

Chapter 17

A Case Study of an Australian University Embedding EfS in a Pre-service Teaching Program

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Introduction

The Millennium Ecosystem Assessment (2005), the first ever global assessment of ecosystem health and human wellbeing, concluded that in order to respond to human degradation of ecosystems and meet the needs of a burgeoning global population, significant changes in policies, institutions, and practices are required. As early as 1987, the World Commission on Environment and Development (WCED) called for a reorienting of economic and social development goals in terms of sustainability, and inherent concerns for intragenerational and intergenerational equity, acknowledging that “the world’s teachers...have a crucial role to play” in the shift towards sustainable futures (United Nations WCED, 1987, p. xiv). In 2009, the Bonn Declaration (United Nations Educational, Scientific, and Cultural Organization [UNESCO]) called for the mobilization of universities’ core functions of teaching, research, and community engagement, reiterating the importance of reorienting higher education curricula, especially teacher education, in developing

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research-informed pedagogical approaches that equip graduates for decisive action on sustainability. The extent to which this imperative has progressed is unclear.

In the Australian higher education sector, *graduate attributes* encapsulate the core abilities and values that a university community agrees all its graduates should develop if they are to become active members of local and global communities (Barrie, 2004; Barrie, Hughes, & Smith, 2009). Despite intentions and claims in policy, however, recent research has focused on why Australian universities have been largely unable to achieve significant systematic changes to student learning experiences, and to deliberately reorient the curriculum so as to foreground the acquisition of these attributes (Barrie et al., 2009). Although support for academics wishing to embed sustainability into teaching and learning is available in the form of guidelines (e.g., UNESCO, 2005a), resources (e.g., University of Plymouth, n.d.; Sterling, 2008; UNESCO, 2005b), scholarly publications (e.g., Fien & Maclean, 2000; Fien & Tilbury, 1996; Hopkins, 2001), and case studies (e.g., Stevenson, Davis, Ferreira, & Evans, 2014), often sustainability learning experiences are facilitated by a few champions and, as such, comprise isolated or disparate experiences, falling short of promoting sustainability knowledge, skills, and dispositions in developmentally cohesive ways across a program (Ferreira, Ryan, & Tilbury, 2006; Steele, 2010; Summers, Childs, & Corney, 2005). Research consistently finds that inclusion of sustainability in teacher education is dominated by isolated activities in, for example, curriculum (Wright & Wright, 2010), project work (Phelps, Maddison, Skamp, & Braithwaite, 2008), science and geography subjects (Corney, 2006; Esa, 2010), or through a dedicated elective subject (Burke & Cutter-Mackenzie, 2010; Whitehouse, 2008). Critics are skeptical of such approaches. Effective sustainability education requires a re-imagining of current practices, involving a shift from add-on to systematic approaches that embed sustainability within a school or department's policies, practices, and teaching and learning activities (Ferreira, Ryan, & Tilbury, 2007a, b; Greenwood, 2010; Sterling, 2004).

At James Cook University (JCU, 1995–2014c), the aim is to become a “national and international leader in teaching and research, addressing critical challenges of the tropics worldwide, through graduates and discoveries that make a difference” (pp. 2 & 5). There is growing commitment to environmental, economic, cultural, and social sustainability through an integrated approach to teaching and learning, research, operations and campus facilities, and community engagement (JCU, 1995–2014c). We are a group of JCU teacher educators in the School of Education at Cairns and Townsville campuses in Australia's Tropical North. Broadly, the key challenges for our tropical northern region involve “the need to address the sustainability of current land use, economic development pathways, and socioeconomic disparity” (Green, Jackson, & Morrison, 2009, pp. 7 & 8). Existing social and economic disadvantage renders many remote and Indigenous communities in Northern Australia especially vulnerable to increasing environmental stresses, including climate change (Green et al., 2009). Climate change is expected to impact the tropics in potentially profound ways, with rising sea levels and increased intensity of tropical storms posing significant threat to coastal communities and estuarine ecosystems (Queensland Department of Environment and Resource Management, 2011), and ocean acidification and increased temperatures endangering coral reefs

(Hoegh-Guldberg et al., 2007). Hoegh-Guldberg and colleagues (2007) presented future scenarios for coral reefs that predict “increasingly serious consequences for reef-associated fisheries, tourism, coastal protection, and people” (p. 1737).

During 2009–2011, the School of Education at James Cook University adopted a whole-of-program approach to embedding sustainability in its Bachelor of Education, as part of a university-wide Curriculum Refresh Project (Australian Department of Education, Employment, and Workplace Relations [DEEWR], 2009–2011), designed to align curriculum more strongly with JCU’s Strategic Intent (1995–2014b). A whole-of-program approach to embedding sustainability was further supported by recognition of sustainability as a cross-curriculum priority in the newly-developed Australian national school curriculum, Foundation to Year 10 (Australian Curriculum Assessment and Reporting Authority [ACARA], 2011). Academic staff engaged in collaborative projects to design dedicated sustainability subjects, revise a longstanding sustainability elective so as to enhance emphasis on climate change education, and embed sustainability principles, concepts, and issues across the early childhood (birth to 8 years of age) and primary (Preparatory to Year 6) majors, including science curriculum studies.

In a recent article, Wals, Brody, Dillon, and Stevenson (2014) proposed that sustainability education and science education need to develop a mature, symbiotic relationship, given “the complex nature of current sustainability challenges, and the need for competent citizens who can adequately respond to them” (p. 583). Indeed, it is our intention at JCU to ensure that pre-service teachers develop understanding of the underlying science and complexity of global and local socio-ecological challenges as part of their first-year program through a core sustainability and science education subject, *Foundations of Sustainability in Education*. Within the later years of their program, our pre-service teachers develop the capacity to plan, implement, and reflect upon sustainability and climate change learning experiences and actions, across diverse school and community contexts. The aim of shaping graduate teachers who are equipped to “make a difference” (JCU, 1995–2014b, title) in their future schools and communities is encapsulated in one of six overarching Learning Outcomes for the Bachelor of Education:

Graduates will be able to demonstrate broad and coherent understanding of underlying principles and concepts and teaching and learning approaches in the areas of Indigenous education, education for sustainability, rural and regional education, and the tropics. (JCU, 1995–2014a, Academic requirements for course completion)

In order to assure graduate achievement of this outcome, aligned assessment tasks were comprehensively mapped across the program.

In this chapter, we examine aspects of learning, teaching, and assessment in: (1) the first-year core sustainability and science education subject, *Foundations of Sustainability in Education*; (2) an embedded component in a third-year core professional studies subject, *Early Childhood Education and Care*; and (3) a final-year elective, *Environmental and Climate Change Education for the Tropics*. We draw upon a range of data sources including student responses in online discussion forums and formal student evaluation data across subjects. Further, in 2012, a JCU Learning and Teaching Fellowship funded an external evaluator (Skamp, 2012) to conduct a series of individual, semi-structured telephone interviews with five online

students, of 40–50 min average duration, to investigate the impact of pedagogical and assessment approaches, including the use of educational technologies, on student engagement and learning in *Foundations of Sustainability in Education*.

Our early childhood pre-service teachers are afforded the option to undertake their studies either face-to-face or wholly online. The online students typically comprise mature-age females (i.e., over 21 years of age) from rural and regional contexts in Queensland, often with experience in early childhood care settings, and family and work responsibilities. The primary majors largely undertake their studies in an on-campus but increasingly blended mode. A relatively small number of external Indigenous pre-service teachers, enrolled in the Bachelor of Education (Primary), remain based within their communities and closely connected to schools. Having delivered the aforementioned final-year elective (now titled *Environmental and Climate Change Education for the Tropics* since 2001), Whitehouse (2008) concluded that “well-conceived, web-based delivery is certainly no barrier to teaching and learning environmental education in the tertiary sector” (p. 11). While Whitehouse (2008) was initially concerned with “how to engage students meaningfully with place-based learning through the no-place of cyberspace” (p. 11), the elective has sustained high levels of student enrollments and satisfaction over time. Facilitating sustainability and science education across multiple modes and for diverse cohorts has substantially enhanced our own pedagogical and technological knowledge and skills. With a view to preparing diverse cohorts of early childhood and primary educators to confidently and competently engage their future students in science and sustainability education across a range of school contexts, our focus in these subjects is on active and collaborative inquiry-based, technology-enabled, and praxis-oriented learning and assessment experiences. As teacher educators, we recognize the importance of modeling and engaging pre-service teachers in authentic learning experiences that also can be effectively implemented in classrooms. In this way, “teacher education represents a unique form of teaching in which both the content of the teaching and the practice of the teaching form the basis of what is being taught” (Edwards, 2010, p. 10).

Science and Sustainability Pedagogy

In a meta-analysis of qualitative studies, Lyons (2006) reviewed remarkably similar reports of school science experiences by students from Australia, the UK, and Sweden, with emergent themes revolving around transmissive pedagogy, decontextualized and irrelevant content, and unnecessary levels of difficulty. Relative to school experiences of science, the literature also indicated that science is traditionally met with resistance from both pre-service and practising primary school teachers due to a lack of confidence and self-efficacy in engaging with scientific content and pedagogy (Murphy, Neil, & Beggs, 2007). In order to promote interest and develop overall positive dispositions towards science learning, a European High Level Expert Group (European Communities, 2004) called for a more

student-centred, socially oriented, and intellectually engaging science pedagogy. Over several decades, there has been growing international agreement regarding the nature and importance of scientific literacy as an outcome of science education (Goodrum, Hackling, & Rennie, 2000). According to Hayden et al. (2011), a key component of scientific literacy is a “commitment to critical understanding of contemporary socio-scientific issues, with a willingness to take appropriate and responsible action and encourage others to do so” (p. 120). These authors argued that in order to act authentically on issues, students must feel a personal sense of investment and believe that even their small-scale actions can lead to empowerment and further action. Gough (2008) proposed that an obvious rationale for developing a different relationship between science and environmental education emerges from the need to respond to students’ declining interest in science despite increasing levels of environmental concern.

As educators, we are aware of the importance of promoting positive attitudes towards science among our early childhood and primary pre-service teachers. In *Foundations of Sustainability in Education*, students develop essential understanding of science and sustainability concepts and principles through participation in inquiry and hands-on experimentation and activities relating to key socio-ecological challenges of local and global relevance. Drawing upon this foundational understanding, in *Early Childhood Education and Care* and *Environmental and Climate Change Education for the Tropics*, students plan for classroom learning experiences aligned with: (1) the Australian National Curriculum (ACARA, n.d.), wherein sustainability is a cross-curriculum priority to be embedded in learning areas such as science; and (2) early childhood curriculum frameworks (Australian DEEWR, 2009; Queensland Studies Authority [QSA], 2010a), which adopt holistic approaches to children’s learning and development, organised according to interdisciplinary areas and learning outcomes (see Table 17.1). So too, in curriculum planning activities, students utilise key Australian Education for Sustainability (EFS) policy documents (Table 17.1), which highlight approaches that emphasise whole-of-school engagement in sustainability (Australian Department of the Environment and Heritage [DEH], 2005), and importantly, school students’ participation in action processes across the Kindergarten to Year 10 spectrum (Australian Department of the Environment, Water, Heritage, and the Arts [DEWHA], 2010). In the Australian context, emphases on individual, school, and community actions are further supported through government-funded projects, such as the *Australian Sustainable Schools Initiative* (Australian Department of the Environment, n.d.).

Given this learning sequence in the Bachelor of Education program where pre-service teachers develop foundational understanding in science and sustainability concepts and principles in the first year that they then build upon and apply in subsequent years to either plan for children’s learning or to engage themselves in sustainability actions, we see utility in employing Dettmer’s (2006) phases of learning and doing in this chapter to explore our pedagogical practices. Dettmer (2006) described three phases of learning and doing: (1) the *essential* or ‘What should learners know?’ characterised by acquisition of essential material by all

Table 17.1 Key Australian curriculum and policy frameworks and relevant organisers

Key curriculum and policy frameworks	Relevant organisers
<i>Australian National Curriculum</i> (ACARA, n.d.)	Cross-curriculum area: Sustainability
<i>Early Years Learning Framework</i> (Australian DEEWR, 2009)	Learning outcome: Children are connected with and contribute to their world – <i>Children become socially responsible and show respect for the environment</i>
<i>Queensland Kindergarten Learning Guideline</i> (QSA, 2010a)	Learning and development area: Connectedness Learning outcome: Shows increasing respect for environments
<i>Educating for a Sustainable Future: A National Environmental Education Statement for Australian Schools</i> (Australian DEH, 2005)	A whole-of-school framework involving curriculum organization, teaching and learning, governance, resource management, physical surroundings, and networks and partnerships
<i>Sustainability curriculum framework: A guide for curriculum developers and policy makers</i> (Australian DEWHA, 2010)	Sustainability action processes wherein the central goal is learning to take action: making a case for change, defining the scope for action, developing a proposal for action, implementing the proposal, and evaluating and reflecting

students; (2) the *developmental* or ‘What can learners do?’ where content is important but presented with flexibility; and (3) the *generative* or ‘To what do learners aspire?’ where the content is novel, processes are open-ended, and each context encourages uniqueness. In the generative vein, it is highlighted in the EfS literature that education processes themselves will need to continuously evolve “in response to the unpredictable and unanticipated challenges of society” (Mochizuki & Fadeeva, 2010, p. 397), and rather than being viewed as delivery mechanisms will be appreciated “as lifelong, holistic, and inclusive” processes (International Conference on Environmental Education, 2007). We subscribe to notions of EfS as a “new paradigm for lifelong learning” that:

...leads to an informed and involved citizenry having the creative problem solving skills, scientific, technological and social literacy, and commitment to engage in responsible actions to ensure an environmentally sound, socially just, and economically prosperous future for all. (Fien & Maclean, 2000, p. 37)

It is important to note that the *Gothenburg Recommendations on Education for Sustainable Development* (Chalmers University of Technology/University of Gothenburg, 2008) identified early childhood as a natural starting point for EfS within a lifelong learning framework. It is our intention, as teacher educators, to equip our early childhood and primary graduates with the knowledge, skills, and dispositions to teach science and sustainability education in diverse school and community contexts within our region and beyond, and for the socio-ecological conditions that they and their students will encounter in the twenty-first century. How we prepare them best for that is in part illuminated in the following section.

Developing an *Essential* Conceptual Base in Science and Sustainability Education

Key considerations in the design of *Foundations of Sustainability in Education* were: (1) how to engage pre-service teachers positively with science and sustainability concepts and practices and build a shared foundational knowledge base, given that our first-year students are generally underprepared in these areas; and (2) how to provide hands-on and experiential learning opportunities that link to future classroom practice and sustainability actions for all student cohorts, including those undertaking the subject in online modes. *Foundations of Sustainability in Education* draws upon the natural and social sciences and geographic and temporal scales to engage students in exploring a number of local and global sustainability issues, such as climate change, renewable and non-renewable energy, water availability and quality, biodiversity conservation and resource management, sustainable food production, and human population growth and wellbeing. In so doing, foundational understanding of chemistry, physics, biology, earth and environmental sciences, geography, and demography is developed. Students are required to demonstrate requisite science understanding in a written examination as seen in Table 17.2 that aligns Dettmer's (2006) phases of learning and doing with the subject's learning outcomes and assessment tasks.

Table 17.2 Alignment between Dettmer's (2006) phases of learning and doing and *Foundations of Sustainability in Education* learning outcomes and assessment tasks

Phase of learning & doing	Subject learning outcome	Assessment task
<p>Essential</p> <p><i>What should learners know?</i></p> <p>Acquisition of essential material by all students.</p>	Students will recall, identify and apply concepts and procedures of science and sustainability to local and global contexts.	Examination
<p>Developmental</p> <p><i>What can learners do?</i></p> <p>Content is important but presented with flexibility.</p>		
<p>Generative</p> <p><i>To what do learners aspire?</i></p> <p>The content is novel, processes are open ended, and each context encourages uniqueness.</p>	Students will develop evidence-informed values and positions relating to sustainability through active citizenship, critical and systemic thinking, and reflection.	<p>Solar still fair test wherein students select independent variable, communicated in scientific report</p> <p>Inquiry into local sustainability issue of choice, communicated through written responses to strategic questioning (involving observation, feelings, visioning, change, personal inventory, and personal action) and creation of digital webstory for children's audience.</p>

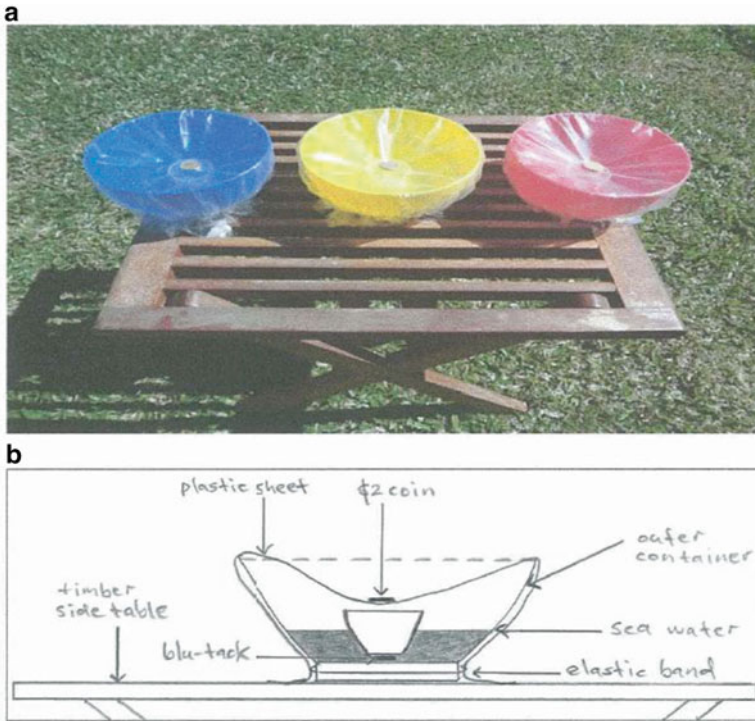


Fig. 17.1 Excerpt from first-year pre-service teacher’s solar still experiment report. (a) Photograph of experimental setup. (b) Labeled diagram of the experimental setup

To a lesser extent, the subject aims to develop students’ inquiry and communication skills, through engagement in experiential learning activities, investigations and assessment tasks, with relevance to school classroom contexts and sustainability actions. In a second assessment task, pre-service teachers design and conduct a fair test to determine the effects of a variable of their choosing on the volume of water captured in a home-made solar still (Table 17.2; Fig. 17.1). They report upon their experimental design and findings in a scientific report, drawing parallels with processes of evaporation and condensation in the water cycle, and outlining potential utility of solar stills, in terms of water purification in sustainable development contexts. In the external evaluation of student engagement and learning in *Foundations of Sustainability in Education*, one pre-service teacher described this assessment task as an opportunity to learn by ‘doing’ and hence of benefit to future practice:

When specifically asked ‘what’ assisted their learning one student referred to the assignments, especially the solar still task, as she was “doing” and “not just reading”- “going through the process of doing a basic experiment and writing it up and going into a little bit of depth” was “quite useful” to her as a “prospective teacher”. (Skamp, 2012, p. 20)

In a third assessment task, students inquire into a local sustainability issue and consider implications for active citizenship driven by questions clustered within the *six families of strategic questions* (Peavey, 1994). These families include: (1) observation questions (e.g., *How does the issue affect your local area?*); (2) feeling questions (e.g., *Has this issue affected your own physical or emotional well-being?*); (3) visioning questions (e.g., *How could the situation be changed?*); (4) change questions (e.g., *What will it take to bring the current situation towards your vision?*); (5) personal inventory and support questions (e.g., *What would you like to do that might be useful in bringing about these changes?*); and (6) personal action questions (e.g., *How can you get others to a meeting to work on this issue?*). While not directly engaging first-year pre-service teachers in action processes, the application of the strategic questions framework (Peavey, 1994) in this assessment task nonetheless involves them in inquiry, reflection, and visioning processes, the latter of which resonates with Dettmer's (2006) generative phase – *What do learners aspire to?* (Table 17.2). In addition, there are opportunities to develop students' technological literacy skills as they are required to communicate aspects of their selected sustainability issue through the creation of a digital webstory, appropriate for a children's audience. The webstory, compiled through original photographs and hyperlinked to supporting web-based educational resources, is an authentic digital artefact, potentially serving as a classroom resource for stimulating school students' interest in a local sustainability issue or as an exemplar of what school students themselves may be required to produce as a culminating assessment task in a sustainability or science unit.

Given that many of our first-year pre-service teachers enter *Foundations of Sustainability in Education* with concerns about requisite science knowledge and their self-efficacy in terms of teaching science in early childhood and primary settings, the purposeful choice of pedagogies that support and enhance engagement is critical (Newton & Newton, 2011). Students interact with the subject's content in part through six online modules that are built on customised websites linked to the university's learning management platform. The six modules—*Education for Sustainability, Water, Energy, Land, Air, and Sustainable Futures*—can be accessed via an interactive online graphic, which not only depicts the overall content organization but the subject's central underlying tenet – that is, that human systems and sustainability are wholly dependent on the environment (Fig. 17.2).

Utilizing an overarching inquiry framework of *tuning in, preparing to find out, finding out, sorting out, and reflecting and taking action* (Hamston & Murdoch, 1996), the modules are designed to scaffold a guided experience of learning and discovery. They accomplish this through inclusion of intended learning outcomes, key questions for consideration, explanations of core science and other disciplinary content relevant to local and global socio-ecological issues, as well as activities based on prescribed reading materials and further stimulus resources to support



Fig. 17.2 Interactive graphic depicting subject's organization and underpinning tenet

classroom implementation and personal actions. Formal student evaluation data attests to the impact of the learning modules on engagement and learning:

The best aspect of the subject was the interactive learning made interesting through the colourful and engaging online modules. I found them very easy to work through and knew exactly what was expected of me. (Pre-service teacher 1, 2012)

[The modules] drew on specific readings with questions that were relevant for synthesising my understanding. They effectively drew on lectures, readings and other interactive sources [and] foster[ed] deep conceptual understanding of the content. (Pre-service teacher 2, 2011)

Lectures in *Foundations of Sustainability in Education*, which are vodcasted for online cohorts, comprise a blend of pedagogical strategies. There is direct teaching of the more challenging science and sustainability concepts already introduced to students by way of the online modules. So too, student-centred pedagogies promote active, discursive, and reflective learning through role-plays, group discussions, stimulus activities, debates, case studies, and critical reading and writing (Bosselmann, 2001; Cotton & Winter, 2010; Sterling, 2004). Weekly tutorials provide greater opportunities for experiential learning and modelling of pedagogies for science and sustainability education. Pre-service teachers perform simple science experiments and activities, such as simulating the greenhouse effect in a jar, identifying soil samples, and using dichotomous keys to classify plants and animals. So as to engage online learners in experiential learning, tutorials have been

developed using Wikis, which include task instructions, links to resources, templates, and examples of high quality student responses. Student evaluation data indicates that opportunities for experiential learning are important in building conceptual understanding ('the *essential*') and an early repertoire of strategies and activities for classroom implementation ('the *developmental*')

Having tutorials for online students was beneficial in understanding the content in a more hands on way. (Pre-service teacher 3, 2012)

The inclusion of teaching examples provided during tutorials will be very useful for our future practical lesson plans. (Pre-service teacher 4, 2012)

The external evaluator concluded that, "it was, without doubt, the 'subject matter' that caught [students'] attention, being supported by the high quality of online delivery and materials" (Skamp, 2012, p. 15). Individual interviews with five pre-service teachers revealed that they found the subject material "personally interesting" (Hidi, 1990) and intellectually engaging (Pittaway, 2012) as it "looked at the bigger picture." In terms of the overall impact of *Foundations of Sustainability in Education* in shaping pre-service teachers' knowledge, skills, and dispositions, the external evaluator observed:

...students described the subject's *impact* on them. They referred to various personal pro-environmental changes they have started to make, and professional changes they intend to make. They did not, however, refer to actions that would characterize them as 'change-agents' for sustainability. This is understandable with this being a first year subject although the longer-term teacher education goal would be transformative learning. (Skamp, 2012, p. 18)

The next section highlights opportunities for transformative learning in the latter years of the Bachelor of Education. It is indeed important for pre-service teachers to, in Mezirow's (2000) words, "negotiate and act on" their own values and beliefs (p. 8), rather than those that have been uncritically assimilated from others, in order to exert greater control over their professional and personal selves "as socially responsible, clear-thinking decision makers" (p. 8). However, given that pre-service teachers "cannot simply conjure up images of enacted sustainability", in *Early Childhood Education and Care*, they are afforded opportunity to create and "interact with tangible examples that support integration of sustainability into their own developing knowledge of practice" (Nolet, 2009, p. 432).

Developmental and Generative Opportunities for Transformative Learning

Early Childhood Education and Care

By the time students undertake *Early Childhood Education and Care*, they have been exposed to, and often have very definite ideas about, science and sustainability education, and its place in early childhood education. Education for sustainability is

a priority in early childhood teacher education. The development of social and environmental responsibility is a learning outcome in early childhood curriculum documents (i.e., the *Early Years Learning Framework* and *Queensland Kindergarten Learning Guideline*, as outlined in Table 17.1). There is also direct reference to sustainability in the Australian Children’s Education and Care Quality Authority’s (2013) recently-implemented *National Quality Standard*, a system by which child care services obtain their licensing. The National Quality Standard mandated that, “Sustainable practices are embedded in service operations” and “Children are supported to become environmentally responsible and show respect for the environment” (Standard 3.3). In the Australian context, this is the first national systemic approach to promoting sustainability across the early childhood sector with recognition in service management as well as curriculum. It makes sense then to include a sustainability component in one of the core early childhood professional studies subjects.

For one assessment task in *Early Childhood Education and Care*, pre-service teachers are asked to select complementary outcomes from the *Queensland Kindergarten Learning Guideline* (QKLG) and *Early Years Learning Framework* (EYLF) (Table 17.1) that will inform an EfS learning experience for children under 5 years of age. They are to develop a stimulus teaching resource—an activity, information bank, book, or game—and write an accompanying rationale explaining choice of outcomes and themes, age suitability of resource, pedagogical strategies to support children in interacting with the resource, and ways in which the resource can promote children’s understanding of sustainability. In 2012, with student permission, resources were showcased, either in person or virtually, at an early childhood community forum. Research was undertaken to discover the impact of this assessment task on pre-service teacher engagement and learning, and findings are reported below.

Before undertaking the assessment task, students were asked to post responses, in an online discussion forum, to the following stimulus questions: *What is Education for Sustainability? Explain how important you think it is in the early childhood curriculum. How would you teach it to 0–5 year olds?* A lecture was dedicated to exploring multiple definitions of EfS, its history of implementation in Australia, links to relevant policy, and translation in practice and high quality resources for use in early childhood care and school settings. Pre-service teachers then engaged in group discussion and practical exercises wherein they evaluated a range of EfS teaching resources, according to ‘principles of good practice for educational resources’ (Australian DEH, 2005, p. 22), and responded to stimulus questions designed to support them in making connections between learning statements and key principles from informing curriculum and policy documents such as:

How could ‘interspecies equity’ or ‘basic human needs’ (Australian DEH, 2005) be linked to ‘identity’ (QKLG)?

How is ‘connectedness’ (QKLG & EYLF) linked with ‘ecosystems’ and ‘cultural diversity’ (Australian DEH, 2005)?

Before submitting the assessment task, students were encouraged to post works-in-progress in the online discussion forum, provide evaluative feedback in regard to

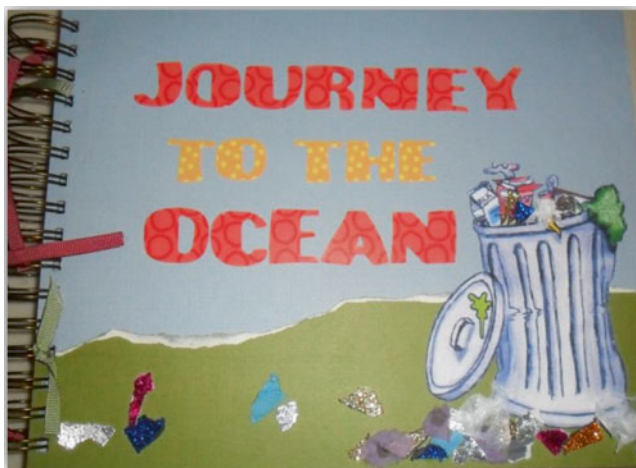


Fig. 17.3 Learning resource to facilitate EfS for children under 5 years of age

peers' resources, and in turn respond to feedback afforded to them by undertaking necessary edits and refinements of their own resources.

Pre-service teachers developed resources enthusiastically, and outcomes and key concepts were thoughtfully chosen. For example, in a game comprising quiz cards, player pieces, a large dice, and a puzzle, children were challenged to make decisions and predict impacts upon the environment. Resource banks, indoor and outdoor activities, books, quizzes, and puppets were also developed. The example in Fig. 17.3 is a story written and illustrated by a pre-service teacher, and accompanied by a sock puppet of the main character. The author stated:

'Journey to the Ocean' is a storybook that was created to engage and encourage young children, up to five years of age, to explore the effects of littering on the Great Barrier Reef. The storyline seeks to empower young children to assume responsibility for littering as it embraces key themes from the Environmental Education for Sustainability Framework such as interspecies equity, participation and respect. (Pre-service teacher I, 2012)

At the culmination of the subject, students were invited to present their resources, either in person or online, to an early childhood community forum. The requirement to explain their resources both within the assessment task and to an authentic professional audience was intended to consolidate student understanding of curriculum and policy frameworks, key sustainability concepts and principles, and age-appropriate pedagogies to engage young children. Pre-service teachers were again asked to post responses to the initial stimulus questions, along with: *How has your perspective changed since engaging in the lecture, discussions, and resource development?* A number of students indicated that including EfS in their professional studies subject reinforced its importance:

After the material I have read, I agree that Sustainability Education is important, which is not how I started off at the beginning of this subject. With the depletion of natural resources, instilling values and empowering action in students about their environment ensures that everyone will quite possibly have a more positive interaction with it. (Pre-service teacher II, 2012)

Pre-service teachers' ideas on how to teach EfS to very young children expanded; while, for instance, initial responses discussed implementing recycling efforts, end-of-subject responses reflected more holistic and authentic approaches to integrating EfS:

Sustainability needs to be taught through children's daily activities in early childhood...It is about teachers responding immediately to these situations and knowing when there is a 'sustainability opportunity.' (Pre-service teacher III, 2012)

By implementing a cross-curricula approach to sustainability, teachers are able to increase their students' understanding and knowledge of the varying issues that are incorporated within Sustainability Education. (Pre-service teacher IV, 2012)

While not all pre-service teachers communicated transformative learning experiences, a number of them made explicit reference to changed perspectives, as can be seen in the following statements:

My perspective regarding Education for Sustainability has considerably changed in terms of how I could teach it to 0–5 year olds. Looking through the sustainability resources posted by all my peers opened my eyes up to the many possibilities out there that are available to teach young kids about protecting and maintaining the world we live in. (Pre-service teacher V, 2012)

I thought it would be possible but that it would be extremely difficult for the young ones to understand. I can now see that teaching Education for Sustainability can be made much easier than I initially thought. (Pre-service teacher VI, 2012)

Many pre-service teachers in *Early Childhood Education and Care* work in schools and prior-to-school settings while undertaking university study. Often, they have witnessed and participated in sustainability programs in their workplaces. Even so, including EfS in this subject expanded conceptual and practical understanding, as captured in the following student's comment:

Although I am lucky enough to have witnessed many environmentally sustainable practices being implemented in child care, I feel like now I am in touch with the concept of sustainability in all its forms, and I have the skills to develop principles and practices of sustainability further into my programs. Having the opportunity to view all the resources everyone has created was a fantastic opportunity for all student teachers to see sustainability programs in action. (Pre-service teacher VII, 2012)

Environmental and Climate Change Education for the Tropics

With its beginning as a fourth-year elective in 2001, *Environmental and Climate Change Education for the Tropics* was one of the first JCU subjects to be wholly delivered online. The original subject was titled *Environmental Education for the Tropics* but over the decade between 2001 and 2010, the general discourse used within the subject shifted from environmental education to EfS in line with developments within Australia. However, given that the subject was designed around the Wet Tropics and Great Barrier Reef World Heritage Areas as unique

contexts for learning, the reference to environmental education was retained. While carefully-designed flexible learning combined with meaningful offline experiences relating to local places has proved a successful and lasting combination (see Whitehouse, 2008), given that some of the original curriculum was now enacted in non-elective parts of the refreshed Bachelor of Education, we decided to redesign this elective to include the developing field of climate change education. Learning to live with climate change and the associated risks, challenges, and uncertainties is one of the key challenges for education systems, schools, and educators in this century (Stevenson, Nicholls, & Whitehouse, 2012).

The subject learning outcomes were refined to reflect these new emphases and articulated according to knowledge, practice, and thinking domains, as follows: (1) students will understand the complexities of climate change education and how climate change can be communicated to different groups of people, including children and youth; (2) students will build a sophisticated repertoire of teaching and learning strategies for effective environmental education practice; and (3) students will analyse and reflect on relevant sustainability education practices in professional and community settings. Beyond analytical and reflective thinking, learning experiences in *Environmental and Climate Change Education for the Tropics* aim to develop an understanding of systems thinking by relating climate change and sustainability issues at the global level to the local scale and providing opportunities for exploring interrelationships in local place-based contexts within which pre-service teachers are closely connected. Much of this learning is thus deeply personal, designed around a transformative adult pedagogy where “learners develop [their] ability to analyze, pose questions, and take action on [the] ... social structures that shape and influence the way they think about themselves and the world” (Dirkx, 1998, p. 3).

In line with a pedagogical approach that promotes social agency, the subject’s modules, readings, viewings, and stimulus resources provide students with reliable, synthesized information and discussion, which do not dwell excessively on ‘doom and gloom’. As long-time sustainability educator Jonathon Porritt (2013) said, “purposeful, action-oriented hope is still our most important resource” (para. 11). The subject is organized into six learning modules, as follows: (1) Origins and interpretations of environmental and sustainability education; (2) Connecting children and adolescents with nature; (3) School–community partnerships; (4) Plastic fantastic; (5) Climate change; and (6) Climate change education. Some of the modules require participation in experiential learning activities and reflection upon those experiences by way of posts in the online discussion forum, comprising one component of assessment within the subject.

The online forum becomes a fertile ground for learning, reflection, and interaction; in fact, there is opportunity for pre-service teachers to interact with and view responses of practising classroom teachers, also enrolled in *Environmental and Climate Change Education for the Tropics*, as part of a Masters of Sustainability program. For instance, in Module 4, given that marine debris is a key environmental issue for tropical environments and a threat to many species of the Great Barrier Reef, students are required to undertake a plastic audit. In the associated posts,

students reflected upon the audit, as well as the potential for or actual implementation of learning about plastics in classroom practice:

At the end of my audit I was shocked to find that I had come into contact with plastic over 100 times over 24 hours. Nearly everything I did involved plastic. An activity like this could certainly be used as part of a teaching unit. I know there's a technology unit in the year 4 curriculum wherein students explore various materials with the intention of designing their own backpack. Conducting 'plastic fantastic' as a side activity could definitely highlight the need for using non-plastic materials as much as possible, since so much plastic is currently unrecyclable. (Pre-service teacher A, 2013)

I did not know about all that plastic in the ocean. I have loved learning all this. I used all the [subject] resources with my class this week and they [the students] were as shocked as I was at first. (Classroom teacher A, 2013)

The main assessment task in *Environmental and Climate Change Education for the Tropics* is a curriculum research project of choice, the purpose of which is to encourage integration of sustainability and climate change knowledge into daily education practice. It enables pre-service teachers to directly pursue a particular interest or passion. Past projects have seen students research and design learning units (e.g., a cradle-to-grave journey of a consumer item, a literacy-rich project involving worm farming); undertake a *Learnsapes* (Australian DEH, 2005, p. 12) analysis of a school ground; and design, implement, and reflect on authentic action projects within school and child care settings. In 2013, one pre-service teacher implemented the project, outlined in Box 17.1, in the early learning centre where they worked in a part-time capacity in addition to undertaking university studies.

Pre-service teachers reflected positively upon the impact of opportunities to engage in, what Dettmer (2006) would regard as, generative learning experiences

Box 17.1: Pre-service teacher project proposal outline, *Environmental Education for the Tropics*

Project description:

1. Educate our center about sustainability
2. Propose the idea of creating a more sustainable play environment for our children
3. Educate and notify our parents
 - (a) Using brochures
 - (b) Signs
 - (c) Word of mouth
4. Fundraise
 - (a) Donations welcome
5. Involve the community
 - (a) Garden enthusiasts
 - (b) Hardware store
6. Involve the students and parents in planting our gardens
 - (a) "Tree ceremony"

where “the content is novel, processes are open ended, and each context encourages uniqueness” (p. 74), as can be seen in the following formal student evaluation feedback:

[I have] learn[t] far more than I thought I would, I was asked to really think and bring myself to the discussions [and] ... I got to do the curriculum research project on a topic I wanted and that was interesting [which was] very motivating for me. (Pre-service teacher B, 2013)

I found that the assessment for this subject allowed me to discover new things that I probably never would have experienced. Often with assessment it feels as though it is something that just has to be completed in order to be signed off on a particular area, whereas the assessment for this subject really allowed me to engage in environmental issues throughout my surrounding area. (Pre-service teacher C, 2011)

Discussion

With commitment to a whole-of-program approach to embedding sustainability, we have sought to promote transformative social learning – that is, to deliberately refocus the early childhood and primary curricula so as to develop, in our pre-service teachers, new ways of thinking, knowing, valuing, and doing (Dettmer, 2006; Wals, 2010; Wals & Jickling, 2002). The student voice, presented in this chapter, suggested that first-year pre-service teachers were engaged in learning the underlying science, socio-political contexts, and potential courses of action relating to local and global socio-ecological challenges, as part of a *big picture* perspective, in *Foundations of Sustainability in Education*. Third-year pre-service teachers opened up to a range of possibilities to embed *sustainability opportunities* in young children’s daily activities in *Early Childhood Education and Care*. Final-year pre-service teachers developed capacity to implement and reflect upon sustainability and climate change learning experiences, involving authentic actions, across diverse school and community contexts in *Environmental and Climate Change Education for the Tropics*.

While this chapter has focused on three subjects in the Bachelor of Education, it is important to note that science and sustainability principles, concepts, issues, and actions are substantively embedded in a suite of other subjects (see, for instance, Simoncini, Lasen, & Rocco, 2014), including science and social science curriculum studies. A compulsory fourth-year subject *Service Learning for Sustainable Futures* serves as the program capstone for both early childhood and primary majors. In this subject, our final-year pre-service teachers are required to engage with community partners and organizations in order to plan, implement, and reflect on local and international service learning projects, which “aim to strengthen communities and focus on activities that promote social and environmental responsibility” (JCU, 1995–2011, para. 1).

Reflecting upon the nature of environmental education, Bishop and Scott (1998) wrote that:

With its multidisciplinary, and its groundedness in the development of a value stance, environmental education begins from the positions that knowledge is socially constructed, multi-faceted and only partially shared, that there are cognitive, conative, economic, moral, and philosophical aspects to be considered, and that there are no certainties, particularly when it comes to action taking. (p. 233)

In contrast, traditional science education is based on the disciplinary characteristics of objectivity, rationality, and truth, and achievement of “outcomes that are ‘scientific’, in the sense of being independent of historical, social, and cultural conditions”, through utilization of the scientific method (Robottom, 2007, p. 28). There are, however, emergent approaches to science education that challenge existing orthodoxies, encouraging consideration of the impact of the sociocultural construction of knowledge. These approaches employ constructivist pedagogical principles to afford students the opportunity to build meaning within a context or from an experience, or become psychologically and physically involved (Dillon & Scott, 2002). A 2006 Australian Council for Educational Research conference, *Boosting Science Learning*, and an associated review, called for a “significant re-imagining of science education”, questioning the proposition of a non-negotiable and structured canon of abstract concepts as the defining feature of science as a human enterprise, and the major focus for school science (Tytler, 2007, p. 1). According to Tytler, the dilemma is how to fulfil the need to teach established scientific knowledge with that of providing representations and experiences of science as practised in contemporary settings. A contemporary and socially responsible science education (Bishop & Scott, 1998) would engage students in more authentic inquiry- and place-based investigations, as opposed to recipe-type experiments, to develop investigative skills, including critical and reflective thinking skills, that are emphasised in curricula and integral in promoting a scientifically literate citizenry (Hackling, 2005; QSA, 2010b), as well as employ active, discursive, and reflective pedagogies so as to engage students in explorations of “socially relevant, interdisciplinary topics and weave scientific understandings and logic into cultural, social, historical, legal, and ethical perspectives” (Tytler, 2007, p. 27).

In turn, it is important to acknowledge that science has a significant role to play within EfS. Bishop and Scott (1998) asserted that, “environmental education not only has the potential to integrate scientific knowledge with action, it has the imperative to do so” (p. 233). An understanding of the Earth as a system, and of key science concepts and processes, is integral to informed engagement in local and global socio-ecological challenges and associated decision-making and action processes (Morse, 2000). It is possible for science knowledge to be represented to students as tentative rather than certain, enabling a critical understanding of the nature of the work undertaken by the scientific community (Bishop & Scott, 1998); a potent example is ongoing exploration of “what is known/unknown/indeterminate” in the climate change field, which is being “continually re-constituted” (Hughes, 2011, p. 51).

The Australian government's Sustainability Curriculum Framework (Australian DEWHA, 2010) endorsed a curriculum that affords students the opportunity "to explore and evaluate contested and emerging issues; to become effective citizens and active change agents by helping them to deal with complexity and uncertainty; and to understand that there is rarely a single solution because new knowledge is continuously generated" (p. 4). Cultivating teachers and students who will serve as active change agents in their classrooms and communities calls for a higher-order learning (Barnett, 2012). According to Barnett (2012), it "looks to human *being* and *becoming* that offer the wherewithal for standing up to the world and engaging with it and in it purposefully" (Barnett, 2012, p. 76). As such, the pedagogical challenge is to facilitate learning experiences that encourage the formation of human qualities, which allow learners to engage effectively with novel content, multiple frameworks, contesting value systems, open-ended processes (Barnett, 2000; Dettmer, 2006) and action situations through which knowledge can be "acquired, modified, or advanced" (Bishop & Scott, 1998, p. 233). These human qualities will yield the adaptability, flexibility, and self-reliance to not only survive but to thrive (Barnett, 2012) in a *supercomplex* world (Barnett, 2000). Dettmer (2006) critiqued the educational taxonomies, developed by Bloom, Krathwohl and colleagues, which have been "used for decades as frameworks for instructional objectives, curriculum design, and assessments of achievement", as now too limited, proposing in part that the cognitive domain needed to be extended to include functions of imagination and creativity and the affective domain enhanced to include wonder and risk-taking (p. 70).

Conclusion

Elements of risk-taking are not only encountered on the part of the learners but by the academic staff in their educational roles (Barnett, 2012). In terms of teacher education and ongoing professional learning, "construing the pedagogical task as the formation of *authentic being*" (Barnett, 2012, p. 76), with emphasis on creative thinking, visioning, wonder, and risk-taking, runs counter to neo-liberal political agendas narrowly focused on student performance in national and international comparative tests in literacy and numeracy. A review of the recently-implemented Australian national curriculum has been ordered by the newly-elected, conservative federal government, with a foreshadowing of a privileging of a 'back-to-basics' approach and, in particular, scrutiny of the worth of the cross-curriculum priorities and their relevance to areas such as science and mathematics (Power, 2014). Lack of articulation of sustainability knowledge and practices in the recently-developed *Australian Professional Standards for Teachers* (Australian Institute of Teaching & School Leadership, 2012) also remains a challenge in validating a Bachelor of Education curriculum that seeks to significantly and systematically refocus the learning in terms of frameworks and questions that are deeper than traditional disciplinary ones and preparation for "life and livelihoods suited to a planet with a biosphere that operates by the laws of ecology and thermodynamics" (Orr, 2004, p. 27).

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