
An Approach to Embedding Sustainability into Undergraduate Curriculum: Macquarie University, Australia Case Study

Leanne Denby and Sara Rickards

Abstract

Universities have been identified as being critical in developing sustainability-focused skillsets and mindsets (UNESCO in United Nations Decade of Education for Sustainable Development 2004–2014, 2004; UNCSD in The future we want, 2012; UE4SD in The state of the art report 2014). A UK-based survey further identified that 80 % of students believe that universities should incorporate sustainable development. Additionally this percentage increases as students progress through their degree (LSIS in Embedding sustainability into teaching, learning and curriculum in the learning and skills sector, 2013). There is also a growing demand from business, for graduates to be sustainability literate, with company leaders increasingly seeing sustainability as one of the top 3 priorities (McKinsey in Sustainability's strategic worth McKinsey global survey results, 2014). Academic discussions around sustainability are often problematic due to many factors including understanding, relevance and time (LSIS 2013; Lozano 2010). The approach outlined in this chapter acknowledged barriers and utilised a method to mitigate these issues. The process focused on program level mapping and coverage of sustainability as an interdisciplinary concept, using the Macquarie University Sustainability Framework. The initial stages undertaken in 2014 investigated connections to sustainability in four undergraduate programs at Macquarie University: Bachelor of Media (Faculty of Arts); Bachelor of Human Science (Faculty of Human Science); Bachelor of Mechanical Engineering (Faculty of Science), and Bachelor of Business

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Administration (Faculty of Business and Economics). The programs involved in this phase were chosen because they were not typically ‘sustainability-focused’ degrees. However, mapping showed all programs demonstrated connections to sustainability learning at the program level, covering a minimum of 86 % of the Framework, with the Bachelor of Human Sciences demonstrating 100 % coverage. Evaluation as to whether graduates leave with sustainability skills and knowledge is yet to be completed. Providing evidence of teaching that not just informs, but transforms students will be vital to increasing employability of Macquarie University graduates. Going forward the authors aim to measure the transformational learning of both academics and students. Essentially, external circumstances at a global level dictate that embedding sustainability into the curriculum is a responsibility all universities must undertake. The evidence gathered to date indicates that this is not an impossible mission, so long as a considered methodology and adequate resourcing is in place to support often time-poor academics.

Keywords

Sustainability • Sustainable development • Curriculum • Higher education

1 Introduction

This chapter proceeds on the assumption there is general understanding that there is no doubt that today’s students face some of the greatest challenges of our times as they enter a changing workforce, surrounded by a rapidly changing society and environment. Growing social and environmental pressures demand new skillsets, fostered through pedagogy that stimulates innovative, active and collaborative learning experiences (Tilbury 2011). Universities have been identified as being critical in developing sustainability-focused skillsets and mindsets (UNESCO 2014; UNCSD 2012; UE4SD 2014). However, academic discussions around sustainability are often problematic due to many factors.

Extensive research undertaken in 2013 on behalf of Learning Skills and Improvement Service (LSIS) looked at exploring and understanding the relationship and relevance of sustainability to education, including understanding the barriers to a broader uptake of Education for Sustainability (EfS) (LSIS 2013). The primary barrier related to a lack of sustainability understanding, and an inability on how to translate it into subject matter. Time was also cited, particularly concerning already busy classes, and a capacity to take time to learn about sustainability and its relevance to subject areas. Acknowledging known barriers provides a useful starting point for thinking about how to progress the EfS agenda.

To mark the end of the United Nations Decade of Education for Sustainable Development, a survey out of the United Kingdom found that 80 % of students believe that universities should incorporate sustainable development. Additionally this percentage increases as students progress through their degree (HEA 2014). There is also a growing demand from business, for students to be sustainability literate, with company leaders increasingly seeing sustainability as one of the top 3 priorities (McKinsey 2014).

Systemic educational change with respect to sustainability has been slow, primarily due to our inability to overcome institutional inertia and disciplinary traditions (Greig 2015).

University leaders and staff must be empowered to catalyse and implement new paradigms, and ensure that Sustainable Development is the ‘Golden Thread’ throughout the entire university system (Lozano et al. 2013)

Essentially, embedding sustainability into curriculum cannot be left for one discipline or program¹ to implement if a shift towards a more equitable and ecologically just world is to occur—teaching what and how we have always taught only assists to maintain current unsustainable paradigms. Therefore, to achieve sustainability mindsets and skillsets, it is critical to consider process as well as content. But what does it mean to have a pedagogical process that encompasses sustainability? And what support is needed to assist academics² grappling with this all too nebulous concept?

A team from Macquarie University, Sydney, Australia, consisting of staff from Macquarie Sustainability (the authors), set about trying to answer these and other questions. The approach used at the University aims to demystify sustainability, using the Macquarie University Sustainability Framework (the Framework) to provide clear guidelines for identifying Education for Sustainability (EfS), and demonstrate how skills for sustainability are applicable in any program. This approach allows investigation as to whether such a framework is useful to academics, and what support is needed for program level, interdisciplinary concept learning.

The initial stages of the project investigated how sustainability is mapped and embedded into four undergraduate programs: Bachelor of Media (Faculty of Arts); Bachelor of Human Science (Faculty of Human Science); Bachelor of Mechanical Engineering (Faculty of Science), and Bachelor of Business Administration (Faculty of Business and Economics).

¹In this context, ‘program’ is equivalent to ‘degree’. Essentially, the grouping of individual units to make a program or degree, leading to a Bachelor qualification. Units are often called ‘courses’ elsewhere.

²‘Academics’ is the term used in Australia to define teaching staff. Often called ‘Faculty’ elsewhere.



Fig. 1 Macquarie University sustainability framework

2 Macquarie University Sustainability Framework

Macquarie University incorporated sustainability as an underlying principle of undergraduate capabilities in 2010. With quality assurance requirements coming to the fore in Australia in 2012, the University was prompted to demonstrate how graduate capabilities were being developed in-line with this guiding principle—and in a way that academics could relate to. A small project team consisting of academics across Macquarie’s four faculties was brought together to develop a framework to clarify the ‘what’ and ‘how’ of sustainability in the curriculum (Fig. 1). This Framework was tested against 72 People and Planet units,³ and

³People units are designed to give students an understanding of what it means to live in the social world, and to develop cultural or social literacy, while Planet units enable students to develop an

Table 1 Sub-themes of the sustainability framework

Harmony & Wellbeing	Economics & Economic Wellbeing	Natural Resources	Climate Change	Implementation & Governance	Learning Skills
Social justice & equity	Production, consumption & waste	Atmosphere	Science of climate change	Participation of stakeholders in decision making	Future thinking, visioning
Health	Trade & development systems	Biodiversity	Social, environmental & economic impacts of climate change	Communication	Responsible innovation (underpinned by ethical decision making)
Human rights	Sustainable economies	Oceans, seas and coasts	Adaptation & resilience	Promoting education, public awareness and training	Critical thinking: ability to challenge, 'find your voice'
Animal rights	Investment	Freshwater	Mitigation	Access to information, sharing of technology	Creative thinking
Cultural diversity	Financing	Management	Risk assessment	International, national & local governance	Clarification & activation of value systems
Poverty		Land use and tenure	Coastal management	Political dimensions	Leadership
Food Security		Planetary boundaries	Transport	Corporate social responsibility	Self-directed, autonomous & reflective learning
Cooperation				Integration of environment & social development in decision making	Practical, real world knowledge
Learning from history				Instruments & mechanisms	Systemic thinking
Disaster management				Capacity building	Consequential thinking
				Sustainable design – sustainable cities	Stakeholder, group collaboration & wider interpersonal skills
					Communication skills

workshopped at two international conferences for further input and feasibility testing. The authors are yet to determine how iterative the Framework should be in order to maintain relevance over time, without compromising any work completed using it as it currently exists.

The Framework consists of five primary content related themes (Harmony and Wellbeing; Economy and Economic Wellbeing; Natural Resources; Climate Change; Implementation and Governance), and pedagogy based on learning skills

(Footnote 3 continued)

understanding of science and the challenges and issues facing the world at present (<http://handbook.mq.edu.au/2015/Units/People> and <http://handbook.mq.edu.au/2015/Units/Planet>).

and value recognition in line with EfS principles. Each primary theme is underpinned by numerous sub-themes (see Table 1), with definition at both the primary and sub-theme level deriving from internationally recognised reference points. At present, the Framework provides Macquarie University with a consistent method for mapping EfS, with the added bonus of building understanding and knowledge of holistic sustainability.

3 Method

Research has shown there are a number of existing approaches to embedding sustainability into curriculum (LSIS 2013):

1. Adding sustainability topics to lectures in an opportunistic manner
2. Having a planned approach to include sustainability topic/s as part of lessons
3. Using existing programs that focus on sustainability in some capacity
4. Having a requirement specified by professional bodies to include sustainability topics in order to complete a degree
5. Developing an additional program or course that focuses on sustainability
6. Including sustainability topics in a capstone or other unit designated as compulsory for learning
7. Adopting different pedagogies to create a different way of working and learning, enabling the learner to understand themselves and the world
8. Including sustainability themes without actually highlighting them as 'Sustainability'
9. Including a combination of the approaches listed above

Informed by previous discussions with academics around the topic of sustainability in curriculum, the authors proceeded on the assumption that approach number 8 was common at the University: academics essentially needed a way to identify the connections with sustainability and their teaching, hence the use of the aforementioned Framework (Fig. 1). It was also acknowledged that approach number 9 would also be relevant, and capturing this element became part of understanding how academics were teaching where connections to the Framework existed (See Sustainability Mapping below).

Time was also spent researching and understanding barriers to engaging academics in sustainability discussions to assist in developing the appropriate way forward. By pre-empting barriers such as time, relevance, and lack of understanding (LSIS 2013; Lozano 2010), the approach was adapted accordingly, to increase likelihood of success. The primary insight gained from this research was ensuring there was a dedicated resource to complete the majority of work involved, rather than placing that burden onto the academics themselves: hence the appointment of an Education for Sustainability (EfS) Manager. This dedicated resource, in conjunction with the Framework, provided a way to alleviate the aforementioned barriers.

Consideration was further given to understanding existing and emerging trends within the University, to ensure that yet another level of complexity was not introduced into the academic workload, and to demonstrate alignment with the broader strategic direction. As it happened, changes were at hand, with the University moving towards better definition and mapping at the program level. Hence program level mapping, rather than sporadic individual unit mapping, became an integral part of the approach.

In order to incorporate the learning from the aforementioned conditions, the authors chose to utilise two methodologies: sustainability mapping and sustainability surveys. For the purpose of this chapter, only the mapping will be discussed.

3.1 Sustainability Mapping

Utilising the Framework, the authors worked with unit convenors to make implicit connections to EfS more explicit, whilst providing support to those who wished to enhance sustainability learning for themselves and/or their students. Table 2 outlines the stages involved for identifying and enhancing sustainability connections, noting that at the time of writing, the authors had only progressed to stage 2 for three programs, and stage 3 for one program (discussed in Results). Some unit convenors have also progressed to the post stage, though this will not be covered in this chapter.

Once mapping was completed, the compilations were given to Program Directors with recommendations. A post involvement focus group was also conducted with Program Directors to evaluate what worked, what didn't work, and any suggestions for improvement.

It should be noted that neither of the authors are employed at Macquarie University in an academic capacity. Both in fact sit within a professional or non-academic office. Recognising the potential friction that could be caused by having non-academic staff enter into the academic space, the authors spent a considerable amount of time undertaking a process of learning. This learning included better understanding the language and circumstance of academics (concerns such as workload and research pressures for example), whilst gaining trust through informal discussions and networking opportunities. There was also a certain amount of determination and passion required in order to make the case for EfS compelling. The fact that the authors also positioned themselves as providing service and support, rather than as 'experts' with all the answers, also seemed to allay concerns, which may have been held by academics.

Table 2 Integrating and mapping sustainability approach

Stage	Approach	Comments
Pre: set up	The authors met with Executive Deans and Associate Deans Learning and Teaching (AD L&T) to gain support and identify a non-traditional sustainability program to undergo mapping. AD L&T then approached the relevant Program Director ^a to ask if they would be involved, after which time, the authors made formal contact with the Program Director	It was essential to gain Executive buy-in, and have that level initially contact the Program Director, so that the Director had the right to veto without direct contact with the authors. Initial discussions with Directors outlined the methodology. Initial communications with Unit Convenors was generated by the Program Director Time impact: while the discussions themselves were not time intensive, coordinating to find suitable meeting times did take some effort on behalf of the authors
1. Preliminary mapping	With input from the Program Directors, the authors identified core units from each program that would be mapped. The authors then used unit outlines to do a preliminary mapping exercise against the Framework. Figure 5 demonstrates this mapping	Using the unit outline provided an opportunity for us to determine what impression a student might have regarding sustainability learning occurring within the program. The authors acknowledge that their in-depth knowledge of sustainability likely skewed the preliminary mapping, when comparing how someone with no sustainability knowledge may have interpreted learning outcomes for mapping Time impact: this stage had minimal impact on Program Directors, but was very time intensive on behalf of the authors, with each unit requiring 15 min to map, resulting in program mapping taking approximately 4 h each <i>N.B. After evaluation, it is unlikely that this stage will continue as validity vs time invested was not worthwhile</i>

(continued)

Table 2 (continued)

Stage	Approach	Comments												
2. Convenor mapping	The authors facilitated workshops and one-on-one discussions with unit convenors to assist them in using a matrix template to populate where they felt they had connections with the Framework. Figures 2, 3, 4 and 6 demonstrate this mapping	<p>Having the unit convenors undertake the mapping exercise themselves allowed gaps between preliminary mapping and their own understanding of where connections occur to be revealed. It also provides a way to understand how the overall program maps with regards to EfS. To gain insight into how the Framework was assessed convenors identified how they were addressing the Framework using the following coding:</p> <table><tr><td>I</td><td>Implicit: Covered but not explicitly. Students may not recognise learning as EfS.</td></tr><tr><td>LTC</td><td>Lecture/Tut Content: Content connected to a theme/s is explicitly covered as content in a lecture/s and/or tutorial/s.</td></tr><tr><td>LTP</td><td>Lecture/Tut Pedagogical: Connections exist through the way in which learning occurs. For example Workplace Integrated Learning opportunities building Learning Skills.</td></tr><tr><td>CP</td><td>Lecture/Tut Content and Pedagogical: A combination of LTC and LTP occurs</td></tr><tr><td>LO</td><td>Learning Outcome: Stated learning outcome of engaging with a unit or program.</td></tr><tr><td>A</td><td>Assessment: Assessment task explicitly connects to EfS.</td></tr></table> <p>Time impact: Most of the impact was borne by the authors in trying to find suitable time to meet with convenors. Mapping by convenors usually took 30 minutes on average.</p>	I	Implicit: Covered but not explicitly. Students may not recognise learning as EfS.	LTC	Lecture/Tut Content: Content connected to a theme/s is explicitly covered as content in a lecture/s and/or tutorial/s.	LTP	Lecture/Tut Pedagogical: Connections exist through the way in which learning occurs. For example Workplace Integrated Learning opportunities building Learning Skills.	CP	Lecture/Tut Content and Pedagogical: A combination of LTC and LTP occurs	LO	Learning Outcome: Stated learning outcome of engaging with a unit or program.	A	Assessment: Assessment task explicitly connects to EfS.
I	Implicit: Covered but not explicitly. Students may not recognise learning as EfS.													
LTC	Lecture/Tut Content: Content connected to a theme/s is explicitly covered as content in a lecture/s and/or tutorial/s.													
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CP	Lecture/Tut Content and Pedagogical: A combination of LTC and LTP occurs													
LO	Learning Outcome: Stated learning outcome of engaging with a unit or program.													
A	Assessment: Assessment task explicitly connects to EfS.													
3. Levels of learning	The authors facilitated workshops and one-on-one discussions with unit convenors to assist them in providing details against levels of learning occurring in the mapping. The Bachelor of Human Sciences case study demonstrates this mapping	<p>A rudimentary tick system was used to capture levels of learning: √ = Some discussion occurs, though not the main focus √√ = Covered in detail √√√ = Consistent theme throughout delivery of unit/major component</p> <p>N.B.: capturing levels of learning is quite a difficult but essential process in establishing depth rather than just breadth. Much of this element is still underway, with the exception of Bachelor of Human Sciences (Fig. 7). At present, the tick system seems to work reasonably well, however further evaluation of effectiveness will occur over time</p> <p>Time impact: as per other stages, most of the time impact was borne by the authors trying to find times convenors were available to meet. For the convenors themselves, this mapping exercise took about 30 min on average</p>												

(continued)

Table 2 (continued)

Stage	Approach	Comments
4. Supporting documentation	The authors facilitated workshops and one-on-one discussions with unit convenors to gather supporting documentation against mapping. This predominantly involves getting access to the online system used by convenors to disseminate information to their students (iLearn) to bring together 'evidence' to support stated claims, in line with quality assurance requirements	This element is still underway and is proving to be the most difficult and time consuming. Often convenors have difficulty determining what would be suitable as a supporting document, which often caused some distress and confusion. It is anticipated in the future authors will be enrolled in iLearn early, and work more closely and intensely with convenors Time impact: this is definitely one of the most time intensive stages for both the authors and convenors. Convenors need to be able to suggest appropriate documentation, which often requires them to revisit what resources, assessments, and tasks they provide to students. For the authors, it requires spending time sifting through the information provided in iLearn, connecting the dots to the mapping. Estimating time involved in this stage is difficult, and can range from 1 h to a full day
Post: continued development	Many unit convenors expressed an interest in further developing their unit to align with sustainability learning	Work will continue with unit convenors to develop appropriate teaching resources, whilst also assisting to bring identified connections to the fore. The post phase is a critical element in maintaining sustainability-learning connections Time impact: the impact in this stage is mostly on the authors, rather than the convenors, and is dependent on whether an appropriate resource already exists in the resource base or if more work needs to be done to develop an appropriate resource. Time required here is variable

The Program Director is a new position at Macquarie University, but essentially is a nominated academic responsible for representing the program, and working to build the program approach being adopted by the University

4 Results

4.1 Key Findings

- Of all the Framework themes from Fig. 1, Climate Change and Natural Resources had the least coverage (Tables 3, 5, 7 and 9)

- Learning Skills emerged as the primary EfS connection across all programs (see Table 1 for details of defined Learning Skills)
- Working with cross-faculty programs verses department based programs proved harder to collectively gather convenors for workshop participation, resulting in more one-on-one transactions (with time impact for the authors)
- The interdisciplinary Bachelor of Human Sciences program emerged as the program with the best overall coverage of sustainability themes (Fig. 6).

4.2 Sustainability Mapping Percentages

As part of the results presented, there are a number of percentages displayed within tables. Following is an explanation of these:

- ‘Program theme level coverage’ is a percentage of the total program coverage, by Framework theme (Fig. 1). For example in Table 3, Harmony and Wellbeing has 19 % coverage, which means that 19 % of possible sustainability connections with sub-themes (Table 1), at a program level are covered.
- ‘Pedagogical coverage’ relates to the spread as a percentage of how the Framework (Fig. 1) is being addressed. For example in Table 4 there is 28 % of the total Framework connections being covered Implicitly (I).

Table 3 Program level theme coverage

Harmony and wellbeing (%)	Economies and economic wellbeing (%)	Natural resources (%)	Climate change (%)	Implementation and governance (%)	Learning skills (%)
19	34	9	3	28	45

Percentage based on the total number of coloured squares within each theme from Fig. 2

Table 4 Pedagogical coverage

I	28%
LTC	33%
LTP	4%
CP	3%
LO	9%
A	24%

4.3 Overview of Individual Program Findings

The following results present unit convenor mapping outcomes (Stage 2), and high-level analysis of this mapping. The case study on the Bachelor of Human Sciences gives a more in depth overview of Stages 1–3 mentioned in Table 2.

4.4 Bachelor of Business Administration

4.4.1 Key Findings

- 86 % of the Framework (Fig. 1) is taught at the program level (Fig. 2)
- Learning skills was the most highly covered area at 45 % (Table 3)
- Most learning occurred through Lecture and/or Tutorial content (LTC) at 33 % (Table 4).

4.5 Bachelor of Mechanical Engineering

4.5.1 Key Findings

- 96 % of the Framework (Fig. 1) is taught at the program level (Fig. 3)
- Learning skills emerged as the key area covered at 64 % (Table 5)
- Assessment (A) emerged as the primary manner by which learning occurred at 26 % (Table 6).

4.6 Bachelor of Media

4.6.1 Key Findings

- 86 % of the Framework (Fig. 1) is taught at the program level (Fig. 4).
- Learning Skills is the dominant path through which sustainability connections occur at 82 % (Table 7).
- Assessment (A) emerged as the primary delivery mechanism for sustainability learning at 53 % (Table 8).

4.7 Case Study

The authors chose to use the Bachelor of Human Sciences as the more in depth case study for two main reasons:

- The interdisciplinary nature of the program set it apart from the other programs;
- Of all the programs, this was the one that progressed the furthest in accordance with the stages outlined in Table 2.

Table 5 Program level theme coverage

Harmony and wellbeing (%)	Economies and economic wellbeing (%)	Natural resources (%)	Climate change (%)	Implementation and governance (%)	Learning skills (%)
21	24	15	14	30	64

Percentage based on the total number of coloured squares within each theme from Fig. 3

Table 6 Program level sustainability pedagogical coverage

YES	21%
I	20%
LTC	19%
LTP	3%
CP	8%
LO	3%
A	26%

4.8 Bachelor of Human Science

4.8.1 Key Findings

- 100 % of the Framework (Fig. 1) is taught at the program level (Fig. 6).
- Preliminary Mapping (Stage 1, Table 2) predicted 29 % Framework coverage, whilst convenor mapping determined coverage to be 79 %, indicating a large difference between what unit outlines are articulating and what is actually occurring (Figs. 5 and 6).
- At 93 %, Learning Skills dominated as the area through which connections and learning occurred (Table 9).
- 38 % of learning occurs where sustainability is a consistent theme throughout delivery of the unit or as a major component—indicated by 3 ticks (Fig. 7).

Assessment of the program level coverage revealed that Learning Skills (93 %), Harmony and Wellbeing (79 %) and Implementation and Governance (79 %), were the primary themes addressed across the program (Table 9).

4.8.2 Pedagogical Coverage

Coverage across all areas was fairly consistent, with the exception of Lecture and Tutorial Pedagogical (LTP), which was considerably low (Table 10). Likewise pedagogical approaches utilised to address themes was also spread across the program (Table 11).

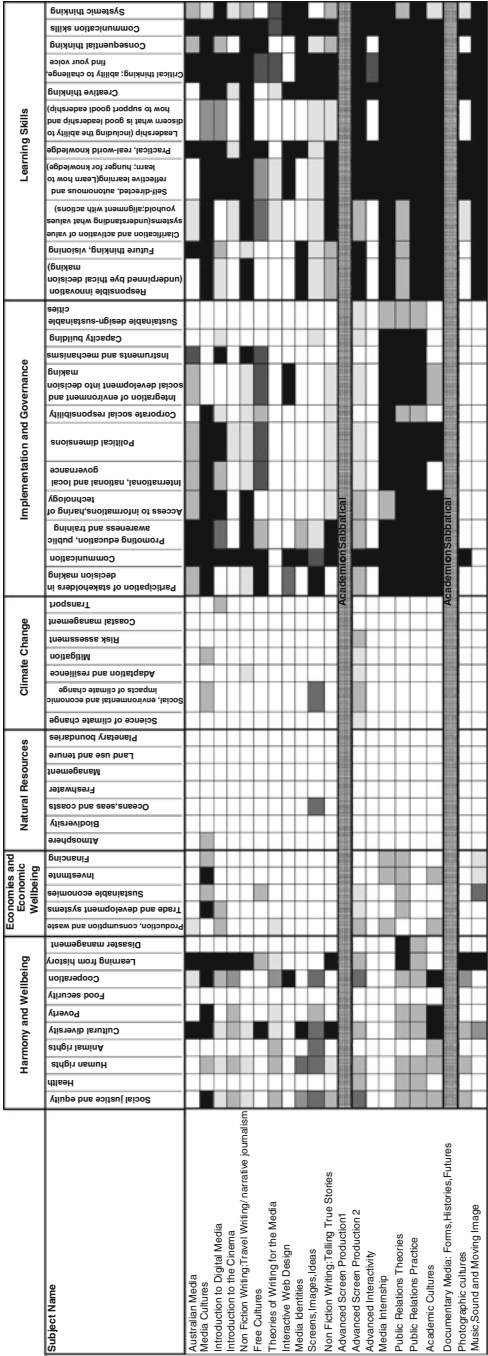


Fig. 4 Convenor mapping bachelor of media

Table 7 Program level theme coverage

Harmony and wellbeing (%)	Economies and economic wellbeing (%)	Natural resources (%)	Climate change (%)	Implementation and governance (%)	Learning skills (%)
43	25	1	7	34	82

Percentage based on the total number of coloured squares within each theme from Fig. 4

Table 8 Program level pedagogical coverage

I	16%
LTC	23%
LTP	2%
CP	3%
LO	3%
A	53%

4.8.3 Levels of Learning

More than a third of learning (38 %) saw sustainability emerge as a major component or consistent theme throughout delivery of units (defined as 3 ticks), while 30 % had sustainability covered in detail (2 ticks) and 31 % involved some discussion though sustainability is not the main focus (1 tick) (Stage 3, Table 2; Fig. 7).

5 Discussion

Education is the most powerful path to sustainability. Economic and technological solutions, political regulations or financial incentives are not enough. We need a fundamental change in the way we think and act.

Irina Bokova, Director-General of UNCSD (2012)

As societal challenges continue to grow, it is no longer sufficient for new graduates to rely on subject or discipline specific knowledge. Nor should it be acceptable for educational institutions to continue to teach the same knowledge and skills in the same way: as Einstein is famously quoted for saying “we cannot solve our problems with the same level of thinking that created them”. Furthermore, students require skills that will enhance their chance of employability (Fallows and Stevens 2000), while encouraging them to break free from reinforcing current

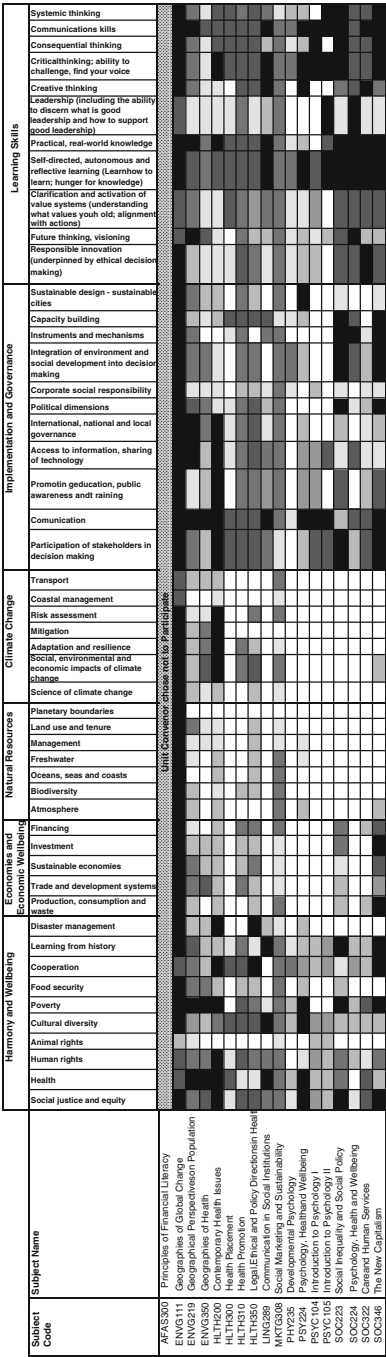


Fig. 6 Convenor mapping bachelor human science

Table 9 Program level theme coverage

Harmony and wellbeing (%)	Economies and economic wellbeing (%)	Natural resources (%)	Climate change (%)	Implementation and governance (%)	Learning skills (%)
79	52	30	33	79	93

Percentage based on the total number of coloured squares within each theme from Fig. 6

unsustainable paradigms. Not surprisingly, the focus of EfS is to equip students with skills and abilities that enable them to understand and resolve complex sustainability problems, to become effective change agents (Johnston 2013; Wiek et al. 2011). These sustainability skills and abilities are transferrable, therefore of value to any prospective employer, whilst positioning EfS as a transformative learning pathway with better outcomes for society more broadly. Interestingly, the results of this work showed that Learning Skills emerged as the dominant area through which connections to sustainability were identified across all four programs (Tables 3, 5, 7 and 9). The fact that EfS Learning Skills dominated highlights the opportunity universities have to create pathways that will ideally lead to a positive societal shift, whilst providing additional value for students in terms of employability.

The programs involved were all chosen because they were not typically ‘sustainability-focused’ degrees. However, as predicted earlier, sustainability is often included without being recognised as sustainability (LSIS 2013), and this is certainly the case here, with findings showing that programs cover a minimum of 86 % of the Framework. At this stage, it appears that much sustainability teaching is occurring implicitly. This is primarily due to unit convenors’ lack of understanding of what holistic sustainability means, rather than by intent. It is anticipated that once understanding improves, gaps and implicit connections to sub-themes within the Framework can be more easily made explicit by design. Without doubt, having the Framework as a reference point for defining sustainability was extremely beneficial, as it gave unit convenors an opportunity to explore connections quickly and easily. Work to date also reinforced the value of program level approaches, as mapping at this level allowed for themes to be addressed in a more strategic scaffolded approach, whilst also reassuring unit convenors and program directors that not every unit had to align with every Framework theme, to provide students with consistent exposure to EfS.

In looking at how to successfully address EfS, the authors came to the understanding that programs, units and academic availability are intricately different—agreement, engagement and outcomes are best achieved through a tailored approach, specific to individual circumstance. For example: Mechanical Engineering was undergoing an accreditation process in which sustainability is an embedded Stage 1 Competency (Engineers Australia 2015). Linking work in this program to the accreditation process resulted in sustainability mapping being a clear value-add for the Mechanical Engineer’s accreditation submission. However, programs with no sustainability accreditation requirements needed a different identified ‘driver’, tailored to their specific needs to encourage engagement. In all

Subject Code	Subject Name	Harmony and Wellbeing				Natural Resources				Climate Change				Implementation and Governance				Learning Skills																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																					
		Social justice and equity	Health	Human rights	Animal rights	Cultural diversity	Poverty	Food security	Cooperation	Learning from history	Disaster management	Sustainable economies	Investment	Financing	Atmosphere	Biodiversity	Oceans, seas and coasts	Fresh water	Management	Land use and tenure	Planetary boundaries	Science of climate change	Social, environmental and economic impacts of climate change	Adaptation and resilience	Mitigation	Risk assessment	Coastal management	Transport	Participation of stakeholders in decision making	Communication	Promoting education, public awareness and training	Access to information, sharing of technology	International, national and local governance	Political dimensions	Corporate social responsibility	Integration of environment and social development into decision making	Instruments and mechanisms	Capacity building	Sustainable design - sustainable cities																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
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Fig. 7 Bachelor of human sciences levels of learning mapping

Table 10 Program level pedagogical coverage

I	17%
LTC	20%
LTP	3%
CP	18%
LO	17%
A	25%

Table 11 Pedagogical coverage by theme

	Harmony and wellbeing (%)	Economies and economic wellbeing (%)	Natural resources (%)	Climate change (%)	Implementation and governance (%)	Learning skills (%)
I	11	11	31	18	19	16
LTC	27	41	36	28	16	9
LTP	7	2	0	0	3	1
CP	18	23	14	21	20	17
LO	13	7	0	10	17	28
A	24	16	19	23	25	29

Percentage based on the number of individual coloured squares, within each theme from Fig. 6

circumstances, it was critical to work closely with the Program Director to establish the most appropriate language, approach and timing for moving forward. Program Directors were a necessary initial link to reaching and engaging core unit convenors, though interestingly, the unit convenors from the Bachelor of Human Science did not necessarily identify themselves as being part of a program. This situation may be specific to this program as it was just newly established.

The Bachelor of Human Science is actually an interesting case for another reason. Unlike any other participating programs, it has 100 % coverage of the Framework (Fig. 6). In fact, mapping levels of learning showed 38 % coverage of sustainability as a consistent theme throughout delivery of units (Stage 3, Table 2; Fig. 7). This outcome, combined with the fact that assessments emerged as the primary method through which pedagogy was covered (Table 10), is a fairly good indication that students should leave the program with enhanced sustainability knowledge and skills. Analysis of impact is yet to occur, as the program is yet to be delivered in totality. The broad spread could indicate the inherent diversity of an interdisciplinary program as a strength for addressing interdisciplinary concepts and the benefit of sustainability as an interdisciplinary concept and ‘golden thread’ in an interdisciplinary course. Additionally, disciplinary teaching must be supplemented

by interdisciplinary education, to provide students with the ability to deal with issues that transcend disciplines (Gardner 2006).

Various research has indicated the primary barriers for embedding sustainability into curriculum, which includes: time; sustainability understanding; over-crowded curricula; relevance to course or discipline not being apparent, and lack of support. (LSIS 2013; Lozano 2010). As previously mentioned, prior to commencing work with these programs, the authors had given extensive consideration to addressing these barriers. Having dedicated staff members undertake a considerable amount of the work on behalf of unit convenors and coordinate the overall process was definitely one of the most important elements in breaking down identified barriers. The response from participating unit convenors supported this position stating that the process was not cumbersome. Having a clearly defined process and upfront expectation of time involved was also another positive, according to feedback.

Despite the progress achieved to date, there are still a number of areas for further research:

- Coding identified in Stage 2, Table 2 is open to interpretation, and as such could be construed as fairly subjective. This becomes problematic when comparing program results, and could also explain the differences in areas such as the Bachelor of Human Sciences where Lecture and/or Tutorial Pedagogy (LTP) was quite low (Table 10).
- Alignment with quality assurance processes to capture sustainability criteria through the introduction of new units and review of existing units is a critical element to ensuring sustainability is embedded regardless of what changes occur.
- Evaluation of student experience and learning is necessary, as is determining how this will actually occur. No baseline was established before changes were made to programs involved in this phase, making impact and comparison difficult.
- Capturing levels of learning, and gathering supporting documentation to ‘evidence’ unit convenor mapping is required. Addressing this aspect covers off assurance of learning elements and provides better understanding of breadth and depth of EfS coverage.
- Further work with units will continue, particularly to track changes unit convenors make as a result of involvement. Several convenors have expressed a keen interest to work closely with us to enhance their unit connectivity with sustainability learning.

Evidence to date indicates that embedding an interdisciplinary concept throughout curriculum is a challenging and time consuming effort, though certainly not impossible. Much of the work needs to occur in the set up—getting the support from appropriate stakeholders and participants, reassuring fears, and surmounting barriers.

6 Conclusion

External circumstances at a global level dictate that embedding sustainability into the curriculum is a responsibility all universities must undertake. The evidence from this initiative indicates that this is not an impossible mission, so long as a considered methodology is in place to support often time-poor academics. Indeed, the methodology outlined is one that could potentially be replicated in other institutions, perhaps with consideration to changes at the local context to ensure applicability and suitability, and take advantage of existing or occurring opportunities.

Having an approach that intended to address known barriers was definitely an advantage. In fact, without sufficient support and clear step progress, the authors question if there would have been as positive an outcome as has been seen to date. In moving forward, the authors believe that while it is a time and resource intensive process to address EfS across curriculum, it will undoubtedly have a positive outcome for Macquarie University, its academics and its students, particularly as employers realise that graduates have more to offer in this space.

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Author Biographies

Leanne Denby has been working at Macquarie University in Sydney as the Director of Sustainability since March 2008. Prior to this Leanne worked at the Australian Research Institute in Education for Sustainability (ARIES) as a Project Director responsible for two higher education focused projects looking to bring about change towards sustainability. Since taking on the role at Macquarie, Leanne has incorporated sustainability as a strategic direction for the University, growing from a single role to a team of nine. Leanne also holds the role of President of Australasian Campuses Towards Sustainability (ACTS).

Sara Rickards is the Sustainability Project Manager (Learning and Teaching) for Macquarie University and currently working on embedding and mapping sustainability the curriculum at the University. She has investigated the Ecological Footprint of Macquarie University's campus, buildings and faculties. Sara has benchmarked universities both nationally and internationally in terms of resource consumption and efficiency. She is a biomedical scientist and environmental engineer, which gives her the ability to develop transdisciplinary solutions to complex issues. Sara has worked in various capacities including; learning and teaching, consulting, facilities and operations.

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