

Teaching sustainable development in higher education: Building critical, reflective thinkers through an interdisciplinary approach

Author

Howlett, Cathy, Ferreira, Jo-Anne, Blomfield, Jessica

Published

2016

Journal Title

International Journal of Sustainability in Higher Education

DOI

[10.1108/IJSHE-07-2014-0102](https://doi.org/10.1108/IJSHE-07-2014-0102)

Rights statement

© 2016 Emerald. This is the author-manuscript version of this paper. Reproduced in accordance with the copyright policy of the publisher. Please refer to the journal's website for access to the definitive, published version.

Downloaded from

<http://hdl.handle.net/10072/100066>

Griffith Research Online

<https://research-repository.griffith.edu.au>

Teaching Sustainable Development in Higher Education: Building Critical, Reflective Thinkers through an Interdisciplinary Approach

Dr Cathy Howlett, Dr Jo-Anne Ferreira and Ms Jessica Blomfield

Abstract

As we rapidly approach the end of the Decade of Education for Sustainable Development (2005-2014), a United Nations initiative whose goal is to integrate the principles, values and practices of sustainable development into all aspects of education and learning (ARIES 2009), a review of the state of the world's environmental health suggests that this goal may remain unrealised. In this paper, we argue that substantive changes are required in both curricula and pedagogical practice in higher education institutions to challenge dominant epistemologies and discourses and to unsettle current ways of thinking about, and acting in relation to, the environment. Central to such a shift, we argue, is the need for higher education curricula to be interdisciplinary and for pedagogical practices to work to build capacities in students for critical and reflective thinking. In support of this argument, we discuss a first year undergraduate interdisciplinary social science course in a faculty of environmental sciences that was specifically designed to develop critical and reflective thinkers. In this way, we present a range of evidence to support the efficacy of an interdisciplinary, student-centred approach in higher education institutions.

Introduction

'We cannot solve our problems with the same thinking we used when we created them.' (Einstein)

The world is currently facing unprecedented environmental disasters (see, for example, the Millennium Ecosystem Report (2005) and the *Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (IPCC 2014). Hannam (2014), reporting on the findings of the IPCC Fifth Assessment Report, notes that global warming will displace millions of people, trigger falling crop yields, stoke conflict and cost trillions of dollars in lost economic output, while poverty and economic shocks emanating from climate change will have a significant impact on migration, increasing the risks of violence from protests and from civil or international conflicts. We know we are overburdening the earth's available biocapacity by consuming 22% above our ecosystem's ability to regenerate (Blewitt 2010). Thus our environmental future looks exceptionally grim.

There are some who suggest the cause of the present state of the planet's health lies with those coming out of the world's best colleges and universities (Cortese 2003, Fullan & Scott 2009). Orr (2004), for example, claims that our current education systems are

essentially equipping individuals to become more effective vandals of the Earth. Wals (2010) concurs, arguing that most of our universities are still leading the way in advancing the kind of thinking, teaching and research that has accelerated unsustainability. It can thus be argued that the higher education sector bears a modicum of responsibility for the current crisis, and consequently, has a role to play in educating students about, and for, sustainability (Everett 2008). However, while Fien (2002) noted the critical role of higher education in advancing sustainability as far back as 2002, the sort of pedagogical innovation necessary for education for sustainability has been slow to develop (Armstrong, C. 2011, Ferreira & Tilbury 2012). Given the state of the environment, there is an urgent need for higher education institutions to re-evaluate their approaches to educating for sustainability. In particular, a rethinking and revision of current higher education curricula is required to enable the development of the sorts of interdisciplinary understandings of social, economic and environmental factors - and the sorts of critical and reflective thinkers and problems solvers – required to achieve a sustainable society (Sipos, Battisti and Grimm 2008).

What is required are higher education curricula and pedagogical practices that foster interdisciplinary and creative ways of thinking about human-environment interactions, as a necessary pre-condition for achieving a sustainable future. These new, innovative educational approaches must facilitate genuine interdisciplinary thinking, and must be conducive to the cultivation of agency, self-determination, critical thinking, a reflective capacity and the development of what might be called ‘a planetary consciousness’ (Wals 2010, 387). In the words of Kagawa and Selby (2010) ‘educational spaces should build a culture of learning awash with uncertainty and in which uncertainty provokes transformative yet precautionary commitment rather than paralysis’ (cited in Wals 2010, 387). In short, higher education for sustainability must be transformative (Mezirow 1978, Cranton 2006), that is, it must work to challenge core assumptions and values students hold and that we as a society hold. Wals and Blaze Corcoran (2006) have described the outcomes of transformative learning as the competence to integrate, connect, confront and reconcile multiple ways of looking at the world. Students need to be able to cope with uncertainty, poorly-defined situations, and conflicting or, at least diverging norms, values, interests and reality constructions, as environmental problems such as climate change mean we do not know what the future will look like, or the particular problems we may face. This will entail changes in the worldviews of both students and educators (Sipos et al. 2008).

In this paper we reflect on our experience teaching sustainable development to first year students within the Griffith School of Environment, Brisbane, Australia. The course, titled ‘Sustainable Development’, has enrolments of between 100 – 150 students. The course has been designed, in part, for students to gain insight into the concept of sustainable

development in all its complexity and ambiguity. It was also specifically designed to develop the following skills: creative and critical thinking, oral and written communication skills, reflective thinking, collaboration and cooperation, and problem solving. These are skills identified by UNESCO as critical for education for sustainability (Sipos et al. 2008). Education for sustainability is education that focuses on the processes of learning and change required to meet the challenges of transitioning towards an ecologically sustainable society. Thus, teaching and learning processes that lead to particular attributes, such as critical, creative and futures-oriented thinkers, and particular environmental citizenship skills, are utilised. The key focus is on content (the information), process (how this information is shared with learners), and reflection (learners relating this information to themselves). Key foci of education for sustainability are, therefore, envisioning a better future, critical thinking and reflection, systemic thinking, participation in decision-making, and working in partnerships for change (Commonwealth of Australia 2009). In this paper we reflect on three of these, interdisciplinary content, critical thinking, and reflection, and their effectiveness in deepening student learning through an undergraduate sustainable development course.

Following Wals and Jickling (2002), who argue that teaching in the areas of sustainability and sustainable development requires educators to reflect on their own teaching, this paper represents our critical reflections on enacting a constructivist informed pedagogy for teaching sustainability, based upon student's perceptions of this enactment, and the transformations that occurred in their thinking throughout the course. Via this reflection on our own teaching practice, the paper seeks to obtain and promote a clearer understanding of educational processes that help cultivate a transformative learning environment (Wals 2010). The aim of the paper, therefore, is to enhance pedagogical practice in the area of education for sustainability in higher education.

The paper begins by discussing the course structure and assessment tasks, with a focus on how constructivist theories of learning have shaped these. This is followed by a discussion of the interdisciplinary nature of the content presented, the ways in which critical thinking was encouraged when students engaged with this content, and the ways in which reflection was used to enable students to relate this new knowledge to their own prior knowledge and experiences, thus grappling with the relevance of this knowledge to them and their world. Our discussion is supported by qualitative comments from students' reflective essays and final course evaluations. We conclude by offering tentative reflections on our own learning journey as educators and facilitators with the aim of contributing to a more informed pedagogical practice.

Course Design - Sustainable Development 1181ENV

This design of this course was influenced by a project run within the Griffith School of

Environment, led by Dr Jo-Anne Ferreira, which sought to share with practising lecturers the pedagogical methods and techniques used by sustainability educators to shape transformative learning experiences for their students. Key to this project was the necessity for academic staff to reflect on their own learning journeys, and, importantly, to encourage and enable students to reflect on their learning journeys. With the support of project leaders, academic staff members utilized their participation in the project as an impetus for the design of the first year course, 'Sustainable Development', and enacted the pedagogical methods and techniques elucidated in the project to shape transformative learning experiences for the students

Overall, the course was designed using constructivist theories of education and was aimed at promoting deep learning (see Warburton 2003) as opposed to surface learning. Constructivist theories of learning claim that learners learn best when they are actively engaged in constructing knowledge within a framework of their own experiences, rather than passively receiving information transmitted to them by textbooks or teachers. Students thus 'construct' their knowledge via already existing interpretative frameworks (Leder 1993, 12-17). Constructivist theories of learning posit that knowledge is constructed in the mind of the learner by 'fitting new understandings and knowledge into and with, extending and supplanting, old understanding and knowledge' (Fry, Ketteridge and Marshall, 2009, 10). Social constructivist theories of learning claim that learning also has a social nature (Phillips 1995) and thus these theories emphasise the necessity of active engagement by learners, and between learners, in the learning process. Such active engagement in the learning process, it is argued, yields deeper understandings (Armstrong, C. 2011). Constructivism is an appropriate theory for shaping teaching about sustainability as it acknowledges that there is no single way of understanding issues (Armstrong, C. 2011). As Jickling and Wals (2008, 7) note, taking a constructivist approach means 'knowledge is not fixed, cut up in pieces and handed over, but rather (co)created by transacting with prior tacit knowledge, the curriculum, and other learners' knowledge and experiences'. Hence, what is known is important, but so too is what students are able to do with what is known. We discuss below how such principles worked to shape the course.

The first thing we wanted to do was to understand what our students already knew about sustainable development so that we could both utilise and build upon this knowledge. We established what was known via an online blog that students were required to submit by the end of week 2 of the first semester. Students were asked to write in 250 words or less what they knew about sustainable development and how they knew this, that is, where their knowledge had been obtained. This initial assessment task served several purposes. It provided an opportunity for students to think about what they knew and, importantly, how they came to know it, thus providing a starting point for them in the

construction of their knowledge about sustainable development. It also provided information to us to help frame our discussion questions and examples used and, importantly, it also served as a point of reflection when students came to write their reflective essays at the end of the semester.

There were also weekly lectures that were overtly interdisciplinary, and addressed political, economic, cultural and ecological aspects of sustainability (amongst other aspects). These were delivered by a teaching team from within the interdisciplinary Griffith School of Environment. These lectures were followed by weekly tutorials where students engaged in a deeper discussion about the weekly lecture content and course readings. Initial tutorials also included an explicit focus on the development of critical thinking skills, including discussions about what critical thinking is and strategies for thinking critically. At the end of each weekly lecture, a perspective or question would also be posed that challenged students to think critically. Key critical questions - using Peavey's (1995) Strategic Questioning as a model - were also developed to shape discussion in the tutorials; therefore, the students were educated for critical thinking, not just assessed on this important skill.

There were two main assessment tasks. The first was an essay critically analysing the merits of nuclear energy as a sustainable energy source when compared with coal or gas. Students were required to present arguments both for and against nuclear energy, and from multiple perspectives – the social, cultural, political and economic. This required students to critically analyse information across a number of disciplines and then to use their analysis to develop a coherent and substantiated argument either for or against nuclear energy. This was a pivotal assessment piece for evaluating a key goal of the course, that is, students' capacities to think critically and to apply this in analysing a contentious environmental issue, and in presenting an evidence-based argument. The second key assessment task was a reflective essay, undertaken at the end of the semester. Students thus used their blogs and the reflective essay at the completion of the course to link theories they engaged with throughout the course, and also to reflect on their learning journey throughout the course.

In summary, the course was designed using constructivist principles of learning, and in a way that students would be challenged, confused and ultimately liberated (Cranton 2006) in their thinking about sustainability. Following Blewitt (2008, 54), we utilised the concept of sustainability as a heuristic device, 'a learning process by which people are enabled to find things out for themselves and to fully appreciate the contested nature of knowledge of the environment and sustainability – and to work out what to do about it'. This was done because we wanted the students' learning journey to be transformative. In the following three sections, we outline in detail the student experience and reflections

on an interdisciplinary approach to content, a critical thinking approach to the process of learning, and the use of reflective practice in helping students to construct new knowledge.

An Interdisciplinary Approach to Course Content.

The world has problems, but universities have departments (Brewer 1999, 328)

There is a general consensus in the literature that one of the problems in teaching about sustainability and or sustainable development is the dominance of traditional single discipline based courses (see, for example, Warburton 2003, Everett 2008, Stephenson et al. 2010, Barth et al. 2007, and Wals 2010), with universities still primarily structured along disciplinary lines. The significant challenges of the 21st century are, however, complex and interdependent and therefore require an educational approach that can prepare students to respond to the interconnected economic, social, scientific, political and ethical aspects of a transition to sustainability (Everett 2008). Such an approach will prepare students to fully respond to the socio-political, socio-economic and biophysical aspects of environmental problems (Warburton 2003, Bender 2012) and to develop creative and innovative ways of thinking about sustainability. An interdisciplinary approach to course content is thus required. An interdisciplinary approach, which focuses on fostering different ways of looking at the world, can also create dissonance in the minds of learners and this is where, according to Wals and Jickling (2002), genuine and transformative learning occurs. Transformative learning is learning that effects change in our frames of reference or worldviews (Cranton 2006, Sipos et al. 2008). Indeed, the assumption of much sustainability education theory is that significant change in cultural worldview is necessary if more sustainable states of society are to be attained (Sterling 2010). Students confirmed that such a change had occurred in their worldview: 'How the course was taught allowed me to let in other people's thinking processes, how to understand things from other views, whether it be environmentally or politically. Really opened my eyes', and 'It taught me to question what information is being fed to us; also, to realise that there are hundreds of different perspectives and worldviews involved in SD'.

Calls for an interdisciplinary approach to education for sustainability are not new, yet higher education institutions remain notoriously stubborn in changing their unidirectional, hierarchical and disciplinary approach to teaching, and interdisciplinary research opportunities are rarely found (Tilbury and Ferreira 2012, Wals 2010, Fullan & Scott 2009, Barth et al., 2007). A problem in trying to use an interdisciplinary approach to understanding environmental problems, and developing some solutions, is that many academics view talking and thinking across disciplines as being extremely difficult

(Strober 2010). To complicate matters further, certain ways of addressing sustainability (for example, in terms of scientific or economic issues) are often seen as somehow superior or inherently better than others (Golding 2012) resulting in a reinforcement of disciplinary hierarchies.

The core principle governing the pedagogical design of our course, and, therefore, a key determinant of the course content, is the idea that sustainability and sustainable development are contested and inherently complex concepts (often conceptualised as 'wicked' problems)¹ and that each and every environmental problem, and its solution, requires input from multiple disciplines (Golding 2012). Thus, the course content was reflective of this, and following introductory lectures and tutorials, each weekly lecture presented sustainability from a different disciplinary perspective. While this was a first year course, and students had limited disciplinary knowledge, Gasper (2010) argues that an interdisciplinary approach does not require expertise in every discipline, but rather a willingness and ability to interact, communicate and learn from different perspectives. A key focus of the lectures and workshops was on presenting each disciplinary perspective as an epistemological approach, or a way of thinking about the problem. Encouragement of students capacity to think in an interdisciplinary manner were effective, as evidenced by these students comments; 'It made me want to think of things from different perspectives, something that I personally wasn't used to doing, looking at EVERY aspect', and 'By looking at the overall subject from different perspectives, for example, in a political way, not just environmental, I have learned to listen and accept other points of view.'

Students worked in groups in tutorials to develop a group presentation that addressed a key environmental issue, such as deforestation, and which incorporated all of the disciplinary perspectives on that issue. Students attested to the efficacy of this pedagogical approach, stating 'How the course was taught allowed me to let in other people's thinking processes, how to understand things from other views, whether it be environmentally or politically. Really opened my eyes.' Finally the efficacy of our focus on an interdisciplinary content approach to the course design is found in the following student comment; 'I have been exposed to different ways of thinking and my world view has been challenged (though not derailed just yet!).'

While the content of the course was interdisciplinary, it was underpinned by the development of critical thinking skills, the second of three key components of education for sustainability.

¹ Seeing environmental issues as 'wicked problems' has a long history in environmental literature (see Bender (2012) for an overview of the history).

Critical thinking process

Critical thinking is *'thinking about thinking while thinking in order to think better'* Paul 2007, n.p.)

There is broad acceptance that the development of critical thinking (Brookfield 2012; Halpern 1998, 2013) is a central feature of university education, with critical thinking listed by most universities as being a key graduate attribute. Indeed, as Bath, Smith, Stein & Swann (2004, 315) note, disciplinary knowledge is transient, therefore

generic skills such as communication, teamwork, leadership and analytical and critical thinking should be the hallmark of any graduate irrespective of field of study, and as such the opportunity to broaden students and develop their generic skills is an important element in undergraduate curriculum.

There is no single definition of critical thinking, however. For Dewey, seen by many as the 'father' of modern critical thinking, critical thinking is reflective thinking, which he defined as:

Active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it, and the further conclusions to which it tends, constitutes reflective thought. ... once begun, it is a conscious and voluntary effort to establish belief upon a firm basis of reasons (Dewey 1910, 6, italics in original).

Critical thinking is thus a form of higher order thinking 'that analyses thought, that assesses thought, and that transforms thought for the better' (Paul 2007, n.p.). Critical thinking encourages a skepticism of thoughts – of one's own and of others. It is thus 'an "active" process – one in which you think things for yourself, raise questions yourself, find relevant information yourself, etc. rather than learning in a largely passive way from someone else' (Fisher 2001, 2). It encourages an open-mindedness about beliefs, and a questioning of arguments that illuminates the reasoning underpinning and evidence supporting such arguments. This is not thinking that is critical in the sense of seeking to negate, however. As Paul and Elder (2002, 21) note, it is about developing fair-minded thinkers.

While the generic attribute of critical thinking is highly valued in universities, the problem is, as Jones (2009) identified, that few academics explicitly teach their students how to think critically, and few students feel that they were explicitly taught this skill. One of the reasons for this that Jones identified is that for many, the focus is on acquiring disciplinary knowledge and this is seen as separate from the development of generic attributes such as critical thinking. She notes that many academics struggle with 'reducing complex attributes [such as critical thinking] to definable learning outcomes' (Jones 2009, 175). The challenge for educators then, is to determine strategies that will help our students to develop through the course of their studies from what Paul and Elder (2002) refer to as Stage 1 thinkers, that is unreflective thinkers who are unaware of problems with their thinking, to Stage 6, or Master thinkers, that is, thinkers for whom skilled and insightful thinking is second nature.

The Watson-Glaser Critical Thinking Appraisal provides a quasi-model for enabling critical thinking through their definition of critical thinking as:

- (1) an attitude of being disposed to consider in a thoughtful way the problems and subjects that come within the range of one's experience;
- (2) knowledge of the methods of logical enquiry and reasoning; and
- (3) some skill in applying those methods' (Glaser 1941, 5).

Having a disposition to question and think in a particular way, and having the knowledge and skills to reason, will allow for the 'persistent effort [required for critical thinking] to examine any belief or supposed form of knowledge in the light of the evidence that supports it and the further conclusions to which it tends'. (Glaser 1941, 5). The Watson-Glaser II Critical Thinking Appraisal developed by Pearson in 2009 simplifies this to an R-E-D model that notes 3 keys to critical thinking: Recognizing assumptions, Evaluating arguments, and Drawing Conclusions (<http://www.thinkwatson.com/think-red/red-critical-thinking-model>). This provides a useful framework to help academics to explicitly teach critical thinking, and for their students to learn this skill.

We were explicit with students in our attempts to develop these critical thinking skills, and this is evident in some of their feedback, including:

I believe the most important skill I have learnt through this course is the ability to think critically. The development of my critical thinking has allowed me to examine and evaluate information and make informed judgments – I now have the ability to view information and situations from various perspectives.

and 'The course was constantly making me critically think about all the ideas of sustainable development. Critically thinking is a new way of thinking'. That they understood what critical thinking is, rather than just that it was important because lecturers said so, is reflected in comments such as: 'How the course was taught allowed me to let in other people's thinking processes, how to understand things from other views, whether it be environmentally or politically'; 'it gave me a completely different perspective on things I (thought) I knew'; and 'I am now aware of the potency of a phrase as seemingly simple as "sustainable development"'. Students clearly had a transformative learning experience through the course: 'In reflecting on my learning journey, it has become clear that the prevalent knowledge I have gained has been to think critically and to question my own assumptions'; and

In reflecting on my learning journey throughout this course I would honestly have to say that 'critical thinking' has been the highlight. The ability to be a critical thinker is a new introduction to me this semester and I feel as though a revolution is taking place in my thought processing. I have no doubts it is a skill I will nurture for the rest of my life.

Reflective thinking - reflection

At the heart of reflective thinking process is a personal perspective on the ideas,

The practice of reflection is widely recognised for its power to foster deep learning (Dewey 1910, Boud et al. 1985, Rogers 2001). According to Rogers (2001), there is general agreement that reflection is a cognitive process or activity that engages the emotions of individuals while requiring them to actively engage in examining how they respond to situations. This reflects Schön's (1983) thinking on the tacit knowledge and experiences of individuals, which Merryfield (1993, 28) calls the 'worldview of themselves, diverse peoples and the workings of the world'. For Mezirow (1991), reflection is a fundamental component of transformative learning—a process he describes as resulting in new or transformed meaning schemes and perspectives. Thus, reflection may enable individuals to change their habits of expectation and, as a result, develop more accurate perceptions, avoid premature cognitive commitments, and achieve greater flexibility and creativity (Mezirow 1991).

Reflective practice as noted earlier, is also a key process for achieving the goals of education for sustainability, namely, the development of critical thinking skills and a commitment to action (Ferreira, Keliher and Blomfield 2013). Effective education for sustainability prompts students to reflect on their assumptions and beliefs in order to challenge and transform these - leading to changes in values, attitudes and behaviours (Fien 1997).

Reflection has the potential to awaken students to the social change aspects of sustainability and recognise the opportunities and constraints in the ideological and institutional contexts within which they currently learn or may work in the future (Ferreira, et al. 2013). Indeed, as Reynolds notes,

[r]eflection needs to be more than a consideration of the technical and organisational aspects of presenting problems. It should also mean raising social, political and cultural issues, questioning purposes and intentions, and if necessary, challenging the assumptions and taken-for-granted on which organisational policies and practices are based (Reynolds 2011, p.8).

Reflection encourages learners to pay attention to the learning journey and makes visible how personal experience shapes values (Armstrong. C. 2011). Encouraging reflection threatens the ways in which many in the academy teach, however, as it requires not only challenging learners assumptions but also doing so in particular - supportive - learning environments (Cranton 2006).

There are a number of strategies for developing the skills and capacities of reflective practitioners. For example, keeping a reflective journal can promote insight into learning processes and the learners changing understandings (Ferreira et al. 2013, Thomashow 1995). Jurin and Hutchinson (2005, 436) state that such activities allow participants to

'gain perceptions of themselves within their perceptions of their environment, especially when coupled with a guided process that encourage(s) reflective thinking'. The same argument has also been made by others, for example, Pavlovich (2007) and Bleakley (2000).

In our course, we included a number of specifically designed tutorial and assessment activities to encourage and support students in learning to become reflective thinkers. These included: an initial blog about their knowledge of sustainability at the beginning of the course, which was then used to reflect upon their knowledge development at the completion of the course via an assessed essay; group activities throughout the tutorial program that encouraged students to reflect on their assumptions and beliefs about the inadequacy of individual disciplinary perspectives on sustainability; and encouragement for students to write a learning journal (non assessed) to which they could return to complete their reflective essay at the completion of the course. Several themes emerged within the students' reactions to these activities, including positivity to having such opportunities, and identification of areas of development and even transformation.

For example, many students expressed surprise and delight in their reflections with regard to their experiences in the course. According to one student, 'Reflecting on this course was very interesting, it wasn't till I sat down to write my reflective essay did I realise how much I had learnt and how passionate about the subject I had become'. Another had this to say about the reflective practice activities: 'They allowed me to cast my mind back over what I had actually learnt. Surprisingly this reinforced my knowledge and application of critical thinking'.

It is clear that the reflective practice activities also allowed students to identify and acknowledge the development of their learning, identifying gaps, and to reflect on their attempts to reconcile such gaps. One student explained it this way:

I started the course with a fairly sound grasp on MY view of sustainability - this course surprised me as it broadened my mind with some of the angles I hadn't considered before. I feel a lot more critical in my thinking, and I don't feel I have all the answers (like I did before) - but I feel that's a good thing as it encourages me to research more about where I feel the gaps in my learning still are.

Students also reported that they had changed their practice as a result of the course and the assessment tasks. As one student noted:

The evolution of my understanding of sustainable development over the entirety of the course has been profound...The content of this course has given me valuable critical thinking skills and made me aware of the potency of a phrase as seemingly simple as 'sustainable development'.

It is clear then that the reflective practice activities students engaged with throughout our course encouraged and enabled reflective thinking and deep learning.

Reflecting on Our Learning Journey as Educators

When we designed this course we committed ourselves to reflecting upon our own learning journey as educators at the completion of the course. The following insights emerged from that reflection, and were used to inform the subsequent iterations of the course. First, we acknowledge the difficulty in adopting an interdisciplinary approach to education for sustainability. While we concur with Gasper (2010, 61) that an interdisciplinary approach does not require expertise in every discipline, it does require a knowledge of basic concepts and approaches within each discipline. First year university students, while not yet locked into any disciplinary perspective, often do not possess the knowledge about basic concepts which underpin such disciplines, for example, a conception of the state as a dominant political actor on the international political stage. We acknowledge that this requires an attention to provision of the basic concepts and ideas in each disciplinary perspective prior to cultivation of critical thinking about the inadequacy of that individual perspective. In subsequent iterations of the course we did not assume they came to us with that knowledge and we dedicated lecture time and provided readings that provided students with these basic concepts and ideas at the heart of the individual disciplines. We also reflected on the continued need to engage students in interdisciplinary collaboration within the tutorial program in order to promote reflection processes (Barth et al. 2007) and committed to continue interdisciplinary collaboration as part of their tutorial activities.

Second, pivotal to the development of students' ability to think critically, and therefore to the success of the course, was our explicit explanation of what critical thinking actually involves. That is, we provided readings and lecture time to detail what critical thinking is and what it entails. We did not assume we could develop this important skill by osmosis. We were explicit and detailed about what critical thinking involves and how it was central to the course. We sought to make the students active participants and agents in the development of their own critical thinking - 'seeking to make them think about their thinking in order to make their thinking better' (Bailey 2012, 210). Upon reflection, we unanimously agree that we were successful in this approach, and that we will continue on with this in future iterations of the course.

While it may appear tautological to some, our final reflection as educators is on the critical role of reflection in all learning and teaching, but particularly in education for sustainability. Student comments above indicate a clear recognition that their capacity to think critically was enhanced – and this recognition has come through a process of reflection on their learning. We can see that students now display an enhanced awareness of their worldview and how it shapes their understanding, interpretation and learning. There is thus evidence of Mezirow's (1991) transformative learning – the students have begun to reshape their identity through examining a range of different

perspectives. They moved beyond factual and instrumental learning and were changed by what they had learnt (Armstrong, C., 2011). Our own reflections, along with our students' reflections, provide a clear indication that such a process has begun – and has laid the groundwork for continued critical, reflective and interdisciplinary thinking throughout the remainder of their studies – and in their everyday lives.

Conclusion

'We academics need to reshape deeply entrenched routines, structures and practices by taking advantage of the privileged position universities have in our society' (Wals and Blewitt 2010, 70)

A key goal of education for sustainability, and the integral pedagogical goal informing the design of this course, was to create a more critical, innovative and reflexive way of thinking and learning in our students. In reflecting on our own experience of teaching in this course we believe we have been largely successful in this goal. This paper has outlined our own learning journey and that of our students.

Employing an overall constructivist approach, the course content was interdisciplinary in nature, with specific tasks designed to develop the skills of critical thinking and reflection in our students, three key components of education for sustainability. As many have argued, effective education for sustainability should prompt students to reflect on their learning in order to lead to changes in values, attitudes and behaviours (Fien 1997, Howard et al. 2000). Our evidence, gleaned from a variety of sources, and largely reproducing the student voice, demonstrates that for most students in the course, their worldviews and knowledge about sustainability and sustainable development have been irrevocably altered. In that sense we feel that the course fulfilled our desires for a transformative learning experience for our students. As Wals and Blewitt (2010, 70) so clearly articulate, we academics do indeed occupy privileged positions in society where we are afforded the opportunity to contribute towards a more sustainable and equitable future for all the Earth's occupants, and remaining in disciplinary silos and avoiding the hard work of teaching critical and reflective thinking skills, is neither tenable nor ethical. We hope this paper contributes in some way to the development of the pedagogy of sustainability, and hopefully, to genuine sustainability.

References

- Armstrong, C., M 2011, 'Implementing Education for Sustainable Development: The Potential use of Time-Honored Pedagogical Practice from the Progressive Era of Education', *Journal of Sustainability Education*, vol. 2, http://www.jsedimensions.org/wordpress/content/implementing-education-for-sustainable-development-the-potential-use-of-time-honored-pedagogical-practice-from-the-progressive-era-of-education_2011_03/
- Bailey, A 2012, 'Critique, analysis and reflection in the study of reshaping environments', in Bender H (Ed.) *Reshaping Environments, An interdisciplinary approach to sustainability in a complex world*, Cambridge University Press, Cambridge, pp. 209-226.
- Barth, M, Godemann, J, Rieckmann, M & Stoltenberg, U 2007, 'Developing key competencies for sustainable development in higher education', *International Journal of Sustainability in Higher Education*, vol. 8, no. 4, pp. 416-430.
- Bath, D, Smith, C, Stein, S & Swann, R 2004, 'Beyond mapping and embedding graduate attributes: Bringing together quality assurance and action learning to create a validated and living curriculum', *Higher Education Research and Development*, vol. 23, no. 3, pp. 313-328.
- Bender, H 2012, 'Introduction: Reshaping Environments – an opportunity for envisioning the future', in H. Bender, (Ed.), *Reshaping Environments, An interdisciplinary approach to sustainability in a complex world*, Cambridge University Press, Cambridge, pp. 1-13.
- Bleakley, A 2000, 'Writing with invisible ink: Narrative, confessionalism and reflective practice', *Reflective practice*, vol. 1, no.1, pp. 11–24.
- Boud, D., R. Keogh and D. Walker (Eds.). 1985. *Reflection: Turning Experience into Learning*. London: Kogan Page.
- Blewett, J 2008, *Understanding Sustainable Development*, Earthscan, London.
- Brewer, G 1999, 'The Challenges of Interdisciplinarity', *Policy Sciences*, vol .32, no. 4, pp. 327-37.
- Brookfield, S 2012, *Teaching for critical thinking: Tools and techniques to help students question their assumptions*, Jossey-Bass, San Francisco.
- Commonwealth of Australia 2009, *Education for Sustainability: The role of education in engaging and equipping people for change*, Canberra: Department of the Environment, Water, Heritage and the Arts & Australian Institute in Education for Sustainability.
- Cortese, D 2003, 'The Critical Role of Higher Education in Creating a Sustainable Future', *Planning for Higher Education*, Mar – May, pp. 15-22.
- Cranton, P 2006, *Understanding and promoting transformative learning* (2nd ed.), Jossey-Bass, San Francisco.
- Dewey, J 1910, *How we think*, D.C. Heath & Co., Boston.
- Everett, J 2008, 'Sustainability in Higher Education. Implications for the Disciplines', *Theory and Research in Higher Education*, vol. 6, no. 2, pp. 237-250.
- Ferreira, J and Tilbury, D 2012, 'Higher Education and Sustainability in Australia: Transforming experiences' in Global University Network for Innovation (GUNI), *Higher Education's Commitment to Sustainability: From Understanding to Action*,

- Higher Education in the World 4*. Barcelona: Global University Network for Innovation. Palgrave MacMillan, Basingstoke, UK, pp. 96-99.
- Fien, J 2002, 'Advancing sustainability in higher education: issues and opportunities for research', *Higher education policy*, vol.15, pp. 143-152.
- Fien, J, & Rawling, R 1996, 'Reflective practice. A case study of professional development for environmental education', *The Journal of Environmental Education*, vol. 27, no. 3, pp. 11–20.
- Fisher, A 2001, *Critical thinking: An introduction* Cambridge University Press, Cambridge.
- Fry, H, Ketteridge, S & Marshall, S 2009, *A Handbook for Teaching and Learning in Higher Education*, (3rd Ed), Routledge, London.
- Fullan, M & Scott, G 2009, *Turnaround Leadership for Higher Education*. Jossey-Bass, San Francisco, CA.
- Gasper, D 2010, Interdisciplinarity and Transdisciplinarity, in Thompson, P and Walker, M, (eds) *The Routledge Doctoral Student's Companion*, Routledge, New York.
- Glaser, E (1941), *An experiment in the development of critical thinking*. Columbia University, New York.
- Golding, C 2012, 'An Interdisciplinary Approach', in H. Bender (Ed.) *Reshaping Environments, An interdisciplinary approach to sustainability in a complex world*, Cambridge University Press, Cambridge.
- Halpern, D 1998, 'Teaching critical thinking for transfer across domains: Dispositions, skills, structure training, and metacognitive monitoring', *American Psychologist*, vol. 53 no. 4, pp. 449-455.
- Halpern, D 2013, *Critical thinking across the curriculum; A brief edition of thought and knowledge*, Routledge, Abingdon, UK.
- Hannum, P 2014, "Food security, economy to be hit by climate change, leaked IPCC draft report shows", Sydney Morning Herald, 19/3/2014, available at: <http://www.smh.com.au/environment/climate-change/food-security-economy-to-be-hit-by-climate-change-leaked-ipcc-draft-report-shows-20140318-34zpm.html#ixzz2wNiz96HD>. Date accessed 18/3/2014
- Hoare, A, Cornell, S, Bertram, C, Gallagher, K, Heslop, S, Lieven, N, MacLeod, C , Morgan, J, Pickering, A, Wells, S & Willmore, C 2008, 'Teaching against the grain: multi-disciplinary teamwork effectively delivers a successful undergraduate unit in sustainable development', *Environmental Education Research*, vol. 14, no. 4, pp. 469-481.
- IPCC, 2014: Climate Change 2014: Mitigation of Climate Change. *Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.
- Jickling, B and Wals, A 2008, 'Globalization and environmental education: Looking beyond sustainable development', *Journal of Curriculum Studies*, vol. 40, no.1, pp. 1-21.

- Jones, A 2009, 'Generic attributes as espoused theory: The importance of context', *Higher Education*, vol. 58, pp. 175-191.
- Leder, G 1993, 'Constructivism: Theory For Practice? The Case of Mathematics', *Higher Education Research and Development*, vol. 12, no. 1, pp. 5-20.
- Jurin, R, & Hutchinson, S 2005, 'Worldviews in transition: Using ecological autobiographies to explore students' worldviews', *Environmental Education Research*, vol. 11, no. 5, pp. 485-501.
- Lotz-Sisitka, H 2009, 'Why ontology matters to reviewing environmental education research', *Environmental Education Research*, vol. 15, no. 2, pp. 165-175.
- Merryfield, M 1993, 'Reflective practice in global education: Strategies for teacher educators', *Theory into Practice*, vol. 32, no.1, pp. 27-32.
- Mezirow, J 1978, 'Perspective transformation', *Adult Education Quarterly*, vol. 28, no. 2, pp. 100-110.
- Mezirow, J 1991, *Transformative Dimensions of Adult Learning*. San Francisco: Jossey-Bass,
- Millennium Ecosystem Assessment. 2005, *Ecosystems and human well-being : scenarios : findings of the Scenarios Working Group*, Millennium Ecosystem Assessment. Eds S, Carpenter, P. Pingali, E. Bennett, and M. Zurek. Island Press, Washington.
- Paul, R & Elder, L 2002, *Critical thinking: Tools for taking charge of your professional and personal life*, Pearson Education, New Jersey.
- Paul, R 2007, 'Critical thinking in every domain of knowledge and belief', Keynote address at *The 27th Annual International Conference on Critical Thinking*. Available at: <http://www.criticalthinking.org/pages/critical-thinking-in-every-domain-of-knowledge-and-belief/698>
- Pavlovich, K 2007, 'The development of reflective practice through student journals', *Higher Education Research and Development*, vol. 26, no.3, pp. 281-295.
- Peavey, F 1995, 'Strategic Questioning. In Context', *The Context Institute*, vol. 40, pp. 36-37.
- Phillips, D 1995, 'The Good the Bad and the Ugly: The Many Faces of Constructivism', *Educational Researcher*, vol. 24, no. 7, pp. 5-12.
- Reynolds, M 2011, 'Reflective practice: origins and interpretations', *Action Learning: Research and Practice*, vol. 8, no. 1, pp. 5-13.
- Rogers, R 2001, 'Reflection in Higher Education: A Concept Analysis', *Innovative Higher Education*, vol. 26, no.1, pp. 37-57.
- Schon, D 1983, *The Reflective Practitioner: How professionals think in action*, Basic Books, New York.
- Sipos, Y, Battisti, B & Grimm, K 2008, 'Achieving transformative sustainability learning: engaging head, heart and hands', *International Journal of Sustainability in Higher Education*, vol. 9, no.1, pp. 68-86.
- Stephenson, J Lawson, R Carrington, G, Barton, B, Thorsnes, P & Miroso, M 2010, "The Practice of Interdisciplinarity", *The International Journal of Interdisciplinary Social*

- Sciences*, vol 5, no. 7, pp. 271-282.
- Sterling, S 2010, 'Learning for resilience, or the resilient learner? Towards a necessary reconciliation in a paradigm of sustainable education', *Environmental Education Research*, vol. 16, no. 5, pp. 511- 528.
- Sterling, S and Scott, W 2008, 'Editorial', *Environmental Education Research*, vol. 14, no. 4, pp. 383- 385.
- Strathern, M 2005, 'Anthropology and Interdisciplinarity', *Arts and Humanities in Higher Education*, vol. 4, no. 2, pp. 125-135.
- Strober, M 2010, *Interdisciplinary Conversations, Challenging Habits of Thought*, Stanford University Press, Palo Alto.
- Svanstrom, M, Lozano-Garci, F & Rowe, D 2008, 'Learning outcomes for sustainable development in higher education', *International Journal of Sustainability in Higher Education*, vol. 9, no. 3, pp. 339-351.
- Tenenbaum, G.,Naidu, S, Jegede, O & Austin, J 2001, 'Constructivist pedagogy in conventional on campus and distance learning practice: an exploratory investigation', *Learning and Instruction*, vol. 11, pp. 87-111.
- The Australian Research Institute for Sustainability (ARIES), 2009, *Education for Sustainability. The Role of education in Engaging and Equipping People for Change*, Maquarie University and Commonwealth of Australia, Canberra.
- Thomashow, M 1995, *Ecological identity: Becoming a reflective environmentalist*. The MIT Press, Cambridge, MA..
- Tilbury, D (2011) *Education for Sustainable Development: An expert review of processes and learning*, UNESCO, Paris.
- Tilbury, D & Cooke, K 2005, *National Review of Environmental Education and its Contribution to Sustainability in Australia: Frameworks for Sustainability*. Canberra: Australian Government Department of the Environment and Heritage and Australian Research Institute in Education for Sustainability (ARIES).
- Wals, A & Jickling, B 2002, 'Sustainability in higher education: From doublethink and newspeak to critical thinking and meaningful learning', *International Journal of Sustainability in Higher Education*, vol. 3, no. 3, pp. 221- 232.
- Wals, A & Blaze Corcoran, P (2006). 'Sustainability as an outcome of transformative learning' in *Education for Sustainable Development in Action*, Technical Paper N°3, UNESCO, pp. 103-110.
- Wals, A and Blewitt, J 2010, 'Third Wave Sustainability in Higher Education: Some (Inter)national trends and Developments, Sustainability Education, Perspectives and Practice Across Higher Education, in *Sustainability Education. Perspectives and Practice across Higher Education*, Earthscan, Washington DC, pp. 55-76.
- Wals, A. 2010, 'Between knowing what is right and knowing that is it wrong to tell others what is right: on relativism, uncertainty and democracy in environmental and sustainability education', *Environmental Education Research*, vol.16, no. 1, pp. 143-151.
- Warburton, K 2003, 'Deep learning and education for sustainability', *International Journal of Sustainability in Higher Education*, vol. 4, no. 1, pp. 44-52.
-