertations (over 200) having a significant SD element in the study objectives.

3.5 Masters (Level 7) Activity

The development of an SD Module at level 7 has been taken by Masters programmes in Infrastructure Engineering, Environmental Health and Construction Project Management as well as sharing material with Masters students from Architecture. The opportunity for in-depth inter-disciplinary studies has been beneficial in team-building and appreciation of the application and solution of SD issues, leading to new understanding and analyses in consensus building, behavioural change, integrated transportation, energy conservation, climate change mitigation and adaptation, SD appraisals and measurement. It is proposed that students from the new Masters in Transport Planning and enhanced Master of Engineering will join this multi-disciplinary cohort.

3.6 Associated Activities

The SDG has built up or encouraged a series of associated activities, to support and complement the teaching pedagogy across the four levels of study:

a. Series of Emotive events in which several disciplines debate and develop outputs in poster format; i. Emotive Evening for final year under-graduates in Property, Engineering, Architecture to debate 'Making Poverty History'; ii. Emotive Morning for seven undergraduate Year 1 disciplines to consider 'SD aspects of UU Campus in 20 years'; iii. Emotive Afternoon for all Masters students in Faculty of Art, Design and the Built Environment to develop resolutions for issues such as 'Food Security';

b. SD Research in cross-cutting themes from built environment disciplines – current SDG studies include Sustainable Water Evaluation Programme; Water Impact on Highway Performance; Sustainable Urban Community Modelling & trade offs; Sustainable Rural Communities; Sustainable Public Health Engineering; Smart Growth models.
c. SD Research with other disciples; project proposals include Retrofitting of Social Housing; Environmental aspects of Distance Learning programmes; Sustainable Highway Performance;
d. Development of a Residential in Environmental Health to seek integration of SD;
e. Support and advice to external clients on sustainability profiling and measurement; projects include Maze Long Kesh as potential National Stadium, disused Landfill Site as Giants Park;
f. Membership of several SD stakeholder bodies and Ministerial Advisory Bodies (Architecture, Construction, Waste Management);
g. Authors of Sustainable Development Policy Directory (Strong, Hemphill 2006);
g. Development of academic enterprise suggestions and projects – proposed development of a SD Game, SD professionals' symbiosis event; SD chief executive lunch;
h. Interaction with and contribution to Higher Education Academy programmes vis-à-vis Geography Earth & Environmental Sciences (GEES), Centre for Education in the Built Environment (CEBE), Council for Higher Education in Art & Design (CHEAD), Centre for Sustainable Communities Achieved through Integrated Professional Education (C-SCAIPE), Engineering Subject Centre at Loughborough;
i. Monitoring of all aspects of the SD provision through i. Documented Student Feedback (SF) on SD awareness and the SD Online testing; ii. Contribution to the Royal Academy of Engineering (RAEng) SD Visiting Professor Annual Workshops; iii. UU Sustainability Visiting Panel (SVP) Annual Meeting; iv. Module evaluation; v. Research annual reviews.

4. CONCLUSIONS

This paper presented a structured approach to the challenge of communicating and developing sustainability in a higher education environment. It addressed the compelling drivers in international and national jurisdictions as set at both generic governmental level and in the context of education, highlighted by the UN Decade of Education for Sustainable Development 2005 – 2014, giving a vital backdrop to this contribution to the transformation and embedding of sustainability education. It concurred with the UN RCE's approach to SD pedagogy of 'social learning', 'communities of practice', and 'knowledge management system' (Mochizuki 2008). Within the wide range of activities associated with the provision of the built environment, professional bodies play key roles in protecting the well-being of members and society, across issues including ethics and education, whilst bringing sharper focus to and appreciation of the sustainability agenda. They enthusiastically approach SD at strategic and operational levels, within their governance and at higher education programme accreditation phases. This has assisted in the imperative to introduce SD at all stages in undergraduate and masters degree courses, in order to establish and build on a foundation for further studies and to ensure that SD is seen as an holistic and integrative study, across the lifetime of graduates.

The UU vision for and journey towards the evolution and development of sustainability education has been conceptualised in a continuum, with 'communicating sustainability' as the base. The following key conclusions have been derived from a ten year period of SD integration into the higher education delivery at UU SoBE:

- SD awareness has a prolific international context, cutting across government and society
- Stimulating foundation lectures are important to gain early multi-discipline engagement
- Access to comprehensive range of quality support material gives key opportunities
- Use of e-learning and online SD testing is a learning and motivation experience

- SD material sits readily alongside all built environment disciplines
- Student teamwork is enhanced through SD inter-discipline teaching groups
- Balance between academic staff engagement and external expertise ensures SD currency
- SD case studies inform and challenge inter-disciplinary teamwork
- Multi-disciplinary activity at Masters level has a richness and interrogative factors
- The Emotive events bring excitement and challenge to all delegates
- Student behavioural change can be an indirect outcome
- Professional bodies support and learn from this integrated and holistic SD strategy
- Links between Teaching, Research and Academic Enterprise are essential

.It is anticipated that the journey towards fulfilling and transformed sustainability education can be translated across other less technical higher education themes and discipline groups as the SD concepts, methodology and application have resonance with human, social, natural, manufactured and financial capitals.

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