

Interdisciplinary Approaches to Embedding Sustainability into Undergraduate Curriculum

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Executive Summary

Universities have been identified as being critical in developing sustainability-focused skillsets and mindsets (UNESCO, 2004; UNCSD, 2012). 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, 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, 2014).

Academic discussions around sustainability are often problematic due to many factors including understanding and capability (LSIS, 2013). Our approach acknowledges barriers and utilises a methodology to mitigate these issues by: clearly defining sustainability through the use of a framework developed by local and international academics; decreasing time required to carry out the process by providing a dedicated resource to conduct the majority of the work; and providing pre-prepared resources on a dedicated website, whilst also providing the opportunity to have resources specifically developed or reviewed when requested by unit convenors. Our process focused on program level mapping and coverage of sustainability as an interdisciplinary concept.

While Education for sustainability is a work in progress in Australian universities, our findings indicate that Macquarie University is emerging as a leader in this space due to our holistic focus to embed sustainability throughout curriculum, and the approach we are using to do this. The initial stages undertaken in 2014 investigated how sustainability is mapped and embedded in four undergraduate programs at the 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 Administration (Faculty of Business and Economics). The programs that were 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.

Unlike other participating programs, the interdisciplinary Bachelor of Human Science program has 100% coverage of the sustainability framework and 93% coverage of sustainability program learning skills – demonstrating sustainability is dominantly spread across the program. This 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 (Gardner, 2006).

Evaluation as to whether graduates leave with the graduate capabilities defined by the University is yet to be completed. Graduate capabilities should be co-defined by industry demand and therefore link to employability (Thomas and Day, 2015). Providing evidence of teaching that not just informs, but transforms students will be vital to increasing employability of Macquarie University graduates. This time and resource intensive process of addressing Education for Sustainability at a holistic level will undoubtedly generate a positive return on investment for

Macquarie University as employers discover our graduates are leaders within this space, when compared to other university graduates. Going forward this project aims 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 rigorous methodology and adequate resourcing is in place to support often time-poor academics.

Introduction

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). However, academic discussions around sustainability are often problematic due to many factors including understanding and capability (LSIS, 2013).

Sustainability education is most simply defined as education that concentrates on the concept of sustainability learning and skill development in a way that aligns with the values of sustainability (Moore, 2005). What and how teaching occurs contributes greatly to creating sustainability mindsets and skillsets in students. By virtue, sustainability education must be interdisciplinary, collaborative, experiential, and ideally transformative (Sterling, Jones and Selby, 2010).

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 student's 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 and Company, 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)

Macquarie University’s white paper “Our University: A Framing of Futures” has stated a firm commitment to ensuring that the principles of sustainability underpin all that we do (Macquarie University, 2013), recognising that:

- Sustainability is a journey and an endpoint
- Sustainability requires challenges to people's thinking and practices on a continual basis
- Education plays a key role in change towards Sustainability
- Issues associated with internationalisation are all intertwined and linked to sustainability
- The active engagement and participation of students and staff is encouraged and considered integral to the successful implementation of initiatives for change.

Exploring and understanding how sustainability underpins education, and the ways in which it can be holistically incorporated is the basis for our successful grant application. Our approach aims to demystify sustainability, test and develop a framework to provide clear guidelines for embedding sustainability in the broader curriculum, and demonstrate how skills for sustainability are applicable in any program. This approach allows us to investigate whether such a framework is useful to academics, and what support is needed for program level interdisciplinary concept learning.

Essentially, embedding sustainability into curriculum cannot be left for one discipline or program to consider and 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 academics grappling with this all too nebulous concept?

The initial stages of the project investigated how sustainability is mapped and embedded into 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 Administration (Faculty of Business and Economics).

This project uses opportunities to learn from different disciplines and perspectives to address an institution-wide, interdisciplinary theme, delivering on curriculum design and strategic objectives at the local level. There is capacity for project findings to be applied to addressing how other interdisciplinary themes can be holistically embedded, as well as to other institutions grappling with curriculum design questions regarding sustainability.

Method

The project included several different elements in order to meet the stated outcomes from the grant application, including: National State of Play; Sustainability Mapping; and Sustainability Survey.

National State of Play

In order to understand what is happening with respect to the education for sustainability nationally, a state of play document was compiled via desktop analysis and email interviews were carried out with sustainability practitioners. This aimed to answer the following questions:

Does your university have:

1. Sustainability programs
2. Compulsory sustainability units in programs
3. Sustainability embedded across entire curriculum
4. Learning and teaching strategy, which includes sustainability
5. Graduate Capabilities specific to sustainability *
6. Dedicated position to Education for Sustainability
7. A Sustainability strategy
8. A Sustainability strategy including Education for Sustainability

*Sustainability was defined using the Macquarie University Framework¹

¹For more information see www.mq.edu.au/sustainability/its

² Note that this amount of time was not required by unit convenor, due to the Project Manager taking on the majority of the work,

Note: when discussing sustainability “Themes” with respect to the framework we mean; Harmony & Wellbeing, Economies & Economic Wellbeing, Natural Resources, Climate Change, Implementation & Governance and Learning Skills and when we refer to “Subthemes” they are the key concepts that make up the “Themes”.

Sustainability Mapping

Macquarie University incorporated sustainability as an underlying principle of our undergraduate capabilities in 2010. With quality assurance requirements against learning and teaching coming to the fore in 2012, the University needed a way to demonstrate how graduate capabilities were being developed in-line with the guiding principles – and in a way that academics could relate. Development of a framework to clarify the ‘what’ and ‘how’ of sustainability in the curriculum was undertaken and tested against all People and Planet units of the time. Using the framework as a way to ‘test’ the principle and capabilities provides a more assured way of honestly mapping sustainability learning, as opposed to the subjective manner in which mapping often takes place, independent of any true understanding of the full meaning and intent of sustainability.

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

1. Adding topics to lectures where possible in an opportunistic manner
2. A planned approach to include the topic as part of lessons
3. Some programs already focus on sustainability
4. A requirement specified by professional bodies in order to complete a degree
5. An additional or dedicated program or course is developed and offered
6. A capstone or other unit designated as compulsory for learning
7. Adoption of different pedagogies, creating a different way of working, learning and enabling the learner to understand themselves and the world.
8. Sustainability is included without being recognised as ‘sustainability’
9. A combination of one or more of the above approaches

This phase of the project commenced on the premise that approach number 8 is common at the University, and utilised the developed framework to make implicit connections to sustainability more explicit, whilst providing support to unit convenors who wished to enhance sustainability literacy. Table 1 outlines the stages involved for identifying and enhancing sustainability connections.

Table 1: Integrating and Mapping Sustainability Approach

Stage	Approach	Comments												
Pre: Set up	Macquarie (MQ) Sustainability staff met with Executive Deans and Associate Deans Learning and Teaching (AD L&T) to gain support for undertaking the project. AD L&T were asked to identify a non-traditional sustainability program that would be involved. AD L&T then approached the relevant Program Convenor to ask if they would be involved, after which time, MQ Sustainability staff made formal contact with the Program Convenor	It was essential to gain Executive buy-in, and have that level initially contact the Program Convenor – so that the Convenor had the right to veto without direct contact with MQ Sustainability staff. Initial discussions with Convenors outlined the project and their involvement. Initial communications to unit convenors was generated through the Program Convenor (scripted email supplied Appendix 1).												
1. Preliminary mapping	MQ Sustainability staff used unit outlines from the core units involved in the program to do a preliminary mapping exercise against the framework. Where core unit numbers were substantial, the advice of Program Convenors was sought as to which units to work with.	Using the unit outline provided an opportunity for us to determine what impression a student might have regarding sustainability learning occurring within the program.												
2. Convenor mapping	MQ Sustainability staff used workshops and one-on-one discussions with unit convenors to assist them in using the matrix template to populate where they felt they had connections with the sustainability framework.	<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 understood. It also provides a way to understand how the overall program maps with regards to sustainability learning. To gain insight into how the framework was assessed academics identified how they were addressing the framework using the following coding:</p> <table><tr><td>I</td><td>Implicit</td></tr><tr><td>LTC</td><td>Lecture/Tut Content</td></tr><tr><td>LTP</td><td>Lecture/Tut Pedagogical</td></tr><tr><td>CP</td><td>Lecture/Tut Content and Pedagogical</td></tr><tr><td>LO</td><td>Learning Outcome</td></tr><tr><td>A</td><td>Assessment</td></tr></table>	I	Implicit	LTC	Lecture/Tut Content	LTP	Lecture/Tut Pedagogical	CP	Lecture/Tut Content and Pedagogical	LO	Learning Outcome	A	Assessment
I	Implicit													
LTC	Lecture/Tut Content													
LTP	Lecture/Tut Pedagogical													
CP	Lecture/Tut Content and Pedagogical													
LO	Learning Outcome													
A	Assessment													

		It is assumed that the code is a hierarchy, for example: if a subtheme is identified as an “Assessment”- it assumes it is a “Learning Outcome” and some of the above.
3. Levels of learning	MQ Sustainability staff used workshops and one-on-one discussions with unit convenors to assist them in providing details against levels of learning occurring in the mapping.	<p>A rudimentary tick system was used to capture levels of learning:</p> <p>✓ = Some discussion occurs though not the main focus</p> <p>✓✓ = Covered in detail</p> <p>✓✓✓ = Consistent theme throughout delivery of unit/ major component.</p> <p>Note: Capturing levels of learning proved to be quite difficult, and is still underway. As such this element has not been included in this report. At present, the tick system seems to work reasonably well, however we will evaluate effectiveness with participants.</p>
4. Supporting documentation	MQ Sustainability staff used workshops and one-on-one discussions with unit convenors to gather supporting documentation against levels of learning and convenor mapping. This predominately involved getting access to iLearn to bring together ‘evidence’ to support stated claims.	This element proved to be the most difficult and time consuming. Often convenors would need to be reviewing what they had provided in iLearn, and what would be suitable as a supporting document, which often caused some distress and confusion. It is anticipated in future that MQ Sustainability staff be enrolled in iLearn early, and work more closely and intently with convenors.
Post: Continued development	Many unit convenors expressed an interest in further developing their unit to align with sustainability learning.	MQ Sustainability staff continues to work with unit convenors to develop appropriate teaching resources, which can be used, while also assisting to bring identified connections to the fore. The post phase is a critical element in maintaining sustainability-learning connections.

A post involvement focus group will soon be conducted to evaluate what worked, what did not work, and any suggestions for improvement.

Sustainability Survey

In order to investigate sustainability literacy, knowledge gaps and potential needs of academics prior to the sustainability mapping process, unit and program convenors were sent an electronic survey modelled from (LSIS, 2013). A total of 19 questions were asked, some of which were relevant to this project, while others aligned with the building understanding of how sustainability overall is perceived.

Results

National State of Play

Universities in Australia have Education for Sustainability on their agenda to varying degrees. Thomas and Day (2015) have identified that the framework for the development of sustainability capabilities is in place, but not all institutions have embedded sustainability capabilities. Figure 1 displays benchmarked results to date, in the Education for Sustainability space at Australian Universities, according to our own desktop analysis and interview process. Results indicate that Macquarie is currently emerging as a leader in this space – a position we would like to further strengthen.

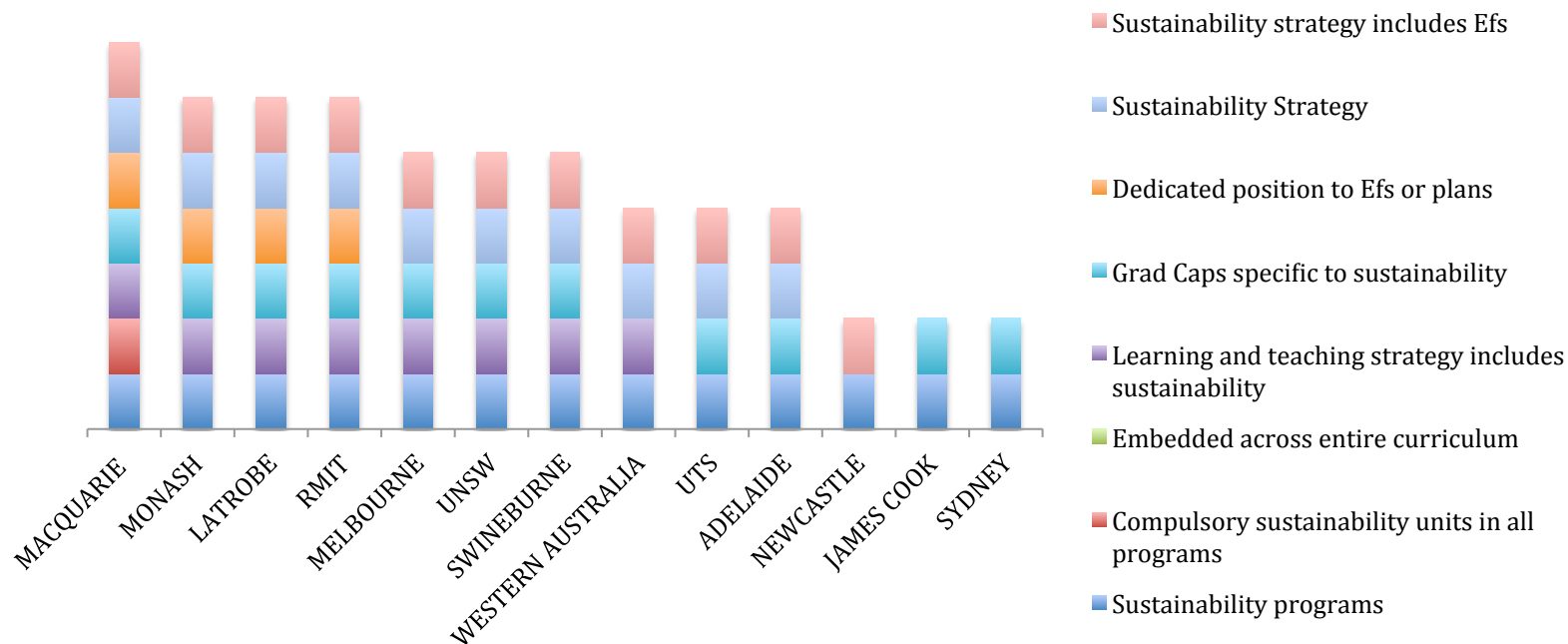


Figure 1: National Education for Sustainability state of play

Sustainability Mapping

Key Findings

- There were varying degrees of difference between preliminary mapping and convenor mapping, indicating that much teaching is occurring implicitly
- Of all the framework themes, Climate Change and Natural Resources had the least coverage
- Learning Skills emerged as the primary theme addressed by all programs
- Working with interdisciplinary programs verses department programs proved harder to collectively gather convenors for workshop participation

- Unit convenors are not always sure what programs they teach into, indicating work needs to be done to ensure that the context of the Program approach is filtering through to all levels.
- Bachelor of Human Sciences emerged as the program with the best overall coverage of sustainability themes.

Individual Program Findings

Bachelor of Business Administration

Key Findings

- 86% of the sustainability framework is taught at the program level
- Subthemes not addressed
 - Food Security
 - Science of Climate Change
 - Adaptation and resilience
 - Mitigation
 - Risk Assessment and Costal management
 - Sustainable Design – Sustainable Cities
- Preliminary Mapping predicated 25% sustainability framework coverage (Figure 2) and convenor coverage was 24% (Figure 3), with some clear differences in what convenors felt they were addressing and what is clear from unit outlines.

Subject Code	Subject Name	Harmony and Wellbeing	Economies and	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	Production, consumption and waste Trade and development systems Sustainable economies Investment Financing	Atmosphere Biodiversity Oceans, seas and coasts Freshwater 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	Responsible innovation (underpinned by ethical decision making) Future thinking, visioning Clarification and activation of value systems (understanding what values you hold; alignment with actions) Self-directed, autonomous and reflective learning (Learn how to learn; hunger for knowledge) Practical, real-world knowledge Leadership (including the ability to discern what is good leadership and how to support good leadership) Creative thinking Critical thinking: ability to challenge, find your voice Consequential thinking Communication skills Systemic thinking
ACCG100	Accounting 1A						
ACCG106	Accounting Information for Decision						
ACCG200	Fundamentals of Management Accounting						
ACST101	Techniques and Elements of Finance						
BBA102	Principles of Management						
BBA315	Business Forecasting						
BBA350	Strategic Management						
BBA360	Business Project (C/P)						
BUS201	Introduction to Global Business						
BUSL250	Business Law						
ECON111	Microeconomic Principles						
HRM107	Introduction to Human Resources						
ISYS104	Introduction to Business information Systems						
MGMT300	The Art of Negotiation						
MKTG101	Marketing Fundamentals						
MKTG216	Consumer Demographics						

Figure 2: Preliminary Mapping Bachelor of Business Administration

Pedagogical Coverage

Analysis of the convenor mapping in relation to where/how they felt themes and sub-themes were being addressed revealed that most learning is occurring implicitly, and through content in lectures. Assessment percentages were quite high – particularly in relation to Learning Skills (Table 3 & 4).

Table 3: Pedagogical Coverage

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

Table 4: Pedagogical Coverage by Theme

	Harmony and Wellbeing	Economies and Economic Wellbeing	Natural Resources	Climate Change	Implementation and Governance	Learning Skills
I	45%	19%	100%	33%	24%	18%
LTC	35%	48%	0%	67%	39%	25%
LTP	6%	0%	0%	0%	4%	4%
CP	3%	0%	0%	0%	6%	1%
LO	3%	11%	0%	0%	10%	11%
A	6%	22%	0%	0%	16%	41%

Key Findings

- 96% of the sustainability framework is taught at the program level
- Subthemes not addressed
 - Planetary Boundaries
 - Coastal Management
- Preliminary Mapping predicated 20% sustainability framework coverage and convenor coverage 30% with variances between the two maps most notable in Climate Change, Natural Resources and Implementation and Governance (Figure 4 and 5).

[illegible]

Figure 4: Preliminary Mapping Mechanical Engineering

[illegible]

Figure 5: Convenor Mapping Mechanical Engineering

Note the black mapping in this instance indicates that the sustainability subtheme is covered – “how” it is covered is yet to be determined

Assessment of the program level coverage by sustainability theme revealed that Learning Skills (64%) and Implementation and Governance (30%) were the primary themes addressed in Bachelor of Mechanical Engineering (Table 5).

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%

Pedagogical Coverage

A substantial amount of learning occurs either implicitly (20%) or through lecture and or tutorial content (19%) and most notably sustainability is assessment based (25%) (Table 6). Learning skills emerged as the primary area through which assessment was occurring (Table 7).

Table 6: Program Level Sustainability Pedagogical Coverage

YES	21%
I	20%
LTC	19%
LTP	3%
CP	8%
LO	2%
A	21%

Table 7: Pedagogical Coverage by Theme

	Harmony and Wellbeing	Economies and Economic Wellbeing	Natural Resources	Climate Change	Implementation and Governance	Learning Skills
YES	18%	42%	24%	6%	31%	17%
I	44%	11%	6%	50%	19%	13%
LTC	18%	11%	24%	6%	23%	20%
LTP	0%	0%	12%	6%	0%	5%
CP	6%	26%	12%	25%	12%	1%
LO	0%	0%	0%	0%	0%	6%
A	15%	11%	24%	6%	15%	40%

Key Findings

- 100% of the sustainability framework is taught at the program level
- Preliminary Mapping predicated 29% sustainability framework coverage, convenor coverage 79%, indicating a large difference between what unit outlines are articulating and what is actually occurring (Figure 6 and 7).

[illegible]

Figure 6: Preliminary Mapping Bachelor Human Science

[illegible]

Assessment of the program level coverage by sustainability theme, revealed that the sustainability Learning Skills (93%) and Harmony and Wellbeing, in addition to Implementation and Governance (79%), were the primary themes addressed in Bachelor of Human Science (Table 8).

Harmony and Wellbeing	Economies and Economic Wellbeing	Natural Resources	Climate Change	Implementation and Governance	Learning Skills
79%	52%	30%	33%	79%	93%

Pedagogical Coverage

Coverage across all areas was fairly consistent, with the exception of Lecture and Tutorial Pedagogical (LTP) (Table 9). Likewise pedagogical approaches utilised to address themes was also spread across the program (Table 10).

Table 9: Program Level Pedagogical Coverage

I	17%
LTC	20%
LTP	3%
CP	18%
LO	17%
A	24%

Table 10: Pedagogical Coverage by Theme

	Harmony and Wellbeing	Economies and Economic Wellbeing	Natural Resources	Climate Change	Implementation and Governance	Learning Skills
I	12%	11%	31%	18%	20%	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%

Bachelor of Media

Key Findings

- 86% of the sustainability framework is taught at the program level
- Missing sustainability subthemes:
 - Food Security
 - Biodiversity
 - Fresh Water
 - Management
 - Land use and tenure
 - Planetary Boundaries
 - Coastal Management
- Preliminary Mapping predicated 14% sustainability framework coverage, convenor coverage 36%, indicating a gap between unit outline and actual teaching (Figure 8 and 9).

[illegible]

Figure 8: Preliminary Mapping Bachelor of Media

Note: Program Convenor identified most appropriate units to map & Figure # demonstrates the chosen units.

[illegible]

Assessment of the program level coverage by sustainability theme revealed that the sustainability Learning Skills (82%) and Harmony and Wellbeing (43%) were the primary themes addressed in Bachelor of Media (Table 11).

Harmony and Wellbeing	Economies and Economic Wellbeing	Natural Resources	Climate Change	Implementation and Governance	Learning Skills
43%	25%	1%	7%	34%	82%

Pedagogical Coverage

Analysis showed that Assessment (53%) emerged as the primary delivery mechanism for sustainability learning (Table 12). Interestingly, there were a considerable number of assessments that also aligned with the themes Implementation and Governance (Table 13).

Table 12: Program Level Pedagogical Coverage

I	16%
LTC	23%
LTP	2%
CP	4%
LO	3%
A	53%

Table 13: Pedagogical Coverage by Theme

	Harmony and Wellbeing	Economies and Economic Wellbeing	Natural Resources	Climate Change	Implementation and Governance	Learning Skills
I	13%	25%	0%	40%	19%	13%
LTC	44%	63%	50%	50%	18%	8%
LTP	6%	0%	0%	0%	0%	2%
CP	10%	4%	50%	10%	2%	1%
LO	0%	0%	0%	0%	6%	3%
A	27%	8%	0%	0%	56%	73%

Survey

The survey results are from a study group of 16 academics across departments and faculties at Macquarie University who participated in the project. Only the questions relevant to outcomes of this project have been included:

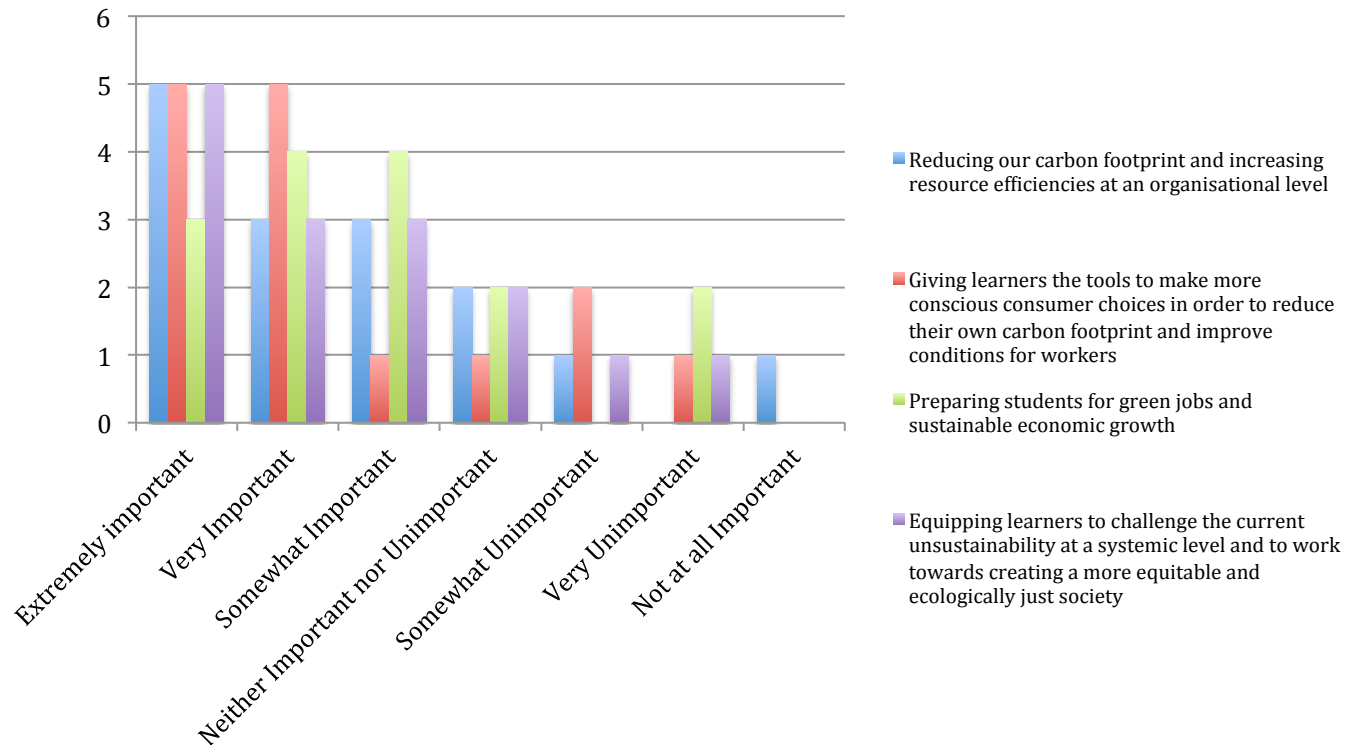


Figure 10: Question – How do you see your role in promoting sustainability?

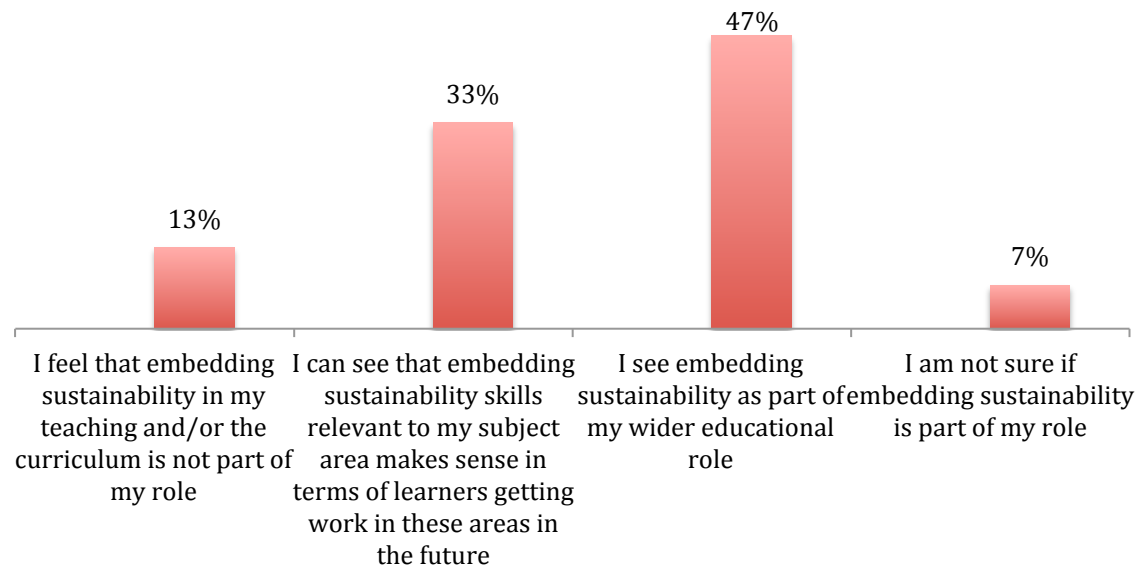


Figure 11: Question - For you personally, which of these statements would you most agree with?

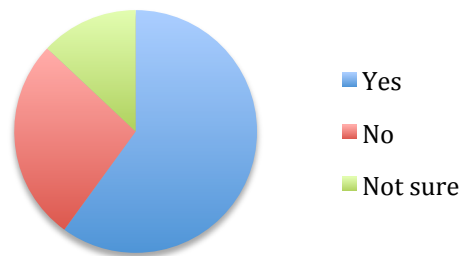


Figure 12: Question - Would you value receiving training or other relevant professional development with regard to embedding sustainability into teaching, learning and the curriculum?

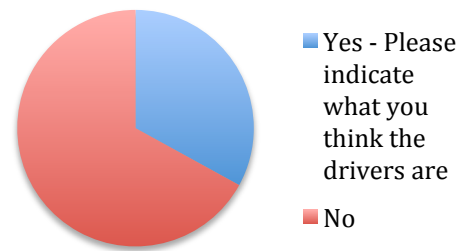


Figure 13: Question - Are you aware of the drivers for embedding sustainability within teaching, learning and the curriculum?

Example Responses:

- There's a gradcap in this area
- Passion of teachers, interest of some students, future requirements of the economy, desire for green wash by institutions
- Professional accreditation
- Graduate capabilities, core values of the university, individuals' interest in advocating sustainable futures for all, student's interest in sustainability.
- Awareness and action is required in order to improve total quality of life now and in the future.

Firmly embedded

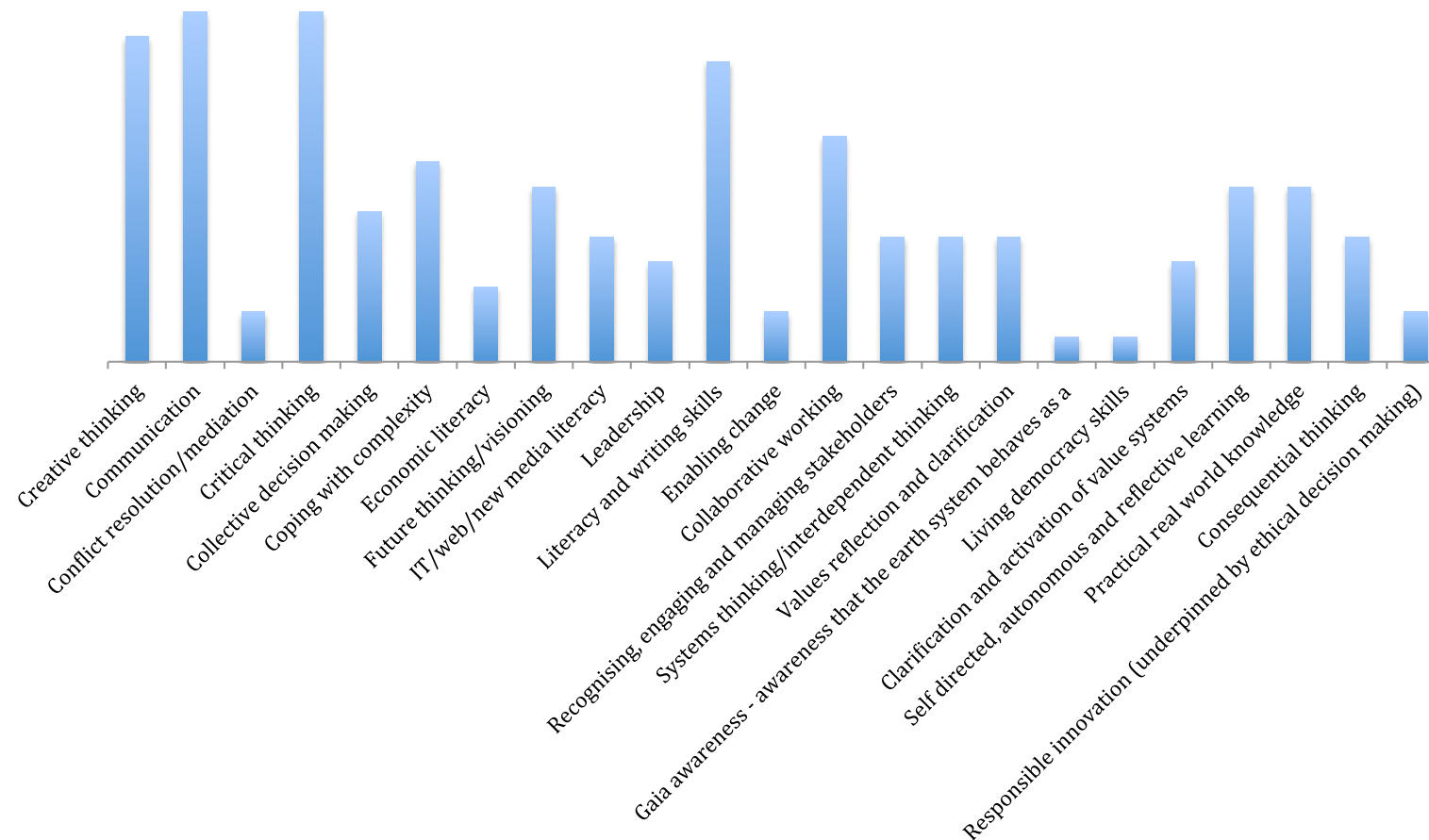


Figure 14: Question - Please indicate to what extent you personally include these skills and knowledge areas within the units you teach

Regularly

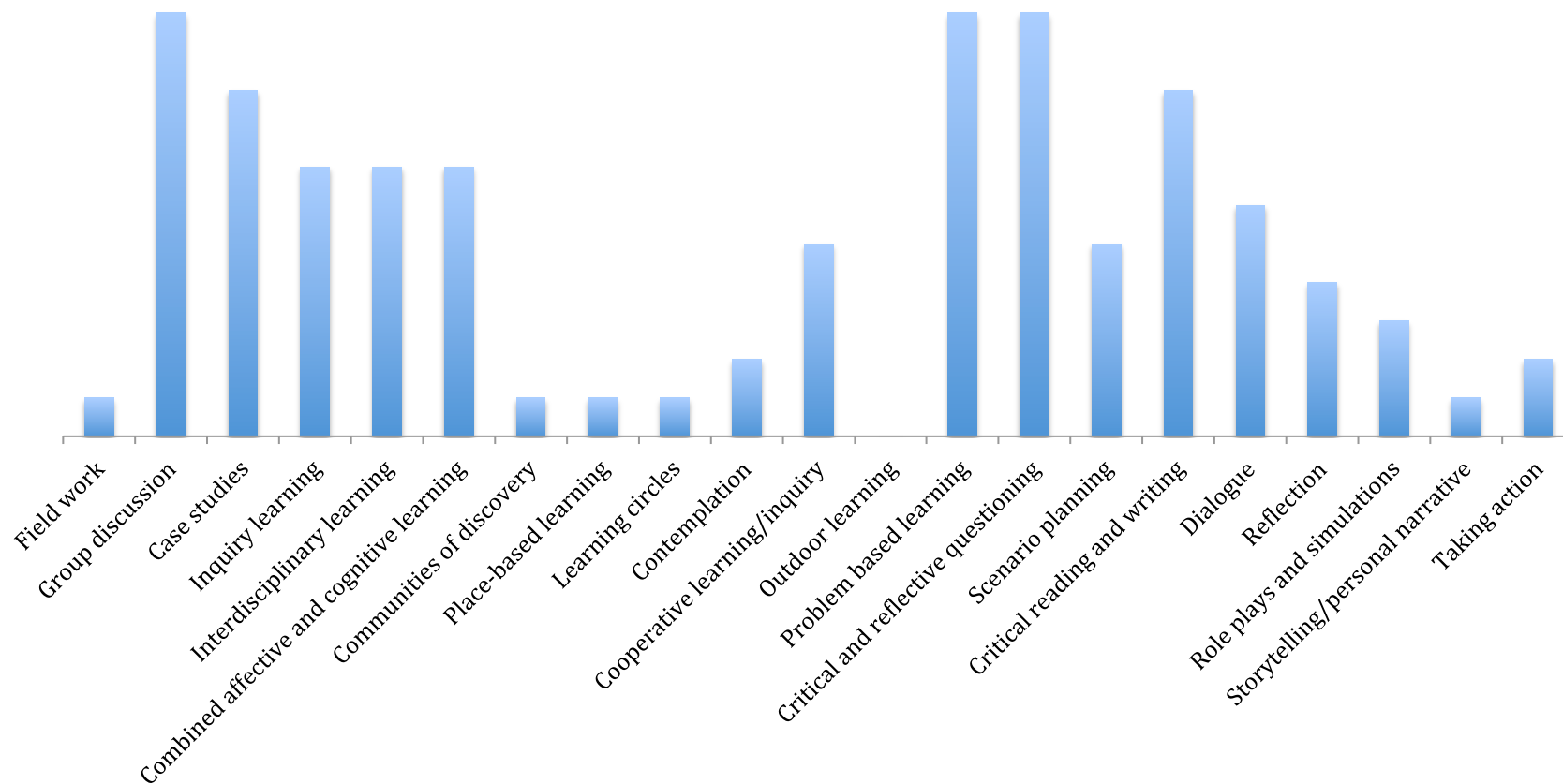


Figure 15: Question - How often do you use these pedagogical approaches?

Key findings

- There were various degrees of sustainability understanding by academics. Some identified a holistic understanding; others understood sustainability in the context of the environment only, while others said they felt they had no understanding.
- Majority of respondents felt that it was extremely important or very important to reduce our carbon footprint and increase our resource efficiency; give the students the tools to make more conscious consumer choices to reduce their own carbon footprint; prepare students for green jobs; and to equip learners to challenge current unsustainability at a systemic level.
- Majority of respondents also see embedding sustainability is part of their wider educational role.
- Somewhat interestingly and in opposition to other results above, most respondents were unaware of the drivers for embedding sustainability in learning and teaching
- Learning skills firmly embedded by the majority of respondents include: creative thinking; communication; critical thinking; literacy and writing skills; and collaborative working. Conflict resolution/mediation; enabling change; and responsible innovation were least embedded skills listed by respondents
- Group discussion; case studies; problem based learning; critical and reflective learning; and critical reading and writing were most regularly used pedagogical approaches, while field work; communities of discovery; place based learning; learning circles; outdoor learning; and story telling/narrative were the least regularly used approaches.

Majority of respondents would also value receiving training or other relevant professional development with regards to embedding sustainability into teaching, learning and the curriculum

Discussion

Education for Sustainability is a work in progress internationally and at Australian universities – notwithstanding the fact that every university is a unique organism and the pathway for education for sustainability is not clearly defined (Ferreira, Ryan and Tilbury, 2014). One of the vital steps required to achieve education for sustainability is demonstrating that sustainability is a broad interdisciplinary concept and is relevant to everything we do, whether it be within our personal or professional life.

The programs that were involved in this phase were all chosen because they were not typically ‘sustainability-focused’ degrees. However, as predicated 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 sustainability framework. Often there were notable gaps between preliminary mapping completed by Macquarie Sustainability in comparison to unit convenor mapping, with a high proportion of implicit

connections to the framework. At this stage it is believed that much sustainability learning is occurring implicitly due to a lack of understanding of what holistic sustainability means, and this is supported by survey results indicating that understanding is yet to be fully developed by academics. It is anticipated that once this improves, gaps and implicit connections to subthemes can be more easily made explicit by design. Ultimately, work to date reinforced the value of program level approaches in learning and teaching, as mapping at this level allowed for themes to be addressed in a more strategic scaffolded approach.

In looking at how to embed an interdisciplinary concept, it was important for us to acknowledge 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 is undergoing an Engineers Australia accreditation process and sustainability is an embedded Stage 1 Competency within that process (Engineers Australia, 2015). Being embedded into the accreditation process resulted in sustainability mapping being a clear value-add for the Mechanical Engineer's accreditation process. However, programs with no accreditation specific to sustainability need a different identified 'driver', tailored to their specific needs to encourage engagement. In all circumstances, it was critical to work closely with the Program Convenor to establish the most appropriate language, approach and timing for moving forward. Program Convenors 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 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, this one has 100% coverage of the sustainability framework, in addition to a minimum of 30% coverage at the program level, based on sustainability themes, and 93% coverage of sustainability program learning skills – demonstrating sustainability is dominantly spread across the program. This 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 enable students with the ability to deal with issues that transcend disciplines (Gardner, 2006).

Various research has indicated the primary barriers for embedding sustainability into the curriculum – over crowded curriculum, relevance to course or discipline not being apparent and lack of support etc. (Lozano, 2010). Prior to commencing the work with these programs, Macquarie Sustainability had given extensive consideration as to how we might address these barriers. Having a dedicated staff member from Macquarie Sustainability to 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. Importantly, involvement led to an increased understanding of sustainability and its relevance to individual units and program outcomes.

Despite the progress achieved to date, there are still a number of areas that need to be further developed:

- Evaluation of student experience and learning is yet to occur, 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.
- Evaluation as to whether graduates leave with the graduate capabilities defined by the University needs to be completed. Graduate capabilities should be co-defined by industry demand and therefore link to employability (Thomas and Day, 2015). Providing evidence of teaching that not just informs, but transforms students will be vital to increasing employability of Macquarie University graduates.
- Gathering supporting documentation to 'evidence' unit convenor mapping is yet to be completed for all units. Addressing this aspect covers off quality assurance elements of learning and teaching.
- 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.

Next steps

- Research linkages: With the release of the Research Framework, work has commenced towards understanding linkages between strategic priorities and the sustainability framework.
- Learning and Teaching strategy: The impending release of the Learning and Teaching strategy provides an opportunity to align and assist in delivering on intent. We remain active in this space.
- Sharing: This work involves identifying 'experts' on campus who can be called upon by academic colleagues, to share their expertise in areas related to the framework.
- Continued support: It is essential to continue to support academics who have been involved in the project to ensure that sustainability connectivity and learning does not fall off the radar. Many academics are still not completely sure of how to make implicit connections more explicit. Support also includes the development of appropriate resources to support ongoing development of units.

- Partnerships with other universities: Interest in the model we are using is growing, and we are endeavouring to make strategic partnerships with other universities to leverage work they may be doing, but also assist them in progressing the EfS agenda.
- 2015: Nine programs have been included for 2015. These are:
 - FOA - Archaeology and Criminology
 - FHS - Primary and Secondary teaching
 - FOS - Biology and Information Technology
 - FBE – Master of International Business & Master of Global Business
 - FMHS – Clinical Science
- Dissemination: Journal submissions and a chapter in 'Teaching Education for Sustainable Development at University Level'

Conclusion

“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 UNESCO (2012)

External circumstances at a global level dictate that embedding sustainability into the curriculum is a responsibility all universities must undertake. The evidence from this project indicates that this is not an impossible mission, so long as a rigorous methodology is in place to support often time-poor academics. Without sufficient support and clear step progress, it is unlikely that there would have been as positive an outcome as has been seen. This time and resource intensive process of addressing Education for Sustainability at a holistic level will undoubtedly have a return of benefit for Macquarie University as employers realise that our graduates offer more in this space.

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Appendix 1 Sample Unit Convenor Letter

As some of you are aware, I have agreed for the Bachelor of Human Science to participate in a project that looks to understand existing connections to sustainability in core units of the program. This is a really exciting opportunity for us to get some recognition for the great work we already do and will continue to do as we evolve the new program, particularly as we will be a case study for the rest of the University, and also universities internationally. I'm not anticipating that involvement in the project will be cumbersome for any of you. The project lead, Leanne Denby, has estimated it should take approximately 20-25 hours² of your time throughout the remainder of the year - and this is mainly through participation in catered workshops. Leanne has offered some budgetary support for us to draw upon should there be a requirement, in order to make involvement easier.

The first element of the project will involve Leanne and the project manager, Sara Rickards, undertaking a high level look at your units to see where connections already exist. This will be followed up with face-to-face discussions with you, and underpinned by a workshop occurring in week 3-4 of semester 2 (dates TBA). The face-to-face discussions will focus on providing better context for the project, and introduce the framework that will be used to have conversations about sustainability, while the workshop will aim for interdisciplinary discussion and practical outcomes. Just to point out, Leanne and Sara are approaching this from a conversational position, not expecting anyone to dramatically change or revamp their existing unit/s, just to look at where connections may already exist and taking it from there. More information about the project can be found [here](#).

I encourage all of you to meet with Leanne and Sara and of course make it to the catered workshop as it will be a good opportunity to find out what is happening elsewhere on campus and provide insight into what is happening in Human Sciences.

Let's use this as an opportunity to showcase and really sell our new degree!

² Note that this amount of time was not required by unit convenor, due to the Project Manager taking on the majority of the work, academics only need to invest as much as 5 hours each.

Appendix 2 Detailed Sustainability Survey Responses

Question – Please provide a brief overview of your understanding of sustainability

1. *I see sustainability as the ability to continue in viable ways. I don't restrict it just to environmental issues but also cultural, political, social and economic.*
2. *The intersection of people with the built and natural environment and a mindfulness about the longer term viability of any initiatives, mindfulness about our impact on resources and planning with intergenerational equity in mind*
3. *Sustainability should focus on environmental sustainability as this is a pressing global issue. Other forms of sustainability (eg economic sustainability) already get plenty of attention. My understanding involves alternatives to a high growth, consumer focussed society and suggests alternative ways of living, travelling, generating electricity, demonstrating our identities, heating our houses, growing our food etc etc. Sustainable growth is in my view, very likely to be a contradiction in terms (see question below)*
4. *Nothing*
5. *Product lifecycle issues; how long can resources last - not depleting resources; building awareness of long-term needs.*
6. *Utilising the available resources in the best manner so that our much blessed environment is safe for future generations.*
7. *Minimising impact on the environment*
8. *Using world's resources in a sustainable manner*
9. *making things last*
10. *Having low impact on the environment and providing work practices and solutions that will have long-lasting effect and low negative impact on the environment.*
11. *Endurance of our world so that future generations may enjoy it in the same state that it is or better.*
12. *Sustainability is the capacity of coupled human-natural systems to foster resilience and growth for humans and their environments, now and in the future.*
13. *Long term viability not just ecologically*
14. *There are three pillars of sustainability - environmental, social and economic.*

Question – For you personally, which of these statement would you most agree with?

- A. *I feel that embedding sustainability in my teaching and/or the curriculum is not part of my role*

- B. I can see that embedding sustainability skills relevant to my subject area makes sense in terms of learners getting work in these areas in the future
- C. I see embedding sustainability as part of my wider educational role
- D. I am not sure if embedding sustainability is part of my role
- E. Other, please state

Question – Are you aware of the drivers for embedding sustainability within teaching, learning and curriculum? (yes, no, not sure)

Question – Please indicate to what extent you personally include these skills and knowledge areas within the units you teach? (Firmly embedded, could do more, do not currently, I do not feel this is appropriate to my students, I haven't thought about it yet) :

- A. Creative thinking
- B. Communication
- C. Conflict resolution/mediation
- D. Critical thinking
- E. Collective decision making
- F. Coping with complexity
- G. Economic literacy
- H. Future thinking/visioning
- I. IT/web/new media literacy
- J. Leadership
- K. Literacy and writing skills
- L. Enabling change
- M. Collaborative working
- N. Recognising, engaging and managing stakeholders
- O. Systems thinking/interdependent thinking
- P. Values reflection and clarification
- Q. Gaia awareness - awareness that the earth system behaves as a single, self-regulating system comprising physical, chemical, biological and human components
- R. Living democracy skills

- S. Clarification and activation of value systems
- T. Self-directed, autonomous and reflective learning
- U. Practical real world knowledge
- V. Consequential thinking
- W. Responsible innovation (underpinned by ethical decision making)

Question – How often do you use these pedagogical approaches? (regularly, sometimes, rarely, never, not sure)

- A. Field work
- B. Group discussion
- C. Case studies
- D. Inquiry learning
- E. Interdisciplinary learning
- F. Combined affective and cognitive learning
- G. Communities of discovery
- H. Place-based learning
- I. Learning circles

Question – Would you value receiving training or other relevant professional development with regard to embedding sustainability into learning and the curriculum? (yes / no /not sure)

