Can Greening the Curriculum Influence Students' Perceptions and Awareness of Sustainability?

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Abstract

In this paper we explore a cohort of Architecture and Environmental Engineering students' perceptions and awareness of sustainability issues prior to and after completion of a module on sustainable strategies in design and construction. The module used learner-centered activities to introduce students to the key issues surrounding sustainability and the wide ranging impact that their design decisions and resultant construction can have on the environment. To gather data on any changes in student awareness and perceptions of sustainability, a pre-post research design was used, with students completing a survey at the beginning and end of the module. Survey data was analysed using a bottom up data-driven approach, the application of Biggs' Structure of the Observed Learning Outcome taxonomy (SOLO) and comparison of distinct issues, themes or concepts. Results were used to explore whether undertaking the module was associated with more informed perceptions and awareness of sustainability and environmental issues which could consequently influence students' approaches to design. Results showed that at the end of the module some students were more able to clearly articulate their knowledge about and views on sustainability and environmental issues. Responses also showed increased sophistication and complexity, with a number of students shifting the focus of their response to reflect the sustainable construction and green building design concepts covered in the module. Overall, these results showed that it is possible to help some students to develop their understanding and awareness of sustainability issues, but that this is not easy to achieve through participation in a stand-alone, one-off module experience. It has also highlighted the importance of aligning student engagement, subject content and the educational context for learning. Given the present focus within the industry on sustainability and the need for graduates who are committed to environmentally responsible behaviour, it is imperative that universities continue to strengthen the education of future built environment professionals in sustainable design. The important role that universities play in preparing many of the world's leaders who have considerable influence over the direction society takes means that they must ensure that graduates are fully equipped to meet the challenges of a changing society.

Keywords: awareness, behaviours, pedagogy, perceptions, sustainability

1. Introduction

Sustainability is currently the most discussed and debated issue of our time; with the media focusing daily on human impacts on the globe including climate change and global warming; and associated implications for current and future generations. No one in today"s society, regardless of age, can fail to acknowledge awareness of the debate, but whether they choose to be convinced that society needs to change, remains to be seen. One area where sustainability has come to the fore is in the built environment, where there is a drive to reduce energy consumption, build for longevity and utilise materials that are neither harmful to the individual or the environment. (Hayles *et al.,* 2010).

The construction industry has recognised the need to implement environmentally sensitive and sustainable management policies, practices and operations in order to meet new policy and legislation. Clients are starting to ask for sustainable or green buildings. There are a number of reasons why public and private clients are seeking to have their buildings designed, constructed and operated in a sustainable manner. These include a necessity to reduce the impact of their buildings on the environment, to reduce building operation and maintenance costs, to improve working environments for the building occupants, or simply to project a better public image (Nobe and Dunbar 2004). Reports have also shown that employee productivity can increase drastically when a building is designed and constructed in a sustainable manner (Freemantle 2002). In addition, the informed client knows that green structures not only reduce operating costs, but are more likely to attract young, highly intelligent workers that prefer companies that demonstrate a commitment to the environment (Flanders 2001).

As a result, the notion of sustainable construction and green building is changing the way structures are commissioned, designed and built. In turn this must impact on the university curriculum, as it is necessary for educators to ensure that students engage with up-to-date concepts and contemporary issues so that they are equipped for the world of work. Indeed, for graduates to meet the changing needs of the design and construction industry it may be necessary to redesign built environment programmes so that they integrate and embed learning about sustainable philosophies and techniques and how to implement them in practice.

2. Sustainability literacy as a core competency

January 2005 saw the launch of the UN‟s „Decade of Education for Sustainability‟ (UNESCO, 2004), a programme which aims to ensure that all higher education curricula include a focus on sustainability and sustainable development. A number of initiatives to promote sustainability education within higher education around the world have been implemented in responses to this programme. One example from the UK is the Sustainable Development Strategy which has identified sustainability literacy as a core competency for all graduates in UK universities (Her Majesty‟s Government, 2005; 39).

It has been shown that students who understand their own ecological footprint and the impact that they have on the planet are more likely to relate to their impact on the built environment, including the environmental cost of transportation (Hayles & Holdsworth, 2005). It is, therefore, important to understand how students perceive sustainability and how they might express that understanding to others.

There is not an extensive body of work in the area of university student understanding and perceptions of sustainability. An overview of the key studies is provided below.

Blaikie (1989) surveyed a group of undergraduate students at a large Australian university to explore their ecological world view (EWV) and whether they exhibited environmentally responsible behaviour. The study found that there were large variations in the level of commitment to an EWV depending on the discipline area students were studying, with business showing the lowest level of commitment, followed by engineering and applied sciences. Social science students and those studying communications were the most committed. The results of the research also highlighted that the level of understanding and commitment to the solution of both local and global environmental problems was lacking, particularly amongst the younger cohort. Tertiary courses appeared to reinforce prior levels of environmental commitment and behaviour, but not challenge them. Blackie highlighted this as a problem for universities.

A later study by Wong (2001) focused on students at a large Taiwanese university during the 1996-1997 academic year. The study focused on: determining students‟ perceptions of local and global environmental issues; their views on the level of sustainability of major Taiwanese resources; their

opinions on environmental coping strategies; and their participation in environmental programmes and activities. Data was collected from students from across the university (arts, science, engineering, management, medicine, law and agriculture), and analysed by discipline, gender and level of study, using a highly structured force-choice questionnaire. The study found that most students demonstrated an awareness and concern for environmental and resource sustainability issues, however, very few students engaged in environmental advocacy.

More recently, Nikel (2007) explored student teachers‟ (studying teacher education programmes in England, Denmark and Germany) understanding(s) of education, sustainable development and education for sustainable development (ESD). Analysis of the results suggested that student learning within ESD could be viewed in its broadest sense as about:

1. knowing and applying tools for decision making;
2. finding one‟s true self;
3. knowing one‟s responsibility and taking it; and/or
4. acquiring knowledge about „what works‟ with the most impact.

The study established the importance for future teachers of „taking responsibility‟ and „having responsibility‟ as key notions in interpreting their pre-professional role and student learning in relation to ESD.

Finally, Van Petergem, *et al.* (2007) looked at education students‟ and teachers in environment-related subjects‟ conceptions and awareness of environmental issues in secondary colleges in Zimbabwe. The study found that the students perceived the environment mainly in terms of biophysical aspects, whereas teachers also included social, economic and political ones.

Studies like the ones presented here, that explore student perceptions and awareness of sustainability issues, are necessary given the lack of research in the area and in Education for Sustainable Development. Universities prepare many of the world‟s managers, decision-makers, designers and teachers, and, therefore, have considerable influence over the direction society takes and it is incumbent on them to ensure they are fully equipped to meet the challenges of a changing society (Fien, 1993; Bekessy *et al*., 2003).

Research into the impact of integrating sustainability into subject content has demonstrated that this can have a positive impact on some students‟ perceptions and awareness of sustainability (Hayles and

de la Harpe, 2007; Hayles *et al*., 2008). This paper furthers this work by looking at students enrolled in Semester One 2008 in 110ARC820, a post graduate module „Sustainable Strategies in Architecture and Construction". The students taking part were either enrolled on an MSc in Environmental Engineering with academic backgrounds in civil, structural and mechanical engineering, environmental science, geography and geology; or the BArch, a two year postgraduate programme for architecture students, leading to RIBA accreditation in architecture.

The module was developed in such a way that it would stimulate discussion between students working in small groups. As a result there was a move away from the traditional education delivery style to a more hands on approach, to make it easier for the students to foster values and behaviours, and deepen their understanding of the issues. Areas that are covered include: water; waste; pollution; energy; indoor and outdoor environments; community aspects; and legislation and assessment tools. They visit innovative green building projects, undertake building audits, question experts in the field, and study their own impact on the environment using interactive web-based tools.

In addition, students carry out group-work research in an area of sustainability auditing. In addition they are asked to complete an independent assignment on a topic relating to one or more aspects of sustainability, showing that they have grasped the key concepts and can apply critical thinking in their approach. Many of the students use this exercise to develop a research question for their Masters and BArch dissertations.

3. Student perceptions and awareness of sustainability

To explore student perceptions and awareness of sustainability and whether participation in the module could be associated with any changes in student understanding, students were asked, at the beginning and end (pre- post) of the module, to complete a survey as part of the planned class activities.

3.1 The survey

The survey was adapted from a questionnaire produced by the Oregon Episcopal School, USA, and aimed to establish student awareness and perceptions of sustainability[1]. It comprised seven questions relating to their understanding (perceptions and awareness) of sustainability, namely:

1. What is your definition of sustainability?
2. How has the concept of sustainability impacted your personal life?
3. In what ways does the UK lifestyle differ from others in the world in terms of each person‟s „ecological footprint‟?
4. If you could teach everyone one critical thing about sustainability, what would it be?
5. Which company/business do you consider a model for sustainability?
6. What is the simplest, most easily effected change which we could all do that would reduce our consumption of natural resources?
7. If you were dictator of the world, what would you require all of the countries to do immediately to save the environment?

3.2 Data analysis

Data was analysed to explore any changes in student definitions of sustainability; levels of sophistication about sustainability; and knowledge of sustainability concepts. Three methods of data analysis were used to analyse the matched pre-post paired responses, namely coded qualitative analysis, SOLO taxonomy and comparison of distinct issues, themes or concepts. Results were seen as important to inform module design as well as future approaches to learning and teaching within the module.

1. Definition of sustainability

   Coded qualitative analysis was used to analyse responses to Question 1. Student responses were analysed using a bottom up data-driven approach using a coding system following Merriam (1990). The passages of text were analysed and codes applied to them which indicated that they were examples of the same or a new thematic idea. At its simplest, this coding process allowed the retrieval and analysis of student perceptions and understanding both within the cohort and between the start and end (pre-post) of the module.

   The coded qualitative analysis was used to determine whether student definitions of sustainability changed from beginning to end (pre-post) of the module.

2. Level of sophistication/complexity

   The SOLO taxonomy (Biggs, 1995) was used to analyse responses to Questions 1-3. The SOLO taxonomy is used to determine complexity of students‟ understanding of a subject. It provides a systematic way of describing how a learner‟s performance grows in complexity when mastering a new topic. The SOLO taxonomy comprises five levels of increasing sophistication, namely:

   - Pre-structural: the student doesn‟t really understand the point and uses too simple a way of going about it.
   - Uni-structural: the student makes simple and obvious connections, but their significance is not grasped.
   - Multi-structural: the student may make a number of connections, but the meta-connections between them are missed, as is their significance for the whole.
   - Relational: the student is able to appreciate the significance of the parts in relation to the whole.
   - Extended abstract: the student is making connections not only within the given subject area, but also beyond it, able to generalise and transfer the principles and ideas underlying the specific instance (Atherton, 2005).

   The SOLO taxonomy was used to determine whether student responses increased in sophistication from beginning to end (pre-post) of the module.

3. Knowledge of sustainability concepts

   A comparison of distinct issues, themes or concepts was used to analyse the results of questions 4-7. This was done by extracting keywords from student responses. In each instance the key issue, theme or concept was evaluated both in terms of the number of times it was mentioned across the cohort, as well as whether the individual‟s response had changed at the end of the module (pre-post).

   The comparison of distinct issues/themes/concepts was used to determine whether student knowledge of sustainability concepts increased from beginning to end (pre-post) of the module.

3.3 Changes over time

3.3.1 Definition of sustainability

Five major themes were identified in the students‟ definitions of sustainability, using coded analysis of Question 1. These, along with their frequency (pre-post) are summarised in Table 1.

Table 1: Sustainability definitions from question one

Theme	*Pre*	*Post*
Progressing/improving without destruction	*9%*	*9%*
Preserving & leaving something for future generations	*18%*	*55%*
Maintaining & continuing human / economic &/or environmental systems	*46%*	*27%*
Balancing the use of natural & manmade resources & products	*18%*	*0*
Minimising human impact	*9%*	*0*
No response	*0*	*9%*

From Table 1, in terms of changes, at the beginning of the module (pre) a significant proportion of students‟ definitions related to “Maintaining & continuing human / economic & /or environmental systems”. However, by the end of the module (post), “Preserving & leaving something for future generations” dominated, demonstrating an understanding that sustainable decision making involves *looking to the future* (see also Appendix 1).

3.3.2 Level of sophistication/complexity

In Table 2, results of the analysis of Questions 1 - 3 (Definition, Personal Impact, UK Lifestyle) using the SOLO taxonomy are presented.

Table 2: SOLO taxonomy results for question 1 – 3

	Question 1		*Question 2*		*Question 3*	
Taxonomy	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*
Pre-structural	*9%*	*0*	*0*	*0*	*0*	*0*
Uni-structural	*27%*	*0*	*45%*	*0*	*55%*	*18%*
Multi- structural	*55%*	*45%*	*55%*	*64%*	*18%*	*64%*
Relational	*1*	*45%*	*0*	*36%*	*9%*	*18%*
Extended abstract	*0*	*0*	*0*	*0*	*0*	*0*
No response	*0*	*0*	*0*	*0*	*18%*	*0*

For Question 1 *Definition of Sustainability*, overall six of the 11 students demonstrated an increase in sophistication in their definition at the end of the module (post). These student whose definitions at the start of the module (pre) was relational, stayed relational (post). The greatest shift in complexity of student understanding of sustainability was demonstrated by those students who at the beginning of the module gave pre/uni-structural definitions (pre)

(An example of a uni-structural definition: "*the use of environmentally friendly renewable resources and materials".)*, and shifted to multi-structural/relational definitions (post)[2]. An example of a relational definition: "*living, working and progressing in a manner which does not adversely impact [on] the environment and ensuring all resources are used wisely to try [and] insure their availability for the future".*

For Question 2 *Personal Impact*, recycling, waste, using the car less (public transport, cycling and walking instead), energy use in the home and designing for sustainability, all featured as key impacts; however the way in which they were discussed by the students differed in sophistication. There was significant movement in the pre and post responses to the question, with 8 increasing in sophistication (see Table 2 and Appendix 1). On the whole, students‟ responses indicate that knowledge of sustainability does have an influence on their personal lives and their awareness of how sustainability impacts on them or indeed how they impact on sustainability became more sophisticated during the semester. They also acknowledged changes to the construction industry which may impact on them.

Architecture student: "*I will now incorporate sustainable design into all of my architecture coursework"*.
Engineering student: "*the planning policy for zero carbon has affected me because I come from a construction background"*.

For Question 3 *UK Lifestyle* overall six student responses increased in sophistication whilst two students who initially could not give a response (pre) gave multi-structural responses (post). Few Student responses (pre and post) demonstrated a relational understanding as most failed to demonstrate how the UK lifestyle differs from others in the world.

An example of a relational response: "*we don't use as much locally grown resources and therefore we import more from abroad. Therefore the average individuals' ecological footprint is greater. We are not as environmentally conscious here as we should be because we are a richer nation"*.

An example of a uni-structural response: "*the footprint for the country is large considering its size*."

However, connections were made with limited resources and particularly energy consumption. An example of a multi-structural response: "*We have a significantly greater footprint than other countries. We are consuming large amounts of resources."*

Results for any changes in student knowledge of sustainability concepts (Questions 4 – 7) using a comparison of distinct issues, themes and concepts, are presented next.

3.4 Knowledge of sustainability concepts

3.4.1 Critical issue (Question 4)

There was a greater spread of ideas at the beginning of the module (pre) than at the end (post) regarding answers to the question "If you could teach everyone one critical thing about sustainability, what would it be". At the beginning of the module answers varied dramatically and were very specific e.g. building with wood; using renewable energy; and not leaving windows open with the heating on. At the end of the module the student ideas were dominated by teaching people to be aware of their actions and the impact that they may have on future generations; and that sustainability is not just about the environment but also takes into consideration social and economic issues (the triple bottom line).

3.4.2 Model business (Question 5)

When asked which company/business they considered to be a model for sustainability, six students could not provide the name of a business at the beginning of the module. The other five students referred to organisations such as friends of the earth and Greenpeace. By the end of the module three students still could not come up with an example. Of the remaining eight, responses had shifted to include LEED (the US"s Leadership in Energy and Environmental Design scheme); architectural firms and a local building contractor (who hosted one of the site visits). By far the biggest shift was from students who gave no response (pre) to giving an example from within the construction industry (post).

3.4.3 Changing behaviours (Question 6)

When asked for the simplest, most easily effected change that would reduce our consumption of natural resources, student initially focused (pre) on, use public/non car transport; recycling; and turning off appliances at the switch. At the end of the module (post) the responses included social sustainability issues such as, purchasing locally produced food; consuming wisely; as well as conserving energy in the home through wall/roof insulation and low energy appliances.

3.4.4 Immediate action (Question 7)

Answers to the question that required students to put themselves into the role of a World Dictator, and nominate what they would require all of the countries to do immediately to save the environment also showed some changes. Initially (pre) the majority of student as dictators" focus was split between using renewable energy and waste and water management. At the end of the module (post),

student dictators proposed similar solutions with the addition of recycling and carbon neutral buildings, however, two students suggested that nothing could be done unless people took ownership of the problem, and that a dictator would go against the whole ethos of sustainability.

4. Discussion and conclusions

The results of the survey administered in week one (pre) of the semester indicated that many of the students‟ definitions demonstrated an understanding of sustainability issues, although they did not always provide sophisticated arguments which demonstrated a relational/extended abstract understanding.

No student response was classified as „extended abstract‟. However, the responses students gave may have been influenced by a number of factors including: limited space in which to provide their response; the nature of the questions being asked; the fact that the activity did not count towards their final assessment; and/or that this was an atypical activity, one that students may not previously have encountered during their degree programme.

Results of the SOLO taxonomy data suggested that the students who gave a less sophisticated (uni/multi-structural) response were more likely to demonstrate an increased level of understanding and critically respond to the questions at the end of the module (relational). This was particularly evident when asked how the concept of sustainability had impacted on their personal lives.

During the semester students were asked to reflect on their own lives, the decisions they make and the impact or consequences these decisions have on others and the environment, before considering the impact of decisions they may make in their professional lives.

From the pre-post results it appears that some students increased their perceptions and awareness of sustainability in terms of how they defined sustainability, the level of sophistication of their answers and their knowledge of sustainability concepts.

Add Link to these findings being possibly associated with teaching that was student centred and focussed on engagement, subject content and the educational context for learning.

Overall, these results show that it is possible to help some students to develop their understanding and awareness of sustainability issues, but that this is not easy to achieve through participation in a stand-alone, one-off module experience. While this is hopeful news for Education for Sustainable Development, it also points to the need for much more connected work aimed at supporting student conceptual change. Indeed, support for sustainability should permeate the curriculum and be aligned to the goals of the programme, learning outcomes and activities, as well as linked to the assessment (Biggs, 2003).

Ramsden (2003) reminds us that while higher education teachers expect that their students will change their conceptions of the world around them through the subjects they are studying he asks "[why do] these changes not always happen?" and "[why do] students often obtain quantities of knowledge, yet fail to change their understanding of what it means?..." (p.40). He suggests that in order to facilitate student learning, that is to help learners change the way they conceptualise the world, the answer lies in how learning is facilitated and the context in which it takes place.

Deep or significant learning, learning for understanding, according to Fink (2003; 2006) is characterised by students:

1. understanding and remembering the key concepts, terms, relationships;
2. knowing how to use the content;
3. being able to relate the subject to other subjects;
4. understanding the personal and social implications of knowing about the subject;
5. valuing the subject and further learning about it; and
6. knowing how to keep on learning about the subject, after the module is over.

Effective student learning that leads to conceptual change involves students actively engaging in learning for understanding, as opposed to memorisation; based on experiential approaches that are underpinned by a learner-centred methodology where the focus is on students‟ experience of learning rather than the teachers‟ experience of teaching (Prosser *et al.,* 2003). Deep learning can be fostered when multiple opportunities for students to engage in activities that intentionally encourage the making of meaning and learning for understanding, rather than recall or memorisation, are provided. Creating significant learning experiences that take students beyond just learning the content are more likely to result in deep learning and facilitate conceptual change (Ramsden, 2003). Such teaching is characterised by:

- aiming to share;
- ensuring that the material is interesting and stimulating;
- engaging students at the level at which they are at;
- being clear what is to be understood, at what level and why; shows respect and concern for students;
- supporting and encouraging independent learning and an ability to adapt to new demands;
- using methods that require thoughtful, responsible and cooperative behaviours;
- focusing on helping overcome misconceptions;
- assessing learners appropriately and providing feedback; and
- relying equally on the teacher being willing to learn from the students

This study has highlighted the importance of student engagement, subject content and the educational context for learning. The results of this study highlight the importance of student-centred activities where students are provided with opportunities to engage with their subject matter and construct their own knowledge and understanding; creating a „hot cognitive economy" (Tag, 2003). This is in line with the constructivist"s view of learning.

The study has also reinforced the need for alignment between curriculum and its intended outcomes, teaching methods and assessment tasks (Biggs, 2003) if students" learning is as intended.

Whilst this module attempted to address these issues, it is also clear that to continue to build on shifts in student conceptual thinking about education for sustainable development, sustainability concepts need to be integrated in context across all modules by all discipline instructors if we are to see lasting change in the way students view their role and contribution to a sustainable built environment, both now and in the future.

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