Educating for Sustainability in Primary Schools

Teaching for the Future

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To David Alan Kennelly

career-long advocate and practitioner of
Education for Sustainability

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PREFACE

Our planet is under enormous stress. Our children are growing up with the legacy of mismanagement of previous generations, including ours, which has resulted in visible signs of large-scale environmental and social harm associated with climate change, ecosystem destruction, resource depletion and pollution. Concerns about the resultant damage have been expressed for many years. For example, a report from the Club of Rome pointed to these potential problems more than 40 years ago (Meadows, 1972), and all of them are now plainly evident. It is clear that these issues are real and that they must be addressed, as is propounded in current international debates and extensive media coverage.

We humans are part of the environment we live in, and our relationship with it is crucial to our own survival and that of all other living entities on our planet. Social inequality is also an endemic planetary problem. About one-fifth of the world's population lives in poverty, an equivalent number are overweight or obese through excess, and several individuals are wealthier than the economies of some countries. While wealthy countries have produced much of the world's environmental damage through excessive resource consumption, swelling populations and expanding middle classes in rapidly developing countries such as China and India are increasing the pressures on our environment.

The future looks precarious. Increasing global temperatures have the potential to cause massive social, economic and environmental damage through rising sea levels and an increasing incidence of extreme weather events. Present conditions are unprecedented in the history of our planet. There have been major changes in the past, including five major extinction periods; the last catastrophic event, probably associated with a meteorite impact, resulted in the demise of the dinosaurs some 60 million years ago. Such catastrophes were previously linked to physical calamitous events, but present conditions are associated for the first time with the effects of one of the planet's life forms—humans. This occurrence stimulated Jared Diamond (1992) to refer to the present period as the sixth major extinction, which is presently in process. More recently, in his book *Requiem for a Species*, Australian academic Clive Hamilton (2010), discussed the potential consequences of simply ignoring the warnings about climate change. He argues that under such a scenario Australians in 2050 will be living in a nation transformed by a changing climate. To respond to this warning, a transformation towards sustainability is needed in how we relate to one another and how we relate to our planet, every other living thing on it and the resources it provides.

Sustainability, as a concept for actions that will result in a viable future for succeeding generations, is a priority. Political, technological, social and economic changes are needed to effect sustainability and must arise at all levels: intergovernmental, governmental, regional, local and individual. While international political change is vital to supporting sustainability, individuals can respond positively by acting sustainably, so that the combined actions of populations will preserve our futures. Each individual's action adds up to the total effect of humanity on our planet. We are all responsible for our collective actions.

Under these conditions, education for sustainability (EfS) must be a major focus. Given that young children will become the next generation of adults, it is vital that they are educated about sustainability issues so they can be critically aware of the problems and take positive action to help preserve their future in a rapidly changing world. While evidence suggests that primary teachers are generally concerned about sustainability issues, an acknowledged lack of understanding of how to teach for sustainability and the perceived constraints emanating from current curriculum priorities commonly inhibit EfS from being developed in many classrooms.

This textbook attempts to address this dilemma by showing how teachers can develop EfS within and across all areas of the primary curriculum in Australian and New Zealand contexts. As a guide, it provides suitable approaches and examples of activities to support teachers as they can address the requirements for teaching all primary curriculum learning areas while also addressing EfS in order to promote knowledge of, positive attitudes towards and suitable action for sustainability in relevant, meaningful, enjoyable and creative ways. We also hope the book will encourage teachers to provide experiences that allow primary students to become more connected to nature—a connection that is an important part of EfS.

Collective action is thus needed to influence our collective impact on our planet. And collaboration is needed to come to collective agreement about what we need to do to achieve sustainability. To this end, the writing of this textbook, designed to support teachers teach EfS, has been a collective and collaborative effort. As a collective, the 29 authors have wide and extensive experience as school and community educators. Individually, they have each had particular expertise to offer the project, arising out of their personal and professional commitment to EfS. During the writing process, the authors communicated regularly through face-to-face meetings and electronic media, an approach that provides a good model for collaborative and collective learning.

Although some of the background material for teachers in this book at times presents what is inevitably a rather bleak picture, it is important not to present children with a view of the environment simply as a series of almost insurmountable problems. Doing so can understandably lead to a sense of hopelessness, disempowerment and what is termed "action paralysis". To this end, the teaching activities suggested in these pages largely attempt to highlight the interconnectedness between ourselves and our environment and to develop in children a sense of action-orientation that embraces positive attitudes, changed behaviours and hope for the future.

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2015

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1. WHY DO WE NEED TO TEACH EDUCATION FOR SUSTAINABILITY AT THE PRIMARY LEVEL?

There is a growing realisation among the peoples of the world of our impact on the environment. When we consider that we depend entirely on our natural environment to provide the resources that sustain our lives (water, food, materials, fuels, etc.), we can see why this situation should cause concern. Part of this concern resides in the knowledge that development trends are not sustainable; our current levels of population and consumption mean we are far exceeding our planet's capacity to support us and other species. These trends are having consequences such as resource depletion and waste disposal, climate change, extinction of species and challenges to the integrity of ecosystems, which we describe in more detail in Chapter 2. These consequences are so severe and widespread that scientists have informally coined a new term for the time we are living in—the Anthropocene—to signify the unprecedented impact of human activity on the Earth.

Hence, many experts on environmental issues have called for changes in human behaviour, towards ways of living that are ecologically, economically, socially, culturally and personally more sustainable. It is clear that we, and particularly our children, need the knowledge and skills to understand the problems we are facing, and to be able to make decisions and take actions to resolve them. We also need attitudinal and behavioural changes that will support a more sustainable future. Education has a crucial role to play in facilitating the kind of knowledges, attitudes and behaviours that will enable us to achieve this goal. However, there has been ongoing debate as to what sustainability actually means and what form this education should take. The sections that follow briefly examine some of these issues.

WHAT IS MEANT BY SUSTAINABILITY?

A sustainable future depends on the interrelationships between four key areas—our ecological, economic, social and political systems. These systems are in a lockstep relationship, as the health of any one of them is influenced by, and in turn influences, the health of the other three. For example, if society is to function well in the long term, we need to have a healthy natural environment, good economic systems and functioning political processes. Changes to one system, such as our environment, have knock-on effects on the other three systems, and we address some examples of these complex interrelationships in Chapter 2. The four systems are often referred to as the "pillars" of sustainability because acknowledging and paying attention to all of these dimensions, and the relationships between them, is fundamental to a sustainable future.

A continuum of different perspectives is apparent in the literature on sustainability. Two positions that capture the main differences in these views are referred to as weaker and

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stronger sustainability (Williams & Millington, 2004). Weaker sustainability reflects an anthropocentric (human-centred) perspective that nature is to be utilised for human benefit. It takes a growth-oriented approach to economic development and does not see a need for radical changes in human demands on the Earth. From this perspective, sustainability is about solving the problems we are encountering through technological development (e.g., better use of resources, alternative energy sources, better waste disposal and recycling techniques), more efficient economic growth and more equitable distribution of the proceeds of that growth. However, viewed from the stronger sustainability perspective, the weaker sustainability model sustains *development* rather than nature or the environment. The stronger sustainability argument is that we need to adopt a more ecocentric outlook that values nature for its own sake. We need to change our social and economic systems to reduce our demands on nature, and we need to actively realise that we cannot replace the ecosystem services that nature provides.

As might be expected given this range of perspectives about what sustainability should be, and how to achieve it, the literature contains hundreds of definitions of sustainability. One of the most frequently used expressions is the Brundtland definition: “Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (United Nations, 1987, p. 1). This definition recognises that development does have environmental constraints and consequences, and that we need to be concerned about the future, especially equitable allocation of resources for future generations, a concept referred to as intergenerational equity.

Despite breaking new ground by highlighting these key issues, the Brundtland definition has attracted considerable criticism for its human-centred focus. Commentators from the stronger sustainability end of the spectrum contest the notion of sustainable development and the weak sustainability perspective that accompanies it. They suggest that the term “sustainable development” is an oxymoron, and that it reflects a dominant neo-liberal and human-centred worldview that prioritises economic development over ecological sustainability. Questions have also been raised about the optimistic assumption that current and future human needs can be balanced by technology.

The Australian Curriculum adopts the following definition of sustainability, which is clearly built on the Brundtland definition but with a notable difference: “Sustainable patterns of living meet the needs of the present without compromising the ability of future generations to meet their needs” (Australian Curriculum Assessment and Reporting Authority, 2014, para 2). In moving from using the term “development” to “patterns of living”, this definition avoids some of the problematic aspects of the original Brundtland definition, and we therefore adopted it for the purposes of this book. In addition, because this book is primarily designed for educators in Australia and New Zealand, the definition is consistent with the ethos of both the Australian Curriculum and the New Zealand Curriculum.

This book contains the perspectives of a range of Australian and New Zealand educators and researchers in this field, and our perspectives vary somewhat along this continuum of weaker to stronger sustainability. We invite you to think critically about what you read in these chapters, and what perspectives they might reflect. It is also useful to reflect about your own worldview. What perspective do you hold? Why do you think as you do, and what does this mean for your professional practice as a primary teacher?

WHAT DO WE MEAN BY EDUCATION FOR SUSTAINABILITY

As might be expected given the range of perspectives about sustainability outlined above, the terminology used to describe the kinds of education advocated for achieving sustainability is also diverse. Among these terms are Environmental Education (EE), Education for Sustainability (EfS), and Education for Sustainable Development (ESD). We also have at hand a plurality of perspectives on the relationship between (respectively) EE, ESD and EfS and the desired outcome of weak or strong sustainability.

While some argue that Education for Sustainability (EfS) smacks of indoctrination by being *for* something (see, for example Jickling & Spork, 1998), EfS is the term we use in this book for three reasons. First, it is the term most consistent with Australian and New Zealand curricula and policy documents. Second, EfS recognises and addresses the complex set of factors making up the world we live in. Third, the deliberate use of Education *for* Sustainability recognises that *action which supports* sustainability is an imperative for quality of life and the survival of future generations.

Because this book relates to Australian and New Zealand curricula, we feel it is important to indicate how this concept is described in each context. The Australian Curriculum explains EfS as follows:

> Education for sustainability develops the knowledge, skills, values and worldviews necessary for people to act in ways that contribute to more sustainable patterns of living. It enables individuals and communities to reflect on ways of interpreting and engaging with the world. Sustainability education is futures-oriented, focusing on protecting environments and creating a more ecologically and socially just world through informed action. Actions that support more sustainable patterns of living require consideration of environmental, social, cultural and economic systems and their interdependence. (Australian Curriculum Assessment and Reporting Authority, 2014, para 3)

This explanation is a relatively complex one and contrasts with the New Zealand Ministry of Education's elucidation of the concept in its senior secondary guidelines for EfS. Here, EfS is "about learning to think and act in ways that will safeguard the future wellbeing of people and our planet" (New Zealand Ministry of Education, 2014, para 1). The ministry also includes the following statement relating to EfS (para 5):

> Mō tātou te Taiao ko te Atawhai
> Mō tātou te Taiao ko te Oranga
> It is for us to care for and look after the environment to ensure its wellbeing
> In doing so we ensure our own wellbeing and that of our future generations.

Despite some differences in these explanations, they are consistent in terms of stressing that EfS should help students gain knowledge and skills that allow them to act to sustain the environment. Both expressions of EfS require us to look after our environment, are futures-oriented and incorporate intergenerational equity as an important underlying principle. As educators for sustainability, we fully support these sentiments.

EE, EfS AND ESD: A DISPUTED FIELD

It is very easy to get tied up in the ongoing debates, assumptions and implications of the different terminology used in this field of education. It is beyond the scope of this book to cover these differences in detail, but they are reflected to some extent in the slightly different perspectives implied in subsequent chapters. In this section we discuss just some of the ways that conceptions of EE have changed over the years. We also look at the ideas that have accompanied the introduction of more recent terms such as EfS and ESD.

Traditionally, there was a belief that simply teaching children (and adults) about the environment through EE would result in changes in behaviour that would benefit the environment. However, lack of evident change and a growing body of research began to show not only that this assumption was invalid but also that if EE were to bring about behavioural change, it had to do more than just teach children about the natural world. A number of researchers called for a move away from this relatively passive form of EE towards a more "socially critical" form, one that required students to question those actions of society that lead to environmental degradation, and to engage in positive action for the environment themselves.

This view of EE has been developed further in recent years, and many experts in the field now maintain that this form of education needs to be holistic, value-laden and action-oriented in order to produce positive outcomes. There is also increasing recognition that consideration of environmental issues requires us to see how cultural norms, economic need for resources, and political decision-making connect human societies to the environment. Thus, we are now acknowledging that the environment is shaped by our cultures: our consumption habits, how we make our living, enjoy recreation, govern ourselves and consider the future.

This acknowledgement has led to EE being expanded beyond simple understanding of the natural world to include numerous facets of how the world works. Furthermore, although much of the environmental degradation in the world is linked to mass consumption of materials and energy by the western world, people subjected to poverty can also damage their environment as they attempt to simply survive. The environment is impacted by how people interact with the world; recognition of the previously mentioned four pillars of sustainability—environmental, economic, political and social—reflects this understanding.

These changes in emphasis accompanied change in discourse towards notions of sustainable development, and hence ESD and EfS. As early as 1987, the Brundtland report (United Nations, 1987) linked sustainable development to education. Since then, other authors and organisations have been drawn to this recognition. For example, the 1992 Earth Summit in Rio de Janeiro produced *Agenda 21*, which stated that "education is critical for promoting sustainable development and improving the capacity of people to address environment and development issues" (United Nations Sustainable Development, 1992, p. 2). This statement was reaffirmed at the 2002 World Summit on Sustainable Development in Johannesburg, which recognised education as critical for sustainable development in its own right and also launched the United Nations Decade of Education for Sustainable Development, 2005–2014. We are in the final year of this decade at the time of writing this edition, but unfortunately many serious problems remain.

EfS POLICY AND CURRICULUM FRAMEWORKS IN AUSTRALIA AND NEW ZEALAND

Because public awareness and changes in behaviour through education are keys to moving societies towards sustainability, it is vital that EfS begins as early as possible if we are to encourage individuals in our societies to live in a more sustainable manner. But what kind of sustainability is being incorporated into our educational systems? Should it reflect a stronger or weaker view of sustainability, and how should we teach it?

Government authorities in Australia and New Zealand have provided some strong and targeted policies to support EfS. At a national level, the Australian Government published a document in 2005, *Educating for a Sustainable Future: A National Environmental Education Statement for Australian Schools* (Australian Department of Environment and Heritage, 2005) which outlined the importance of education in achieving a more sustainable future and provided a vision of what environmental education for sustainability might involve:

> Environmental education for sustainability involves approaches to teaching and learning that integrate goals for conservation, social justice, cultural diversity, appropriate development and democracy into a vision and a mission of personal and social change. This involves developing the kinds of civic values and skills that empower all citizens to be leaders in the transition to a sustainable future. (p. 13)

The document also argued for environmental education for sustainability to run from K–12 (ages 4–18) in Australian schools.

Five years later, the Australian Department of Environment, Water, Heritage and the Arts (2010) produced its action-oriented *Sustainability Curriculum Framework* for teaching sustainability in schools. The new Australian Curriculum has since incorporated sustainability as one of three mandatory cross-curriculum priorities. Although the current educational policy and curriculum environment in Australia supports EfS, we need to remember that education policies and curricula are political and potentially ephemeral statements of values. This point was highlighted recently when Australia's current federal education minister announced a review of the new Australian Curriculum and the place of sustainability in it, questioning specifically the place of sustainability in science and mathematics. The review subsequently reported that reviewers were:

> … not convinced of the efficacy of having a cross-curriculum 'dimension' of the curriculum that does not clearly anchor these so-called priorities in the content of learning areas and subjects, and recommend that a complete reconceptualisation of the teaching of the cross-curriculum priorities be undertaken (Australian Government Department of Education, 2014, p. 4)

It is hoped that this book will go some way to demonstrating the myriad ways that sustainability can be integrated into all the learning areas of the primary curriculum.

The New Zealand Government has also shown a commitment to education as a key driver of sustainable development. This commitment gained momentum in the late 1990s with the publication of *Guidelines for Environmental Education in New Zealand Schools* (New Zealand Ministry of Education, 1999). The guidelines, which were accompanied by a subsequent professional development process for implementation and an advisory service to support it, maintained that "environmental education is an important component of an effective policy framework for protecting and managing the environment" (p. 8). More recently, the revised New Zealand Curriculum (New Zealand Ministry of Education, 2007) recommended sustainability as a key integrating, future-focused theme in teaching and learning in all schools. However, these commitments, along with funding of the non-government Enviroschools programme, are, as in Australia, subject to political change, and the emphasis in New Zealand in more recent years has been squarely on economic growth rather than sustainable development. These changes have somewhat stalled progress in implementing EfS in schools in both countries.

In line with the complexity of this area, there are ongoing debates about just *what* is being prioritised in EfS policies. Some commentators consider that current EfS policies tend towards the weaker sustainability end of the spectrum and that EfS in primary schools could focus more on enhancing the connections between children and nature and facilitating a more ecocentric view of the relationship between humans and the natural world. As a primary teacher, you should find it helpful to identify your own position on the sustainability spectrum in order to critically engage with whatever policy and curriculum frameworks you encounter.

TEACHING EDUCATION FOR SUSTAINABILITY AT THE PRIMARY LEVEL

Despite the above concerns, several exciting EfS-related ventures are taking place in Australian and New Zealand schools. In Australia, for example, the aim of the government-instigated Australian Sustainable Schools Initiative (Australian Department of the Environment, 2009) is to get all members of each school community and the wider community involved in improving sustainability. The initiative has the following goals:

– Learning and teaching for sustainability as an integral component of school curricula;
– Schools actively engaged in a continuous cycle of planning, implementing and reviewing their approach to sustainability as part of their everyday operations;
– Schools using natural resources, including energy, water, waste and biodiversity, in more sustainable ways;
– Schools and school authorities reporting on changes towards sustainability;
– Young people sharing ownership of sustainability initiatives and decision-making;
– Schools working towards sustainability in partnership with their local communities;
– Schools and school authorities implementing governance practices that support effective environmental education for sustainability;
– Individuals supported to make effective sustainability decisions and choices; and
– Schools and communities developing values that support a sustainability ethos.

When endeavouring to meet these goals, students are often involved in taking direct action, such as gathering baseline data through biodiversity, energy, and waste audits, implementing strategies to increase biodiversity in the school grounds, and reducing energy consumption and waste production. These types of action-oriented projects are a vital part of EfS. All too often, sustainability issues are presented and discussed solely as a series of problems, and while it is important to acknowledge that problems do exist, an overemphasis on them can leave children feeling severely disempowered. Action-oriented projects allow them to see that change at a community level is possible and so are vital to keeping young people engaged with sustainability issues and positive about the future.

In New Zealand, the New Zealand Curriculum encourages teachers to develop sustainable citizens, thereby providing an impetus for EfS in primary schools. Grassroots development of EfS in primary schools has been growing as greater awareness of environmental and sustainability issues spreads. This growth has been supported by a myriad of non-governmental organisations (NGOs), as well as local government agencies. While support for the advisory service in EfS has gone, the Enviroschools programme continues to play a key part in EfS in primary schools. This programme began as a community initiative and remains strongly supported by local government and community groups (Enviroschools Foundation, 2014). At the beginning of 2014, over 920 schools and early childhood centres (approximately 35% of all New Zealand schools) were offering the programme, and many more schools would like to be part of it. This uptake of the programme represents a significant impetus for EfS in New Zealand primary schools.

Despite these very positive initiatives, considerable research evidence indicates that EfS is not being effectively taught in parts of Australia's and New Zealand's primary and secondary school sectors. Sadly, a quantitative study of the views of almost 5,000 educators in both the government and non-government school sectors across Australia indicated that the vast majority (91%) of Australian teachers have yet to integrate sustainability into their teaching practice. This lack was apparent despite the same study showing that 92% of the teachers surveyed believed that sustainability is important, of value to students and *should* be integrated into the curriculum (Australian Education for Sustainability Alliance, 2014). We now briefly examine the reasons for this discrepancy—the focus of this book—in the primary sector.

EfS IN PRESERVICE TEACHER EDUCATION

One of the key problems is that although research among primary level teachers indicates a high level of concern for the environment, many teachers are not well prepared for teaching EfS in schools (Cutter-Mackenzie & Smith, 2001; Ferreira, Ryan, & Tilbury, 2007; Miles, Harrison, & Cutter-Mackenzie, 2006). The concept of EfS is generally poorly understood, and in some cases there is also a lack of awareness of national or state policies on EfS. This situation is compounded in many instances by a poor conceptual understanding of environmental and sustainability issues, and the social, cultural, economic and political dimensions of them. These limitations can understandably result in a lack of confidence to begin teaching EfS. Certainly, research by a number of the authors in this book suggests that many of the above factors are major barriers to teaching EfS. Finally, teachers are often unaware of how to integrate EfS effectively into their teaching and therefore see it as something "extra" to be "forced" into an already crowded curriculum.

Compelling arguments for the need for pre-service and in-service teacher education in EfS have recurred in international forums since the 1970s. This agenda was given enormous impetus by the Tbilisi Declaration (UNESCO, 1978), was later described as "the priority of priorities" (UNESCO-UNEP, 1990), and facilitated development of guidelines and principles for incorporating EE into in-service and pre-service teacher education (Hungerford, Volk, Bluhm, Dixon, Marcinkowski, & Archibald, 1994; Lahiry, Sinha, Gill, Mallik, & Mishra, 1988). These early initiatives have been more recently supported by the previously mentioned UN-declared Decade for Education for Sustainable Development (2005–2014) and a recommitment, 35 years on, to the goals and principles of the original Tbilisi conference (UNESCO-UNEP, 2012). In Australia, we have seen recent specific attempts to embed EfS into pre-service teacher education programmes (Steele, 2010).

Despite this long-standing international agenda, in Australia and New Zealand few primary Bachelor of Education/Teaching programmes include a dedicated unit on EfS, although the situation is improving. Thus, many new graduates remain ill-equipped to incorporate EfS into their teaching, particularly at a time when they are under stress from dealing with a wide range of new tasks, and consequently tend to focus almost exclusively on "core business". Education for sustainability, we argue, has to be core business, and the goal of this book is to take another step towards this priority of priorities by helping primary teachers go about this business effectively and with confidence, and to see the possibilities and advantages that EfS principles and practices bring to primary education in general.

ABOUT THIS BOOK

The main purpose of *Educating for Sustainability in Primary Schools: Teaching for the Future* is to address some of the issues raised in the previous section, and also to consider recent curricular developments in Australia and New Zealand. The chapters are grouped into three sections.

The first section, titled Pedagogical Considerations, comprises four chapters. The first of these chapters (Chapter 2) outlines some core concepts and issues associated with sustainability and situates these through discussion of how teachers can contextualise their own understanding of how to teach EfS and how students learn EfS.

Chapter 3 links theory to practice in EfS by explaining a number of pedagogical approaches in a way that makes them easy to implement. Particular attention is given to Jensen's (2002) model of "action competence" because when this model is used appropriately, it not only provides students with a sound understanding of environmental issues, but also allows them to take action to address these issues at a local level. Consequently, the action competence model can combat the paralysis and disempowerment that students may experience when confronted with environmental problems.

Chapter 4 encompasses best practice in EfS early years' education. The focus here is on children of about three to five years of age. The underlying philosophy throughout this chapter is to recognise children as active and powerful agents of their own learning. The chapter has two parts. The first explores relevant pedagogy for various educational settings, including the home and the broader community. The second examines relevant pedagogical frameworks based on contemporary research and best practice exemplars from the early childhood field. Effective teaching to address a diverse range of learning needs within a variety of educational contexts is explored in Chapter 5.

The second section, consisting of Chapters 6 to 12, is titled Learning Areas. It explores integration of EfS into seven such areas (abbreviated as LAs) across the curriculum. Each chapter provides a number of activities for primary students and demonstrates how EfS concepts can be developed from K–6 (ages 4–11 in Australia; Years 1–8 in New Zealand) through the process of progression. The order of the LA chapters is influenced by the model for integrating EfS across the curriculum discussed in Chapter 3 (see also in this regard figure 3.2 from Murdoch & Hornsby 1997, p. 14). According to the model, social studies, personal development and health along with science and technology can be used to address the core content, skills, attitudes, values and behavioural outcomes for EfS, while literacy, numeracy and creative arts outcomes can be addressed concurrently. However, all areas are important in EfS, so the order of chapters does not reflect an implicit priority sequence.

The third section of this book, Cross-curricular Approaches, contains three chapters. Chapter 13 explains how to adopt a thematic approach to EfS by taking themes such as water or energy and exploring them within the context of each LA. Chapter 14 explores indigenous perspectives on sustainability in both New Zealand and Australia. The chapter also explores, amongst other matters, how indigenous relationships with the land can inform teaching of EfS. Finally, Chapter 15 discusses a whole-school approach to EfS, using for illustrative purposes school gardening as a cross-curricular initiative involving not only the whole school but also the local community.

It is imperative that children have a sound understanding of the major environmental issues affecting our planet, and that they know the actions they can take to lessen human impact. We hope this book will help teachers provide experiences across the curriculum that encourage children to behave more sustainably and to become advocates for more sustainable living.

Figure 1.1. Children from Hukanui School in Hamilton, New Zealand, planting native trees in order to restore a local gully (Photo courtesy of The Enviroschools Foundation)

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PEDAGOGICAL CONSIDERATIONS

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2. ISSUES AND DIMENSIONS OF SUSTAINABILITY

As outlined in Chapter 1, sustainability comprises interlinked environmental, societal, political and economic dimensions (see also UNESCO, 2010). What is happening in relation to any one dimension will affect, and be affected by, what is happening in all the other dimensions. For example, a local water shortage (environmental dimension) could lead to loss of income for people relying on that source (economic dimension), demographic changes if people move out of the area (social dimension) and conflict between different water users (political dimension). This is not a hypothetical example. Situations such as this have occurred in some parts of Australia; for example, in the Murray-Darling Basin, and analogous problems continue to occur across the globe. Hence, the sustainability of our future is enhanced by actions that jointly conserve our natural environment, build social systems that are peaceful and concerned with equality and human rights, and implement democratic political arrangements and appropriate economic development that takes into account the constraints and limits of our planet.

Because of the interrelationships between these different dimensions, understanding the full complexity of threats to sustainability can be challenging because the issues span so many disciplinary areas: the scientific and technological basis of environmental problems, the sociocultural values and attitudes behind them, and their political and economic contexts. This complexity highlights the importance of an interdisciplinary approach to EfS in school education—this "subject" is not one that can stand alone. It is a perspective and an ethos about our relationship with our world, and it is a perspective and an ethos that can infuse all school learning areas in Australia and New Zealand as well as in many other educational jurisdictions.

Table 2.1 shows the key general ideas encompassed by sustainability and expressed in the Australian Curriculum. As is outlined in these key organising ideas (OIs) in the table, EfS as formally articulated in Australia has a focus on three kinds of ideas. First, we need to know about the *systems* that sustain us. We need to understand that these systems are interdependent and that all living things, including humans, depend on healthy ecosystems for survival. The second set of ideas relates to *world views*. Here, we need to recognise this interdependence and appreciate that our views are formed by our experiences and our actions. The final set of ideas—*futures*—is action oriented. We need to design and engage in actions that take into account the needs of future generations as well as our own, that reflect values of care, respect and responsibility, and that are carefully informed, designed and evaluated.

The current New Zealand Curriculum (New Zealand Ministry of Education, 2007) does not provide such detail because it does not accord sustainability the status of a priority. However, the curriculum is clear that teachers need to include sustainability thinking in their work, as a core part of the vision for New Zealand's young people is that they contribute to the social, cultural, economic and environmental wellbeing of New Zealand, and that

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learners value ecological sustainability. As described in Chapter 1, teachers are encouraged to consider sustainability as an integrating, future-focused theme in their teaching.

Table 2.1. Organising ideas for the sustainability cross-curriculum priority of the Australian Curriculum (source: Australian Curriculum and Reporting Authority, 2014).

Systems	
OI.1	The biosphere is a dynamic system providing conditions that sustain life on Earth.
OI.2	All life forms, including human life, are connected through ecosystems on which they depend for their wellbeing and survival.
OI.3	Sustainable patterns of living rely on the interdependence of healthy social, economic and ecological systems.
World views	
OI.4	World views that recognise the dependence of living things on healthy ecosystems, and value diversity and social justice are essential for achieving sustainability.
OI.5	World views are formed by experiences at personal, local, national and global levels, and are linked to individual and community actions for sustainability.
Futures	
OI.6	The sustainability of ecological, social and economic systems is achieved through informed individual and community action that values local and global equity and fairness across generations into the future.
OI.7	Actions for a more sustainable future reflect values of care, respect and responsibility, and require us to explore and understand environments.
OI.8	Designing action for sustainability requires an evaluation of past practices, the assessment of scientific and technological developments, and balanced judgments based on projected future economic, social and environmental impacts.
OI.9	Sustainable futures result from actions designed to preserve and/or restore the quality and uniqueness of environments.

Because the key ideas outlined in Table 2.1 necessarily reflect one interpretation of sustainability, it is valid to consider, in the spirit of critical inquiry that is so important to EfS, what this framework does not capture. Some might argue that it doesn't sufficiently foreground the love, awe and wonder of nature, spiritual dimensions of our relationship with nature, and connections to place that research suggests is so closely linked to pro-environmental attitudes and behaviours. It is also worth considering what kind of ethical assumptions and moral considerations underpin the framework. Is the framework human-centred? Does it, *should* it, grant (or at least allow) the intrinsic value of non-humans?

In addition to these ideas, EfS also requires specific kinds of knowledge. The influential work of Jensen (2002) suggests that EfS needs to be explicitly action-oriented, as it is actions that make a difference to the state of our world. This action-orientation is very evident in EfS-related statements in both the Australian and New Zealand curricula, and is dealt with in much more detail in Chapter 3. However, for the purposes of this chapter, knowing how to act in relation to any given problem requires that we know about the following:

– *Causes:* Why do we have a particular problem and what conditions led to it?
– *Effects:* What are the consequences and impact of a problem? How widespread is it?
– *Visions:* Where do we want to go in relation to this problem? How can things be different, and what are the possibilities that can be dreamt of or envisaged?
– *Change strategies:* How can we change things? What direct and indirect actions can we take?

In the remainder of the chapter, we use Jensen's knowledge dimensions, particularly cause and effect, to frame a discussion of some contemporary sustainability issues that we chose because they illustrate a range of the interconnected dimensions of sustainability. We draw out some of the environmental, societal, political and economic dimensions of these issues along the way, and invite you to think about these dimensions of sustainability as you read through the issues, and also to consider the interrelationships between them.

CAUSES

Many of the sustainability issues we face today relate back to three interlinked causes. These are the rapidly growing human population, overconsumption by Western developed nations, and associated poverty in developing countries.

Population

One of the key contributing causes to many of the problems we face today is the fact that, as pointed out by Malthus decades ago, our human population is rapidly outgrowing the capacity of Earth's resources to sustain us. Most recent credible figures show that the planet's total population of humans has nearly tripled in just six decades, from about 2.5 billion in the 1950s to currently well over 7.0 billion people. Projections estimate an 80 percent probability of a world population of between 9.7 and 12.5 billion by 2100 (United Nations Department of Economic and Social Affairs, 2014). Each one of these people needs food, water, clothing and shelter, but there is only so much food, water and resources that the planet can provide. The Food and Agricultural Organization of the United Nations (FAO, 2013) estimates that in the period 2011 to 2013, 842 million people—12 percent of the world's population—were unable to meet dietary requirements, and that the vast majority of these people were living in developing countries.

There is no doubt our population can't keep growing at the current exponential rate; our world is a finite space with finite resources, and at some point we will exceed its carrying capacity. Sooner or later the rate of population growth will have to slow, whether by choice, through socio-political initiatives aimed at limiting numbers, or by the stark consequences of disintegrating ecosystems or not enough food, water and resources to go around. We are seeing both of these events already occurring, through disincentives for having children, (exemplified by the one-child policies in China), the post-Second World War declining birth rates in Japan, and the grim statistics of deaths in many of the poorest countries in the world through malnutrition, lack of access to clean drinking water and consequent diseases. Current rates of population growth are unsustainable environmentally, socially, economically and politically. The consequences of population growth are, though, exacerbated by, and cannot be separated from, the closely related issue of resource consumption.

Consumption

A major challenge to the sustainability of the Earth's systems that is closely linked to overpopulation is the consumption patterns of humans and the issue of "needs versus wants". Much of Western society is extremely materialistic, and we are incessantly encouraged to buy more material things. In terms of economics, businesses quite understandably want us to buy their goods, and so do governments, which is why they are so concerned about "consumer confidence". Economic stability and associated high employment and standard of living are important to us all. But almost everything we purchase involves some environmental cost through the resources extracted to make and package it, the emissions involved in its transportation and the waste produced when it is no longer required. Population increase, especially in developing countries, is exacerbating this concern, but the problem of unbridled Western consumption cannot be ignored. On a per capita basis, Westerners consume much more than people in the developing world. The cartoon in Figure 2.1 sums up the social implications of this inequitable situation. It is somewhat confronting but well worth reflecting upon.

Figure 2.1. "Somebody tell those people at the front to stop reproducing".

Sadly, children are targeted quite relentlessly by advertisers. As Shah (2006) points out, there might not be anything wrong with businesses attempting to make sales and profits, and indeed some form of economy is important for society to function. However, the effects of targeting children to be consumers and them becoming overly conscious of materialistic things need to be questioned. We concur absolutely with Shah and argue that primary teachers should be in a position to raise these issues in a sensitive manner, as it is very important that children learn early on to begin distinguishing needs from wants. This area can be a very contentious one for teachers because in raising these issues they risk being accused of peddling a particular ideology. However, any education is inevitably value-laden and needs to acknowledge values of social justice and equity. Given the importance of this issue, it should be addressed sensitively with young children, who need to be provided with a means to become critical and thoughtful consumers.

Poverty and inequity

The inequitable consumption outlined in the previous section reflects some stark statistics. About one-fifth of the world's population lives in grinding poverty, with most of these people living in developing countries (including the poorest, lowest per capita income, and least industrialised countries of the world, mainly in Asia, Africa and South America), while one-quarter live in relative luxury, consuming around 80 percent of the world's resources. Some of the world's poorest countries (e.g., the Democratic Republic of the Congo, Liberia and Afghanistan) have also endured long periods of political unrest, in seemingly self-perpetuating spirals of poverty and civil war. Political unrest, persecution and war have also resulted in more than 10 million refugees worldwide (United Nations Refugee Agency, 2014), many of whom are poverty stricken and totally dependent on humanitarian aid in refugee camps.

The poor of the world are generally powerless. They are often unable to meet their basic needs for food, shelter, health and education, with children particularly vulnerable: 1 in 10 children worldwide die of poverty-related causes such as malnutrition and water-borne diseases. People born into poverty are often trapped because they have little or no control over resources (particularly land) available to improve their positions. They also have limited access to education and the public services taken for granted in more wealthy countries. Even within the poorest countries, gross inequalities still exist between rich and poor, between rural and urban regions and between men and women. For example, women make up some 70 percent of the world's poor, as they are responsible for most of the subsistence food production (up to 90 percent in Africa), but receive less food than men because of gender discrimination in food allocation. Globally, one woman in every three is illiterate, compared to one man in five. Due to the daily tasks involved in growing food, gathering water, fuel and resources, poor women are dependent on natural resources, and they are the first to suffer when these resources are degraded. And girls are more likely than boys to be taken out of school to help with these tasks (World Bank, 2000).

Poverty and inequity are also very evident in the relatively well-developed countries of Australia and New Zealand. For example, in both countries, indigenous groups fare relatively badly on all sorts of socioeconomic measures such as income, employment, education and health. In fact, the lifespan of Indigenous Australians and Māori is 20 years less than that of non-indigenous people. While fuller discussion of this situation is well beyond the scope of this book, primary school teachers of children from poor backgrounds have a particularly important (and difficult) role in helping children out of the cycle of poverty through the power of education.

In approaching EfS, therefore, we need to acknowledge that poverty is integral to the problem of environmental degradation, and we need to address matters of poverty and human rights as much as environmental issues. Deforestation in poor countries along with the associated damage to soils and watercourses is exacerbated by short-term survival imperatives and lack of infrastructure. Some of the poorest countries (e.g., Bangladesh) are bearing the worst impacts of climate change, which has been caused largely by the energy-dependent lifestyles and consumption patterns in the wealthiest countries. The environment cannot be considered separately from the economic development that supports or destroys it, and environmental degradation is an impediment to development of any kind. More egalitarian, equitable approaches to wealth distribution are required worldwide so that human populations can obtain essential resources for quality of life. Indeed, if people are not protected, then environmental destruction is even more inevitable, as poverty and environmental destruction reinforce each other.

EFFECTS

The combination of the three issues outlined above has had many effects on our natural environment. Those that we outline here are just some of the main ones: climate change, pollution, overuse of resources and waste, and declining biodiversity.

Global warming and climate change

Climate change has become one of the major global issues over the last few decades. There is general scientific consensus that human activity is having a serious impact on the atmosphere, as stated by the Intergovernmental Panel on Climate Change (IPCC) in 2013:

> Human influence has been detected in warming of the atmosphere and the ocean, in changes in the global water cycle, in reductions in snow and ice, in global mean sea level rise, and in changes in some climate extremes … It is extremely likely that human influence has been the dominant cause of the observed warming since the mid-20th century. (IPCC, 2013, n.p.)

How humans are causing the climate to change Earth’s atmosphere allows light to pass through it to the ground, which gets warmer and gives off heat as infrared radiation. As this heat rises into the atmosphere, some of the naturally occurring gases in the atmosphere (such as carbon dioxide) absorb the heat so that it can’t all escape. This process is similar to the build-up of heat in a parked car in the sun, or in a greenhouse. Without this natural so-called greenhouse effect, the surface temperature of the Earth would be well below zero, so life on Earth actually requires this effect. However, by burning fossil fuels and changing land use patterns, we humans are adding to the “blanket” of greenhouse gases, hence trapping more heat and causing problematic levels of global warming.

In particular, since the Industrial Revolution, humans have been pumping much more carbon dioxide (CO_2, a greenhouse gas) into the atmosphere. The concentration of carbon dioxide in the atmosphere in 2011 was 391 parts per million (ppm)—considerably more than the range of 170 to 300 ppm recorded during the past 800,000 years (IPCC, 2013). This increase in carbon dioxide concentration is predominantly caused by humans burning fossil fuels such as coal and oil. These fossil fuels are the carbon-rich remains of ancient plants and animals that have been buried in the earth for millions of years. When we dig up these vast, long-buried carbon stores and burn them to heat our houses, power our cars or generate electricity, the carbon that they are composed of reacts with oxygen to produce carbon dioxide, which is released into the atmosphere.

Carbon is cycled naturally through plants, which remove carbon dioxide from the atmosphere during photosynthesis in the growth season and use it to make the carbon building blocks of the wood of trunks and branches. By cutting down forests without replanting trees, humans have contributed further to the greenhouse effect. This has had the double effect of releasing more carbon dioxide from the burnt or decomposing vegetation, while simultaneously reducing the amount of carbon dioxide taken up from the atmosphere by the normal growth and activities of plants.

Carbon dioxide is not the only greenhouse gas contributing to the greenhouse effect. Methane (CH_4) is another naturally occurring gas produced by anaerobic (without oxygen) respiration by organisms such as bacteria. Methane can be stored in the Earth's crust and in ocean floors, and is used as a fuel in the form of natural gas. Though it is present in smaller amounts in the atmosphere, methane has over 20 times the global warming potential of carbon dioxide. Methane levels have increased markedly in the last two centuries. This rise is partly due to gas wells releasing stored methane from the Earth, as well as leakage from gas pipes. It is also partly due to agriculture, particularly the increase in the number of farmed animals that pass methane into the air as a result of anaerobic digestion of plants by cellulose-digesting bacteria in their guts. Huge quantities of methane are trapped under the Arctic permafrost, which, if released by melting of the permafrost caused by rising global temperatures, could accelerate global warming to very dangerous levels.

Among many other greenhouse gases are chlorofluorocarbons (CFCs) in the troposphere (the lowest layer in the atmosphere where weather changes take place). CFCs were formerly produced by industry in significant amounts, particularly in aerosols and fridge coolants, but these sources have been restricted through legislation in recent years. CFCs in the stratosphere (the highest layer in the atmosphere) contribute to the decrease in ozone (O_3), a gas that is important in terms of screening Earth from harmful ultraviolet radiation. Ozone depletion by CFCs in the stratosphere is a problem separate from global warming, although many people confuse them. An extremely common misconception is that "the hole in the ozone layer lets heat into the atmosphere, causing global warming".

Consequences of global warming Some of the main effects of global warming are:

– *Sea level rises:* When water is heated, it expands, which causes sea levels to rise. The melting of ice resting on land, such as glaciers and the vast ice deposits in Antarctica and Greenland, is also contributing to rising oceans. Sea-level rises and associated floods and storm surges are already causing problems to infrastructure and tainting fresh water supplies in low-lying countries such as Bangladesh, and oceanic islands such as Kiribati and the Marshall Islands. These problems are also being experienced by coastal cities of many countries worldwide, and this is a key risk for New Zealand (New Zealand Climate Change Centre, 2014). About 643 million people, or one-tenth of the world's population, who live in low-lying coastal areas are at great risk of ocean-related impacts of climate change (Roy, 2007).
– *Acidification of oceans:* The world's oceans have absorbed about half of the carbon dioxide emitted as a result of human activity. When carbon dioxide is absorbed by seawater, carbonic acid is formed, and it is this that has made the upper layers of seawater about 25 to 30 percent more acidic. The increasing acidity is likely to affect the ability of

organisms such as plankton and corals to build their calcium carbonate "skeletons", with potentially grave consequences for marine biodiversity and food webs, including fish stocks.

– *Increases in frequencies of extreme weather patterns:* Cycles of drought and flooding rains linked to the El Niño Southern Oscillation (ENSO) are a natural part of the Australian environment, but these are becoming more extreme and more frequent as part of the broader climate change patterns caused by global warming. This development is especially concerning in Australia where water is already a major issue, as exemplified by the well-publicised problems in balancing environmental flows, water allocations to farmers, economic viability and the social fabric of small rural towns in the Murray-Darling Basin over recent years. Australia and New Zealand are likely to see more temperature extremes, heatwaves and frequent and severe bushfires (Climate Council of Australia Ltd, 2014). Flood damage is another key climate change risk for New Zealand (New Zealand Climate Change Centre, 2014).

Social impacts of such changes locally and globally are profound for communities affected by floods, fires, and rising sea levels, especially for small Pacific Island states whose entire populations are at risk of being displaced as climate refugees. Political impacts of climate change are growing, with international leaders needing to balance environmental, social and economic imperatives in relation to dealing (or not) with the problem. For example, in Australia, a previous Labour government implemented a "carbon tax", which became extremely politically and socially contentious, and subsequently lost the next election to a conservative government promising to "Axe the Tax". Economic impacts to agricultural and fishing industries are probable in Australia and New Zealand as well as across the world, and the financial costs from damage to infrastructure are likely to be vast. Environmental impacts in addition to those outlined above include loss of biodiversity, particularly in vulnerable alpine areas and coral reefs, and water shortages in some parts of the world, including parts of Australia and New Zealand.

Pollution

Pollution of the air we breathe, the water we drink, and of our natural systems is a problem across the globe. The OECD recently labelled air pollution as the "invisible killer", claiming it is the biggest environmental cause of premature death (OECD, 2014). In understanding how pollution occurs, it is important to understand that materials are made from atoms, which rearrange themselves and combine in different ways, but do not get destroyed, and are still in the system even if we can't see them. There are only about 100 different atoms (represented by the elements of the periodic table), with about 25 atoms most common in what we see around us. Many children leave school understanding that matter is made of particles, but they think these particles are tiny bits of iron, sugar, and so on, and that these particles melt, burn, expand and change in the way that they have experienced everyday materials doing. With an atomic view of matter, we can understand that burning fossil fuels is actually a process where oxygen atoms from the air join with carbon atoms in fuel to produce carbon dioxide. The fact that the product of this process is invisible can be difficult for children to access, and they may think that when something burns it is used up or disappears.

Volatile materials from chimneys, exhaust pipes and aerosol cans end up in the atmosphere and can interfere with material cycles and energy flow. When fossil fuels burn, they combine with oxygen to produce oxides, which are mainly carbon dioxide and water. However, sulphur dioxide (SO_2) can make up five percent of chimneystack fumes from burning coal. Burning petrol also produces nitrogen oxides (N_2O); a significant component of waste from vehicle exhausts. Oxides of sulphur and nitrogen give rise to acids when they dissolve in rainwater (acid rain), which can damage living things by restricting the enzyme action that controls chemical processes in cells. Acidic conditions can also cause toxic metals (normally not soluble) to dissolve and damage living tissues. In these ways, substances we discard can get incorporated into living tissues and damage them, and then, in turn, damage ecosystems.

There are many other examples of toxins that can damage ecosystems, such as pesticides, herbicides and fertilisers used for agriculture. These can be washed into rivers, causing water pollution or algal blooms, and also reduce soil biodiversity. Some chemicals can persist in food chains and webs. The classic example is DDT, which, despite its now restricted use, is still pervasive in ecosystems across the planet because it does not degrade and so remains in food chains. More recently, economic interests of corporate agribusiness, as well as concerns about food security worldwide, have led to rapidly expanding monocultures of genetically-modified crops that are resistant to the herbicide glyphosate, which is then applied broad scale to remove competing weeds. This herbicide, although much more benign than some previous alternatives, is thus being "built" into large-scale cropping systems.

Other sources of water pollution include washing powders containing phosphates. These act as nutrients for plant growth, causing algal blooms, which can be toxic. Excess nutrients in water can also result in excessive aquatic plant growth, leading to plant death and decay by bacterial action, which then removes oxygen from the water, killing most of the animal life, a process called eutrophication. Cleansing materials, disinfectant and bleaching agents may keep our homes clean, but they all end up at the sewage works and pass into rivers or the sea, where they damage living things. In general, we use too many cleaning agents in our homes and on our bodies, and they place considerable stress on the environment.

Resource use and waste

We humans use the planet's resources to make the things we want and need. However, as outlined in some of the preceding sections, this use is not equitable. People from developed countries use far more resources than those from developing countries, and also produce far more waste. Many resources in nature are finite and in limited supply, such as fossil fuels and metals. These are called non-renewable resources; once they are used up, there won't be any more. Other resources can be made again by "relatively rapid" natural cycles, such as paper products derived from growing trees. These are called renewable resources.

As part of our consumption behaviours linked to the economic systems we live in, we buy and use products made from non-renewable resources, and later discard them. We generate huge quantities of things like old fridges, bikes, car tyres, batteries, clothes, plastic products, packaging and e-waste from non-renewable resources such as plastic and metal. Our consumption patterns also generate a lot of waste of renewable resources such as paper, cardboard and food. Although much of this waste goes to landfill, some of it, especially plastic bags, ends up as litter, or is washed into the oceans by stormwater outflows. Plastic pollution in oceans is reaching alarming levels and leading to the death of birds and marine animals that mistakenly ingest the plastic, feed it to their young, or get tangled in it.

Loss of biodiversity

Biodiversity is short for "biological diversity", and it simply means the variety of organisms in a particular area, including variability within and across species and ecosystems. A slightly more poetic definition from the "father" of biodiversity, E. O. Wilson, puts it like this: "This is the assembly of life that took a billion years to evolve. It has eaten the storms—folded them into its genes—and created the world that created us. It holds the world steady" (Wilson, 1992, p. 15).

We are losing the biodiversity on Earth. Species are becoming extinct at such a rate that some scientists have coined the term the *Anthropocene* to describe this period of time in which human activity is leading to mass extinctions. Globally, almost 900 species known to humans have become extinct or at least extinct in the wild, and over 11,000 are endangered or critically endangered, meaning that they are very likely to become extinct soon, unless we undertake urgent measures to save them. According to the International Union for Conservation of Nature and Natural Resources (IUCN, 2014), about 11,000 further species are considered vulnerable to extinction over the longer term.

Both Australia and New Zealand have their own unique and distinctive biodiversity, found in no other places on Earth and resulting from their long periods of isolation from other land masses. For example, New Zealand has unique birdlife, particularly flightless birds, while Australia is recognised as a mega-diverse country that is home to a range of unique animals and plants such as monotremes (platypus and echidna), marsupials and many others. However, at the last count (24 July 2014), 894 of Australia's native species and 175 of New Zealand native species were considered as threatened with extinction (IUCN, 2014). In 2011, UNESCO highlighted the severity of global losses of biodiversity by declaring the period 2011 to 2020 the Decade of Biodiversity and announcing a strategic plan on biodiversity to try to deal with some of the issues related to these losses (UNESCO, 2011, 2014).

Many of the losses to biodiversity have occurred through systematic destruction of natural habitats for human exploitation, while climate change is posing a new threat. Land clearing, predominantly for agriculture but also for forestry, mining and urban development, is one of the most important contributors to declines in terrestrial biodiversity we have seen. Clearing of forests and other vegetation types is continuing worldwide, and this is often exemplified by the plight of endangered orang-utans, whose habitat is diminishing because of forest clearing to make way for palm oil plantations. This single example highlights the other dimensions of sustainability related to declining biodiversity: palm oil is economically important as a source of employment and income for local small farmers in some quite poor parts of the world, and hence political initiatives to limit deforestation for palm oil have been slow to emerge.

So why is this loss of biodiversity a problem? To understand this, we need to get an idea of interdependence, that the living things on Earth depend on one another in complex ways, and that disturbances in one part of the web of life often have unanticipated, distant and long-term repercussions. One example of this in the Australian context is the disastrous consequences of adding just one species to a pre-existing web, the poisonous cane toad. It is devastating populations of predators that ingest it and therefore affecting, in complex ways, the other components of ecosystems. An equivalent in New Zealand is the introduction of possums from Australia. These animals are causing vegetation die-back, threatening some plant species in particular, and perturbing ecosystems by competing with native birds for food and eating their chicks.

Humans are also enmeshed in this web of dependence. We are, for example, totally dependent on plants and animals for food, and on healthy, functioning, biodiverse ecosystems for a whole range of benefits. The benefits to humans afforded by ecosystems are captured by the concept of *ecosystem services.* Ecosystems generate services that benefit humans, such as cycling nutrients, cleaning air and filtering water, pollinating crop and other plants, providing food, medicines and other resources, regulating climate, and offering recreational and cultural benefits. The economic value of biodiversity and associated ecosystem services is now being recognized, as is its importance in reducing poverty and achieving sustainable development (UNESCO, 2011, 2014).

The problem of declining biodiversity and associated changes to ecosystems can be viewed through two lenses. The first presents a human-centred (anthropocentric) perspective; the second a non-human centred (ecocentric) perspective that grants some intrinsic value to non-human as well as human beings. From an anthropocentric perspective, losing biodiversity (say a rainforest) diminishes our quality of life materially and spiritually because it diminishes the ecosystem services it provides. This thinking relates to the idea of intergenerational equity, which means that we have an ethical responsibility to ensure our grandchildren have enough to eat and drink, have access to natural resources and are able to swim in clean oceans and rivers, walk through rainforests and experience the awe and wonder of nature. A more ecocentric perspective grants other species with intrinsic value apart from their value to humans, and a right to exist—the concept of interspecies equity. From an ecocentric point of view, conserving a rainforest is important because its component species and their interactions are important in their own right, quite apart from the forest's use to humans.

Causes and effects: Making the connections

All of the causes and effects described above are interlinked, and linked to many others that we have not mentioned here. As just one example of some conceptual links between these concepts, *consumption* in the West is using an *inequitable* amount of the world's *resources* and resulting in *pollution* and large amounts of *waste*. It is also exacerbating *climate change*, which is likely to contribute to further declines in *biodiversity*. Many other interrelationships exist between these concepts, which therefore have linked environmental, societal, political and economic dimensions that must be considered if we are concerned about sustainability. The complexity of the interrelationships between these abstract concepts can be difficult to understand, including by primary students, but it is important that we, as teachers, have an overview and a sense of this web of connections of which we are a part.

A useful concept that summarises the range of human impacts on Earth's ecosystems is the idea of an "ecological footprint". The ecological footprint of a country is a measure of the land and sea area used to provide space for infrastructure and produce the food, fibre and timber which that country uses, and to assimilate the wastes it emits. The global ecological footprint in 2007 was an area of land equivalent to one and a half times the area of Earth. This is clearly not sustainable, as we only have one finite planet, so we are, in a sense, "borrowing" from future generations in order to meet our own needs and wants. In fact, demands on our natural world, as indicated by ecological footprint measures, have doubled since the 1960s (Global Footprint Network, 2010). Because our world is not an equitable place, we don't all have the same ecological footprint. Wealthy countries consuming many resources and generating large amounts of waste have a much higher ecological footprint than countries struggling with poverty. For example, the world average ecological footprint is about three hectares per person. Australia has the eighth highest footprint globally, at about seven hectares per person, while New Zealand is 35th in the world at about five hectares per person (World Wildlife Fund, 2010). Personal ecological footprint calculators have been developed that allow individuals to calculate their own, their family's or their school's ecological footprint (for two examples, see http://www.footprintnetwork.org/en/index.php/GFN/ page/calculators/ and http://www.wwf.org.au/our_work/people_and_the_environment/human_footprint/footprint_calculator/). The ecological footprint concept concisely sums up our current problem that the demands we are making on Earth have outstripped its capacity to supply those demands.

VISIONS

At the core of education for sustainability is vision: that a more sustainable world is possible, and that education which is infused and informed by sustainability principles has the power to create better futures for everyone. This book is a reflection of this common vision of its authors. Many of us have seen and, in some cases, contributed to wonderful things happening in primary schools, and watched children grow up to be responsible and thoughtful adult stewards of the environment. We have seen children and teachers create biodiverse native ecosystems in place of degraded, eroding land. We have seen children researching, planning, fundraising and implementing initiatives such as water tanks, rooftop photovoltaic systems, energy conservation measures and waste-recycling systems in schools and beyond. We have heard children passionately argue for social and environmental justice, and weep at injustice.

Hence, we can imagine a world where far less poverty, inequity and overconsumption is possible. We can see that tackling the problems of climate change, pollution, waste and declining biodiversity is feasible and not beyond the wit or will of humans. All of this is not simply naïve, wishful thinking towards some nebulous Utopian ideal. We are very aware of the monumental systemic impediments to more sustainable futures, but we can also see that change is happening across many of the aspects of sustainability referred to above, and that, with appropriate education, humans have the capacity to make further changes in the direction of a better future.

CHANGE STRATEGIES

All of the interlinked issues we have raised in the causes and effects section above have the potential to be changed. But this change is not easy, as the problems are enmeshed in a matrix of vested interests of multinational corporations and governments, greed, vast differentials in power and resources and conflicting values systems and ideologies. To make change, we need to address these broader factors. This need is a call for action that emphasises the role of EfS in critical thinking, encouraging cooperation, and the ability to interrogate and influence the directions of our political and social systems. We can see this happening at grassroots levels through organisations such as *Get Up* and the *Australian Youth Climate Coalition*, both of which harness the enormous power of social media and crowdsourcing to create change. These organisations, mostly led by young people, have influenced many political decisions in relation to sustainability. Change for the better is happening on a range of levels, and it is important that we, and our students, recognise and celebrate this as an antidote to action-paralysis and despair that many feel about the state of our world. Hope is vital to making change. Some of the change strategies and opportunities related more specifically to the issues above are outlined below, as examples.

Population

The issues raised by unsustainable population growth are deeply ensnared with the economic and political fabric of our social systems and consequently are very contentious for a range of demographic, environmental, religious and ethical reasons. However, we do have, through advances in science and technology, the capacity to make a range of choices in dealing with our population problem. We can limit population growth through birth control. We have the capacity to move food from where it is produced to where it is needed, and to increase food production through agricultural practices, including genetically modified food (although this also has its problems). Some people argue that we are still able to produce enough food to feed the world's population, but that for a range of social, political and economic reasons, this food is not going to the people who need it most. We also have the capacity to change our capitalist economic systems. Some commentators (e.g., Mander, 2012) argue that capitalism is no longer viable given the collision between the infinite growth on which it depends, and the constraints of a finite resource base on the planet. He suggests that we need to develop economic systems that do not require ever-increasing populations to 'grow' consumption.

Apart from education, other ways to break the cycle of poverty and environmental degradation include international measures that work towards peace and tackle structural inequalities between rich and poor countries, and a poverty focus on national development. Local actions and initiatives such as the Fair Trade movement are blending environmental action with human rights and meeting human needs. The livelihoods and survival of the poorest people depend upon the wealth of the natural environment and its fundamental resources such as trees, soils and water. We can work with the knowledge of these people, who know how to manage these resources sustainably using traditional methods of agriculture involving soil and water conservation. They know which crops are resistant to drought and pests, which trees provide efficient burning of wood, and how to rotate crops to maintain productivity.

Global warming

Many people regard global warming as the most pressing environmental issue currently facing humanity and urge immediate action to reduce it. Because the social, economic and environmental consequences of worst case climate scenarios would be ruinous for very large numbers of people in many parts of the world, as well as the natural environment, the scientific, political and economic consensus is that we should adopt *the precautionary principle* and take appropriate actions now. The main focus for action is to adopt measures to reduce greenhouse gas emissions. Actions required to reduce greenhouse gas emissions need to occur at *political* (via governmental legislation), *technological* (via sustainable technology innovations) and *social* (via actions by individuals and communities) levels.

Examples of *political actions* are international agreements such as The Kyoto Protocol, carbon trading systems, taxes to penalise or incentives to reduce greenhouse gas emissions, and actions such as reforestation and protection of existing forests. Many countries in the world are adopting a mix of direct and indirect climate change action, and although the international efforts need to be stepped up, some change is underway.

Examples of action at a *technological level* include developing energy production methods that involve fewer greenhouse gas emissions. Changing to renewable sources of energy such as solar and wind are already occurring, with both of these having huge potential in Australia to take over from the traditional reliance on large reserves of coal. Uptake of rooftop photovoltaic systems in Australia has been enormous, helped partly through government subsidies, and costs of these installations have decreased to such an extent that they are much more affordable than previously. New Zealand, in contrast to Australia's emphasis on coal-fuelled electricity, uses mainly hydro-electric power to generate electricity, where water falls through turbines located in dams constructed in rivers, forming artificial lakes.

Examples of *social action* by individuals or groups of people, including some that are very suitable for families and primary school children, are numerous. Several examples follow.

– *Conserving energy* in the home, that is, by using less electricity, thereby resulting in fewer greenhouse gas emissions from power stations, or using less fuel for heating by avoiding waste of electricity or reducing heating. Some ways that energy can be conserved include these approaches:
  - insulating roofs (where most heat escapes) and walls, making heating more efficient by restricting heat loss;
  - switching off lights that are not being used and using long-life, energy-efficient light bulbs;
  - purchasing energy-efficient appliances—energy efficiency of "white" kitchen and laundry appliances such as cookers and washing machines are often shown on the appliance;
  - switching off appliances that are not being used—about 10 percent of energy use in the average home is due to electrical items left on "stand by";
  - closing doors and windows to avoid heat loss;

  - avoiding overheating room spaces by keeping thermostats lower and wearing more clothes to keep warm through insulation;
  - drying clothes outside rather than in tumble driers; and
  - switching to alternative energy sources such as solar heating or solar electricity by taking up government subsidies for their installation.
- *Planting trees* and conserving natural environments to enhance the uptake of carbon dioxide by photosynthesis.
- *Eating less meat*—ecologically, it is much more efficient to eat plant produce; far less agricultural land would be needed if we reduced our meat consumption. And, finally,
- *Making energy-efficient transport choices* such as public transport, walking or cycling, and buying locally to reduce transport costs and fuel use associated with "food miles".

A *combination* of political action, technological developments and combined individual actions derived from a sense of social and environmental responsibility is needed for effective change to reduce greenhouse gas emissions and restrict climate change. Climate change is happening, and its impacts are being felt now, so some *adaptation* to the effects of climate change will be required, even if we do make substantial improvements directed towards reducing greenhouse gas emissions.

Pollution

Technologies are being developed to clean up toxins from exhausts and chimneystacks, while international agreement has restricted CFCs so that ozone levels can recover in time. Eco-friendly cleaning products are increasingly available in supermarkets, and many developed countries have some kind of environment protection agencies that set standards and monitor and penalise environmental pollution from sewerage treatments and industrial activities.

Waste

Many parts of Australia and New Zealand are moving away from indiscriminate dumping in landfills of "waste" comprised of items that are broken, obsolete or unfashionable in landfills. We are recognising that dumping resources into landfill sites takes up valuable land and can lead to pollution of water and air through leaching of toxins into the soil and production of methane from anaerobic decomposition of green waste such as garden clippings. We are also recognising that some waste is a valuable resource and can be recycled. So, increasingly, we are moving to refuse, reduce, reuse and recycle our use of materials to conserve finite resources and restrict environmental impact. These 4Rs also act to limit global warming given that all goods involve energy, mostly sourced from fossil fuels, in their production. Local councils play a major role in these recycling schemes through door-to-door collection of domestically sorted wastes, collection days and drop-off transfer stations. Households and primary schools can contribute to this effort by implementing the 4Rs as part of their daily routine. Recycling green waste through composting systems, worm farms or keeping chickens is easy to do in primary schools, and comes with many learning opportunities.

CONCLUSION

We see these examples of change strategies, and many others we have not mentioned, as evidence of the possibility of a more sustainable future. However, we also recognise the magnitude of the changes required, the scale and complexity of which highlight the importance of different values and ways of thinking in EfS. Sustainability issues, with their messy, conflicting priorities and perspectives, are deeply embedded in values, so being able to clarify one's own and analyse others' values is an important element. Addressing the threats to sustainable futures requires reflective and critical thinking that accommodates complexity, questions assumptions and probes different aspects of sustainability problems. It also requires *creative* thinking that can be applied to envisaging alternatives and designing solutions to complex problems. These approaches are therefore central to EfS.

Although EfS is a cross-curricular endeavour, its different dimensions, and the different knowledges and ways of thinking outlined above, often form the focus of different learning areas. For example, knowledge about the function of ecosystems and how natural systems interrelate is a natural "fit" to the science and geography learning areas. Creative thinking with respect to scientific and technological solutions is different to creativity in the context of, say, developing a good persuasive text, as a form of indirect social action, during an English class. Envisioning alternative futures can be enhanced by harnessing the affective domain through the creative arts.

In addition, in most primary schools, programmes and timetables are arranged according to the learning areas, which are sometimes taught by different specialist teachers. For these reasons, many of the remaining chapters in this book focus on what EfS might look like within the various specific learning areas. However, other chapters focus specifically on how sustainability teaching can be integrated *across* learning areas. In all these cases, there are some generic characteristics and approaches to teaching and learning for sustainability. We address these in the next chapter.

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3. HOW TO TEACH EDUCATION FOR SUSTAINABILITY

Integrating Theory and Practice

I touch the future. I teach.

(Christa McAuliffe, cited in Nick Green, 2014)

The title of this chapter may appear a little daunting to many teaching practitioners. However, if we view theory as being about significant educational principles for informing effective teaching practice, then it is important to include in this book some theory related to the teaching and learning of education for sustainability (EfS). In this chapter, I briefly outline the role of EfS before explaining how ideas about teaching and learning have changed in relatively recent times. I also highlight how the EfS literature, policy documents and guidelines have become more inclusive of action competence and a futures-oriented approach (Australian Government Department of Environment, Water, Heritage and the Arts [AGDEWHA], 2010; New Zealand Ministry of Education, 2010). I then illustrate how effective teaching in EfS can be guided by Jensen's model of *action competence* (Jensen, 2002), especially in terms of engaging primary school students directly in sustainability issues, with the intention of enabling them to realise their visions for a sustainable future.

THE ROLE OF EDUCATION FOR SUSTAINABILITY

UNESCO has bestowed on education, both formal and informal, a significant role and responsibility in the area of sustainable development. UNESCO sees the task of education as facilitating worldwide the infusion into school and life in general, attitudes, values, practices and behaviours that align with sustainable development. The recent United Nations Decade of Education for Sustainable Development (DESD 2005–2014) was directed toward using education as a means of instilling in individuals the following: respect for dignity and economic justice for all, respect for the human rights of future generations, and acceptance that the economy occurs within the bounds set by ecology and not the other way around (UNESCO, 2006, pp. 15–16).

Historically, environmental education (EE) began with a focus on maintaining and improving the natural environment. However, EfS has since been conceptualised in a broader manner to include, in addition to considerations relating to the natural environment, the wellbeing of society and economic issues (Jenkins & Jenkins, 2005). According to UNESCO (2006, p. 4), education can generate a "positive societal transformation … [that produces] behaviours and practices which will enable all to live a full life without being deprived of the basics". The Belgrade Charter (UNESCO-UNEP, 1975), ratified as early as 1975 by numerous nations, set the global framework for EE, especially in terms of linking

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environmental preservation with socially just development. The latter integrates the three "pillars" of sustainability—society, environment and economy (UNESCO, 2006, p. 14). The critical need for EfS was further emphasised by the United Nations' Agenda 21, established at the Earth Summit held in 1992. It became a blueprint for action to achieve a more sustainable world (United Nations Sustainable Development Division, 1992). Agenda 21 charged all levels of education, in both the formal and informal sectors, with responsibility for the "critical" process whereby societies and individuals can reach their "full potential", thus "building capacity" to appropriately attend to environment and development issues (United Nations Sustainable Development Division, 1992).

International and national organisations, as well as national policy and guideline documents concerned with EfS, have articulated the importance of promoting a futures orientation in this form of education (AGDEWHA, 2010; Earth Charter International, 2000; New Zealand Ministry of Education, 1999; UNESCO, 2006). Indeed, the preamble of the text for the *Earth Charter*, a document that outlines the values that humanity must embrace in order to achieve the goal of a fair, sustainable and peaceful world, illustrates the significance of facilitating such "foresight":

> We stand at a critical moment in Earth's history, a time when humanity must choose its future. As the world becomes increasingly interdependent and fragile, the future at once holds great peril and great promise. To move forward we must recognize that in the midst of a magnificent diversity of cultures and life forms we are one human family and one Earth community with a common destiny. We must join together to bring forth a sustainable global society founded on respect for nature, universal human rights, economic justice, and a culture of peace. Towards this end, it is imperative that we, the peoples of Earth, declare our responsibility to one another, to the greater community of life, and to future generations. (Earth Charter International, 2000, preamble)

Education for sustainability emphasises the significance of contributing to the creation of a preferred sustainable future by explicitly visualising it in teaching and learning, as well as recognising that the future is something that humans fashion as a direct result of their present values, attitudes and actions (UNESCO, 2002, pp. 20–21). Similarly, the Australian Sustainability Curriculum Framework, which provides guidelines for curriculum and policy developers, emphasises the need for EfS to be both "present and future-oriented" in full knowledge that any actions carried out in the present will influence what occurs in the future (AGDEWHA, 2010, p. 4).

In order to generate a sustainable future, EfS can aid members of a society to produce an appropriate and informed balance, within their particular context, between the pillars of sustainability. For example, if too much emphasis is placed on economic growth, the quality of human life and urban and natural environments could be threatened (Jenkins & Jenkins, 2005). This outcome might manifest itself through various forms of pollution, resource depletion, increased inequity and injustice, poverty, land disputes, disease and even conflict. Effective EfS informs individuals and societies about how they can reach a suitable balance between economic development and environmental sustainability.

An example of too much emphasis on economic development leading to environmental degradation, conflict, social disintegration and loss of life occurred in Bougainville, an island that is part of Papua New Guinea. Economic interests initially took precedence when land was taken from local Bougainvilleans so that it could be mined for copper. These developments changed land relations and allowed multinational mining interests and the New Guinean government to profit disproportionately, to the detriment of many of the locals. Ensuing unsustainable mining operations produced river pollution, destruction of local wildlife, loss of livelihood (fishing), sickness and death. The local landowners' initial resistance and the consequent retaliation by the New Guinean forces led to a 12-year conflict that ultimately resulted in the death of approximately 10,000 people and the traumatisation of thousands more. The Bougainville experience illustrates how exploitation of the environment for profit can disrupt the balance between the pillars of sustainability and ultimately result in significant conflict in certain situations (Jenkins & Jenkins, 2005).

Some of us might view this example as an extreme one. However, the future is likely to witness many similar scenarios if we continue to over-exploit the Earth and deplete resources such as the water, soil and air on which we all depend. In this early part of the chapter, I have highlighted the need for effective EfS that can raise individuals' awareness of these issues, help them reduce their impact on the environment, and thereby enable them to contribute to a more sustainable future. However, instilling understanding and actions conducive to balancing the pillars of EfS also relies on effective teaching and learning practices that facilitate students' creative decision-making and problem-solving skills. A useful way of discussing what constitutes effective EfS in this context is to explore theory and practice in education more generally, and the relationship between these two components in EfS in particular. Accordingly, in the remainder of this chapter, I look at some of the theory behind effective learning and teaching practices and how we can link this theory to EfS.

EFFECTIVE LEARNING AND TEACHING

Traditionally, students were perceived as "empty vessels" passively waiting for teachers to fill them with knowledge. This approach to teaching, known as the *transmission model*, is characterised by a very teacher-centred approach to education. The teacher is viewed as the "expert" who generally imparts knowledge from the front of the classroom using a "chalk and talk" method. Students sit in rows facing the front of the room, where the teacher is dominant. Such teachers often develop lessons by writing notes on the board that summarise what they have already articulated to the class. Students have little input except to answer the teacher's questions, for which the teacher usually already has prescribed answers. The transmission model consequently allows minimal opportunity for students to discuss their ideas with their peers, and there is little room for creative thinking and problem solving.

This teacher-centred method used to be the norm. However, educational research has since made clear that students are not empty vessels but come to the classroom with their own ideas about the world around them. Also, rather than being passive recipients of knowledge, they actively construct their knowledge based on their own experiences. This research led to the development of *constructivist theory* and the *constructivist movement*, which took a radically different theoretical view of teaching and learning to that of the *transmission model.*

Early constructivists, such as Piaget, Vygotsky and Bruner, believed that learning implies an *active, student-centred* process in which teachers take an interest in their students' ideas. These authors brought somewhat different emphases to their theorising. For example, Piaget

(Flavell, 1963) emphasised cognitive development of individuals in interaction with their environment, while Vygotsky and Bruner focused on construction of knowledge within a social context via interpersonal interaction. That said, all shared the belief that students are *actively* involved in constructing meaning.

Bruner (1996) advocated that "Learning should be participatory, proactive, communal, collaborative, and given over to the construction of meanings" (p. 84). When students actively participate in learning, they tend to construct new or modified views of the world. They can begin to question their pre-existing ideas if they discover, through different learning experiences, that these new experiences challenge their current thinking. Learning becomes a means of reconciling the conflict between the original views of the students and what they now conceive as "reality" in light of new experience (Festinger, 1957). In this context, rather than conveying knowledge, the teacher facilitates students' constructions of new understandings about the world.

Learning from and with one another is also extremely important, as Vygotsky (1978), a *social* constructivist, pointed out. He highlighted the social and cultural nature of cognition (thinking), whether it develops through interaction with parents, siblings, peers or teachers. Once children and young people begin working and exploring ideas together, their learning can become far more powerful and effective. This outcome is especially true when teachers deploy the essential characteristics of cooperative learning, such as individual accountability (everyone has a job to do) and positive interdependence (everyone must work together to create a group product and for the group to succeed) (Johnson & Johnson, 1987; Kagan, 1992). Student perspectives are broadened and numerous ideas engendered, thus extending students' potential to learn more with their peers than on their own.

Having briefly examined some of the theory that has led to an emphasis on active, student-centred learning, I now go on to relate this specifically to EfS.

LINKING EDUCATION FOR SUSTAINABILITY TO TEACHING AND LEARNING THEORY

Ideas about what EfS is and how to teach it are diverse. However, Huckle and Sterling (1996) identified a "recurrent theme" within this diversity, namely that EfS is "process-driven, participatory and empowering, is liberatory and continuous" (1996, p. *xiv*). This definition implies that, to be effective, EfS needs to draw on constructivist theory and actively engage students in learning about sustainability issues, generally through use of cooperative or collaborative strategies. It also indicates that EfS needs to leave behind the passive transmission model of education in favour of the more transformational constructivist model.

We can define EfS as transformative because it aims to change unsustainable social and individual practices to sustainable ones, as well as the structures that maintain these practices (Kemmis & Mutton, 2012, p. 192). Thomas (2009, p. 245) states that for appropriate sustainable change to occur, pedagogy must focus on "how to learn" rather than on knowledge accumulation. Thomas notes that one of the commonalities between EfS and transformative education is "critical thinking". Students can be taught to avoid passive acceptance of received views and to critically reflect on preconceived, unchallenged notions, and this can effect change. This model of EfS sees the teacher as a facilitator of learning, and it affords opportunity to critically examine possibilities for change, which is sorely needed given the current unsustainable patterns of living in most countries of the world.

One particularly effective approach to directly engaging students in sustainability issues is Jensen's (2002) model of *action competence*. This action-oriented approach requires students to engage actively with sustainability issues in a multidimensional manner involving four facets of knowledge. Although Jensen's model features environmental issues, it can be readily adapted to the broader area of EfS, as shown in Figure 3.1. As the figure shows, an EfS issue is explored in light of its "symptoms" (effects), its "root causes" and any "preferred futures" (visions) that students can generate about what a sustainable future could look like in light of this particular issue. It also brings to the fore any "change strategies" (actions) likely to facilitate such an appropriate vision.

It is important to note that "futurising"—imagining and exploring alternative futures in order to choose a preferred future (Bateman & Smith, 2004; Slaughter, 1996)—is of benefit to numerous disciplines. However, it is EfS where this attracts specific mention (Hicks, 2008, p. 78). Commentators have argued that the futures orientation has been missing from environmental education (Hicks & Holden, 1995). They claim that in order to bring about a desired sustainable future, we need to create complementary visions and subsequent actions in the present. It makes sense that what we do/think and imagine today will shape our futures!

Jensen (2002) stresses the need for the educational process within the action competence model to be student-centred and democratic. As an example of this approach, students from Paracombe primary school in Australia instituted a Great Environmental Makeover at their school. They decided to focus on the problem of drought, and through a very participatory, democratic, student-led process researched, planned, implemented and documented the establishment of a drought-resistant native garden. Many other Australian and New Zealand schools are engaged in similar initiatives. The Paracombe example demonstrates that "change strategies and actions" developed and chosen by students can bring about an appropriate transformation in keeping with their desired sustainable future. In order to become active agents of change, students had first to utilise their critical and creative thinking skills in order to imagine alternative and preferable visions of what the school grounds could be and then generate appropriate actions to transform their school environment. Visualising a preferred future is thus a necessary step before appropriate actions can be decided and acted upon.

This example of a practical application of Jensen's model of action competence also illustrates the model's value as a method for incorporating EfS into the curriculum. It draws on students' experiences of their world, engages them in a collaborative way, and gives them a strong sense of empowerment if their actions, following the generation of their preferred future, result in positive change. This process clearly requires teachers to encourage students to identify issues where change is needed and to work closely with them to ascertain their preferred direction following an analysis of the potential consequences of their alternative imagined futures (Bateman & Smith, 2004, p. 83).

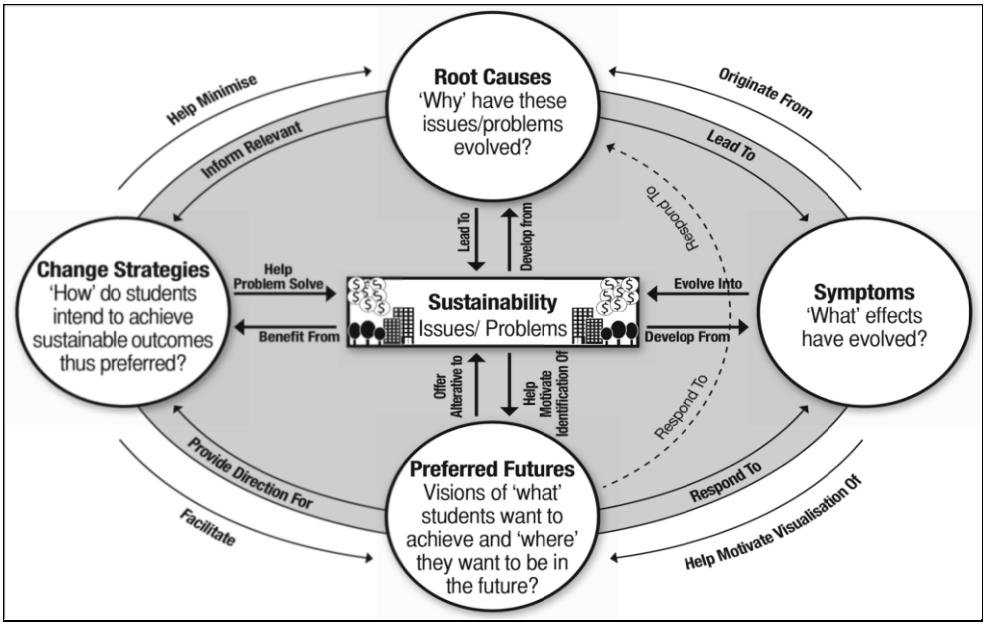

Figure 3.1. "Knowledge" required for sustainability (adapted from Jensen's model of action competence 2002, p. 330)

In Australia, the idea of action competence has been integrated into the Sustainability Curriculum Framework (AGDEWHA, 2010), which spells out the process of taking action—from making a case for change through to implementing and then evaluating specific actions. Relevant research into development of action competence in New Zealand schools has led to identification of five features that help promote students' action competence: experience, reflection, knowledge, visions for a sustainable future, and action-taking for sustainability connectedness (New Zealand Ministry of Education, 2010).

Envisioning a sustainable future necessitates teacher support through "tools and opportunities for holistic creative thinking" (New Zealand Ministry of Education, 2010). Among the range of tools available for EfS in the New Zealand context is an action planner, provided as a scaffold. The planner helps teachers and students foresee how the impact of a particular environmental problem could be minimised. It also helps them develop a plan of action to bring this vision to fruition (New Zealand Ministry of Education, 2010).

Young people can also use other specific futures tools to help them realise the sort of world in which they want to live (Inayatullah, 2008, p. 20) and strive towards. Examples include visualising, modelling (AGDEWHA, 2010, p. 10), futures wheels, mapping the past, present and future, envisioning more just and sustainable alternative futures, and deciding on a preferred future and then looking back from that future and analysing how it might be achieved. Furthermore, when students use the skills needed to generate preferred futures in combination with Jensen's model of action competence, they can markedly lessen the sense of "action paralysis" that many young people experience when confronted by what appear to them to be almost insurmountable problems (Uzzell, Rutland, & Whistance 1995). In this respect, the model can be used to address even significant global issues, such as climate change, by facilitating the analysis of what might be done at a local level and then following up with appropriate action. These approaches can also be used to develop a wide range of higher order cognitive skills relating to critical and creative thinking, analysis and evaluation.

HOW CAN I FIT EFS INTO MY PROGRAM?

Over time, scholars and practitioners have presented many ideas about how to teach education for sustainability. EfS is certainly as much about *how* we, as teachers, teach as *what* we teach. It is also about how we live our lives both professionally and personally and thus set ourselves as examples for our students (Hogan 2006, p. 5). In addition, the "overcrowded curriculum" means that unless we feel confident and competent to teach EfS, this area of education is likely to remain a "should do" rather than a "can do".

The National Environmental Education Statement for Australian Schools suggests that the preferred pathway for implementing EfS in Australia is by "working across all curriculum areas" while simultaneously being "complemented by whole school policies and activities in other related areas" (Australian Government Department of Environment and Heritage, 2005, pp. 13–14). However, when citing problems associated with the crowded curriculum, the recent review of the Australian Curriculum advocated explicitly "embedding" sustainability only within specific content areas that curriculum planners deem directly relevant. The Australian Sustainable Schools Initiative encourages schools to integrate EfS into their curriculum and everyday management (Department of Environment and Heritage, 2005), and more schools are beginning to adopt "whole-school" approaches to sustainability. The New Zealand Curriculum (New Zealand Ministry of Education, 2007) promotes sustainability as a future-focused theme that is a rich source of learning opportunities. The Enviroschools Programme (Enviroschools Foundation, 2014) is one initiative fostering whole-school approaches to EfS in many New Zealand schools.

Figure 3.2 presents a useful model—one that teachers should find practical and easy to adopt—for integrating EfS across the curriculum. This model allows us to cover essential content, skills, attitudes, values and behavioural outcomes from the humanities and social sciences, the natural sciences, and health and physical education, while concurrently addressing literacy, numeracy and creative arts outcomes. This concurrence is achieved by identifying "rich concepts" (e.g., social justice, wellbeing, war, resources and so on) and addressing them in a cross-curricular manner. It follows that more outcomes can be met within a shorter amount of time if we integrate learning areas (LAs). In other words, we can be more efficient with the limited teaching time available to us. According to Murdoch and Hornsby (1997), students' motivation to learn is enhanced when they can deal with meaningful rich concepts as authentic "real-life" issues.

English, other languages, mathematics, the arts (visual, music, drama, dance), technology and physical education (PE, dance and movement) provide ways for students to explore, research, imagine, re-formulate, perform, communicate and evaluate rich concepts (Murdoch & Hornsby 1997, p. 14). Literacy, the creative arts, numeracy, and information and communication technology are tools that can be effectively used for inquiring, investigating,

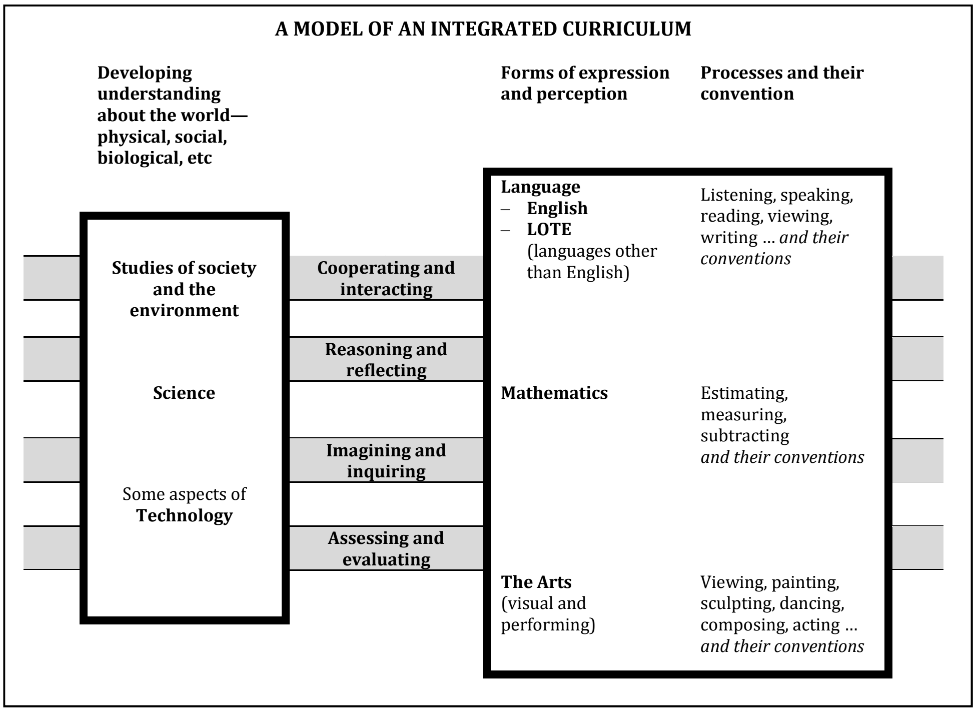

Figure 3.2. A model for integrating EfS across the curriculum (Murdoch & Hornsby, 1997, p. 14).

viewing, listening, reading, designing, moving, acting, performing and assessing. It is essential that all subjects (LAs), because of the varying skills and knowledges they develop, are encompassed if we are to address the interdisciplinary nature of sustainability issues.

But how can we make links between these so-called rich concepts, the pillars of sustainability and the curriculum? The following list of rich concepts (also taken from Murdoch & Hornsby, 1997, p. 18) provides some insight into how these topics can be made comprehensive enough to provide an "umbrella" for specific subtopics drawn from the various LAs. Examples of rich concepts include citizenship, ecological sustainability, human rights, justice, conflict and cooperation, social justice, needs and wants, diversity, relationships, spirituality, work and leisure, imagining and constructing a future, thinking critically, wellbeing, energy, change, power and control, inequity, the global society and time … the list goes on.

If we take, for example, the rich concept of "relationships", we can readily explore this concept in a variety of ways. Relationships can be investigated within the context of families, friends, work colleagues, communities and countries, or natural or built environments. In particular, we can examine how healthy relationships are developed and ultimately lead to improved wellbeing (health and PE). Within the natural sciences (science and technology), relationships and interactions between the biophysical world and humans could be a natural progression from the previous subtopic. The role of technology (in the past and the present) could be incorporated into this topic by investigating how it has influenced human and non-human life.

Thus, for example, students might study interactions between the rise of factories and quality of human life. Elements of society and the environment would also feature here, with associations across the physical, social and biological worlds producing both positive and negative effects. How humans perceive and relate to the natural world can vary greatly. Some people are human centred (anthropocentric) in their thinking, regarding the natural world as a resource to be used for the benefit of the human species and with little regard for other living things. Other people are more ecologically centred (ecocentric), viewing the natural world as intrinsically valuable for its own sake as well as an integral part of our life support system—a relationship professed by many traditional societies. Examining such issues allows students to engage with a number of the LAs while discussing the why and what aspects of EfS.

Students could then proceed to envision a sustainable future that involves healthy and happy relationships at home, at work and at play and encompasses the physical, natural and social worlds. Subsequently, the students' desired sustainable future could provide the impetus for a range of change strategies to be planned. After further researching and exploring this rich concept, the students might choose to act in certain ways to improve their relationships with someone at home, at school, in the community or with the natural world. An example of their chosen action might be planning and creating a garden to supply fresh organic vegetables for the school canteen and local restaurants. This action implies learning about how to create healthy human–nature interactions and relationships.

From there, students could also be involved in fundraising to buy and then plant native vegetation to attract bird life and improve the playground environment. Additional funds raised could be donated to a local care facility for the elderly in order to make their lives more comfortable. Follow-up visits to the residents, with students perhaps performing songs/role-plays/recitations might also become a "planned" outcome. Community relationships between the young and the aged would likely be improved as a result. All these actions emanate from the students being occupied in informed problem-solving and democratic decision-making processes directed toward improving the environment, society and the economy.

In summary, Murdoch and Hornsby's integrated model and Jensen's framework for action competence can provide a valuable starting point for effective integration of EfS within a number of LAs, while allowing students to meet a broad range of outcomes. A combination of these two frameworks, along with futures tools and Australia's and New Zealand's curriculum and policy documents, could produce "small step" changes in students' behaviours. Such changes are most likely to be facilitated when students are permitted to act democratically and to make decisions and choices predicated on their visions of society, economy and environment. During this process it is crucial for any action taken to have as its aim a positive environmental outcome *for* the future as well as other relevant and worthwhile educational outcomes related to curriculum contexts.

CONCLUSION

In this chapter, I examined different theories of learning and their association with changing pedagogies from those centred on the teacher and the transmission of knowledge, to those centred on the student and the construction of knowledge with the teacher as facilitator. The vision for education, according to UNESCO (2002, pp. 10–11), is to foster capacity for futures thinking and to emphasise teachers' roles as agents of change. I also, in this chapter, discussed how adopting Murdoch and Hornsby's (1997) model of integration with Jensen's knowledges makes it possible to integrate EfS into the curriculum. This approach allows teachers to employ effective learning and teaching practice based on constructivist theory and student experiences. For students, use of these theories and models enables them to explore issues of sustainability in ways that involve personal and societal actions, with these actions not only contributing towards their preferred visions of a sustainable future but also developing significant higher-order cognitive skills.

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4. YOUNG CHILDREN SAMPLING SUSTAINABLE LEARNING AS *HEALTHIER ME*

In this chapter, we consider educational practices that lead children's authentic learning. We focus these ideas on children about three to five years of age. Our philosophy, built on an overarching education for sustainability (EfS) approach, recognises children as active, powerful, contributing agents in their own learning, especially when collaborating with others.

We begin the chapter by setting a broad context for relevant pedagogy. Here we outline early education settings, with the description underpinned by the understanding that these settings *do* influence young children's understandings and values. We then explore relevant pedagogical frameworks based on contemporary theories and research, along with wise practice from the early childhood field. This section is followed with a look at children's learning and educators' teaching within a context involving exchanging questions and exploring possibilities. These ideas set the scene for the heart of the chapter—a sustainable learning sampler titled *Healthier Me*.

This sampler represents moving away from interlocked pedagogical frameworks towards putting them into everyday practice, within an integrated learning approach embracing one big idea and action concept. This starting point leads to the creation of a longer-term collection of interrelated learning events. Young children and educators can jointly explore the big idea of *Healthier Me* from many angles across early childhood curricula and within the broad frame of people and place. Because overarching EfS-pillars of environment, economics/politics and society form a vital lens for both educators' planning and children's learning (refer to Chapter 1), they also frame the sampler.

Finally, we challenge early childhood educators' notions about young children and embedding environmental studies and sustainable concepts into early childhood settings. We also challenge you to reflect on your professional stance towards EfS for young children.

MULTIPLE LEARNING CONTEXTS

Settings

Early childhood education settings and everyday life experiences impact on what children take with them as they enter primary school. These settings and events also influence young children's later learning and dispositions. Relevant settings for young children vary from their homes to local communities. In Australia and New Zealand, early childhood services encompass children's centres, kindergartens, play centres, preschools, childcare centres and family day-care schemes. Influential aspects of local communities include many other people and places. With this variety of early childhood education settings as a physical context in

N. Taylor et al. (eds.), Educating for Sustainability in Primary Schools, 45–63.

mind, we now move to the human contexts of body and mind that also shape educators' teaching and children's learning.

Pedagogical and theoretical frameworks

Various multidimensional approaches or lenses inform this pedagogical work with young children. They include ones that:

– shape education practices for the early years;
– reflect the nature of young children's learning and knowledge; and
– display ways that educators might teach most sensitively.

As examples, some frameworks encompass the concept of environment or place as the "third teacher", with adults and children being the other two (Wilson, 2008). The outdoors is vital here, and we propose that today's early childhood educators need to do more about reconnecting in meaningful ways with "outside" (Elliott, 2014a, 2014b; Littledyke, 2007). We challenge educators to commit to Froebel's original ideas about a "children's garden" (Ashby, 1972; Press & Wong, 2013). Also, as in the pedagogy of Holt's (1989) now classic writing, we encourage every educator to be a "middle person", with each child as one "centre of experience". We furthermore consider that a broad and extended lens of rights with responsibilities provides both a foundation and principles for everyday and everywhere Early Childhood Education for Sustainability (ECEfS) (Davis, 2014).

Theories or principles help explain phenomena (Nutbeam & Harris, 2005). They may guide and support our understandings and provide justifications for our plans and actions. They can inform rationales shared with others, such as our colleagues, parents, local councils, regional communities, broader government and society in general. Theories and research can inform us about solid educational reasons for committing to aspects of early years education. Professional and personal beliefs can be seriously questioned and deeply considered. For example, we can justify and carry out shared edible gardening with young children and then work side by side preparing tastings of plant foods using picto-recipes (McCrea, 2008, 2014). While engaged in this activity, educators can think about everyday food as much more than a four-letter word, since it is social, cultural, historical, and much more. Such thinking is called "philosophical rumination" (Allhoff & Monroe, 2007, p. 2). We outline a few relevant theories below.

Bioecological systems theory Bronfenbrenner's ecological systems theory (Berk, 2006; Bronfenbrenner, 2005; Stanger, 2011) continues to be a useful tool for early childhood educators (see Figure 4.1 for an adaptation). It can guide, in many ways, our conceptualising about how people and environmental features and places influence children.

This theoretical approach is displayed as a series of concentric circles with the child at the centre. *Microsystem* includes unique people and places, events and interactions closest to a child, with each aspect influencing the child's development, including his or her learning. Relationships between this layer, other layers and the child within the centre are multidirectional. *Mesosystem* represents the relationships or linkages formed between people and places within a microsystem. *Exosystem* encompasses various social settings further removed from the child, with these influences being less direct but still potentially very powerful. The outer ring, *macrosystem*, consists of sociocultural beliefs or values, ideologies, and legal and customary practices; governments, cultural groups and religions are thus involved.

Also, because a child's world evolves, these near to more distant influences change over time rather than remaining static. Both life events, such as the birth of a sibling or the child growing, and societal happenings, such as the effects of reduced funding for childcare provisions, alter a child's daily world as time passes. Thus, a *chronosystem* intersects all layers of the model, from the child outwards. More recently, this systems approach has been reconsidered as "bioecological" in nature in order to reflect aspects of children's lives as both "nature" (including biological and genetic dispositions) and "nurture" (encompassing sociocultural environment, place, forces and relationships). This term also reflects the idea of interacting parts within biological ecosystems (Berk, 2006). The approach has furthermore been reoriented to clearly reflect an ecosociological view (Stanger, 2011), which ought to assist educators in their ECEfS work with young children.

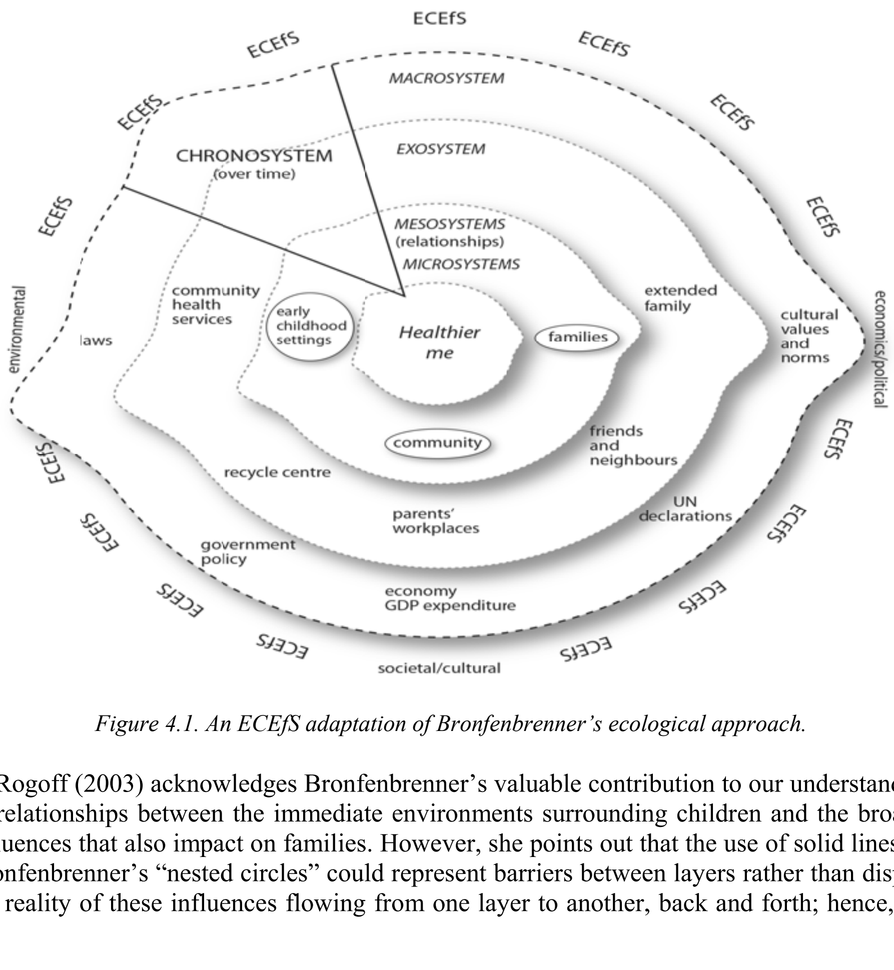

Figure 4.1. An ECEfS adaptation of Bronfenbrenner's ecological approach.

Rogoff (2003) acknowledges Bronfenbrenner's valuable contribution to our understanding of relationships between the immediate environments surrounding children and the broader influences that also impact on families. However, she points out that the use of solid lines for Bronfenbrenner's "nested circles" could represent barriers between layers rather than display the reality of these influences flowing from one layer to another, back and forth; hence, our adaptation and extension of this approach in Figure 4.1 through inclusion of organic-looking circles with broken or segmented lines that help reflect two-directional permeability of influences and relationships. Such permeability is an indicator that young children can be influencers as well as influenced. We also added ECEfS as an outer encompassing and penetrating lens.

As an example, the following identifies specific but broader EfS-related influences at the macrosystem and exosystem layers. Such influences clearly demonstrate how seemingly distant events can affect children's holistic health, as demonstrated in the section below detailing the *Healthier Me* sampler. Beyond the sampler, these and other influences can touch young children during their daily lives at home and in early childhood settings.

– *Macrosystem* influences could be:
  - government policy ⇒ non-smoking in public places
  - laws ⇒ Australian/New Zealand food labelling legislation
  - economy/GNP ⇒ funding of early childhood services.
– *Exosystem* influences could be:
  - community health ⇒ accessibility of child health centres
  - television ⇒ fast-food advertising during children's television viewing hours
  - local park ⇒ the provision of child-focused spaces or not.

Social constructivism theory While Bronfenbrenner's approach provides a broad contextual view of children growing and developing, Vygotsky's and Piaget's ideas have also shaped early childhood educators' practice over the years in the form of social constructivism. Constructivist theory is about understanding that children build or construct personal knowledges and meanings as their own theories. They do this through personal and shared experiences and interactions within social and physical environments. Chaillé (2008, p. 5) suggests that constructivism is "the theory that underlies the choices and decisions you make about how you set up the classroom, choose the curriculum, and respond to children's work and ideas".

We suggest that within such a view, educators ought to recognise that while children's understandings and learnings are culturally and family influenced, they are also quite personal and individual. Social constructivism theory enables the creation of constructivist pedagogy that educators can use when planning and implementing everyday early childhood curricula. Such pedagogy is firmly based in the belief that young children are theory builders. As such, their development with learning, that is, young people changing, cannot be separated from their social contexts or places (refer again to Figure 4.1 and see also Edwards, 2009). Similarly, children's language plays a central role in their learning because the children discuss ideas with others.

Other key concepts Many other theories, research studies and professional principles can support educators' pedagogical ideals and their everyday encounters with children. First, it seems that in order to understand both children's learning and educators' teaching through an EfS lens, we must ensure that the concept and expression of "caring" is centre stage across early childhood education. Doing acts of caring and having an ethic of care within our everyday lives involves ecological interrelationships among relevant people and places (Collins & Ting, 2014; Lawson, 2009; Wilson, 2008). For young children, such caring is a means for living a personal ecology (Holt, 1989) or displaying Edward Wilson's "biophilia" as a love of nature (Wilson, 2008). Similarly, Gardner's naturalistic intelligence could be a basis for children learning greater respect and care for surrounding people and places.

Making meanings of surroundings from an ethos of respect and care is more valuable than being fearful, which, according to Richard Louv's notion of "nature-deficit disorder", arises from a lack of positive experiences with nature (Maller, 2009; Wilson, 2008). Both knowing and respecting the broader world are reflected in "Learning Outcome 2: Children are connected with and contribute to their world" of the Australia-wide curriculum guide (Australian Government Department of Education, Employment and Workplace Relations for the Council of Australian Governments [AGDEEWR], 2009; Elliott, 2014a). Similarly, in New Zealand, there are instances of ECEfS explicit embeddedness in children's learning within the framework of the country's *Te Whāriki* early childhood curriculum (Duhn, 2012; Duhn, Bachmann, & Harris 2010; Ritchie, 2012, 2013).

The importance of experiential learning or being actively involved is well established across early childhood education. This concept resonates with Laevers' (2000) identification of the crucial difference between deep-level learning and superficial learning within group settings. He stresses that deeper learning, as a form of wellbeing, occurs when children are engaged or involved and also feel good about themselves. In contrast, superficial learning "does not affect the basic competencies of the child and ... has little transfer to real life situations" (p. 21). Furthermore, ideas from emotional intelligence (Goleman, 1996), empathic intelligence (Arnold 2005) and ecological intelligence (Goleman, Bennett, & Barlow 2012) support this personal and affective nature of learning. Because the aim of this chapter is helping educators facilitate children's dispositions of care and responsibility for all environments, it is essential that an affective dimension is taken seriously. Additionally, in order to fulfil this aim, children's resilience alongside their authentic empowerment and agency within the everyday world is worthy of consideration (Caiman & Lundegard, 2013).

LEARNERS, EDUCATORS AND QUESTIONING

Children's authentic learning

The many contemporary concepts about the young child reflect at least two broad views—a professional or educator view and a personal or family and community view. How each of us views and perceives children as people influences how we define their learning and our teaching. Within ECEfS settings, we believe that young children can sensitively engage their heads (understanding), hearts (believing/feelings) and hands (doing) for holistic learning (McCrea, 2008).

This "HHH" approach is about children being actively engaged and purposefully involved. As theory builders, children construct ideas about people and places through play that links with their personal interests. We propose that children learn most effectively when surrounded by relevant people and places, and when both are enchanting and engaging. As young children explore and encounter people and places, all their senses help them engage with the surrounding world. For example, on a warm summer evening, a child might smell the aroma of a cucumber vine or a tomato plant as he or she brushes by the leaves. This scent can be particularly powerful if Mum or Dad also sniffs the air and mentions the smell. In this way, children's sensory experiences are enhanced by adult involvement and guidance. Every day, in all kinds of ways, educators and parents together with young children think about our place as humans on planet Earth. Being sensitive to the Earth's natural cycles represents a biocentric (nature-centred) rather than an anthropocentric (human-centred) view of people and places. A biocentric view is essential for educators if they commit to intertwining EfS with children's learning, and if they plan to assist young children as they gradually form biocentric habits of mind or disposition.

Another significant aspect of children's learning is their everyday experience of life, which we express as *everydayness*. Children's active participation in daily life tasks and routines often results in meaningful, authentic learning (Rogoff, 2003). Through making genuine contributions to joint adult tasks, children gain a sense of agency and, over time, refine their essential daily life competencies. Children's lack of engagement in "mature community activities" undermines their beliefs about "pitching in" and their abilities to actually do so. This sense of being able to make contributions to family life and aspects of local community life is fundamental to successful and meaningful ECEfS. In addition to children developing a sense of agency, the opportunities they have to do adult work and be part of real life (Nimmo 2008) provide children with times for "sustained shared thinking" (Wood & Attfield, 2005) and active citizenship (Young & Elliott, 2014). The very act of being involved necessitates authentic interactions and relationships between adults and children.

Educators' intentional teaching

There are so many ways that early childhood educators might meaningfully interact with young children. For example, MacNaughton and Williams (2009) identify 27 elements within everyday teaching. These range from the less complex (e.g., demonstrating, describing, encouraging) to the more demanding (e.g., decolonising, democratising, philosophising). In order to successfully embrace these elements, educators must understand children's actions and responses at a deep and theoretical level. Thus, educators are compelled to recognise the meanings of events and the worth of accomplishments from each child's perspective, yet also maintain a collective view of learners.

This idea leads us to review the roles that early educators may adopt. Such roles can be displayed as an action framework for wiser practice and more transformative and transactional teaching, especially within the context of ECEfS. Early childhood educators' various roles are based on supporting children's authentic learning through play and guiding their holistic development within everyday life. This responsive context for supporting children encompasses educators' multitude of roles.

We brainstormed and identified a number of educator roles. They include:

- flexible planner;
- skilled observer;
- good listener;
- respectful communicator;
- reflective motivator;
- relational supervisor of safety, access and equal opportunities;
- sensitive co-player;
- professional researcher;

– clever question-asker;
– problem-poser; and
– documenter and theory builder.

The roles of question-former, question-extender and issue-poser are particularly important for young children's reciprocal learning.

In addition, educators must be committed to EfS within a global perspective. However, it is vital that educators, when working with young children, translate a global view into a view encompassing the familiar local level. Swiniarski and Breitborde (2003, p. 17) provide an example of this notion in practice through their identification of the "background" dispositions and sensitivities that underpin being a "globally literate teacher". This educator:

– views the curriculum from an international perspective;
– makes connections and identifies universal implications;
– is knowledgeable about world issues, affairs and happenings;
– is sensitive to unity and diversity issues;
– is involved in local and international happenings;
– is open to new ideas;
– willingly shares ideas with others;
– employs critical and creative approaches to problem solving;
– performs on the basis of a personal moral imperative; and
– exhibits a positive spirit when teaching and learning and is reflective.

Incorporating EfS into children's early learning is less a matter of a taught curriculum consisting of discrete or separate learning areas and more about children actively engaging with everyday life concepts. Such learning is influenced by a hidden curriculum (Swiniarski & Breitborde, 2003).

A hidden curriculum includes unspoken and unplanned aspects of learning experiences and interactions with people and learning environments from which children may receive powerful messages about what is acceptable or unacceptable, and what is valued or not. This area can be challenging for educators to acknowledge and actively engage with because it encompasses values, beliefs, expectations and aspirations that arise from educators, families and community. Because these assumptions and practices are often unrecognised and unchallenged, they can be labelled examples of hidden curriculum.

Contributing questions and children questioning

Approaches to ECEfS should reflect what we know about how children think, learn and question their world. As one example, an integrated approach where food is at once concept and subject could include using whole language ideas, practising socioconstructivist processes and strategies, and designing opportunities that use a range of intelligences over time within project-based phases. Interacting with foods is one essence of the *Healthier Me* sampler (Bone, 2005; McCrea, 2014). As a practical way of enacting this approach, educators might design learning experiences that involve children in noticing, wondering why, finding out, sharing possibilities and documenting findings. Again, an authentic, integrated curriculum can be positively informed by environments, particularly immediate surroundings and local places.

Planning for children's learning through ECEfS emerges and evolves from the children's world views and their everyday questions. Educators also contribute questions, provide effective starting points and guide extensions to children's integrated learning. Questions differ. Some elicit ideas and further avenues for exploration. Others may stop the flow of children's ideas. Divergent questions are most useful for eliciting children's current understandings and encouraging them to explore and express their ideas with confidence. Divergence encourages pondering, mental exploring and reflecting, such that children are more apt to review their own experiences and formulate their own questions. Within this purview, one of our roles as educators is to encourage children to think about, design and ask questions, and to do so in ways that are divergent rather than closed.

Harlan and Rivkin (2000) identify seven purposes of questions. These are:

– instigating discovery;
– eliciting predictions;
– probing for understanding;
– promoting reasoning;
– serving as a catalyst;
– encouraging creative thinking; and
– reflecting on feelings.

When three- to five-year-old children and educators ask each other relevant, meaningful, open-ended, speculative questions that they then co-explore, many possibilities for linking people and places arise. This interaction facilitates questions that lead to many more. Examples of these types of questions appear in the section on *Healthier Me* below.

We used these question types as a starting point for creating four layers of ECEfS-linked planning (see Table 4.1). Encouraging children to create their own questions about *Healthier Me* can open up many issues and views for joint investigation over time. Such questions can be prompted by a precipitating event or an observed behaviour, with content varying from broader people or place phenomena to specific healthier and wellbeing aspects of daily life. Within sensitive surroundings, an idea might arise from a child's thinking during a quiet time today and then appear for actioning tomorrow.

A *HEALTHIER ME* SAMPLER OF SUSTAINABLE LEARNING

In order to gain understanding of the sampler, let's first briefly explore children's wellbeing and integrated learning. So what do we mean by health and wellbeing within the context of *Healthier Me*? To answer this question, we can look initially at the concept of health from an adult perspective, and then from the child's perspective. Being "healthier" is about total or holistic health. The Ottawa Charter of Health Promotion defines health promotion as a process of enabling people to increase their control of their health in order to improve it. Under the charter, the action components of health promotion are creating supportive environments, building healthier public policy, strengthening community action, developing personal skills and reorienting/establishing health services (Nutbeam & Harris 2005). The charter has been used worldwide as a basis for creating health-promoting education settings. These ideas are explored in more detail and from a different perspective in Chapter 12. For the early childhood field, specific links with children's health promotion can be found in *Te*

Whāriki (New Zealand Ministry of Education, 1996), where a strand termed "wellbeing" supports the holistic development principle.

Table 4.1. Healthier me: exploring people and places with questions.

Instigating discovery (ID)	*Eliciting predictions (EP)*
What is my house like? What is on my street? How far is it to the nearest shops? How do I get to my preschool/childcare centre? What kind of green spaces are in my neighbourhood? Who do I live with? What members of my family do I not live with? Who lives on my street? What/who makes a family? What/who is a friend? What can I see in my neighbour's garden?	What would happen if your family's car broke down and you had to get somewhere? What would happen if the supermarket ran out of food? What would happen to some of our food if we had no refrigerators? What would happen to us if we ate nothing but ice cream all week?
Probing for understanding (PU)	*Promoting reasoning (PR)*
Why are there different kinds of homes in my street? Why are the homes in my street all the same? Why do some homes have gardens and some do not have gardens? Why are some families very big and some families very small? What is a neighbour? How come she looks different from me? How come he has two daddies and I have one mummy and one daddy?	What does healthy mean? Why do you think we say that some foods are healthy and some foods are not healthy? Why do you think healthy food is good for you and how does it help your body? Why do you think supermarkets stack all the lollies at the checkout? Where are the healthiest foods in the supermarket? Where are the fruit and vegies in the supermarket? Why are foods displayed in certain ways in supermarkets? What do trees do? What happens if we don't look after the environment? What is pollution? Why is it bad for us and why is it bad for the environment? Why do we recycle?

Table 4.1. Healthier me: exploring people and places with questions (contd.)

Serving as a catalyst (SC)	*Encouraging creative thinking (CT)*
What could we do so that we have more green spaces in our neighbourhood and around the preschool or childcare centre? Could we ask the supermarket to move the lollies? Could we ask the supermarket to display the healthier food by the checkout?	What could we do if all the families in the preschool or childcare centre could use cars, trains, buses, planes? What would it be like if there was no place to play outside in your neighbourhood? What do you think the trees would say to us about our neighbourhood if they could talk? What would you plant if you could grow your own food? What would you make if you could cook your favourite meal?
	Reflection on feelings (RF)
	How do I feel about my house/neighbourhood centre? Do I feel comfortable when I am there? How does it feel to be me? What does it feel like to sit in a quiet space? What does it feel like when I have to sit still for a long time? How do I feel when I am playing: inside/outside/home/community? How do I feel when I can't play? How do I feel when I play with my friends? How do I feel when I play alone? What scares me?

What does integrated learning look like? The *Healthier Me* sampler reflects children's various environmental learning ideas, such as *in*, *about* and *for* the environment (Davis & Elliott, 2003). However, it goes beyond these words to children's explicit decision-making and action-taking (Young & Elliott, 2014) and also to Holt's (1989) notion of "distance from self". Holt's model is represented by a child encircled by many everyday words about people and places. The model's outer edge presents adult or BIG sciences. All *Healthier Me* planning outlined here is based on educators taking account of learning experiences and resources in terms of their availability, appeal and appropriateness for the children they work with. Educators' emergent plans and children's questions and actions represent interlinking and integrating curricula learning areas; Table 4.2 provides cross-curricular examples.

The second aspect of our sustainable learning sampler involves a four-layered planning process. The *Healthier Me* sampler presents as a sequence of four layers or stages, each of which emphasises children's exploratory learning processes, their daily lives and purposefully engaged thinking. *Healthier Me* encompasses reciprocal and intertwined learning and living in early education settings and beyond (McCrea, 2006). For children, learning about "healthier me" involves their heads, hearts and hands, underpinned by daily routines and relevant ECEfS considerations (McCrea, 2008). The *Healthier Me* sampler evolves from an educator-questioning perspective to children's own speculations. These types of questions and this type of questioning help shape and identify concepts about both people and places within the *Healthier Me big* idea.

Layer 1: Circles of my living and learning

The initial planning layer of the *Healthier Me* sampler is displayed as a series of concentric circles (see Figure 4.2), the core of which represents a child's perspective of "my living and my learning". Children explore other people via the questions of *Who do I live with? Who is part of my life?* The people circle encompasses:

– adults, children, families and others;
– the relationships, interactions and communication between and among these people;
– their lived values, personal and shared emotions, spiritual/religious beliefs and issues; and
– contemporary realities of gender.

Beyond "people" is a circle of "places". It reflects children's environments and employs the questions *Where do I live? Where do I visit?* The places circle is comprised of many environments—natural, built, economic, political, sociocultural, local community and domestic/family.

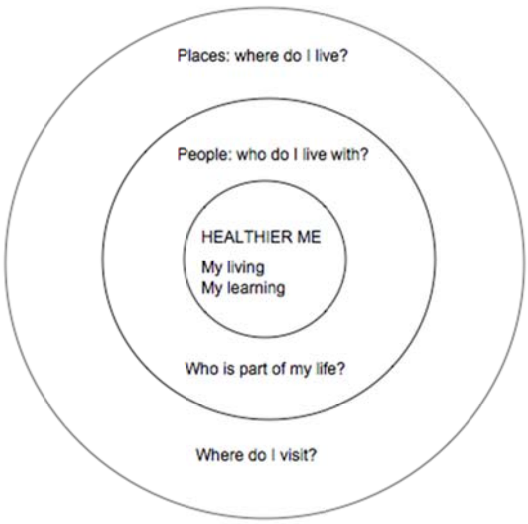

Figure 4.2. An ECEfS adaptation of Bronfenbrenner's ecological approach.

Layer 2: People and places questions

In the next layer of planning, divergent questions are used to identify relevant people and places (Harlan & Rivkin, 2012). Although these questions are adult-posed, we consider that they represent the kinds of questions children might be thinking about silently or as self-talk and so have not shared them with you or other children (see Table 4.1). These questions could be used in many ways with young children; they can be modified and extended with children as well as revisited over time. Overarching questions such as *What is here? What goes there?* can encourage young children to take on a geographer role of mapping places.

Because mapping various places is a form of local sociocultural eco-geography, it can extend children's and educators' views of the surrounding world. The idea of "vernacular" or everyday mapping seems to bring this representational artefact, process and practice (Gerlach, 2014) into a realm where three- to five-year-old children can actively engage in planning, documenting and displaying aspects of *Healthier Me*, especially places. Playing with being a geographer means that as young children ask questions they can map ideas in both two- and three-dimensional forms against the pillars of EfS. Their questioning and mapping can also represent commitments to "caring about" within an *everydayness* framework.

Layer 3: People and place questions with EfS pillars

In this layer of planning, the EfS pillars of environment, economics/politics and society are explored in terms of potential questions. Educators can use divergent questions and specific examples of questions to plan and implement learning experiences, pillar by pillar, or across pillars within the EfS framework (see Figure 4.3).

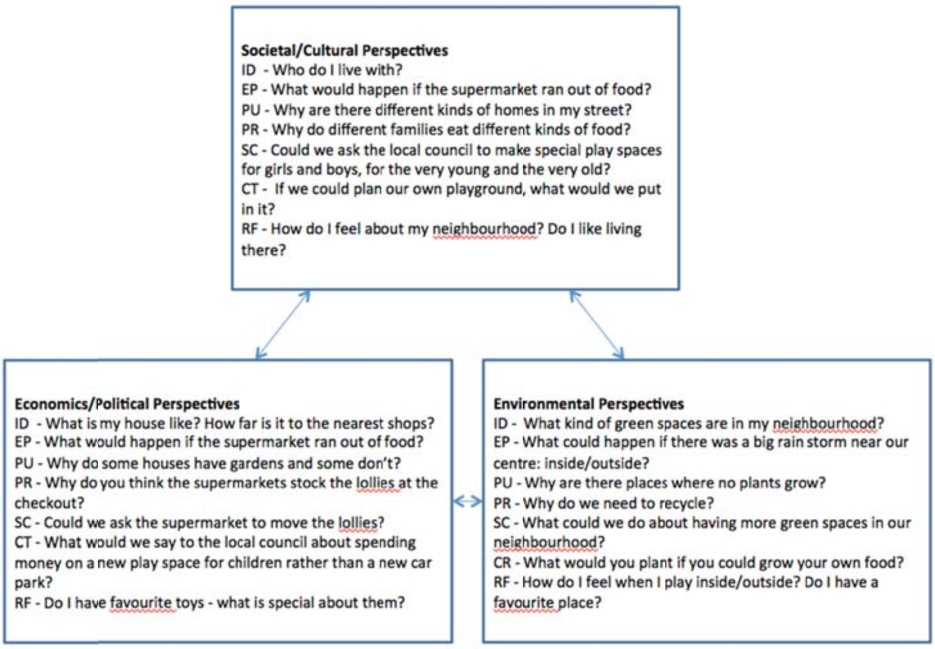

Figure 4.3. Relationships between EfS pillars and Table 4.1.

Table 4.2. ECEfS planning framework from questions to learning.

Planning questions with learning experiences	*Curriculum links*	*Children's developmental domains, learning processes and abilities, including daily routines*
ECEfS ECONOMIC/POLITICAL PERSPECTIVES		
• *What is my house like?*		
Have children carry out a survey of the number of bedrooms per house and create a collective block graph. Ask them to draw or paint their personal bedrooms. Encourage them to create different sized/shaped houses with unit blocks and other natural materials, inside or outside.	Maths, art, architecture, social studies, engineering, physics	Planning, problem solving, questioning, classifying, recording, observing, imagining, using tools, fact learning, manipulating
• *How far is it to the nearest shops?*		
If feasible, walk to the shops and then have children create their own plan or map using personal choice of art materials. Photograph local shops and make a neighbourhood shopping scrapbook for the library corner.	Geography, art, maths, Human society and its environment (HISE), architecture	Physical: walking, hopping, skipping, body balance, observing, classifying, drawing, representing, using tools (camera), imagining, measuring
• *What would happen if the supermarket ran out of food?*		
Help the children undertake a survey of who already has an edible garden at home. Have them note what is grown and eaten rather than purchased. Plan an edible garden for the centre.	Geography, art, maths, science, technology, horticulture, weather and climate, nutrition	Planning, hypothesising, problem solving, digging, planting, arranging, interpersonal and nature caring
• *How could we convince the local council to spend more money on play spaces for children rather than on a car park?*		
Role play: brainstorm and write a letter to the council. Cooperatively design a play space as a large cardboard mural for sharing with parents and community members.	Technology, critical literacies, literacy, creative landscape, maths, government studies	Planning, problem solving, collaborating, advocating, writing and drawing, sketching listening, displaying and explaining, role playing, measuring, comparing, spatial positioning awareness, mapping

Table 4.2 ECEfS planning framework from questions to learning (contd.)

Planning questions with learning experiences	*Curriculum links*	*Children's developmental domains, learning processes and abilities, including daily routines*
ECEfS SOCIETAL/CULTURAL PERSPECTIVES		
• *Who do I live with?*		
Bring together children's picture books reflecting different family types. Have the children discuss, compare and relate to their own experiences. A cultural diversity perspective can be taken here. Create images of family members in 2D and 3D formats	HISE, personal histories, geography, maths, literature, sociology, cultural studies	Discussing, sorting and classifying, speaking and listening, observing, reflecting, making things, constructing, sense of self and others, exploring families, gender and bodies
• *What would we do if the supermarket ran out of food?*		
Set up a role-play/fantasy area with supporting artefacts and materials. Children can create an alternative place to live and find food.	HISE, drama, multiliteracies, design technology, food and nutrition	Cooperating, collaborating, creative thinking, problem solving, researching, fact learning, experimenting with objects, symbolising, arranging, responding to changes/adapting
• *What would we put in our community playground?*		
Use a plan, design, make approach: children can draw, paint or create 3D models with art materials. Alternatively, they can work in the sand tray, small-world area, block area (inside and outside) to create their ideal play space.	Design technology, art, physical education, health education	Creative thinking, problem solving, spatial/sensual awareness, reflecting, gender issues, body image, map making
• *How do I feel about my neighbourhood?*		
Listen to soft music. Ask children to find a comfortable position in which to relax and then visualise themselves and their lives. Children then share ideas quietly with a partner. Have children express their ideas through art media e.g. creating a tone poem with musical instruments.	Music, art, drama, HISE, multiliteracies, science	Creative thinking, expressive thinking, spatial/sensual awareness, reflecting, observing, meditating speaking and listening, emotional: interaction, gender issues, encountering, expressing emotions

Table 4.2 ECEfS planning framework from questions to learning (contd.)

Planning questions with learning experiences	*Curriculum links*	*Children's developmental domains, learning processes and abilities, including daily routines*
ECEfS ENVIRONMENTAL PERSPECTIVES		
• *Why are there places where no plants grow?*		
Set up two large sand trays reflecting different environments, such as a sandy desert and a temperate region. Introduce small-world characters, animals and plants over time, so allowing creation of play spaces that children can use and maintain. Alternatively, extend or begin a vegetable garden in pots or plots; care for it over time. Later, prepare tastes using picto-recipes	Geography (climate, weather), science, HISE, history, food learning, geology	Observing, spatial/sensual awareness, collaborating, sorting, classifying, producing and preparing foods, caring for plants, being concerned for plants, making meaning, being sensitive to natural aesthetics
• *Why do we need to recycle?*		
Make paper by reusing paper from the centre office: children can create a collage with this paper. Make a poster with the children for the kitchen/food recycling area. Engage in junk (family wastes reused) modelling. Identify materials: paper, plastic, metal, wood, glass, food waste. What happens to these when we no longer need them?	Art, science, HISE, design technology, biophysics, chemistry	Creative thinking, problem solving, observing, collaborating, sorting, classifying, pretending, constructing, following directions, practising actions that reflect an environmental ethic, recycling centre waste
• *How do I feel when I play inside or outside?*		
Have children discuss and describe inside and outside spaces and what they can do there. Which parts of their bodies do they use when they actively engage in these spaces? Do they feel different when they are outside and can use their bodies in different ways? Are there times when we shouldn't go or don't want to go outside? Play weather musical compositions e.g. rain dance. Have children sit quietly to observe nature, climate, wildlife and weather go by. How does the passing time influence feelings of pleasure, calmness, etc.?	Physical education, science, health education, music, geography (climate, weather), psychology	Reflecting, observing, spatial/sensual awareness, speaking and listening, emotional: expressing likes and anxieties, using five senses, gender issues, body image, sensitivity to beauty of nature, noticing and respecting nature

Layer 4: Learning experiences across EfS pillars

The final layer of planning consists of a table framed by the pillars of EfS. This table presents possible EfS-related questions with relevant learning experiences. The questions and learning experiences are then linked with curriculum areas and with the many ways children develop, learn and do (refer to Table 4.2). This planning layer therefore enables educators to clearly justify and articulate their early childhood education plans through an EfS lens. Table 4.2 also demonstrates how discrete curriculum areas can be integrated and result in emergent, authentic learning with young children.

The table does not, however, represent comprehensive plans for whole lessons or learning experiences, such as rationales, goals or resources. This is because an authentic plan must be set within the multifaceted context of the educator and the children she or he is working with. One key resource that we suggest is the wealth of children's literature, as this can provide both stimuli and support for children's conceptual learning, particularly—when EfS ideas are focal (Korteweg, Gonzalez, & Guillet, 2010).

Now that we have outlined the layers of this *Healthier Me* sampler, it is over to you, as educator, to consider, refine and add to it before turning it into reality for yourself and the children you work with now and into the future.

EDUCATOR REFLECTIONS INTO EARTH FUTURES

While we support the notion of children as essential agents of change, especially in the context of ECEfS, it is important to remember that it is not the role or responsibility of young children to "save the planet" for everyone else. This kind of expectation of young children would be inappropriate. Rather, the progression of everyday life and explicit interaction with Earth cycles during children's early years and within early education can reflect meaningful learning and change. For example, one popular practice is for children to collect plant food wastes from home or centre meals for a worm farm or composting bins. The immediacy and *everydayness* of such unfolding practices may have longer-term impacts on children's beliefs and actions, while also relating directly with their active and realistic involvement now. Children of this age can be caring local citizens, even though their understandings of implications linked with their current actions will vary from our adult sense of experience. Thus, children form vital habits of mind and affective dispositions that may well be carried with them throughout their lives.

Our intent here is to demonstrate meaningful approaches for children's everyday learning and living across an educational program. As such, emergent events that flow and extend gradually over time from one to another are a major key to children's sensitive learning and living, and this is particularly so if concepts are revisited later as transformations with new questions, new perspectives and different possibilities. This everyday early education practice, couched with rights and responsibilities, is emergent yet intentional. Such practice continues to expand from children's ideas and educators' guidance. In fact, we consider that pedagogical issues surrounding the young are more effectively addressed when educators clearly articulate broader professional principles and their own philosophies. For example, local professional learning events may well do much to extend and strengthen educators' understandings and their team collaborations for children's best interests within ECEfS contexts. Such events could incorporate mentoring, networking and establishing communities of practice.

Finally, we challenge you to consider the many issues in this chapter by reflecting on where you are now professionally. Then, when you have done that, we further challenge you to reconsider and turn to where you want to go with young children and ECEfS so that they and you can work towards new futures for Earth.

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SUSEN SMITH

5. DIFFERENTIATING TEACHING FOR SUSTAINABILITY FOR DIVERSE STUDENT LEARNING

This chapter outlines how differentiated teaching can be used to address diverse student learning when educating for sustainability. A key feature of this chapter is the provision of effective teaching and learning exemplars that offer authentic, differentiated enrichment opportunities for a diverse range of student learning needs within a variety of educational contexts. Specifically, this chapter aims to:

– Define diversity in today's educational contexts;
– Describe communities of empathetic enquiry for education for sustainability (EfS);
– Discuss the dynamic nature of differentiating teaching and learning;
– Present examples of effective differentiated teaching and learning within a variety of educational contexts;
– Provide examples of well-known models of differentiated practice pertaining to EfS themes; and
– Provide some specific, authentic EfS enrichment strategies.

DIVERSITY IN TODAY'S EDUCATIONAL CONTEXTS

The increasing diversity of the student population in primary classrooms has led to greater recognition being paid to the needs of students with varied backgrounds, experiences, ethnicities and capabilities. Diversity in this context includes variety not only in student populations, but also in teaching personnel, pedagogy, curriculum, resources and environments, and the different combinations of these related entities. Current educational policies support the provision of varied student needs within inclusive classrooms, although educational contexts can be as diverse as the curricula, pedagogy and the students themselves (Australian Curriculum and Reporting Authority [ACARA], 2013; Hyde, Carpenter, & Conway, 2013).

While accommodating student diversity in primary classrooms can be difficult, educational provision should always support the development of all students' potential, including nurturing the talents of gifted students, which is in line with thinking and directives in policies. For example, in 1999, Australia's then Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA) prefaced its publication detailing national goals for schooling in the twenty-first century with this statement: "Australia's future depends upon each citizen having the necessary knowledge, understanding, skills and values for a productive and rewarding life in an educated, just and open society. High-quality schooling is essential to this vision" (MCEETYA, 1999, p. 1). Ten years on, the council published updated goals. When taken together, these encapsulated the aims of developing each child's holistic needs, enabling students to become informed, involved, confident,

N. Taylor et al. (eds.), Educating for Sustainability in Primary Schools, 65–85.

creative and successful learners in an environmental context of increased technologies, and beliefs in equity and excellence for all (MCEETYA, 2008). Fortunately, schools and teachers have access to many pedagogical and curriculum models that can be used to help students achieve these aims.

Within the context of EfS, reference to relevant models can help teachers support students as they develop "an understanding of, and concern for, stewardship of the natural environment, and the knowledge and skills to contribute to ecologically sustainable development" (MCEETA, 1999, p. 1). In 1936, John Dewey suggested that children's schooling should have a link with life in the adult world. Teaching strategies focused on real-life learning can be utilised within a differentiated curriculum, a practice that is central to addressing student diversity in many areas of learning, including EfS. A differentiated curriculum and pedagogy provides multiple pathways for learning which accommodates students' different readiness, strengths, interests and needs. Such practice empowers students because it allows them to experience individually appropriate ways to explore concepts as part of their learning process (Maker & Schiever, 2010). Students' uniqueness becomes even more valued when differentiated teaching and learning occurs within communities of empathetic enquiry (Tomlinson & McTighe, 2006).

COMMUNITIES OF EMPATHETIC ENQUIRY FOR EDUCATION FOR SUSTAINABILITY

This section provides a framework for curriculum differentiation from an ecological systems view. The framework incorporates considerations and strategies relating to empathetic teaching and learning.

An ecological systems view

Bronfenbrenner's (2005) ecological systems theory (drawn from understandings of interactions within biological ecological systems) presents cycles of influences on the child's development that move from within the family out to the local community and on to world contexts. This ecological systems view not only emphasises significant interrelationships between child, family, local and global environments, but also recognises that interconnected relationships exist within and across personal, educational and environmental contexts. It is through education that partnerships of social interconnections and learning interactions can occur. Hence, social and learning interconnections between people, supportive structures and resources across educational contexts can provide the foundation of a shared, constructive, collaborative community approach to provide for student diversity. These interrelationships are now referred to as educational ecologies, and empathy needs to be a key factor in developing these interconnections (Cooper, 2011; Sterling, 2011).

Empathetic enquiry in educational ecologies

A mechanistic view of the world can lead to a perspective wherein humans would have power and dominance over the natural environment. Some pedagogical approaches, such as the transmission approach, reinforce this view (see Sterling, 2011 for a critique). In contrast, both Rifkin (2010) and Sterling (2011) promote the need for empathy. The Australian

Curriculum sustainability cross-curricula priority states that "all life forms, including human life, are connected through ecosystems on which they depend for their wellbeing and survival … [and that] sustainable patterns of living rely on the interdependence of healthy social, economic and ecological systems (ACARA, 2013, np). Such statements support an educational, ecological systems framework. In this instance, they also underpin quality relationships among people, communities and/or educational contexts within a holistic world.

With regard to educational ecologies, quality relationships reflect empathetic consideration of the perspectives, ideas, needs, concerns and/or learning preferences of others. This consideration, in turn, helps to promote positive interrelationships and quality student learning outcomes. An empathetic view of education respects interconnected relationships within teaching and learning environments where approaches to shared enquiry can be developed while upholding students' empathetic views of nature and one another (Cooper, 2011; Sterling, 2011).

Teachers can help create empathetic contexts that value student diversity if they are able to work with a differentiated curriculum, use pedagogical practice focused on student strengths, and differentiate their teaching strategies according to individual student learning needs. Such an environment should not only support all students but also challenge them (Smith, 2009). The role of teachers, parents and students as agents for change is crucial to supporting the social transformation needed to promote sustainable actions in the future (Frisk & Larson, 2011; Stuhmcke, 2012). The following case study provides an example of an empathetic teaching and learning community.

CASE STUDY 1: DEVELOPING AN EMPATHETIC TEACHING AND LEARNING COMMUNITY

Robyn is an experienced teacher who teaches a Grade 3 (middle primary) class in a small regional school. There are 28 students in her class, one of whom has disabilities, two who have learning difficulties and two with intellectual gifts. There are also a number of suspected underachievers. Robyn maintains that her class has 29 "teachers" and that the classroom and surrounding environment make up her class's teaching and learning ecology.

A strong advocate of "communities of learning", Robyn reinforces this practice in her pedagogy. She has arranged her class to reflect the interconnected relationships between the students, resources, teacher and support networks. Students sit in groups and are encouraged to provide peer assistance. Tutor and mentor pairings are common, with student learning occurring in a variety of supportive grouping contexts that utilise varying resources. The class is also paired with an older class for whole-class tutoring and mentoring.

Some years ago, Robyn developed a cross-disciplinary integrated unit offering strategies for developing skills across all learning areas. The whole school and local community members were incorporated into this integrated class programme where students worked in collaborative groups to discuss key issues and undertake empathetic dialogue that acknowledged each another's perspectives. Robyn's class also invited other classes to participate in the project. Each of these classes took on responsibility for designing one section of the school grounds. The students drew scale maps of the playground, identified where gardens, trees, bushes, seating, play areas, covered areas and other needs were required. The children then presented their plans to the whole-school community, who voted to determine the most popular one.

The children acquired cuttings from their homes, families and other members of the local community donated trees, and the school (with student and parental participation) set up various stalls to raise funds to purchase additional materials and plants. Community organisations supported different parts of the project, and local retailers provided products at cost price. Each student also nominated family or community members who were interested in assisting with the project. Community members volunteered their expertise and shared their skills with the students through a mentoring program. This project provided Robyn's students with authentic learning opportunities, as it enabled her class to energise the school community to replant the playground that was almost devoid of vegetation at that time. Today, the school is surrounded by fully-grown trees, beautiful gardens, seating in various parts of the school grounds, grassed areas for play, and surroundings that invite students and teachers to undertake activities within nature, outside the classroom. The students, with the support of community members, continue to maintain the playground and outside learning areas.

This case study exemplifies EfS through authentic, shared, constructivist, and empathetic learning. It shows how a whole school community can use EfS to create this type of learning while simultaneously building an empathetic community both within the school and beyond its gates (Eames, Barker, Wilson-Hill & Law, 2009).

DYNAMIC NATURE OF EFS WITHIN AN EMPATHETIC TEACHING AND LEARNING COMMUNITY

As already stated, the differentiated curriculum requires use of effective teaching strategies to engage students in ways that enable their individual learning needs to be addressed. The differentiated curriculum can be viewed and implemented in two distinct ways. First, broad-based differentiated curriculum programmes are interactive, ongoing and inclusive of multiple contexts. They provide relevant learning across many educational environments, embrace the individual, family, community and school, and provide students with cross-institutional and classroom support tailored to their individual needs. Second, within the classroom context alone, differentiation involves teaching in a flexible manner by using various programmes and strategies that cater for students' individual needs, strengths, interests, skills and readiness for learning. Curriculum differentiation involves varying the content taught as well as the learning processes and the products or outcomes of that learning, and ensuring both teaching and learning take place in a variety of learning environments (Tomlinson & McTighe, 2006). The interconnected relationships between these factors position teaching and learning as active, dynamic processes (Smith, 2009). Positive teacher attitudes towards student diversity are an essential underpinning of this type of dynamic differentiated provision, the effectiveness of which is characterized in part by the relationships developed within it.

Another marker of the effectiveness of the differentiated curriculum is teaching and learning that is varied and flexible. Differentiation ranges from simple tasks requiring use of concrete resources to develop foundational understanding, to complex tasks that develop deeper and more abstract understandings (Maker & Schiever, 2010). Under the teacher's guidance, students move flexibly from slower, structured, guided, facilitated learning tasks to faster, open-ended, self-regulated, independent learning tasks.

Furthermore, differentiation promotes quality teaching and learning experiences that are meaningful, built on prior understandings, link with real-world concepts and are essential to promoting future learning. This process is at the heart of social constructivist learning and teaching. In essence, differentiated education is a complex, interactive process that requires teachers who are effective in their ability to use an eclectic mix of quality teaching methods in diverse learning arrangements, with a variety of resources and support techniques in order to facilitate student learning of relevant concepts. Ultimately, curriculum differentiation is a dynamic teaching process, inclusive of ongoing assessment, reflection and feedback. This process forms the foundation for planning strategies that engage students and then solidify their (quality) learning.

MODEL OF DYNAMIC DIFFERENTIATION: A FRAMEWORK FOR PLANNING EFFECTIVE DIFFERENTIATED TEACHING PROCESSES IN VARYING LEARNING ECOLOGIES

Effective curriculum differentiation involves varying assessment methods, content, learning processes, products and outcomes cyclically throughout different educational contexts. As we have seen, focusing on students' *individual needs* is central to differentiating the curriculum and also to the model of dynamic differentiation (MoDD) represented here (Smith, 2009). The model provides phases for planning differentiation and represents differentiation processes in various learning contexts: *the whole class, supported smaller groupings* and *individual or independent*. Teachers and students move dynamically and flexibly between these teaching and learning contexts according to individual student needs, teacher expertise, support structures and available resources.

Figure 5.1 provides a visual representation of the MoDD. In the description and discussion of the model that follows, each of the model's major components is *italicised* so that it can be easily linked back to the model. For more in-depth details of these components than is possible here, see Smith (2009).

Because the individual needs of students—their strengths, interests and learning preferences—are central to determining their readiness for learning, the first phase of the MoDD is *assessing learning*. Teachers can use a variety of assessment techniques during this phase in order to provide a foundation for planning their teaching (Maker & Schiever, 2010).

Once individual student needs have been assessed and profiled, the planning of whole-class curriculum differentiation can begin. This involves organising the classroom's physical environment and determining classroom management processes and programming. The focus of this phase of the MoDD is *enriching learning*. Enrichment within whole-class contexts means challenging students' academic engagement through activities tailored to their individual readiness, strengths, interests, learning preferences and educational needs. Tailoring for diversity can be accomplished through the use of varying strategies, such as asking open-ended questions and providing open-ended tasks, varying the use of vocabulary and slowing or quickening the pace of learning as needed. Examples of whole-class enrichment activities include cognitively challenging tasks, discussions and debate as well as creative, risk-taking activities such as project-based tasks and problem solving.

Sustainability issues and concepts can provide the foundation for extremely rich, relevant, and authentic enrichment activities. Student learning can also be enriched through the use of learning centres, where students choose organised activities, resources and processes that address their various learning preferences. Furthermore, differentiation involves student-centred, constructivist learning strategies and could include philosophical dialogue, access to a wider variety of resources in the classroom, ICT usage, and the provision of as many learning task options as possible to allow for choice.

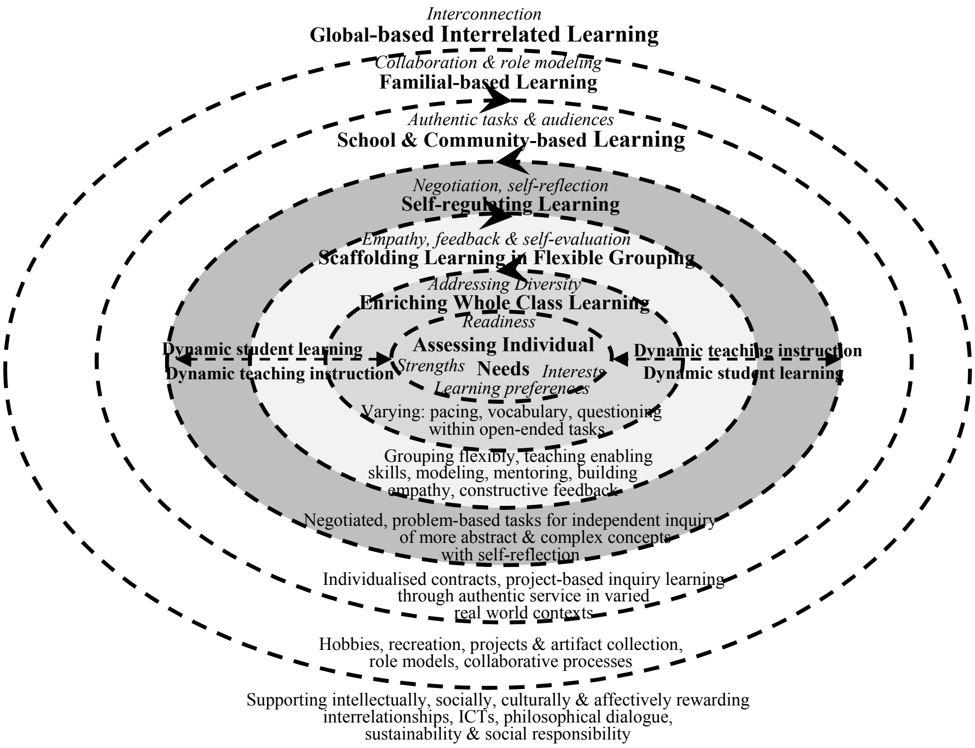

Figure 5.1. Model of dynamic differentiation (MoDD): Overview of some processes for dynamically differentiating pedagogy for diverse student needs within diverse educational ecologies.

Because all students require some form of scaffolding of their learning (in-class support), *scaffolding learning* is the third phase of the differentiated curriculum presented in the MoDD. This phase can build on the whole-class enrichment differentiation strategies. Supportive strategies can be resource-related or involve teaching students enabling techniques for empathy building. Resource-related strategies that scaffold student learning and simultaneously support teachers include tutoring, mentoring, modelling, guided practice, adjusting or modifying presentations and providing visual guides and graphic organisers.

Multimedia, learning objects and other varied material resources, for example, interactive white boards (Roblyer, 2006) can also be brought into the mix.

Building learning communities, varying groupings, modelling strategies, setting learning-group roles, spontaneously implementing practices based on student interests and feedback typically enhance learning outcomes. For example, cooperative learning processes could be used to enhance group projects. Teaching students enabling strategies means developing students' thinking and organisational skills, helping them support their own learning through self-regulation and assisting them to develop empathy for one another's views. The teacher's role in facilitating a differentiated curriculum during this phase of the model is essentially one of using both resource-related and enabling strategies and encouraging students to provide one another with peer assistance within flexible grouping options.

Teaching strategies that encourage students to become *self-regulated learners* further build upon the differentiated whole-class techniques. Some students might need specialised teaching approaches, such as aide-supported learning, individual education plans, curriculum compaction or acceleration. Others might need more independent practice and individualised teaching and learning, which could include self-directed learning, contracts or independent projects. Once students become self-regulated learners, they are on their way to becoming autonomous learners. Furthermore, such learners are likely to be lifelong learners, so what they learn through EfS is likely to translate into an enduring interest in environmental sustainability, as advocated by the Australian Department of the Environment and Heritage (2005).

The MoDD reinforces the dynamic nature of teaching and learning because it provides teachers with the flexibility they need to respond to individual student needs within a whole-class environment. The process also allows for the provision of extra support for a student when needed, with that support typically involving extension, acceleration or specialised learning. The student, in turn, also responds flexibly and dynamically to learning opportunities and contexts in line with his or her learning needs. Some students will spend more time in scaffolded, self-regulated or accelerated learning, while others will learn more within the whole-class or small group context.

In summary, the process depicted in Figure 5.1 supports teachers to conduct needs assessment of the individual students in his or her class and then to use the resultant information as the basis of whole-class teaching, the outcome of which is differentiated learning opportunities for all. Also, differentiation between learning content, processes and products or outcomes permeates each educational learning context in the MoDD cyclically and continuously. The next case study, Case Study 2, provides an EfS-based example of dynamically differentiated teaching and learning.

CASE STUDY 2: DYNAMICALLY DIFFERENTIATING EFS TEACHING AND LEARNING

Zak teaches a multi-grade class in a large regional school, and his students have just begun working on a unit on rainforests. Zak has already *assessed the individual needs* of his students and built a profile of their individual strengths and interests as well as of the whole-class needs. He's been using *whole-class enrichment learning strategies* to extend and individualise learning, and has set up learning centres so students can choose tasks according to their individual learning preferences. Open-ended questions also mean that students can choose their own learning processes and products and respond according to their own interests, learning level and available resources.

Zak also favours *scaffolding learning* through small-group cooperative learning activities. These groups serve as small-group communities of enquiry. When engaged with the unit on rainforests, each small group can choose a topic to investigate that not only relates to the subject, but also ties in with the interests of the group members. The group will then create topic questions and use graphic organisers to develop their project plans. These plans will form the basis of group-based contracts. If needed, some individual students will also plan individual contracts collaboratively with Zak. Some more advanced learners already have individual contracts designed to challenge, extend and further enrich their learning.

Zak has also been teaching his students skills that foster their *self-regulated learning*, and he has organised varied classroom resources so that students can independently access what they will need when working on the rainforest unit. In line with his practice in relation to other teaching content, Zak will provide students with varied learning experiences and environments through different information and communication technologies, the school library and the playground (for paired and grouped tasks) and excursions to out-of-school destinations. He will also call on community members with expertise in the subject matter being studied, who will support the study programme by working with each small group and leading excursions. Students know they can decide on their learning processes and how they will research their projects. Each student also knows he or she will undertake a different role within the group as its members address the questions they've raised. Zak is already encouraging the students to present their group project outcomes to authentic audiences, such as school assemblies, community groups and interested organisations. The unit on rainforests is no exception in this regard.

Zak intends to end the unit of work by asking students to self-evaluate how and what they learned during it. He asks students with individualised contracts to create displays that represent their individual learning processes, products and outcomes. Essentially, throughout the work on rainforests, Zak will be facilitating differentiated learning via exploring a variety of concepts and questions within a variety of content, processes, resources, assessment, products and outcomes across different learning environments.

According to the MoDD, Case Study 2 provides a brief overview of the first four steps in planning and implementing a differentiated programme within a whole-class context. The model can also be applied in other educational contexts, thus extending the learning environments in which a differentiated curriculum for all students can operate, inclusive of students with special needs and giftedness. These contexts, which include the *school community*, the *local community*, *the family,* and even the *global community*, can also serve as support structures or resources for differentiated learning. Various strategies, resources and technologies make it possible for individual students, classrooms and the school to connect and interconnect with these communities (Mulrine, 2007; Smith, 2009). The MoDD also allows for the incorporation of other models of curriculum differentiation that offer frameworks for developing lesson plans, units of work and/or sequences of strategies for student learning within and across educational contexts.

DIFFERENTIATION MODELS FOR EFS FOR STUDENT DIVERSITY

When planning integrated units, lessons or a sequence of EfS tasks, teachers can use any one or more of the many different curriculum differentiation models available to assist them. For example, Maker's model of curriculum differentiation (Maker & Schiever, 2010) is based on a broad conception of differentiation focused on allowing students to choose from among open-ended tasks that address relevant issues, emphasises conceptual learning and aims to develop higher order thinking and inductive reasoning. Freedom to choose tasks suited to interest and ability empowers students as co-teachers and co-learners because it allows them to self-regulate their learning. The key feature of Maker's model is its interlocking components of content, processes and products/outcomes, each of which can be modified to suit a variety of educational contexts. Figure 5.2 highlights the relevant teaching and learning strategies within each of these four key components.

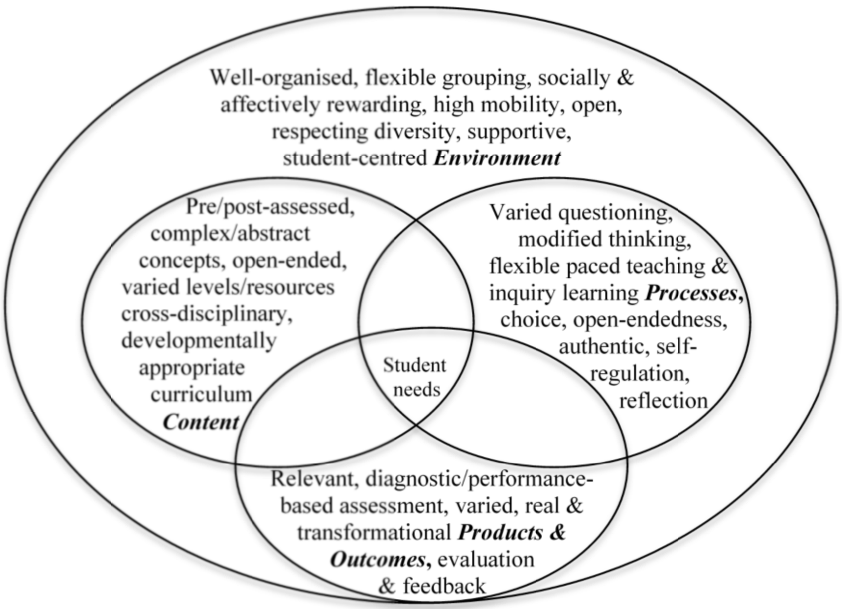

Figure 5.2. Adaptation of Maker's model (Maker & Schiever, 2010) showing the four key components of curriculum differentiation: content, processes, products and environments.

Maker's model helps teachers plan differentiated activities. As with the MoDD, the first step in Maker's model requires teachers to assess individual student needs and then determine differentiated content, processes and products or outcomes that will enrich the learning of the *whole class*, inclusive of students with learning difficulties or other special needs. In this respect, Maker's model also aligns with Phase 2, *enriching learning*, of the MoDD. The next step is to plan activities that *most* students in the class can undertake, with scaffolding as needed (MoDD Phase 3—*scaffolding learning*). The final step in the organisational process is planning tasks that only *some* students can complete. These tasks are intended mainly for advanced learners with more self-regulated learning skills and thus link into MoDD Phase 4—*self-regulated learning*. Table 5.1 provides an example of planning differentiated EfS tasks according to Maker's model. This example could be the basis of a whole unit of work or a series of sequenced lessons on the chosen EfS topic.

Table 5.1. Planning differentiated EfS activities according to Maker's model.

Theme: Environmental sustainability
Learning areas: Geography, Science, Technology, English, Mathematics, Health and Physical Education
Grade: Years 4 to 6, *Term:* 1
Outcomes: Locally relevant learning outcomes can be built into this table of content and learning activities

Where? **Environment**	**What?** **Content**	**How?** **Processes**	**Outcome** **Product**	**Assessment and resources**
Enriching learning: Classroom: *whole-class* discussion to define sustainability. *Small groups* explore different areas of the school to assess their sustainability.	Debate why the school should have a sustainability programme and what practices and values it should entail. Students use *different levels of resources* to identify practices and values for which they can be responsible.	In small groups, all students *examine school areas* and develop action plans detailing how to improve or maintain the areas sustainably. Teachers and students reflect on practices and beliefs.	Students choose action plan tasks and apply them with *community support*, e.g. re-vegetate a garden, recycle, do a cost audit of energy use	All students use *evaluation sheets* to record their views and beliefs. Observe and compare students' *actions* with their recorded belief systems. *Community support.*
Scaffolding learning: *Individuals, pairs or small groups* allow peer support and enable access to their required resources to prepare for learning activities.	All students *reflect* on what they currently know about sustainable practices and create a mind-map of the content.	Use Williams' matrix to plan whole-class learning activities. For example, one task could be to design and explain posters that *reflect personal views* and attitudes on sustainability.	Older *mentors* enable sharing and evaluating of one another's posters and outcomes. *Display posters around the school* and respond to others' enquiries.	*Community mentors and support processes and resources to support all students.*

Table 5.1. Planning differentiated EfS activities according to Maker's model (contd.)

Where?	**What?**	**How?**	**Outcome**	**Assessment and resources**
Environment	**Content**	**Processes**	**Product**	
Enriching learning: *Classroom/ library:* Create a group evaluation of the action plans and use these as a basis for further activities and exploration of values associated with action.	Most students *explore the relationship* between actions and values involved in creating an eco-friendly school.	Use de Bono's thinking hats to *develop questions* forming the basis of an analysis of beliefs and actions on sustainability. Students respond *according to their own learning preference*, e.g., textually, orally, musically, mathematically.	Most students perform a play, mime or role-play showing many of the actions, values and attitudes portrayed with regard to sustainable practices in the *class,* school and local community.	Each student keeps a *self-reflection* journal throughout the term. Use checklists to *assess* how students relate their values and actions and how they present these.
Self-regulated learning: *Classroom/ library/play-ground/ community: Individually or in a small group,* students *independently* record on concept maps their ideas as to what sustainability is and what they can do about it.	Some students explore why the school's sustainability process is in place and what it presently encompasses. Students *choose* further content/concepts needing investigation.	Some students in *small groups* organise an ecological survey of the school to determine sustainable practices and actions required. They also *individually choose* a sustainability issue and research how it affects the school. Have them interview key community personnel.	Some students classify and graph concepts and data collected in the *ecological audit/survey*. They then reflect on the results and how they add to the action plans. Have them also present an Information report on an *issue that they choose* to the wider school community	Collect student data, analysis and recording processes. Examine the links the students make between the data collected, concepts, actions and expressed attitudes. Interview data, information reports and presentations, and *students' self-evaluations*.

Note: The *italicised* words reflect some key components of the MoDD.

Differentiation models that are hierarchical in nature or have varying components aid the planning of learning activities suitable for addressing student diversity. Some of the models chosen could include smaller differentiation frameworks, such as Kaplan's (1986) grid (also known as the depth and complexity curriculum model) and Williams' (1993) cognitive-affective interaction matrix, or larger frameworks, such as Betts' Autonomous Learner (2004) model, Smith's (2009) MoDD and McCluskey, Treffinger and Baker's (2002) amphitheatre model.

Some frameworks include the affective component needed for the development of empathy. Examples include de Bono's (1985) thinking hats and Williams' (1993) matrix model. Williams' model provides guidance on implementing differentiated learning content, processes and outcomes. It offers 18 diverse teaching strategies that promote the critical and creative thinking so necessary for students to negotiate the complexity and uncertainty of many sustainability issues. It also aids pre- and post-assessment of and support for students' socio-affective needs. This model also favours highly dynamic teaching and learning because the strategies provide challenge as well as flexible socio-affective interactions between students and teachers. The cognitive dimension includes elements such as fluency, flexibility, originality and elaboration, while the affective dimension encompasses risk-taking, complexity, curiosity and imagination. Tasks can be planned to incorporate some or all of these elements.

Table 5.2 can be used as a basis for enriching student learning, as an individual or whole-class contract and/or for project-based learning. It can be applied in a variety of the educational contexts within the MoDD (e.g., for *enriching learning* or for *self-regulating learning*).

Using taxonomies and matrices for planning differentiation

A feature of the MoDD planning process is to integrate models into matrices, known as the 'mind matrices' as they address cognitive aspects of learning. Combining models and taxonomies together in matrices can provide even greater opportunity to plan differentiated teaching for supporting diverse student needs (Noble, 2004). For example, combining Gardner's (1983) multiple intelligences and Bloom's revised taxonomy (Anderson & Krathwohl, 2001) provides more opportunity for depth and breadth of learning. These matrices can be used to differentiate according to cognitive questioning and are also useful when differentiating activities for varied thinking capacities (Noble, 2004). Maker and Schiever's (2010) DISCOVER matrix is another model that integrates multiple intelligences with teaching problem solving at different levels of complexity.

Combining frameworks to plan differentiated learning activities can also address the individual learning preferences and interests of all students, while simultaneously meeting both cognitive and affective needs. For example, Table 5.3 shows a matrix of EfS questions and learning tasks combining Bloom's revised taxonomy and Edward de Bono's thinking hats which can provide a more holistic approach to teaching EfS for diverse student learning.

Table 5.2 Planning differentiated EfS activities using Williams' matrix.

Theme: Empathy and sustainability
Learning areas: Geography, Science, Technology, English, Health and Physical Education
Grade: Upper primary, *Term:* 2
Outcomes: Locally relevant learning outcomes can be built into this table

Description of strategies	**Examples of learning activities or questions for inquiry learning**
PARADOX: Statements or propositions that seem to be self-contradictory but may express a truth.	The increase in social media has decreased the quality of personal interactions needed to sustain more empathetic relationships. In a small group, debate this notion.
ATTRIBUTE LISTING: Identify inherent properties that must be open ended.	Rank the principles of sustainable living. How could these principles make a difference in your life?
ANALOGY: Find similarities between things or situations that may in other ways be different.	Create an analogy comparing an aspect of nature with an aspect of humanity, e.g., "Rainforests are the lungs of the world." Then explore how you could use this analogy in an advertising campaign for education for sustainability.
DISCREPANCY: Explore missing links in knowledge and understandings.	How can family units contribute to future sustainability practices? Explore gaps between how your family lives now & how you could implement more sustainable & empathetic practices in your family.
PROVOCATIVE QUESTION: Use inquiry to motivate curiosity/imagination.	How have innovative technologies contributed to a more environmentally sustainable presence or sustainable future?
CHANGE EXAMPLES: Show the dynamics of things. Make modifications, alterations and substitutions.	Evaluate how society's attitudes have changed towards sustainability. Create a concept map showing the relationships between key concepts needed to form a more sustainable future.
HABIT EXAMPLES: Examine habits to build sensitivity to new ways of thinking.	Explore new ways to overcome old habits regarding shopping, wastage, recycling and reusing. How can your solutions support those less fortunate than yourself?
ORGANISED RANDOM SEARCH: Undertake a structured case study for a new course of action.	How can technologies promote more empathetic relationships? Design new ways to conserve and use natural energy sources, feed the poor, live more simply, communicate socially and relate empathetically.

Table 5.2 Planning differentiated EfS activities using Williams' matrix (contd.)

Description of strategies	**Examples of learning activities or questions for inquiry learning**
SEARCH SKILLS: Use research skills to explore prior practices, then trial and error new ways.	How many ways did you use sustainable practices over the weekend? Which did you use most? Which would be best to use in the future? Explore the internet for websites promoting more environmentally/ politically/socially sustainable practices. Create a database of these.
TOLERANCE FOR AMBIGUITY: Use open-ended questions or situations for investigation.	What would be the impact on society if people could no longer access fresh water from a tap, or use electricity or access the internet or use cars, unless they were battery operated?
INTUITIVE EXPRESSION: Use senses, imagery, role-play and creative expression to convey emotion.	How would you feel on hearing a world heritage site had been destroyed? Imagine you've been sent to a destroyed Amazon rainforest. Express your feelings in a way of your choice (e.g., poetry, painting, dance, music, mime, drama or other media).
ADJUSTMENT TO DEVELOPMENT: Identify and compare prior learning, errors and examples.	How have indigenous peoples contributed to sustainable environments? Investigate situations in history where Indigenous Australians or Māori and their environments have been influenced negatively or positively by European resettlement/invasion.
STUDYING THE CREATIVE PROCESS: Analyse the characteristics of creative people, processes and products.	What are the characteristics and practices of people who advocate for a more sustainable future in the world today? Develop an action plan for sustainable practice based on what these advocates say and do.
EVALUATING SITUATIONS: Use a variety of ideas or actions to analyse implications and consequences.	Compare two forms of sustainable practices in your school. Create a Venn diagram describing the similarities/differences between these practices. Which practice is the most effective?
CREATIVE READING SKILLS: Create new ideas through reading.	Read about improving your sustainable living practices. How could you apply this advice in your class, school, community?
CREATIVE LISTENING SKILLS: Create new ideas through listening	How has sustainable practice evolved over the last century? Interview members of two or three family generations. Listen for how they used sustainable living practices in the past and now use them in the present. Timeline the changes.
VISUALISATION: Visually present ideas in non-traditional ways (e.g., artistically, three dimensionally).	What is a sustainable ecosystem? Design a diorama displaying a sustainable ecosystem or a poster, webpage or media item advertising a newly created sustainable ecosystem.

AUTHENTIC EFS ENRICHMENT STRATEGIES

Because authentic EfS teaching has real-world relevance, learning activities involve real-world problems, issues, concepts and solutions. Authentic EfS learning lets students undertake complex activities collaboratively, make choices, undertake tasks from different perspectives using a variety of resources, and empathetically dialogue and engage with others within various contexts. Authentic EfS tasks focus on processes and on content and conceptual learning. Moreover, multiple investigations or solutions allow for integration of varied assessment tasks within processes and result in quality learning outcomes evident in diverse products.

Learning connected to community-based projects not only provides a service to the community but also gives students opportunities for active problem-solving in real-life learning within authentic contexts. Community-based projects help them develop self-regulated learning that aids achievement of relevant, meaningful EfS outcomes. Authentic tasks can be used to enrich student learning and applied across several LAs or disciplines. The many enrichment strategies available can be used within whole-class, small-group or independent contexts and to differentiate EfS teaching and learning, as emphasised in the MoDD descriptions above. The subsection below provides more detailed consideration of self-regulated learning, project-based learning and contracted tasks.

Self-regulated learning with project-based learning and contracted tasks

We should never assume that students "know" how to be autonomous or independent learners. Independent learning strategies should be taught to students and can be practised within various grouping contexts. Students should be encouraged to assist each other throughout learning activities and taught how to support their peers within varying learning contexts. These approaches support both the students and the teacher. As students develop greater resiliency, self-confidence and the capacity to plan their own goals, they will become more independent self-regulated learners, thus facilitating even more learning.

Examples of independent learning approaches include self-directed learning, cooperative learning, reciprocal teaching, project-based learning and contracted tasks. Self-directed learning could involve the use of ICT programs, learning centre tasks, development of individual contracts with set goals and the use of ready-made educational kits that enable students to follow directions and complete learning processes for individualised outcomes.

Cooperative learning empowers students by teaching them specific roles within varying group structures so reinforcing responsibility for their own learning. Each group can plan their projects or devise a contract that provides the goals each member of the group will work towards. These goals can also be used in assessment rubrics so students know exactly what they are working towards. This provides the opportunity for students to self-assess their own learning outcomes or peer-assess throughout the task or at the conclusion of the tasks.

Reciprocal teaching is a student-centred, opened-ended, socially collaborative learning process within small groups, where students assist each other's learning of content, concepts and processes. Each team member takes turns to be the leader and guide the group through questioning, clarifying, summarising and predicting. Reciprocal teaching is usually used in

Table 5.3. A MoDD mind matrix combining de Bono's thinking hats and Bloom's revised taxonomy.

	Red Hat Immediate/ Instinctive feelings	**White Hat** Facts/ details	**Yellow Hat** Positive aspects	**Black Hat** Negative aspects	**Green Hat** Imagination/ Lateral thinking	**Blue Hat** Organisation/ Reflection
Creating			How have innovative technologies contributed to sustainable practices? Write a recount of your creation of new technologies to support more sustainable living.		Read about improving your sustainable living practices. How could this advice be applied in your class, school or community?	Develop an action plan for sustainable practice based on practices of famous advocates for sustainability.
Evaluating	Evaluate how society's attitudes towards sustainability have changed. Use a concept map to show relationships between key concepts needed for a more sustainable future.		Explore the relationships between actions, key concepts and values involved in creating an eco-friendly school.		What would be the impact on society if people could no longer access fresh water from a tap, or use electricity or access the internet or use cars, unless they were battery operated?	Explore the gaps between how your family lives now and how you could implement more sustainable and empathetic practices within your family.
Analysing	How would you express your feelings when hearing about the destruction of a world heritage site?	Create a Venn diagram describing the similarities and differences between two forms of sustainable practices used in your school.	How have indigenous peoples contributed to sustainable environments?	Investigate situations in history where indigenous people or environments were influenced by resettlement or war.	Create an analogy comparing an aspect of nature with an aspect of humanity. Then explore how you could use this analogy in an advertising campaign.	Keep a self-reflection journal over a term, analysing your perspectives of the processes of implementation of sustainable practices in the school.

	Red Hat Immediate/ Instinctive feelings	**White Hat** Facts/ details	**Yellow Hat** Positive aspects	**Black Hat** Negative aspects	**Green Hat** Imagination/ Lateral thinking	**Blue Hat** Organisation/ Reflection
Applying	The increase in social media has decreased the quality of personal interactions needed to sustain more empathetic relationships. In a small group debate and dialogue.	In what ways have innovative technologies contributed to a more environmentally sustainable presence and how can they form the foundation of a sustainable future?	Explore new ways to overcome old habits regarding shopping, wastage, recycling and reusing. How can your solutions support those less fortunate than yourself?			Explore the internet for websites that promote more environmentally politically and socially sustainable practices and create a data base of these. How could you use the websites for EfS?
Understanding	Debate why the school should have a sustainability program and what practices, concepts and values it should entail.	In a small group organise an ecological audit of the school to determine sustainable practices and actions required.	Rank the principles of sustainable living. How could these principles make a difference in your life?			
Remembering	Whole-class discussion to define sustainability.	Find out how many ways students in your class used sustainable practices on the weekend.	What is a sustainable ecosystem? Design a diorama displaying a sustainable ecosystem.		Create a poster, webpage or media article advertising a newly created sustainable ecosystem.	

Note: The model depicted in this table also uses the questions and strategies from Maker's model and Williams' examples cited earlier in this chapter. These questions and strategies help display the links between the frameworks. Try creating questions likely to prompt learning or learning tasks for the remaining sections in the matrix.

reading instruction but can be extended to other learning areas. This scaffolding approach has been found to be successful in supporting students' understanding of content, for note-taking and for assisting students to internalise comprehension processes (Cooper & Greive, 2009).

Project-based learning (PBL), also synonymous with problem-based learning or inquiry-based learning, is a differentiation strategy that empowers students to work at their own level on interdisciplinary topics of considerable interest and importance. Because PBL provides challenging and authentic learning processes and contexts, it facilitates relevant learning outcomes for individual students. Students can work individually or as co-learners in pairs, small groups or as a whole class. The teacher acts as a facilitator by helping students plan their respective projects, determine resources they'll need and identify possible outcomes. Students can identify a topic or issue of concern and plan how to address that issue and reach a resolution. The PBL approach is evident in all three case studies presented in this chapter.

Any of the aforementioned differentiation models, taxonomies or matrices can be used as group-based or individual learning contracts. These contracts can be planned with individual students or with small groups or with a whole class. Contracts empower students to plan their own learning content, processes, products and contexts and so promote student engagement (Smith, 2009). Contracted tasks provide the opportunity to engage with the whole school or the community, as exampled by Case Study 3. All three case studies provide examples of dynamically differentiating EfS teaching with students as co-learners using contracts and projects with the aid of school and community support.

CASE STUDY 3: DYNAMICALLY DIFFERENTIATING EFS TEACHING THROUGH PROJECT-BASED LEARNING AND COMMUNITY PROGRAMS

The "Education for Eco-Engagement" teacher professional learning programme enables educators and community members to practise strategies related to differentiating the curriculum for diverse student needs, identify strategies for managing groups effectively and support small community-group projects. The aim of this professional learning programme is to provide the foundations that enable teachers and mentors to facilitate the learning of small groups of interested students or gifted students as they work to identify sustainability issues pertinent to their school and local environment, and to complete a contract or project on their identified issue or issues using a variety of processes.

Follow-up sessions with teachers support the ongoing process of project development and implementation, while the contract ensures responsibility for the project. Community members become mentors of group projects. A forum for sharing the outcomes of projects, such as a competition or a festival, is used to round out the programme, and this is followed with the development of an action plan designed to sustain practices. This programme can be linked with other community programmes such as:

- The Sustainable Living Challenge;
- The Children's Groundwater Festival;
- Science Week;
- Enviro Week;
- Earth Day and other expos;

- Biology, Earth and Environmental Science (BEES) Day;
- Enviro Inspiro;
- Treefest;
- School Sustainability summits;
- Cool Australia Green teams;
- Tournament of Minds;
- Future Problem Solving;
- Mindquest;
- The YouTH Leading Australia programme; and
- The Frog Dreaming Sustainability Conference.

The last of these programmes, Frog Dreaming, is an award-winning Australian programme supported by grants from local organisations. The conference includes Grades 5/6 (upper primary) students and teachers from a range of regional schools. The thinking behind the programme is that people must feel a connection to the land if they are to develop empathy and an interest in preserving it for future generations.

The aim of the conference is to provide an opportunity for young people to take an active role in developing a comprehensive understanding of Indigenous Australian culture, local environmental issues and a spiritual connection with the land. Students are provided with a unique learning experience that requires them to use interactive and highly creative activities, in the company of a variety of educational facilitators and like-minded peers from the wider community. Objectives for participating students are for them to accomplish the following:

- Deepen their level of understanding of Indigenous Australian culture and current environmental and sustainability issues;
- Empower them, especially in terms of demonstrating resilience when faced with environmental problems;
- Form networks/partnerships and make connections with peers and relevant organisations/professionals/individuals from the community; and
- Develop real solutions to environmental problems.

When preparing for the conference, schools work (for two terms) on cross-curricular sustainability projects that have a local focus and that they choose. At the conference, students present a performance of their findings through a variety of media, including drama, art, music, video, PowerPoint, and the like. Early in the event, students are assigned to tribes, each of which chooses a totem from threatened species or important landscapes. The tribe then creates a performance on their totem of their own devising. Although each tribe has older student mentors and adult "experts" from Landcare or National Parks and Wildlife Services (NPWS) as support, they control the process.

The mentors' responsibilities include sharing with all members of the tribe the stories and information relating to the totem animal. The tribe as a collective then work with the head of the tribe to develop a performance to tell the story of the totem (and its importance in the health of the landscape) to the other tribes. The performance involves a dance, music, costumes, body markings, artwork and a story. The performance takes place in the evening, with the rest of the tribes coming together in a corroboree for a night of celebration. During the second day of the conference, NPWS rangers, Landcare employees, members of the local Indigenous community and other members of the public present a number of workshop activities. All workshops are interactive and unique in design in order to fully engage each participant. The role of teachers is essentially to facilitate students' projects.

Frog Dreaming is a highly successful programme that creates high levels of interest among the children and empathetic actions. As one child commented, "Frog Dreaming was so much fun and I learnt about so many things. Last year, I came back as a mentor to help one of the groups learn about and do a performance about koalas" (New South Wales Landcare Gateway, 2012). The links that the programme develops between the students, educators (i.e., the mentors and leaders), the community, families and Australia's traditional heritage are very strong. These empathetic processes nurture the success of the programme, while feedback to school communities ensures ongoing interest in the programme and the sustainability of its processes and student learning outcomes.

REFLECTING ON EDUCATION FOR SUSTAINABILITY

Opportunities to reflect on EfS can provide the basis for enhancing teachers' planning for differentiated teaching and learning. Developing communities of practice also provides additional supporting contexts for teachers to share their concerns and reflect upon and reiterate their best practices for student diversity (Effeney & Davis, 2013; Wesley & Brusse, 2001). Questions that could be used to begin this process of reflection include the following examples:

– Why differentiate teaching and learning in education for sustainability (EfS)?
– How can you create a community of enquiry to differentiate the curriculum for EfS?
– How can you engage diverse student learning through differentiating EfS?
– How is differentiation for student diversity in inclusive educational ecosystems a dynamic approach to EfS?
– What structures are needed to support the differentiation of EfS in your educational context?
– What differentiation models or frameworks could be useful in EfS?
– What specific differentiation strategies would support EfS in your educational context?

CONCLUSION

This chapter outlined how differentiated curriculum and pedagogy can be used to address diverse student learning when educating for sustainability in primary school classes. It defined diversity in today's educational contexts and discussed the dynamic nature of differentiating teaching and learning. Various concepts that describe communities of empathetic enquiry for EfS were also outlined, and practical case studies were provided.

Additionally, the chapter presented well-known and emerging models of effective differentiated teaching and learning for EfS that use authentic enrichment strategies. These strategies are underpinned by the premise that a curriculum differentiation model should be based on a student's diverse needs, for example, readiness to learn, strengths, interests and learning preferences, and should involve diverse contexts that will challenge as well as support all students. Because the process of effective teaching and learning is varied and flexible, curriculum differentiation ultimately becomes a dynamic teaching process. This is inclusive of ongoing assessment as a basis for planning strategies that engage students and produce quality-learning outcomes within teacher-, student- and/or ecologically-mediated (or resource-based) educational contexts.

The chapter also provided practical examples of selected frameworks for planning differentiated teaching for different students' learning needs using authentic EfS enrichment strategies. The final section emphasised the need to reflect on and share best EfS practice.

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SOME USEFUL WEBSITES

Australian Sustainable Schools Initiative (AuSSI): http://www.environment.gov.au/topics/sustainable-communities/sustainability-education/aussi

Australian Sustainable Schools Initiative (AuSSI) fact sheet: http://www.environment.gov.au/system/files/ resources/e6b1349c-d6ca-4771-9fd3-f0246eacf6ef/ files/aussifactsheet.pdf

Australia's World Heritage Places Education Program: http://www.environment.gov.au/topics/heritage/education

Austega Information Services and Gifted Resource Centre: Overview of research into the curriculum differentiation educational strategy: http://www.austega.com/gifted/16-gifted/articles/37-curriculum-differentiation.html

Cool Australia curriculum materials: http://coolaustralia.org/curriculum-materials/#body-wrapper

Differentiating instruction … one size doesn't fit all: Effective strategies to improve student performance: http:// www.learnerslink.com/differentiating-instruction/

Differentiated instruction in online environments: Learning styles and multiple intelligences: http://www.slideshare.net/jkchapman/differentiated-instruction-in-online-environments

Education for sustainability: http://www.educationforsustainability.com.au/resources/useful-websites

Educational resources: http://www.environment.gov.au/topics/sustainable-communities/sustainability-education/aussi/educational-resources

Frog Dreaming: http://www.snelandcare.org.au/linkedfiles/2013FrogDreamingcasestudy.pdf

Learn, teach and collaborate using digital resources to support the Australian curriculum http://www.scootle.edu.au/ec/p/home
New South Wales Department of Education and Training Curriculum Support: Differentiating the curriculum: http://www. curriculumsupport.education.nsw.gov.au/policies/gats/programs/differentiate/
Sustainability education: http://www.environment.gov.au/topics/sustainable-communities/sustainability-education
Sustainable living challenge: http://www.sustainableliving.com.au/
UNESCO: Changing teaching practices using curriculum differentiation to respond to students' diversity: http://unesdoc.unesco.org/images/0013/001365/136583e.pdf

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LEARNING AREAS

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6. EDUCATION FOR SUSTAINABILITY IN PRIMARY SCIENCE EDUCATION

Science education has an important role in education for sustainability (EfS). While the so-called "four pillars" of environmental, economic, social and political factors underpin EfS, scientific literacy is essential in terms of understanding many sustainability issues and their possible solutions, particularly in relation to the environment. Scientific literacy has been defined as "the knowledge and understanding of scientific concepts and processes required for personal decision-making, participation in civic and cultural affairs, and economic productivity" (National Academy of Sciences, 1996), all of which are important with respect to addressing sustainability issues. More recently, the Australian Curriculum (Science) (Australian Assessment, Curriculum and Reporting Authority [ACARA], 2014) included the explicitly espoused aim for students to develop "an ability to solve problems and make informed, evidence-based decisions about current and future applications of science while taking into account ethical and social implications of decisions". How we approach science and how we apply science through technology has significant beneficial as well as harmful implications for our world, and it is this consideration that has particular relevance to educating for a sustainable future.

Sustainability, as discussed in Chapter 1, is concerned with the idea that current and future human activity and wellbeing are intrinsically linked to the quality of the environments in which we live. Science promotes understandings about sustainability-related issues and how human activity contributes to them, as well as providing an imperative for remedial action, given that an unsustainable future is, by definition, disastrous. Science education, therefore, can contribute significantly to informed action for sustainability by connecting cognitive and affective domains, thus linking understandings of the physical world with attitudes and values in the social world, a process that can facilitate motivation to take informed action. Of course, knowledge does not always lead to action, as people are often contradictory in what they believe, say and do (see Kollmuss & Agyeman, 2002, for a discussion of the "knowledge–action gap" in EfS). However, given that understanding problems of this kind is a prerequisite for informed action, educators need to prepare students for lifelong informed and ethical decision-making by providing science education underpinned by EfS principles and practices.

We begin this chapter by offering an overview of science and EfS in the Australian and New Zealand curricula. We then explore attitudes towards science, and approaches to science learning and teaching as relevant to EfS. This content is accompanied by examples of engaging classroom experiences, and it places particular emphasis on the "living world". Our intent is not to provide a set of recipes but to inform educators' thinking about links between

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science and EfS and to encourage further investigation as relevant to particular learning and teaching contexts.

SCIENCE AND EFS IN AUSTRALIAN AND NEW ZEALAND CURRICULA

Table 6.1 summarises New Zealand's and Australia's national primary-school science curriculums (Australian Assessment, Curriculum and Reporting Authority [ACARA], 2014; New Zealand Ministry of Education, 2014), which, despite some minor differences in organisation and terminology, are strikingly similar. The "strands" of each curriculum are indicated in the figure by asterisks, while the sub-strands are bulleted and greyed to aid interpretation. In the general domain of *knowledge and understanding*, both curriculums contain the four focuses of biological, chemical, physical, and Earth and space sciences. These are signified in the Australian Curriculum by the strand "science understanding", and they form the four strands of the New Zealand Curriculum. In relation to processes and skills, the Australian Curriculum has two strands—"science as a human endeavour" and "science inquiry skills", the content of which is conceptually similar to the single New Zealand-equivalent strand of "nature of science". One interesting slight difference between the two curriculums is the New Zealand achievement objective of "participating and contributing". Although similar in many respects to the Australian "use and influence of science", it contains a more explicit action orientation: for example, "make decisions about possible actions" (Level 3, New Zealand) as opposed to "understand the effect of their actions" (Year 1, Australia).

At a more detailed level across the two curriculums, the key concepts and skills deemed important in primary science are very similar. In the knowledge domain, these concepts include the following:

- evolution, diversity, interdependence and survival of living things (*biological sciences*);
- energy—types, transfer and transformations (*physical sciences*);
- properties of substances and changes of state and reversible and irreversible changes to substances (*chemical sciences*); and
- Earth as part of the solar system and changes to Earth from natural processes and human impact (*Earth and space sciences*).

What is conspicuously absent from the primary science curriculums in both countries is explicit reference to climate change, which is noteworthy given the magnitude of the issue, its widespread coverage in media that children are likely to encounter, and the science that is needed to understand and articulate its causes and effects. That said, the complex, abstract and multi-disciplinary nature of climate science can make it difficult for teachers and children to develop an accurate and sophisticated understanding of the interlinked scientific phenomena that have led to the problems we are now experiencing. For teachers, dealing with climate change in primary classrooms tends to be a delicate exercise in professional judgement.

Because this topic can be a very frightening one for children, we suggest that this judgement should focus on emphasising the actions children can take and should avoid catastrophising what we nevertheless acknowledge is a dire problem. Certainly, there is scope in the curriculums to teach about climate change under outcomes such as "Scientific knowledge is used to inform personal and community decisions" (ACSHE217) and

"Energy from a variety of sources can be used to generate electricity" (ACSSU219) in the Australian Curriculum, and at Levels 3 and 4 in the "Planet Earth and beyond" strand of the New Zealand Curriculum: "Investigate the water cycle and its effects on climate, landforms and life".

Table 6.1. Summary of national science curricula in New Zealand and Australia.

Domain	*Australia*	*New Zealand*
Knowledge and understanding	Science understanding*	
	• Biological sciences • Physical sciences • Earth & space sciences • Chemical sciences	Living world* Physical world* Planet Earth and beyond* Material world*
Processes and skills	Science inquiry skills*	Nature of science*
	• Questioning and predicting • Planning and conducting • Processing and analysing data and information • Evaluating • Communicating	• Investigating in science • Communicating in science
	Science as human endeavour*	
	• Use and influence of science	• Participating and contributing
	• Nature and development of science	• Understanding about science

ATTITUDES TOWARDS SCIENCE AND LINKS TO EFS

In an earlier era, science was considered value free; it was about truth or certainties and the dogmatic application of scientific methods to investigate parts of systems rather than whole systems. While some people still hold these views, the more contemporary model of science incorporates values, ethics, critical questioning, creativity, probabilities, collaborative approaches and a focus on whole systems rather than just parts. It is this latter model that offers direct links to the principles and practices of EfS. The following points highlight some of these links.

Unfortunately, many adults hold negative attitudes towards science, with these attitudes developed when they were students. Research shows that students, past and present, often experience school science as difficult, boring and insufficiently relevant to the real world (Goodrum, Rennie, & Hackling, 2001; Lyons & Quinn, 2010), partly on account of a transmissive, theory-focused pedagogy that provides insufficient hands-on work (Tytler, 2007). We also need to recognise that because some applications of science and technology have contributed to unsustainable practices, with unforeseen or unsustainable consequences of some innovations, many people blame the science for these problems rather than its inappropriate application. It is therefore important to facilitate students' critique of these problems as part of promoting positive attitudes towards science and also EfS. Facilitating such attitudes with respect to the potential explanatory power of science to investigate and inform ways of living more sustainably is essential.

Science, like any other human endeavour, involves values: we use values to determine what applications and kinds of science are most important to our society, what science should be taught, and how we should choose to respond, through science, to a given environmental or social problem. People operating from different perspectives and worldviews, such as anthropocentric and ecocentric (both alluded to in Chapter 1), can also have quite different ideas about how to use scientific knowledge and technologies in response to given socio-scientific questions related to sustainability.

Religion and cultural background also influence people's values and knowledges in relation to science. For example, people subscribing to creationist accounts of the origin of the Earth or of humans may find it hard to reconcile these views with the scientific explanation of evolution or the Big Bang theory. The dreaming of Indigenous Australians and "intelligent design" are two examples. A recurrent strong theme of connection to and stewardship of the land (see Chapter 14) is evident across the range of value systems of Indigenous Australians and New Zealand Māori. The associated traditional practices of these peoples align with Western scientific insights from ecology into environmentally sustainable ecosystem management. However, other values and knowledges might not align so well. Essentially, it is important, with regard to teaching science for sustainability, to recognise the diversity of views and values that may exist in the classroom for both teachers and students.

While scientific investigation may offer new ways of dealing with issues of sustainability, ultimately there is a social dimension and a social responsibility to change our ways of "thinking, acting and relating" for sustainability (Kemmis, 2009). Because sustainability is multi-dimensional, the combination of scientific literacy about the environment and a commitment to ethical social responsibility can be an empowering combination for transformative change in any community.

Science is not a primarily individualistic endeavour: local, national and international collaborations provide a well-recognised way of working scientifically. This practice mirrors the collaborative approaches demanded of EfS in addressing issues of sustainability at both local and global levels. Encouraging students to practise shared investigations and problem-solving pertaining to science and sustainability topics not only promotes construction of science knowledge but also furnishes them with opportunities to practise collaborative skills in order to achieve contextually relevant outcomes.

Science deals in facts and in theories that are held tentatively, as they are contingent on the evidence that supports or refutes them. Because of the complexities of interacting variables and processes, scientific knowledge is sometimes expressed as probabilities. A good example is climate science, where predictions and explanations are expressed in tightly defined probabilistic terms such as "almost certain". In terms of sustainability issues, probabilities and potential impacts need to be weighed up and best possible options enacted. A scientifically and ethically informed decision-making process is paramount. Practising such decision-making skills in a school context thus offers a foundation for lifelong decision-making about sustainable living.

Nature study over many years has been foundational in primary years science, more so than other aspects of science such as geology, physics and chemistry. Positive nature experiences help children develop the connection to and love for nature that is so important for later pro-environmental behaviours and deep connection to place. However, there is growing concern that children are becoming increasingly disconnected from nature, leading to "nature-deficit disorder" (Louv, 2008) and "ecophobia" (Sobel, 1996). Teachers can nevertheless facilitate children's nature experiences anywhere, from special wild places through to the school playground, by expressing and encouraging curiosity, appreciation, joy and wonder about the plants, the flowers, the insects and other animals in the children's environments.

These highly important nature experiences are tangible and accessible for children and teachers alike in the primary setting. But gaining comprehension of the complexities of sustainability requires more than a focus on activities such as growing seeds on cotton wool or bird watching outdoors. Teachers need to reflect on their attitudes to appropriate science and nature experiences, and to consider the concepts and topics that might be relevant to children's construction of deeper understandings about sustainability.

Science as the study of the whole and not simply parts is highly relevant to EfS, for at the core of sustainability practice is comprehension of interactive, interdependent and constantly evolving wholes or systems. Human actions and inactions impact daily on the systems within which humans are embedded. Recognition of this systemic worldview, gained through investigating science, offers a foundation for understandings about sustainability. Giving students opportunity to examine relatively small-scale systems such as local gardens, streams and bush land, to gather and share community perspectives about these places and to engage in diverse lines of science inquiry relevant to them may bring them to a point where they can exercise a systems-based view. The links between science and EfS offered above also suggest different ways of teaching and learning to promote sustainability. The following section provides an overview of these.

APPROACHES TO SCIENCE TEACHING AND LEARNING FOR EFS

Because science knowledge alone is insufficient to promote attitudinal shifts towards sustainability, teachers ideally need to reflect on approaches to teaching and learning in science so as to establish and maximise opportunities for promoting sustainability. Learning in science for EfS is essentially enquiry-based and socially grounded; it is learning that empowers and motivates students to understand and act on sustainability issues. Students with opportunity to develop the cognitive and affective features of learning implicit in the list below are typically well placed to construct science concepts and exercise the attitudes and skills aligned with EfS. Thus, the main aims of science for EfS require students to:

– employ scientific methods and ideas in order to aid their interpretation and understanding of the world;
– construct meaningful personal frameworks for understanding science;
– critically analyse, within the framework of scientific validity, scientific ideas and the application of those ideas;
– critically evaluate the social and environmental implications of the application of scientific ideas;
– practise personal decision-making about appropriate actions informed by scientific knowledge;

– demonstrate a sense of interest, enjoyment and excitement in their science-based learning; and
– experience a sense of beauty, respect, reverence and awe in their approaches to the environment and their understanding of humans' place in the universe (list adapted from Littledyke, 2008, p. 3).

What are appropriate approaches to teaching science for EfS? Contemporary ideas in regard to this question draw broadly from constructivist theories. People exploring ideas from the perspective of personal constructivism see meaningful personal frameworks for understanding science as central to understanding issues of sustainability. According to this perspective, teaching processes must therefore take into account students' ideas, with these challenged, extended and reformulated, if necessary, to help students learn meaningfully and scientifically (Littledyke & Huxford, 1998; Skamp, 2008). Research into brain processes shows that people construct their understandings of the world by forming neural networks through new experiences. These networks link to existing networks to create interactive networks. Because people can find many scientific ideas counter-intuitive, they may hold views about the world that make sense to them on the basis of their own experience but contradict scientific understandings. Prior experiences and views thus influence the construction of meanings from new experiences.

Students, however, do not construct their personal ideas in a vacuum or by passively ingesting facts from an authority such as a teacher; their construction of ideas is mediated by and depends on their interactions and discussions with other people in their social world. What is known as social constructivism (after Vygotsky) emphasises that we (children and adults) learn with, and from, social interactions with others. Hence, teaching science for sustainability should facilitate students' personal constructions of scientific ideas through conceptual change. Teachers can aid this process by creating the rich, discursive, science-based learning environments that typically encourage active and socially-located construction of scientific concepts.

The Australian guide to primary science, titled *Primary Connections* (Australian Academy of Science, 2014), advocates using the 5Es (engage, explore, explain, elaborate and evaluate) as a constructivist sequence to frame teaching of science. The *engage* phase elicits students' prior understandings, from which the teacher can plan learning activities that will build on these understandings and provoke conceptual change from intuitively held non-scientific views to scientific ideas (though this can be very much harder to do than is implied by this glib description). By *exploring* the scientific ideas with their peers, students together find things out and share their learning experiences. Students bring these ideas into the *explain* phase. Here, the students and their teachers develop and represent their scientific understandings. This phase is followed by opportunity for students to *elaborate* their understandings by applying them to new contexts. From there, students move to the *evaluation* phase, during which they re-represent and reflect on their learning, while their teachers assess the learning that has occurred (Australian Academy of Science, 2014).

As an example, consider the following description of teaching the scientific concept of insulation for sustainability. As you read through it, try to identify the prior understandings the child has and the interactions that encourage the student to construct (personally and socially) a more scientifically accurate understanding of the concept. How do the teacher questions help in this regard? Are there other avenues the teacher could use to facilitate a socially constructivist learning environment that might better expedite the student's learning?

Insulation: an example of an approach to teaching science for EfS

Insulation is an important concept linked to EfS but can be challenging to fully understand, as this classroom conversation shows:

Teacher: How do you keep food warm when you want to carry it somewhere?
Child: You wrap it in towels and things like that, or newspapers.
Teacher: Now how does the newspaper keep things warm? What are the things it keeps warm?
Child: Fish and chips.
Teacher: So, if you wrap fish and chips up in newspaper and you bring it home, it's warm when you get home, right?
Child: Yes.
Teacher: What about ice-cream?
Child: It melts.
Teacher: If you wrap it up in some newspaper, how would that help it to melt?
Child: It would insulate it and make it warm.

For this child, wrapping something to insulate it makes it warm, whereas to the scientist, insulate means preventing flow of heat energy. How can we support and extend children's understandings in a constructivist way to improve their understandings of this important concept? A constructivist approach using the 5Es to teach this concept could look something like the following.

– *Engage*—To arouse students' interest, bring "ice hands" into the classroom. You can make these by filling rubber gloves with water, tying their tops and putting them in the freezer section of a fridge. Children nearly always find presentation of these ice hands dramatic if they have not seen them before. To elicit prior understandings, invite students to exchange ideas: "Compared with the unwrapped ice hand, will ice that is wrapped melt faster, melt at the same rate, or melt more slowly?" When the children answer, ask them why they have answered this way: that is, find out what the children *think* as a starting point for testing their ideas.
– *Explore*: Invite the children to check out their ideas (or hypotheses). The children who think that the wrapped ice hand will melt quickly are often surprised to see that it melts more slowly than an unwrapped hand. Further investigations involving the wrapping of cold and warm objects (not too hot because of safety implications) can follow. For example, Kindergarten to Year 2 children could use cold and warm water in plastic bottles and feel the difference after an hour or so (qualitative measurement). Years 3/4 children could compare the temperatures using a thermometer, while Years 5/6 children could take regular temperature measurements (quantitative measurement) over the period (e.g., every five minutes) and construct graphs of changes in the temperatures. They could compare a range of different materials to see which ones are most effective in restricting temperature change. Of course, students will need to have previous experiences to build on when working on these activities. Thus, for example, young children should have experienced

melting ice and feeling different hot or cold objects so they have points of comparison. Older children can build on this experience by using thermometers to measure the temperature of different objects, while the oldest children should be familiar with the following investigation sequence.

- *Identify* a suitable *question*.
- *Predict* what you think will happen.
- *Investigate* by deciding what you could change (variables), by changing one thing (what we changed—independent variable), keeping everything else the same (what we kept the same—control variable), measuring something as a result of that change (what we measured—dependent variable), drawing a table of results, and drawing a graph that shows the pattern of change.
- Find *patterns* and *explain* why the change happened.
- *Evaluate* the trustworthiness of your conclusions are. Are they valid (i.e., believable)? Are they reliable, that is, can you repeat your experiment and get similar results?

– *Explain:* Students can now explain their developing understandings: they may be able to state that wrapping ice slows down melting, which could lead into a discussion about how wrapping cold and hot things restricts heat energy flow, so that cold things stay cold and hot things stay hot for longer.

– *Elaborate:* Further investigations into insulation in different contexts can relate to students' experiences. Many students might think that "clothes make us warm", whereas the more scientific view emerging from investigations to test their ideas is that when we experience blankets keeping us warm, we imagine the warmth coming from the blanket, which is why we might assume that wrapped ice will also melt. So, insulation involves restricting heat flow, and insulators, such as clothes with air spaces (air is a poor heat conductor), are poor at conducting heat. Examples of application of insulation in other contexts are:
  - blanket-type materials prevent heat from flowing out of our bodies so we feel warm;
  - oven gloves prevent us from burning our hands;
  - gloves keep our hands warm when we make snowballs;
  - a teddy bear wrapped in the blanket does not get warm but our own body wrapped in a blanket generally does;
  - things put in cool boxes keep them hot or cold, depending on what is put in them; and
  - the insulation in fridges and ovens keeps foot cold or hot.

– *Evaluate:* During this phase, students review what they have learned. Ask them such questions as: Do we now have different understandings about keeping warm or cold and insulation? How does this knowledge help us understand the world differently? In subsequent teaching, use the conclusions from this activity to prompt further investigation.

LINKING SCIENCE AND SUSTAINABILITY

Educating for sustainability in science requires seeing and making links between key scientific and sustainability concepts. In this section, we outline some of the ways you can do this at the primary level. As an initial example, consider again the description of teaching the concept of insulation outlined above. You can extend this concept by relating it to climate

Table 6.2. Examples of activities for developing concepts of insulation and global warming.

Kindergarten to Year 2	*Years 3 to 4*	*Years 5 to 6*
What happens in the classroom in summer when the windows are left closed (for a short period)?	Compare the difference in a car, conservatory or greenhouse when windows are open or closed. Why does it get cooler or hotter?	Design and make a mini-greenhouse using plastic PET bottles. Test the greenhouse effect by measuring the temperature change in the sun.
What happens when the window or door is left open in winter or summer (for a short period)? What does it feel like?	Leave two boxes with clear plastic lids in the sun with the lids on and off and compare how hot they get.	Design and test a mini eco-house (using a box). Consider, in particular, window placement and ventilation.
Pack a suitcase with clothes for a hot place, cold place. Why do we wear different clothes? What happens when you wear the wrong clothes for the weather?	Test different textiles for insulation by comparing heat loss from hot water bottles. Which clothes are suitable for which weather?	Create temperature graphs of heat loss from different textiles. Look at fibre structure under a microscope and note especially the air spaces. Find out about and design clothes for different weather/parts of the world
What happens to animals and plants in winter and summer? (We see fewer animals and plants can stop growing.)	Find out about animal migrations in different parts of the world. Find out about leaf fall in autumn in temperate zones.	Why do animals migrate? (For food, for reproducing.) Why do leaves fall? (If the ground is frozen, they'd lose too much water from their leaves.) If species are adapted to where they live, what might happen if temperatures increase due to climate change? (Some will die out or their distribution will change.)
Find out about animals in hot and cold places. How do they keep warm or stay cool?	Draw and compare tropical and polar animals for insulation and heat loss. How do bodies keep or lose heat?	Compare heat loss from a small container with loss from a large container (polar animals are usually larger with layers of fat to restrict heat loss). Design an animal for the tropics or the pole.
How can we remind ourselves to use suitable clothes and to open or close windows and doors to keep rooms warm or cool?	Draw a poster to remind people how to reduce energy use by wearing suitable clothes and insulating the home.	Investigate from internet and other resources how fossil fuels from power stations produce greenhouse gases. How can this process influence global warming?

change, thereby explicitly and meaningfully linking the scientific concept of insulation to sustainability. Begin by establishing the interrelationships between the science and the sustainability issue. In this case, understanding insulation in terms of restricting heat flow can be linked to three other ideas.

1. Global warming arises through greenhouse gases that restrict heat loss from the planet and raise atmospheric temperatures. Hence, we need to reduce greenhouse gas emissions.
2. Greenhouse gas emissions are produced through burning fossil fuels.
3. Reducing energy use by preventing heat loss (such as efficient house insulation or wearing more clothes when it is cold rather than turning up the heaters) reduces greenhouse gas emissions in situations where heating is fuelled by fossil fuels, either directly through gas heaters or indirectly through electricity generated by coal, oil or gas-fuelled power stations.

At all stages of primary school, ideas need to be developed in a concrete way by relating them to direct experiences and investigations. With younger children (Kindergarten to Year 2), the concept of insulation needs to be personally relevant and reinforced by use of the term in meaningful contexts. With older children, suitable activities can promote construction of understandings with indications for suitable actions. Table 6.2 presents examples of how these types of activity can be used to progressively explore insulation and global warming.

The scope for building links between science and sustainability in this way across Australia's and New Zealand's curriculums is enormous. The recommendation for schools to employ, with respect to EfS in primary education, a constructivist, enquiry-based approach that draws on and follows students' and teachers' lines of interest offers many opportunities for creative, innovative investigations into issues relevant to curricular content. To seed some ideas for each of the elements of the two countries' science curriculums, Table 6.3 documents possible approaches to linking key science concepts with key sustainability ideas.

In the remainder of this chapter, we consider in detail some of the biological aspects of primary science often included in strands titled "The living world" in New Zealand and "*Biological science*" in Australia. We examine, in particular, a number of ecological concepts and how teachers can develop these understandings in primary-school children.

RELATIONSHIPS WITHIN THE ECOSYSTEM AND EFS

Among the most important EfS concepts in the biological strand of science are those of the interrelationship and interdependence of living things within ecosystems. One of the organising ideas for sustainability in the Australian Curriculum is that "all life forms, including human life, are connected through ecosystems on which they depend for their wellbeing and survival" (ACARA, 2014). Much of this content is covered in Year 4 under the content descriptor ACSSU073: "Living things depend on each other and the environment to survive". In the New Zealand Curriculum, these relationships are introduced in Level 5 science (senior primary/junior secondary) through the achievement objective "Investigate the interdependence of living things (including humans) in an ecosystem". These concepts of interdependence are particularly pertinent to EfS, as it is very important for children to understand that all living things are interlinked in various ways and that humans are part of this interlinked system.

Table 6.3. Key concepts in science and EfS in the Australian and New Zealand curriculums.

Curriculum element	*Key science concepts*	*Key EfS concepts*	*Examples of possible approaches to support EfS*
AC: Communicating NZ: Communicating in science	Ways to represent information (e.g., written descriptions, graphs, tables)	All	- Communicate results of an investigation of some animals and plants living in a local ecosystem by making up a song, making a poster, diorama, annotated collage of digital photos, graphing frequencies of species counts, writing a description of the ecosystem, communicating informally with family and friends, writing a scaffolded report, presenting evidence to support its protection at a role-played public enquiry, debating a topic (e.g., "It's important to preserve the biodiversity in the school grounds"). - Communicate an action plan to reduce electricity usage at school by writing a research report about alternative sources of electricity, writing a formal proposal to the principal that compares and contrasts alternatives to writing persuasive texts. - Work as an editorial/journalist team to research (including role-played interviews) and produce a TV show or magazine called *Environment Matters*. Present as a recorded broadcast or magazine/newspaper.
AC: Science inquiry skills NZ: Investigating in science	Planning and conducting investigations to answer science questions; representing and evaluating data and conclusions	Biodiversity, natural cycles and systems, ecology, resource management (e.g., water, energy, paper, plastic, etc.)	- Investigate a problem such as electricity use in a school. How much electricity is used, what is the likely source of the electricity and how can electricity use and CO_2 emissions be reduced? - Use a plug-in electricity meter to measure the power that classroom appliances use. Convert that to running costs and CO_2 emissions. Examine the school electricity bill and CO_2 emissions. Research the sources of electricity in your area. Trace the energy transformations from source to classroom appliances. Discuss/research alternative energy sources. Develop, define, implement and evaluate an action plan to reduce electricity use. - Conduct fair tests on the effect of different water or temperature regimes on the growth of plants or mealworms. - Plan and conduct a survey of biodiversity in the school grounds and identify any indigenous/native plants and animals

Table 6.3. Key concepts in science and EfS in the Australian and New Zealand curriculums (contd.)

Curriculum element	*Key science concepts*	*Key EfS concepts*	*Examples of possible approaches to support EfS*
AC: Use and influence of science NZ: Participating and contributing	Science knowledge and applications affect people and inform decisions and actions; science and society influence each other.	Stewardship, social participation, values and lifestyle choices.	- Show and tell: find objects, pictures or stories to link with the EfS topic of the week (e.g., water, waste, caring for nature). Students take turns presenting science news of the week about how we can improve our environment or reduce our ecological footprint (e.g., from TV, newspapers, internet). - Debate locally relevant socio-scientific issues such as conserving or logging a bush area or the content of a mining or development proposal. Use a "consequence wheel" to emphasise different values/perspectives held by stakeholders, and the likely direct and indirect consequences of different actions. - Discuss positive and negative consequences of particular technologies using social, economic and environmental lenses.
AC: Nature and development of science NZ: Understanding about science	Nature of science and how it has developed.	EfS in science requires evaluating past/present negative and positive impacts of science on social, economic, environmental systems.	- Find out about scientists, scientific processes or inventions that have changed the world, explicitly including women and cultural diversity. Present and display findings. Discuss in relation to positive and negative impacts on society and the environment. - Role-play real-life situations in history and in the present to show effects of changed views and technology (e.g., Edison's light bulbs, Pasteur and bacteria, Darwin and evolution).
AC: Nature and development of science (contd.) NZ: Understanding about science (contd.)	Nature of science and how it has developed	Scientific investigations can help us find out about our world if we do them properly. Scientific evidence can help guide decisions about future actions for sustainability.	- Include problems (e.g., Galileo and new ideas about the place of Earth in space). - Discuss how we know what we know in relation to some socio-scientific issue: cover observation, evidence, data, and reliability. - Plan and suggest methods for improving a given class experiment to test a cause and effect relationship, such as the effect of salinity on plant growth, effect of dilute acid (vinegar) on sea shells. - Critically appraise some applications of science in relation to sustainability (e.g., introduction of cane toads or vaccines). - Consider issues such as oil spills through activities such as oil on feathers in water.

Table 6.3. Key concepts in science and EfS in the Australian and New Zealand curriculums (contd.)

Curriculum element	*Key science concepts*	*Key EfS concepts*	*Examples of possible approaches to support EfS*
AC: Biological sciences NZ: Living world	Evolution, diversity, interdependence and survival of living things	Inter-dependence, resource management, natural cycles/ systems, ecology, stewardship, conservation, biodiversity, habitats, inter-species equity.	- Conduct a "schoolyard safari"/invertebrate survey. Record biodiversity in school grounds over time (photos), build food chains and webs in the local context, establish native plants, kitchen garden/compost heap etc. - Investigate a local environmental ecology problem (e.g. damage by introduced species). Explore possible solutions and implement the best solution. - Research and discuss indigenous land management and their relationship to country; indigenous calendars of seasons.
AC: Physical sciences NZ: Physical world	Energy: types, transfer and transformations	Resource management: conserve finite resources (fossil fuels); use renewable alternatives; ecological footprint.	- Make simple electrical circuits in models. - Investigate energy use in home. Build/model energy-efficient houses. What are the different forms of energy and energy conversions used? (E.g., electricity to produce heat, light, sound.) - Explore links between electricity generation and power-station greenhouse gas emissions. - Produce a pamphlet on how to reduce energy consumption and associated greenhouse gas emissions. - Discuss/research how we can reduce electricity use (e.g., by using energy-efficient appliances, switching lights off, closing doors, wearing more clothes in winter).
AC: Chemical sciences NZ: Material world	Properties of substances and changes of state; reversible and irreversible changes to substances	Management of finite and renewable resources and of waste.	- Investigate rubbish: carry out home or classroom audit. What categories of material are there? - Investigate properties of materials in terms of their use. Research their origins (problems of limited resources). How are the materials used to produce goods? - Develop and implement an action plan to reduce, reuse and/or recycle waste plastic or paper in the classroom. - Investigate land fill and recycling. Experiment with biodegradable and non-biodegradable substances.

Table 6.3. Key concepts in science and EfS in the Australian and New Zealand curriculums (contd.)

Curriculum element	*Key science concepts*	*Key EfS concepts*	*Examples of possible approaches to support EfS*
AC: Earth and space sciences NZ: Planet Earth and beyond	Earth as part of solar system; changes to Earth from natural processes and human impact; the variety of ways in which Earth's resources can be and are used	Water and atmospheric cycles; soil as a growth substrate.	- How do we and other living things respond to day and night or seasons? - Design an ecology dome for living on Mars. What living and physical things will be needed for survival over a sustained period of time? - Investigate the impact on Earth's surface of erosion, flood, fire, drought. Discuss links with land management decisions. - Investigate local water sources, uses, how waste water is treated and where it goes; relate to water conservation.

Students also need to be aware of the delicate balance within ecosystems because of these interrelationships and of the fact that many human activities disrupt this balance. For example, human over-exploitation of fish stocks can lead to the complete collapse of fisheries; introducing alien species to new ecosystems or countries can devastate the delicate ecological balance. Many Australian and New Zealand children will be aware of this latter problem due to the disastrous introduction of cane toads, rabbits and foxes (Australia) and rabbits, possums and stoats (New Zealand). It is thus vital for children to understand the interrelationships between living things and how human behaviour can affect them.

At the primary level, teaching about interrelationships often begins with relationships centred on feeding. This topic helps develop children's understanding of food chains and webs, before they move on to studying decomposition of organic materials and recycling of nutrients. In this way, students can ultimately move towards understanding the balanced flow of energy and material that takes place in ecosystems, as depicted in Figure 6.1. The system shown in the figure is a complex one, and many primary school students may not gain full understanding of it. However, many of the concepts needed to understand materials and energy flow are developed at this level. The section that follows provides a range of activities that promote children's constructions of understandings about interrelationships within ecosystems.

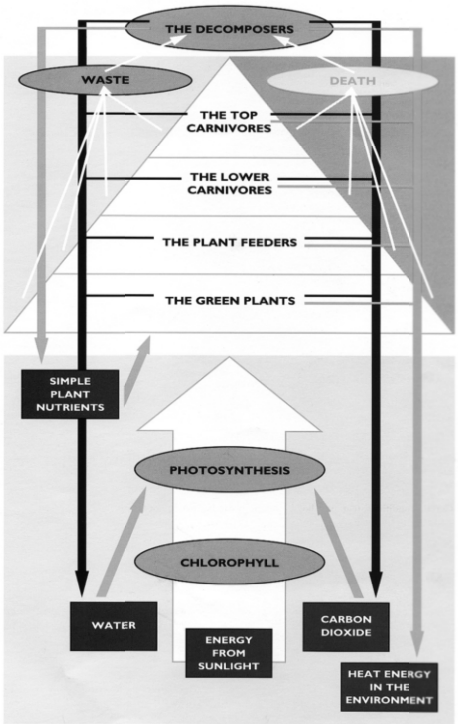

Figure 6.1. The flow of energy and materials in the ecosystem (extract from Bailey, 1994).

FEEDING RELATIONSHIPS—DEVELOPING THE CONCEPTS OF FOOD CHAINS AND FOOD WEBS

Food chains

As Wenham (2001) suggests, the animal whose feeding relationships we know best is ourselves, the human species. Investigating the sources of some of our foods is therefore a useful way to develop three concepts essential to understanding any ecosystem: food chains, producer and consumer. These concepts relate to the content descriptor in the Australian Curriculum for Year 4 that states "Living things, including plants and animals, depend on each other and the environment to survive" (ACSSU073). In New Zealand they are found at Levels 1 to 2 of the "living world" strand: "Recognise that all living things have certain requirements so they can stay alive". When young children are asked to draw food chains, many draw their own food in terms of the processing that takes place, as the drawings in Figure 6.2 clearly show.

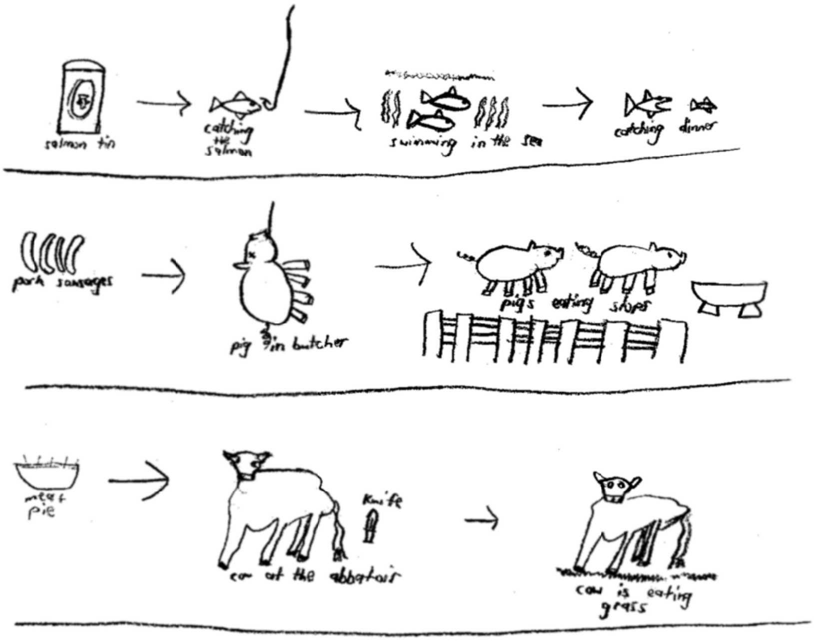

Figure 6.2. Young children's ideas about food chains (courtesy of Dylan Ramsay).

A useful strategy when attempting to help children develop a more scientific view of food chains (in which the origin of food is related back to the sun) is to start with simple human food chains involving unprocessed foods and have children draw these (see Figure 6.3). These drawings serve to show an important feature of all food chains, namely that all have a plant at their base because only plants produce food materials whereas animals consume them (Wenham, 2001).

human	**human**
↑	↑
cow (beef)	**kangaroo**
↑	↑
grass	**grass**

Figure 6.3. Simple human food chains.

Once the basic concepts of food chains have been established, students can explore simple food chains that do not involve humans. The best way for them to do this is to examine feeding relationships in the school grounds, a local park or bush land. Food chains involving birds are the easiest to explore, as they often include plants, insects and animals such as hawks, foxes and cats that prey on smaller birds. Clearly, you, as the teacher, need to treat predation in a food chain with some sensitivity; use your experience and knowledge of your students to do this appropriately. Encourage the children to demonstrate and refine their understandings by creatively making food chain mobiles, posters or sequencing puzzles utilising self-drawn or photographic images of a range of animals and plants. Have students verbally explain their work to the class, and display it and share it with their families.

Food webs

Food webs, which are made up of a number of food chains, give a better representation of interrelationships in an ecosystem than food chains. Once students are able to construct a number of food chains for a particular ecosystem, encourage them to link these together to produce a food web, as in Figure 6.4. Again, this activity is best done through reference to a local ecosystem, such as the school grounds or a local garden.

A useful activity for further developing the food chain concept is the "web of life". Here, children take on the roles of different plants and animals in a food web, with the animals in the web linked, by string or thread, to other organisms they consume. This activity not only provides a strong visual representation of the interdependence within an ecosystem but also illustrates how the web will break down if one type of organism is removed from the system due to human activity. You can supplement this hands-on activity with one of several available internet-based virtual food web building activities, for example from the Gould League. These allow students to build food-webs in a range of ecosystems, and provide a very visual representation of the links that are evident between living things, as well as being quite engaging for students.

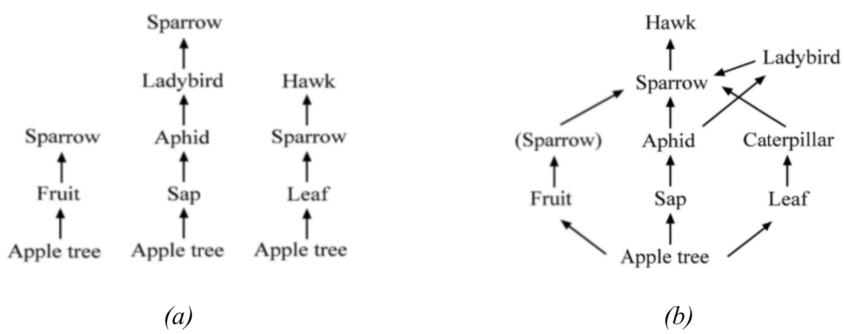

Figure 6.4. Combining garden food chains (a) to form a food web (b).

Nutrient cycling through the ecosystem

The concept of nutrient cycling is also important to EfS, although it is conceptually more difficult than concepts relating to feeding relationships. However, it is important to provoke children's thinking about this concept, especially in relation to the role of micro-organisms in maintaining soil fertility, the use of pesticides that often kills beneficial micro-organisms in the soil, and why composting certain food materials is beneficial. In Australia, this topic can be explored in Year 4 under the content descriptor ACSSU072: “Living things, including plants and animals depend on each other and the environment to survive”. In New Zealand, the topic is introduced at Level 5 of the “living world” strand. This aspect of EfS can also be used to develop children’s understandings of biodegradable and non-biodegradable materials, thus facilitating informed decision-making about types of packaging and the use of plastic bags in shopping. A follow-on activity could be that of promoting a campaign in the school to reduce the amount of plastic waste, plastic bags in particular.

So that they can explain the recycling of nutrients through an ecosystem, students must first be aware that organic material decomposes and that organisms are involved in decomposition. A number of activities illustrate this notion quite effectively. Ask students to fill bait bags (i.e., small plastic-mesh bags) with pieces of fruit and vegetable waste, bury the bags in the soil for a few weeks and then dig them up and examine the contents. Students should find that most of the fruit and vegetable waste has decomposed. They might also find some of the organisms responsible.

Establish a compost bin and have the children deposit waste fruit and vegetable material in it. Again, ask them to examine this material periodically to observe how it breaks down and the types of organisms that become resident. Conduct simple “fair tests” using slices of bread to determine what conditions or combination of conditions (warm, cold, moist, dry, light, dark) best suit the development and growth of bread moulds. Students can use the prediction–observation–explanation process as part of this activity. As an extension of the project, help the children develop a school garden and use the composted material as soil conditioner. Let them see how this process improves the soil’s water-retention and aeration properties, and acts as a fertiliser for plant growth.

Younger children can examine samples of leaf litter, arranging the leaves according to the extent they have decayed and relating the decay to whether the leaves were at the top of the litter or in the layers below the surface (Figure 6.5). Use this activity to determine children’s ideas about why parts of the leaves have decomposed and to facilitate their construction of understandings about decomposition and the organisms involved in this process.

Figure 6.5. Stages in decay of leaves (reproduced by permission of Sage Publications, London, Los Angeles, New Delhi and Singapore, from Martin Wenham, “200 Science Investigations for Young Students”, Sage Publications, 2001).

The decay and recycling of biodegradable organic materials can be contrasted with the long-term persistence of non-biodegradable materials, such as plastic, which decomposers cannot break down. Upper primary students can develop their own fair test to demonstrate this. Younger children can establish a mini-landfill to compare the decomposition rates of different types of everyday packaging items. Items that children select to bury might include a tin can, a milk carton, a plastic container and a paper bag in pots of soil or a disused garden bed. Invite the children to create a label for each item, dig up the items at intervals to investigate the rates of decomposition, and create a photographic record. Students could also document the process in a class journal or diary over several months, with this content providing further opportunity for them to discuss waste management both in the school and at home. Concept cartoons such as the one presented in Figure 6.6 generally provide a useful stimulus for discussion about the concept of biodegradability and other environmental issues. Students can also use cartoons as the basis of planning fair tests and other investigations.

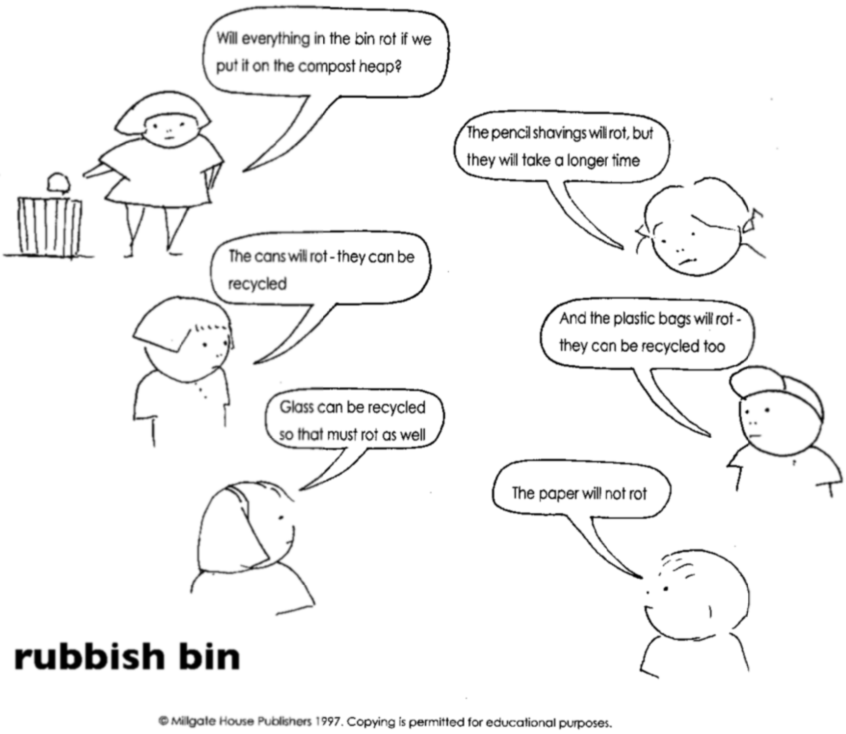

Figure 6.6. An example of a concept cartoon related to environmental issues (rubbish bin cartoon from Keogh & Naylor, 1997). Reprinted with permission from Brenda Keogh and Stuart Naylor, Millgate House Publishing Ltd. (www.millgatehouse.co.uk)

Human impacts on the ecosystem

In addition to constructing an effective understanding of the concept of interrelatedness, children can begin to explore the impact of human activity on ecosystems. In Australia, this concept is linked to the Year 6 content descriptor ACSSU094: “The growth and survival of living things are affected by the physical conditions of their environment”. In New Zealand, it addresses the “science living world” Levels 3/4 descriptor: ‘Explain how living things are suited to their particular habitat and how they respond to environmental changes, both natural and human-induced”. As with predation, treat this topic sensitively, as much discussion of human impact is invariably depressing and potentially guilt-provoking. Where possible, explore with your students remedial actions that can be taken to repair human impact, and offer children some positive scenarios. The “habitat survival game” offers a very engaging way for students in upper primary classes to explore human impact. Table 6.4 provides the instructions. The example used in it draws on the fauna of Australia, but these can be changed to suit New Zealand or other contexts.

Have students use the internet to find out what positive actions New Zealand and Australia are taking to protect endangered native animals and report these back to the class. Use the following website to exemplify the impact of an introduced species on an ecosystem, in this case the impact of possums on native forest in New Zealand: http://www.unesco.org/education/tlsf/mods/theme_d/interact/mod20task01/Possum_Game_beta.htm. This activity is a useful follow up to the habitat survival game.

The theme of human impact on ecosystems can be explored further using an activity that traces the story of a river (see Table 6.5). Again, this activity is highly engaging and has a strong visual impact, and it can also be linked to local action and to the teaching of the water cycle, which in Australia occurs in Year 7 and in New Zealand at Levels 3/4, in the “Planet Earth and beyond” and “Earth systems” content strand descriptor: “Investigate the water cycle and its effect on climate, landforms, and life”.

This activity, as presented in Table 6.5, is most appropriate for Years 5 and 6 students. However, you can readily simplify and shorten it for younger students. Consider following up the activity by having students take some form of local action. This might involve a visit to a local creek, river or pond close to the school. Initially, students could undertake an inspection of that body of water to observe, photograph and document litter-based pollution such as cans, plastic bottles and bags and larger items such as shopping trolleys and car tyres. They could then follow this up by investigating the water quality, using simple chemical testing kits. However, at the primary level, it is usually more engaging for students to use what are called *indicator species* to determine water quality. Certain species of aquatic animals can tolerate much higher levels of pollution (which usually means lower levels of oxygen in the water) than others. For example, amongst the fish species in Australia and New Zealand, trout (rainbow trout in particular) can tolerate only very low levels of pollution, because they need lots of oxygen to survive. This is why these fish are mainly found in clear, fast flowing streams and rivers. Trout can therefore be used as indicators of the health of a body of water.

Table 6.4. Instructions for habitat survival game.

To play this game, children need to play the following roles:

1 Sixteen to 24 native species:
- four to six brush-tailed wallabies
- four to six eastern water dragons
- four to six koalas
- four to six satin bowerbirds

2 Three introduced species:
- feral cat
- fox
- disease carrier

3 Two, three or four humans

Other equipment and props:

– costumes
– a designated area that will provide an imaginary habitat for native animals
– five human impact cards (mining, logging, fire, clearing, weeds)
– 150 food cards
– 150 water cards
– 180 life cards (each native animal has a set number of life cards): eight for each individual animal
– four species information sheets

Aim of the game:

The animals need to move up and down a designated area simulating their habitat. They gather food and water supplies (from labelled buckets) while avoiding threats of cats, foxes, humans and disease.

Rules:

1 Each threatened species can take only one food and one water card at each visit to food and water stations.
2 They must leave the food and water station immediately after gathering their food and water and move around their entire habitat before returning to replenish their food and water.
3 The animals have three minutes of idealistic living in their habitat before threats are introduced.
4 On the blow of the whistle, the game controller allows the following to enter the habitat area: one fox, one feral cat and one disease carrier. The object is for these introduced animals and the disease carrier to chase and capture (by tapping them on the shoulder) the native animals.
5 At various points throughout the game, humans are permitted to briefly enter the habitat; they will present the greatest threat.
6 The objective for the human is to steal food and water cards from the animals by tipping. Once tipped by a human, the native animals must hand over all food and water cards and immediately seek more food and water from the buckets.
7 Humans can also steal one card at a time from the food and water buckets but must travel the length of the habitat before stealing again from the buckets.
8 Each time a human enters the habitat, he or she, in addition to stealing food and water cards, places a human impact card on the ground. As a human leaves the habitat, the game controller stops the game and reduces the size of the habitat as a result of the human impact card (these cards itemise fire, logging, clearing, mining, weeds).
9 The game is over when one of the following occurs: (a) humans have retrieved all food and water cards, (b) many native animals have lost their life cards, and (c) no habitat is left.

Debrief:

Discuss with the children the effect the introduced species, humans and disease carrier had on the balance of the native animals in their habitat during the game. Relate this game to a native animal that they know is being affected by one of the human-introduced problems.

Table 6.5. Outline for story of a river activity.

Activity outline:
Ask students, in pairs, to rank the significance of different causes of water pollution based on their own experiences and knowledge of the various causes of water pollution. The class can then discuss the impacts and the significance of each, and identify what issues may exist in their own catchment.

Aims:
- To explore the links between lifestyle and water pollution
- To investigate decision-making processes

Activity instructions:
Briefly introduce the concept that water is a precious resource and that in many ecosystems it is under threat of pollution. All of us living within water catchments contribute directly or indirectly, significantly or not so significantly, to the degradation of our waterways, often without realising the relationships and impacts that humans make.

Materials:
- One clear container such as a small fish tank filled with water (four- to five-litre capacity)
- Catchment story labels
- Beakers or jars containing appropriate substances

Advance preparation:
1. The activity story identifies 15 land uses. Adapt the number to suit the size of the group. For example, each land use could be assigned to two people, some uses could be omitted or more than one allocated per participant. Some land uses could be omitted if they are not relevant to your catchment.
2. Prepare one labelled container for each participant. Fill with substances and quantities listed in the table below. Photocopy the "labels" and cut and tape a label to each canister.

Land Use	*Prop*
– Power station	– Vinegar (acid rain)
– Farming country	– Baking soda (fertiliser), green cotton 'algae'
– Piggery	– Thick muddy water
– Grazing land	– Salty water, Thick muddy water
– Coalmine	– Vinegar (acid run-off)
– Hobby farms	– Yellow water/toilet paper
– Fishing	– Tangled fishing line
– Park	– Styrofoam, plastic, etc.
– Tourism	– Paper, plastic, etc.
– Subdivision	– Soil
– Gardens	– Baking soda (fertiliser)
– Storm water	– Leaves, glad wrap/plastic, bit of an advertising flier
– Roads	– Vegetable oil
– Industry	– Soapy water, green cotton 'algae'
– Tannery	– Food colouring (red) or beetroot juice

Table 6.5. Outline for story of a river activity (contd.)

Procedure: 1. Place a clear container (e.g., a small fish tank) containing four to five litres of water in a central position in the room and explain it represents the river. 2. Distribute the canisters among the group. Remind them not to open them until their land use is mentioned, at which point they are to empty their canister into the clear bowl of water—the river. 3. Read the story in a dramatic way, pausing when each land use (bolded) is mentioned. Remind participants to come forward and empty their canister. *Note*: The title of the river in the story has been left open so that you can include the name, if you wish, of the local river that runs through your catchment.

The Story of a River

This is the story of the travels of a river through its catchment. It begins in the higher parts of the catchment where the rain runs off the slopes and the water begins its long journey to the sea. In the valley below there is a **power station** that generates electricity for the region. It burns large quantities of coal and releases pollutant gases into the atmosphere. These pollutants combine with moisture in the atmosphere to produce acid rain. Rainfall carries these acids back to Earth's surface and can pollute the very source of the river. The water speeds up as it descends the slopes. The river continues its journey towards the sea through **farming country** where, recently, some crops were fertilised. Afterwards, it rained heavily and the run-off into the river brought with it some of the fertiliser, which causes too much algal growth in the river.

The neighbouring farm is a **piggery**. Some of the manure from the pig pens washes into a drainage pipe that then empties into the river. On the other side of the river are **grazing lands**. There are very few trees remaining, and in some of the lower parts of the pasture, the water table has risen because the trees are not using the water anymore. This water brings the salts in the soil up to the surface making the land unusable. It also means that run-off from the land is salty, and this threatens the freshwater organisms and animals in the river. A grazing herd of cattle feeds on the vegetation on the banks. When heavy rains arrive, the river banks collapse into the river.

The **coal mine**, which supplies raw material for the power station, pumps water out of the river to clean its equipment and to flush out some of the waste. The waste includes various acids, which all drain back into the river. Slowly, the river starts to wind its way through the outskirts of a major town, where there are a number of **hobby farms**. The houses here are not connected to a sewerage system but have their own septic tanks. Occasionally, these tanks overflow and seep untreated sewage directly into the river.

Around the bend, we find a number of people making use of the river. Someone is **fishing** on the banks. Unfortunately, their line gets caught around a rock and is left in the water. Another group of people is enjoying a picnic at a **park** overlooking the river. A gust of wind blows some of their rubbish off the table and down into the water. Further downstream the river is being utilised for **tourism**. A charter boat is giving some people a scenic tour of the river. Drinks are for sale on board, but not everyone uses the bins that are provided, and where does their rubbish end up?

The river now starts to meander through a new **subdivision** that is being developed on the edge of town. Many of the trees have been removed, and when it rains, the top layer of soil is eroded and contributes to silting up the river. The river continues on through the middle of the town, where most houses have a **garden**. To keep those nasty bugs away, the gardeners use a range of pesticides. At the end of the day, they turn on their sprinklers to water the plants. The pesticides wash off into the storm-water drains and enter the river. The **storm-water drains** also collect all the leaves, bits of plastic and blown-away junk mail.

People who have spent the day at work are now starting to drive home. The **roads** are choked with traffic. Oil drips out of many of these cars, and sometimes they brake in a hurry, leaving traces of rubber on the road. Every time it rains, these pollutants are carried into the storm-water drains and straight into the river.

Some **industry** can also be found along the river in the industrial outskirts of the town. The industries use detergents to keep their production equipment clean. But sometimes they hose the dirty water out of the factory into the gutter where it disappears into a storm-water drain. Once again, however, this water flows straight into the river. If there are phosphates in the detergent, it causes excess algae growth in the river. When the algae dies and begins to rot, it uses up oxygen that animals in the water rely on. They may suffocate as a result.

On the opposite bank, demolishers have discovered a few drums of something mysterious from an old **tannery**. They don't want to spend the money or time to take them to the local chemical waste facility. Someone suggests emptying their contents into the river. Everyone agrees, and the waste is released into the river, to the detriment of all the organisms and animals living in it.

With one final bend, the river finally arrives at its mouth and flows into the sea. But look at what flows out with it!

What can we do with our river? A heavy rainstorm would help. The fresh supply of river water from rain can help flush out many pollutants. Indeed, rivers can be a major way of flushing and cleaning ecosystems. However, this process only moves the problem to a coastal area where other ecosystems will be affected. We must reduce the amount of pollution that is entering the river.

Notes: All of the substances used are non-toxic. This version of "Story of a River" is adapted from "Water: Learn it for life!" Education Queensland (2008). It is available online at http://www.nrm.qld.gov.au/waterwise/resources/ pdf/activities/4_5pollution_river.pdf

With students, use the composition of the invertebrate community to determine how clean the water is (see Figure 6.7). Many insects that live out of water in the adult stage actually lay their eggs and have their larval stage in freshwater.

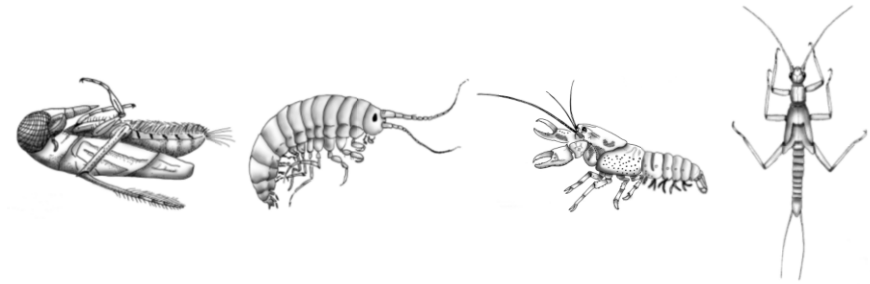

Figure 6.7. Examples of freshwater indicator species. From left to right (not to scale): Hemiptera (true bug or backswimmer), very tolerant; Amphipoda (side swimmer), tolerant; Decapoda (yabbie), sensitive; and Plecotera (stonefly nymph), very sensitive. (Drawings reproduced with kind permission of John Gooderham and Edward Tsyrlin.)

Some of these larvae are very sensitive to even low levels of pollution, so if they are present in a lake or river, it must be clean. Examples include mayfly, stonefly, caddis fly larvae and nymphs, as they are often called. However, if very large numbers of mosquito larvae and bloodworms are present, the water quality is probably poor. Excellent guides to indicator species can be found at the following sites for Australia and New Zealand respectively:

- http://australianmuseum.net.au/streamwatch
- http://www.landcareresearch.co.nz/resources/identification/animals/freshwater-invertebrates

Students can use fine mesh nets to sample for invertebrates, and they always enjoy this activity. Clearly, normal field-trip precautions need to be taken. You will also need to ensure that the children return all animals safely to the water at the end of the activity, an action that will encourage them to treat all living things with respect. If you and children find the body of water is unhealthy, guide them into working on an action plan aimed at improving its quality. This process might involve canvassing the local council and supermarkets, contacting a local college or university to have further testing done and/or organising a local clean-up day and inviting the media to promote and report it.

The following website offers a positive and challenging means of rounding off these activities on the health of water bodies: <http://www.catchmentdetox.net.au/home>. With younger children, the picture story book *Cry Me a River* (McRae, 1991) offers a way to usefully explore this topic, with potential for the children to act out the story in a sandpit or digging area outside the classroom or to recreate this type of area on a smaller scale indoors in a trough.

Biodiversity

In the previous section, we noted that the health of an ecosystem can often be gauged by the types of organisms inhabiting it. Another important indicator of the health or otherwise of ecosystems is their biodiversity. This term refers to the number of different species found in an ecosystem. As a curricular topic, it is introduced in the Australian Curriculum in Year 3 under the content descriptor ACSSU044: “Living things can be grouped on the basis of observable features and can be distinguished from non-living things”. In the New Zealand curriculum, it is found at Levels 1 to 2 of the “living world” strand: “Recognise that there are lots of different living things in the world and that they can be grouped in different ways”. It appears again at Levels 3 to 4 of the same strand: “Begin to group plants, animals and other living things into science-based classifications”.

Biodiversity is a key concept of environmental sustainability (Commonwealth of Australia, 2005), and many activities pertaining to this content area can enhance students’ knowledge *about* their environment and their connections to nature that are so important to developing youngsters’ pro-environmental attitudes and behaviours (Bögeholz, 2006). Another important aspect here is that of engaging students through being outdoors, at a minimum in the school garden if the school is fortunate enough to have one, so that they can enjoy exploring what is around them. Here, the students can conduct invertebrate surveys (often referred to as “minibeasts” or “schoolyard safaris”), based on investigation of questions about the biodiversity, such as the number of different kinds of invertebrates evident in the locality? Or they can take a focused look at one common species, say, ants or snails, and conduct controlled experiments (fair tests) about their behaviour. For example: Do the ants eat sugar or meat? How fast do snails move? Do slaters prefer dark or light? Students can present their results in a range of ways—tables, graphs, drawings, written or verbal descriptions, digital photographs and so on.

As a class, the children can map the biodiversity in the school grounds or keep a long-term running photographic record by taking digital images of the biodiversity in the school grounds and placing them on a wall chart. Photos should include all plants, invertebrates, visiting birds and reptiles, amphibians and mammals found. Help the children duplicate and use these images in the form of cards. The cards can be used to form locally relevant food chains and webs. They can also be used for games, such as "Snap!" called out when two birds, two flowering plants and so on are played consecutively.

The children can also shuffle the images around in order to classify the biodiversity into groups. They might begin with a simple two-group arrangement of living and non-living things (some students may think that plants are not living things) and then move on to more complex groupings, such as insects, mammals, reptiles and so forth. From the more action-oriented perspective of education *for* the environment, children can enhance the biodiversity of their school grounds by researching and planting indigenous gardens, creating specific butterfly or lizard gardens or frog bogs, or moving further afield to experience involvement in bush or dune/riverbank regeneration.

All of the above activities should be infused with notions of respect for all life, interdependence, critical thinking and values analysis. They should also implicitly ask such questions as why there is more biodiversity in some areas than others, and why it matters to look after (conserve) biodiversity.

Adaptation

Closely linked to the concept of biodiversity is the concept of adaptation—how organisms survive in particular habitats. This is also an important concept in EfS because children need to understand that adaptation is strongly linked to survival and that events such as global warming may be having an adverse impact on adaptation. For example, insects such as mosquitoes that carry malaria and dengue fever are now spreading into different areas of the planet due to climate change. Other species that cannot adapt to the changing temperatures resulting from global warming may simply die out, reducing biodiversity and disrupting food chains and webs. In the Australian Curriculum, this concept is covered in Year 5 under the content descriptor ACSSU043: "Living things have structural features and adaptations that help them to survive in their environment". In New Zealand, it appears in the "science living world" strand, Levels 3/4: "Explain how living things are suited to their particular habitat and how they respond to environmental changes, both natural and human-induced".

The following activity invites upper primary students to be creative while constructing their understandings of adaptation. It can be easily changed to accommodate different skill levels and the availability of resources. It can also be modified to take into account global warming. This activity is typically conducted after students have examined a range of living things in their natural habitats and when they have discussed how these organisms have adapted in order to survive.

Begin the activity by providing students with one or more hypothetical environments, such as those outlined in the following examples, adapted from Taylor and Jones (2001):

A. This habitat is very dry and sandy with very few plants but plenty of insect life. It has high daytime temperatures but becomes cold at night. There are large numbers of predatory birds in the skies above.
B. This habitat is below ground. There are lots of roots and worms and moles in the habitat. Large surface predators probe into this habitat with their single tusk hoping to spear prey.
C. Many plants and tree roots are evident in this freshwater habitat. Predatory fish hide among the underwater vegetation; some hunt small prey using an electrical discharge. There are lots of fish of all sizes and plenty of insect larvae in the mud at the bottom.
D. In this habitat, snow covers the ground for much of the year. Ice extends out over the sea, and it is possible for animals to get into the cold water. There is plenty of plankton in the sea and many fish. There are also large seaweed beds. Several large predatory mammals swim under the ice and occasionally come up through holes in the ice to breathe.

Ask the students to work in groups to design a hypothetical animal that will survive in one of the above environments. Tell them they can use a range of materials to produce a model of their animal (see Figures 6.8 a-d). These materials can include modelling clay, bottle tops, corks, waste cardboard/paper/wool/string/ribbon, buttons, etc. Once each group has produced their animal, they report back to the rest of the class, explaining how the various features of the animal help it to survive.

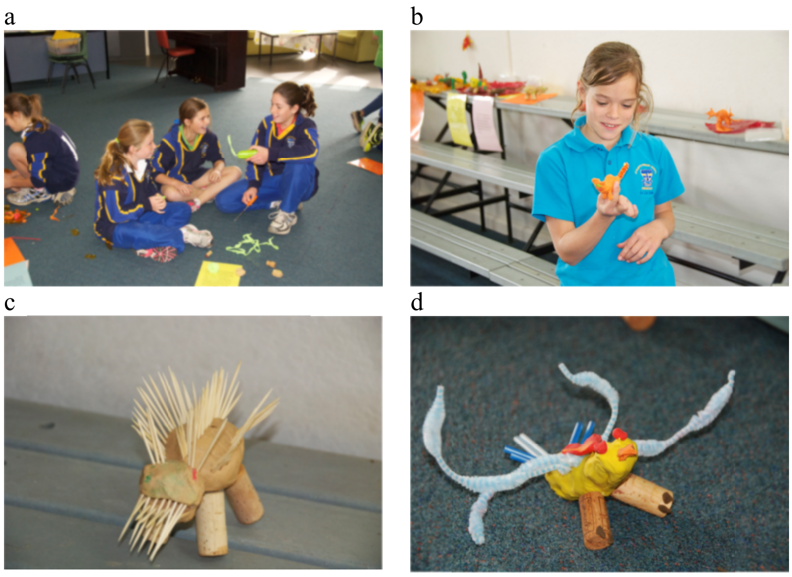

Figure 6.8. Upper primary school children constructing their hypothetical animals (a), explaining how their features help them to survive (b), and two of their hypothetical animals (c,d).

Because EfS requires students to take action, either directly or indirectly, make sure that an opportunity for this to occur is built into this activity. Ideally, students should identify ideas for their own actions relating to the concepts of adaptation and habitats. Some possible options could include:

- assisting the survival of local native plants and animals in the face of adverse climate conditions by exploring different watering and mulching regimes;
- documenting local animal or plant species over time and any changes in populations possibly linked to environmental degradation;
- writing to a local government body about protecting a local native habitat; and
- talking to others (classes/parents) about the unique animals and plants that have adapted to live in their local habitats, and perhaps creating a map of where they live.

In this final section of this chapter, we have provided several activities for promoting students' construction of understandings about relationships within ecosystems. There are obviously many other activities available, but the ones presented here as exemplars are those that have proven to be very engaging with our own students.

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7. EDUCATION FOR SUSTAINABILITY IN PRIMARY TECHNOLOGY EDUCATION

This chapter focuses on integrating education for sustainability (EfS) into technology education in primary schools in New Zealand and Australia. The curricula of both countries have featured technology education as a learning area since the late 1980s and early 1990s (Australian Curriculum Assessment and Reporting Authority [ACARA], 2014a; New Zealand Ministry of Education, 1993). The development and use of technology is a key part of life in today's society. For students, studying technology at school can develop their thinking about and engagement with technology and its role in society, and provide them with access to technology-related careers (New Zealand Ministry of Education, 2007).

Technology education involves a focus on design, innovation to solve problems, and enterprise. It incorporates technological knowledge and practice and develops an understanding of the nature of technology. Because technology is a distinctly human-oriented activity, it has social (including ethical and political), cultural, economic and environmental dimensions. It is this multidimensional nature of technology education that provides clear opportunities to integrate it with EfS.

Technology and the development of society are closely linked. Technological developments have enabled us (human beings) to dramatically expand our natural capacities, allowing us to fly, move fast, gain greater physical power, farm other species, and expand the number of our own species beyond the carrying capacity of our environment. These developments mean that today we have significant influence over much of the natural and physical world.

This influence has had much benefit for our species as well as some general benefits for Earth. Examples of benefits for humans include improved medical provision and food production systems. Technologies that enable us to rectify damaging aspects of human activity, such as "cleaning up" after pollution spills and reclaiming land damaged by natural disasters, may be seen as positive for the planet. However, we have become increasingly aware of the many negative impacts that our technological abilities are also having on Earth. Examples of these technologies include mineral and fossil fuel extraction and production of synthetic materials that are not readily recyclable or biodegradable. If we are to continue our existence as a species on this planet, it is critical that we come to understand and then address these detrimental impacts.

Technology is fundamental to human development; so is sustainability. It therefore makes good sense to provide our children with education that enables them to make consequential links between these two important concepts. Technology-related learning in primary schools centres on designing and making tasks that generally readily engage young children. Such tasks allow the children to link the conceptual and the practical, so creating learning that they

N. Taylor et al. (eds.), Educating for Sustainability in Primary Schools, 121–134.

find meaningful because they can easily connect it to real-life contexts. Creative thinking and practical abilities may also be fostered.

Technology education encompasses three key ideas/outcomes. First, it requires development of technological knowledge underpinned by some of the principles on which it draws, such as aesthetics, efficiency and optimisation. Our students need to understand how and why things work, the role of design, and how enterprise relates technology to societal needs. Knowledge of materials and systems is also essential. Evident here is the clear link to the principles of sustainability, such as renewable resource use and waste minimisation.

Second, technology education requires our students to develop technological practice or skills, ranging from identifying needs (which includes technological and sustainability criteria) to developing a design brief, doing functional modelling to test ideas, evaluating the tests, making a product or system, communicating these outcomes to an end user and evaluating if and how the criteria have been met. Technological practice of this kind also requires consideration during the design phase of ethics, legal and safety requirements, and the impacts of the product or system on society and the environment.

Thinking about these aspects of technological practice makes clear an important point, namely that the decisions made throughout the technological process cannot be predicated on economic, social and environmental sustainability factors in isolation. Instead, each of these dimensions must be considered together. For example, individuals designing a product should consider the choice of materials from a cost and availability perspective and also the social conditions under which these materials were produced (e.g., fair trade, child labour) and the environmental impacts, including manufacturing and disposal, of their use. While some of these issues may contain concepts too advanced for young children, we can use simple examples to introduce them to these principles.

Third, technology education requires students to understand the nature of technology and its impact on society and the environment. Students can attain this understanding by exploring the role of technology in society and identifying, from a sustainability perspective, how beliefs and values can enable or constrain technological development. Students might, for example, investigate the difference between needs and wants in terms of how different levels—individual, community, nation or the planet—view various technological developments. From here, students could discuss the practice of consumerism and social justice between first world and third world countries and across past, present and future generations.

As a teacher, you can approach integration of EfS and technology education in several different ways. Two, however, tend to be particularly effective. The first would see you selecting an environmental or sustainability issue and then having students design a technological solution to the particular problem. An obvious environmental context, such as recycling or water conservation, will not only focus students' technological practice and learning on producing a technological outcome that will have positive effects for the environment but also help them see that technological practice can be applied to solving environmental problems. Using the second approach, you would focus on developing a technological product or service and ask students to consider sustainability matters through the development. Here, issues of sustainability are accorded the same priority as issues of aesthetics and function.

These two EfS-based approaches, or a mixture of them, typically bring together many ideas and values that can be overly complex for young students. When endeavouring to cover all aspects of your technology education curriculum, you may consequently find it difficult, perhaps impossible, to include all aspects of sustainability in your teaching. Instead, gradually integrate sustainability ideas into your technology teaching so that sustainability becomes a way of thinking for students and not just another thing to learn.

EfS emphasises knowledge, experience and action dimensions. Knowledge is relatively easy to cover and can be built into, for example, exploration of materials and how sustainable they are. Providing students, young students especially, with experiences directly pertaining to environmental issues is an important—and generally fun—way of helping them reflect on and build knowledge. Such experiences could take place in the school grounds, in the bush, or at the beach. Experiences centred on environmental issues that can be addressed or solved through technology include visits to waste disposal sites or degraded waterways. Just how you might bring sustainability practice into a technology education context is less obvious, but often revolves, in terms of direct actions, around waste-disposal systems such as worm farms and paper recycling. Many other options present, however, when indirect actions are considered, as we show at the end of this chapter.

Taking action is fundamental to learning in EfS, as was discussed in relation to the notion of action competence in Chapter 3 of this book. Technology education itself demands a form of action when its focus is on developing a product or system to solve a technological problem. This action-oriented aspect of technological practice offers a good linking point for EfS. At first glance, bringing in this further layer of complexity (i.e., requiring action for sustainability within technological practice) may seem a little daunting. Added to this is the realisation that young, primary-age students may find it difficult to know how to take self-initiated action for sustainability (see, in this regard, Eames et al., 2006). However, when action in an integrated technology education and EfS context is framed correctly, it can be viewed as students making an active and intentional choice to develop technological solutions in an environmentally sustainable way. So, for example, students might use a renewable material in their work or they might strive to ensure that the messages they convey or the pathways they offer for recycling their products when marketing them or in any other communication about them are clear. These indirect actions help to raise awareness about sustainability issues.

Thus far, we have made the case that technology education and EfS can sit comfortably together. We now examine the technology education primary school curricula of New Zealand and Australia and their potential for EfS. Table 7.1 provides a summary of the themes in each curriculum.

TECHNOLOGY EDUCATION CURRICULA

The technology curricula of Australia and New Zealand have developed over time. Focusing initially on students' technical endeavours, such as practical manufacturing skills in woodwork, metalwork, cooking, and sewing, the two curricula have progressed through phases of design, make and appraise to the contemporary approach of technology education based on developing students' technological literacy. The development of the Australian national curriculum (Australian Curriculum Assessment and Reporting Authority [ACARA],

Table 7.1. Comparison of themes across technology education curricula of Australia and New Zealand.

Country	*Areas of technology*	*Technology strands*	*Content structure*
Australia	Design and technologies	Knowledge and understanding	Use, development and impact of technologies in people's lives Design concepts across a range of technology contexts
		Processes and production skills	Critiquing, exploring and investigating needs and opportunities Generating, developing and evaluating design ideas for designed solutions Planning, producing (making) and evaluating designed solutions
	Digital technologies	Knowledge and understanding	How data are represented and structured symbolically Components of digital systems: software, hardware, network Use, development and impact of information systems in people's lives
		Processes and production skills	Collecting, managing and interpreting data when creating information, and when determining the nature and properties of data and how it is collected and interpreted Using a range of digital systems and their components and peripherals Defining problems and specifying and implementing their solutions Creating and communicating information, especially online, and interacting safely, using appropriate technical/social protocols
New Zealand	Biotechnology control Food Hard materials Information and communication structures Textiles	Technological knowledge	Technological modelling Technological products Technological systems planning for practice
		Technological practice	Planning for practice Brief development Outcome development and evaluation
		Nature of technology	Characteristics of technology Characteristics of technological outcomes

Sources: Australian Curriculum Assessment and Reporting Authority (2014); New Zealand Ministry of Education (2007).

2014b) out of the country's previous states-based curricula has seen the emergence of a dichotomous view of technology wherein digital technologies are kept separate from the other forms of technology, and are labelled respectively as "design" and "technologies"). This separation also exists in the New Zealand curriculum (New Zealand Ministry of Education, 2007), but perhaps to a lesser extent given that digital technologies in the guise of "information and communication technology" still reside alongside other areas of technological endeavour.

In both curricula, learning in technology is structured around knowing and doing through a technological practice approach. In the Australian curriculum, learning is separated into two strands—"knowledge and understanding" and "processes and production skills". A similar structure exists in the New Zealand curriculum, through the strands labelled "technological knowledge" and "technological practice" (see Table 7.1). The most obvious difference between the two curricula is the presence of a third strand, "the nature of technology", in the New Zealand curriculum. Here, students learn not only *in* technology but also *about* technology itself.

The approach to student learning in technology that these curricula imply is one where students learn while actively involved in technological practice. Such practice can be defined simply as "what technologists do", in a similar way to medical practice being described as what doctors do. Several models of technological practice have been developed that attempt to show the holistic nature of technology and the different dimensions of its interactions with human endeavour (see, for example, Kline, 1985; Pacey, 1983). In addition to delineating the technical aspects of technology, such as knowledge of skills and techniques, tools, machines, and manufacturing, the models identify the dimensions of technology. These encompass knowledge of cultural and organisational aspects, such as goals, values, beliefs, ethics, creativity, economic ideologies, and users and consumers.

When considering EfS in technology education, we gain opportunity to focus on issues of sustainability as valid dimensions of technological practice, alongside more traditional dimensions such as function and aesthetics. This more holistic view builds on the earlier models of technological practice and is useful for teachers as we grapple with the detail of curriculum expressions of technology while simultaneously trying not to lose sight of the big picture. This overview of technological practice in terms of its dimensions also allows us to identify the most obvious opportunities for linking EfS into technology education.

In essence, this approach to linking EfS and technology education takes a holistic view of technology relevant for the 21st century, with technological practice positioned not only as engagement with the technical components of technology, but also as appreciation of cultural, organisational and environmental aspects. As teachers, we should be mindful that if our technology programme is one of students simply making stuff, then we are probably not meeting all of the dimensions of technology education that we could be; we will also be significantly diminishing opportunities for EfS.

The curricula structures presented in Table 7.1 support an approach to technology education that provides opportunity to address EfS through authentic, practical, problem-solving technological practice. Adoption of this approach gives prominence to several consistent components of classroom practice. These include investigating/gaining technological knowledge, designing, producing/making, and critiquing/evaluating/reflecting.

Although this list is not comprehensive and although a wider understanding of technology education is not the brief of this chapter, other curriculum research has identified up to 13 components that could be addressed (see, for example, Johnsey, 1995, pp. 203–205). They include identifying, clarifying, specifying, researching, generating, selecting, modelling, planning, making, testing, modifying, evaluating and selling.

When approaching EfS through technology education, teachers can offer the following sorts of activities as a means of linking technological practice and EfS. These activities focus on concepts of environmental sustainability within technological practice. Again, the list is not exhaustive, or prescriptive. Also, depending on the age and previous experience of the children, some or many of the activities can be incorporated into the children's technological practice. Students can thus:

– Plan for environmentally sustainable technological practice by:
  - identifying authentic contexts (the technological problem/need/opportunity /scenario) where environmental and/or social sustainability issues allow possible technological practice
  - recognising characteristics of environmental sustainability in design, such as optimisation, product life cycle analysis, design for disassembly, design for repair, material recyclability, renewability of resources, carbon footprint
  - investigating and identifying the sustainability characteristics of existing technologies, and developing criteria around how these characteristics might be incorporated into or improved on in their own designs.
– Design environmentally sustainable solutions by:
  - identifying the stakeholder groups (including environmental) influencing the technological problem, and investigating their influences on design specifications
  - developing design briefs that take into account not only the technical requirements of the solution but also the views and concerns of stakeholders and environmental considerations, so facilitating culturally, environmentally and socially defensible products, processes and systems
  - planning, implementing, managing and evaluating the design process so that it is directed toward design solutions to technological problems that take into account sustainability as well as functional, aesthetic and production specifications
  - modelling and testing proposed technological solutions with regard to sustainability as well as functional and aesthetic specifications
  - considering the implications of production methods in relation to sustainability issues as well as aesthetic, cultural, ethical, safety and functional factors
  - developing an understanding that technological products are made from Earth-sourced materials and that these resources must be managed for sustainability, with the latter a process which includes consideration of their supply and disposal, their performance characteristics and the possibilities for renewability and recyclability.
– Realising technological solutions by:
  - matching the characteristics of resources with tools and techniques suited to making environmentally sustainable products that meet design challenges
  - selecting and safely using equipment and other resources to meet the requirements and constraints of design tasks focused on constructing technological outcomes,

including concepts, plans and briefs, technological models and fully realised products, to specified quality standards including environmental standards
- understanding how production systems have changed over time in response to changing societal demands, including the change to environmental sustainability, and applying these ideas to their own production systems
- evaluating the fitness for purpose of technological outcomes (product, process or system) against the original specifications and intent (including environmental sustainability) of the problem.

– Developing a greater understanding of the nature of technology by:
  - identifying the impacts, positive and negative, of new technologies on society and the environment
  - developing the understanding that technology is a human endeavour that influences people, communities and the environment in complex ways.

While this list of student activities can seem characteristic of a sequential approach to technology, in reality these activities exemplify a far more reflexive approach to technological practice. This is because students are asked to critique, analyse, value and appreciate the complex relationships between technology and society and to consider these when designing not just the technical aspects of a solution but all aspects of and throughout the process of technological practice. Instead of sequentially "marching" through the process of technology, students take a more iterative approach by asking questions about how the technology they are developing will work and affect other people and the environment. This "conversation" as a designer with respect to a design problem holds great opportunities for developing EfS within technology education and marks one aspect of students developing critical technological literacy and action competence. Donald Schön expresses this potential thus:

> A designer makes things. … This work occurs in particular situations, using particular materials. … Typically, this making process is complex. … The designer shapes the situation, in accordance with his [sic] initial appreciation of it, the situation "talks back', and the designer responds to the situation's talkback. … In answer to the situation's talkback, the designer reflects in action on the construction of the problem, strategies in action, or the model of the phenomena. (Schön, 1983, p. 78)

In summary, the key to integrating EfS into technology education using a technological practice approach is to develop questions that reflect issues of sustainability and can be applied when developing the design brief that students respond to during their technological practice. These questions should identify the specifications of the intended technological product and provide opportunity to bring sustainability issues into the forefront of each student's technology education experience. Such questions also frame the search for relevant knowledge and understanding about technology and how it interacts with society. They furthermore bring attention to how issues of sustainability can influence technological practice.

Whatever the context chosen for teaching and learning in technology, once the technological problem has been identified and students have become involved in technological practice, you and they can discuss and define the characteristics of a successful solution, with these eventually specified in the form of the design brief. Issues of sustainability can be included during development of the brief specifications and discussion of the characteristics of a successful solution. Traditionally, design specifications reflect functional, aesthetic and production issues. In technology education reflecting EfS, issues of sustainability are included during the process involved in designing and evaluating the criteria for success. We now provide some examples of how this process can be achieved in primary school settings.

PRACTICE IN TECHNOLOGY EDUCATION AND EFS

Here we present three examples. The first two begin with an environmental issue and then incorporate some form or forms of technology in the process of finding a solution. The third focuses on a technological problem that includes consideration of sustainability during attempts to find solutions.

1. Education for sustainability incorporating technology education

Learning experiences in technology education should be based on an authentic context that offers students and their teachers the opportunity to identify and address an appealing real-world need or opportunity. Student practice in this type of unit generally follows a process of planning, designing, realisation and evaluation, culminating in the development of a final outcome that is fit for its intended purpose. The following commentary relates to an instance of EfS that incorporated technology education. It tells the story of a group of nine-year-old students and their teacher who identified an environmental problem in their local area and then addressed it using a technological solution. This issue provided students with opportunities to gain experience in the environment, inquire into knowledge about the environment and take action for the environment.

Identifying an authentic context The story begins on the outskirts of a city in New Zealand where a gully system and stream runs behind a group of farmlets and lifestyle blocks. Although the gully is owned by the local city council, local residents maintain it on an ad hoc basis. The gully is bordered on the northern side by an animal research centre. In earlier times, this area provided a popular swimming hole and fishing spot for local families. However, it deteriorated over time, with the waterway becoming blocked with debris, which resulted in the swimming hole also filling up with rubbish and becoming stagnant. Local residents blamed the deterioration on run-off from an old silage (fermented cattle feed) dump located on the research centre's property and not far from the stream. A resident in the area wrote to the local newspaper in an attempt to draw attention to the damage and gain support to reclaim the area as one that families could again enjoy.

The resulting buzz of interest amongst the students and their parents provided a perfect platform from which teachers at a nearby school could launch a unit pertaining to the technology curriculum and the EfS curriculum. The problem provided an *authentic, real-world context* with an environmental focus that was challenging, motivating and provided extensive opportunities for learning in both curricula, as well as necessitating background research associated with bacterial action and the break-down of silage.

Planning for technological practice and EfS action Once the topic was introduced to the students, it quickly gained momentum and initiated animated discussion as students attempted to grapple with how they should proceed. The teacher's role was to ensure that students planned their project carefully by investigating and clarifying the problem, seeking expert help and remaining aware of the needs and interests of the various stakeholders.

Investigating the context The students identified several preliminary investigations during the planning phase. One of the key questions they addressed was whether or not rotting silage was in fact responsible for damage to the stream and, if so, what landowners needed to do in order to prevent further pollution and restore the stream to its original condition. In order to help students fully understand the problem, the teacher suggested they should investigate silage—its purpose, how it is made, and how it is most effectively stored.

A city council environmental specialist visited the class and explained that incorrectly stored silage can result in run-off. Should this run-off drain into nearby streams, it typically impacts on water nitrate levels, plant growth and the ability of animals (fish, invertebrates) to survive in the water. He emphasised that the quality of the stream water running through the gully needed to be confirmed, and he suggested that the students run a series of tests and then compare their results with those gained from a healthy stream. This approach provided the students with opportunity to experience working in a particular environment in order to gather data. The students sought the help of the city council officer to help them carry out the series of tests, first at the gully site and then at another stream known to have very good water quality. The tests included or focused on identification of pH levels, nitrate levels, water turbidity and velocity, plant life, animal life and features of the surrounding catchment area.

Figure 7.1. Students testing water quality in the degraded gully stream.

On receiving the results of this work, the students were surprised to discover that the nitrate levels in both streams were within a similar range. With the help of the city council officer, they decided that run-off from silage was not the only reason for damage to the gully stream. They concluded that a range of factors, largely concerned with management of the stream's banks and bed, was contributing to the damage. The implications for preventing further damage included ongoing maintenance of the stream to remove blockages, planting to provide stability to the banks and create areas of shade, and establishing designated and properly constructed crossings for horses and other animals to avoid compaction of the soil and reduction of its natural absorbency.

Designing and realisation For the students, finding the solution to the water quality problem was more complex than they had originally assumed. With the help of experts from the city council and the research centre, the students and their teacher agreed that the solution needed to focus on sharing the information they had gathered not only with those owners whose land bordered the stream but also with those who had waterways running through their properties that fed the stream. They agreed that the best way to achieve this would be to produce an informational pamphlet for distribution to these landowners. The pamphlet would allow the students to disseminate an important message on sustainable water management practices to those people whose actions were most likely to have an effect on the students' goal of improving the water quality of the stream. The teacher offered students support in designing the pamphlets, especially with respect to providing guidance with formatting, selecting appropriate images and ensuring that the information to be incorporated was accurate and likely to be accepted by the residents whose properties bordered the stream.

Identifying key attributes of the pamphlet During their work on a previous unit, the students had experimented with developing simple pamphlets. Under their teacher's guidance, they now drew on these skills to design and construct a pamphlet that was credible, informative and sufficiently motivating to prompt the receiver into action. The students collected a range of existing pamphlets in order to identify the features of a professionally designed pamphlet. One group of students also visited a local design company to gain further expert advice. This work led to discussions on the characteristics of the target recipients of the pamphlet and on its visual appeal, with the latter requiring consideration of font and picture size. Students also addressed accuracy of information, material selection, and structural details (e.g., number of panels, the position of folds). These elements formed the criteria guiding the students' pamphlet design and the assurance that the final product would meet its purpose. Students selected and checked information for accuracy, determined which images and text would have instant appeal to adult householders and considered how the guidance in the brochures would be received. The success of this work thus relied on students considering the values and attitudes of stakeholders and planning their action accordingly.

Modelling and developing a prototype The teacher had the students form design groups and asked two members from each group to produce a mock-up of their pamphlet so they could ascertain its capacity to impart information before beginning work on the first draft. Students printed several black-and-white models of their pamphlets, each time assessing and refining the content and text/graphic placement in order to achieve the best fit. Throughout, the teacher encouraged the students to keep their final goal in mind and to ensure that they continued to address the previously identified attributes.

Figure 7.2. Completed pamphlets.

Evaluation On completing their modelling and editing work, the students gave their pamphlets to a representative from the research centre for critique and feedback. Several modifications later, the final versions were printed. Before delivering the pamphlets, the school composed a covering letter which explained the nature of the students' project and offered opportunities for feedback through a temporary portal on the school website. The delivered pamphlets and letter were received by residents with considerable interest and goodwill. While the long-term effectiveness of this action is uncertain, the students made extensive individual gains in their understanding of the processes involved in taking personal action to resolve environmental problems.

2. Designing bird-nesting boxes—sustainability and technology

In this example, both sustainability and technology education act as drivers, with the two learning areas complementing each other. Many primary schools have found that bird-nesting boxes form the basis of a topic well suited to this complementarity. The impetus for the topic (i.e., bird-nesting) usually derives from an interest in attracting native birds to the school grounds or in protecting those birds already there or found elsewhere in the local community.

One such example in New Zealand has been a focus on designing nesting boxes for penguins, in particular the world's smallest penguin, the little blue. This penguin can be found nesting in burrows in sand dunes all along New Zealand's coastline. These nesting sites have come under increasing pressure in recent years from the twin threats of coastal development and introduced predators such as cats and stoats. In response to these threats and consequent nesting failures, schools and community groups have been constructing nesting boxes within which the penguins can safely breed. In some instances, schools have collaborated with community groups to build and locate the nesting boxes. Building nesting boxes provides an authentic context for technology education. By allowing students to develop knowledge of the nesting requirements for the little blue, gain empathy for the bird, and learn how to take action for a more sustainable future, the activity meets objectives in both technology education and sustainability education.

As with the first example (stream degradation), it is important that students engaged in this activity take an inquiry learning approach so that they can formulate and find answers to questions that interest them. Teachers can facilitate this process by perhaps introducing the topic through a discussion centred on the problems associated with penguins nesting in the local area. Introductory work might include research about penguins and their place in the marine ecosystem, including their feeding and breeding behaviour. A field trip to a coastal site, possibly at dusk as the penguins come ashore, would help students gain a better understanding of the challenges the penguins face, and help develop empathy. This experience could lead to discussion of possible solutions to the difficulties the penguins experience throughout their breeding season, with the teacher guiding students towards a nesting-box solution.

If students accept this solution, a design phase should ideally follow, during which students consult stakeholders such as coastal landowners, develop a design brief and undertake modelling in order to ascertain the specifications for the nesting boxes. The aspects of function and production would need to be considered, as would decisions concerning choice of materials. These decisions would need to acknowledge sustainability and end-of-life waste issues for the materials, as well as their suitability for the penguins. Key design elements, such as ensuring only the penguins can access the boxes and that the boxes fit aesthetically within the coastal environment, would also be important. A feasibility study designed to consider issues such as costs of materials, access to construction tools, and possibly labour may also be required.

During the realisation phase, keeping the students' learning opportunities in view is vital. Depending on the age of the children, it may be necessary to engage adults (parents, community members) to help construct the nesting boxes, as occurred in a collaboration between a Lions club and Kahutara School (Aorangi Restoration Trust, 2013). However, ensuring that the adults do not alter the design of the boxes without first discussing this matter with the children is of fundamental importance. If adults take over this task, the children's learning about design cannot be assured. Adults can also help with transporting and siting of nesting boxes, and parents can be encouraged to join their children by signing up for a roster to monitor use of the boxes. In addition to periodic monitoring of the numbers of birds coming ashore and assessing how well the technological design process has met the criteria for penguin breeding success, evaluative techniques can be used to ascertain overall project outcomes.

In this example, the production of nesting boxes that lead to successful penguin breeding is an important outcome but is not the main focus. Rather, the key objective is student understanding of technological thinking and practice and sustainability thinking and behaviour, such that the students can transfer their learning to other contexts.

3. A technological problem incorporating sustainability

In this alternative approach to linking technology education and EfS, the chosen context could be one that is independent of environmental connections. To express this thought another way, the authenticity of the context remains an important consideration but the context may not be overtly environmental. For example, a common issue in junior classrooms is that of children bringing small, precious items to school such as toys and marbles that can be easily lost or misplaced, a situation that the children generally find very upsetting. A technological solution to the problem could be to have them design and construct a personal container to hold their special possessions. In addition to helping the children understand the place of design drawing and concept sketching, or the skills of construction, such as measuring, cutting and joining, this type of unit can encompass issues of sustainability.

Reference to the list of possible activities that focus students' technological practice on concepts of sustainability suggests examples that offer the basis of teacher planning. Thus, for example, students could learn about sustainability through the technological practice associated with developing containers for their precious items by:

– Investigating existing containers that will meet their needs and then identifying the sustainability characteristics of those containers and how these might be incorporated or improved upon in their own designs;
– Developing a design brief (set of criteria) for their own individual container that specifies its technical requirements as well as their personal preferences of materials and style, justifying these in terms of the social setting of their classroom (the intended place of use) and the environmental implications of their choice of materials;
– Modelling (including drawing and working models) and testing proposed container designs with regard to sustainability and also functional and aesthetic attributes;
– Matching the characteristics of available resources (tools, techniques, students' skill levels) to the construction requirements of their chosen container, which they have designed to be environmentally sustainable; and
– Evaluating the fitness for purpose of their container against their stated functional, aesthetic and sustainability specifications (as noted in their design brief).

This activity should enable students to understand that materials are resources used in technology and that these resources must be managed for sustainability, with that management including supply and disposal. Questions about the materials (e.g., wood, cardboard, plastic, clay, metal, etc.) the container could be made from would consider, in addition to those regarding ease of manufacture, issues of sustainability. The source of the material and how it became available for them to use, whether it is renewable or non-renewable, how much energy is used in making it, what material will be used to join or fabricate it and what effects all of this might have on the environment become important. As students consider these questions, they will also be learning to identify the impacts, both positive and negative, of new technologies on society and the environment. For example, when deciding which materials to choose for their container, they can identify what wastes will be produced when the container is made of any or all of these materials and the issues of what happens to this waste. Depending on the age of the children, an additional level of consideration could be the life expectancy of the container. The question of what will happen to the container once the children no longer want it can be posed. Can it be recycled or reused somewhere else? What is the product's expected life cycle?

It is important to note from this example that a number of the suggested activities present a logical fit with the specified context (a container for precious things) and the intended technological practice. Another point to note is that no one technology example can include all of the suggested activities, or that there is a linear order in which they should be addressed. The list simply gives examples of the types of activities that assist teachers connect EfS with technology education in a holistic sense.

Many similar opportunities to teach EfS within primary technology education are evident within our communities. Such opportunities should all, however, focus on producing something and lead to indirect or direct action in promoting sustainability messages.

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8. EDUCATION FOR SUSTAINABILITY IN PRIMARY SCHOOL HUMANITIES AND SOCIAL SCIENCES EDUCATION

> As we move into the 21st century, human institutions, from local to global, are facing many economic, social and environmental challenges. Sustainable development is that which is economically viable, socially acceptable and environmentally sound. Development is not sustainable if it does not integrate all three elements. It implies long-term synergy through changes in business practices and lifestyles, as well as the adoption of environmental and social standards to stay within the limits of available resources. (International Union for Conservation of Nature [IUCN], 2002, pp. 1–2)

Today's major news stories show in how many ways people are concerned about sustainability issues. There is concern about our economy, about availability of and access to water for various uses, about safety and peace in our neighbourhoods as well as peace between and within countries, and about whether we will have enough resources to support the world's population and the lifestyles we desire. These are concerns about the sustainability of the way we live and the ways in which people have organised themselves individually and in groups to meet their needs materially, socially and emotionally.

In this chapter, I examine the ways in which the parts of the primary school curriculums in Australia and New Zealand that draw from the social sciences and humanities contribute to children learning about how their society functions and how people and their societies can organise to live sustainably. In particular, I look at how the subjects of geography, history, economics and business, and civics and citizenship, given the ways the two countries include them in their primary school curriculums, can contribute to developing the understanding, skills, values and attitudes necessary for sustainable living. I also outline some important concepts needed to explain sustainability issues from economic and social perspectives, and then proceed to illustrate how inquiry learning for knowledge and understanding and values outcomes involving sustainability can be implemented.

SOCIAL INSTITUTIONS AND SUSTAINABILITY

Understanding sustainability requires understanding concepts and ideas about social behaviour and culture, as well as environment, recognised in the conception of sustainability as having 'three pillars': social, economic, environmental. Such concepts are central to the humanities and social science disciplines. Teaching for and about sustainability requires teachers to hold a deep understanding of these complex concepts so that they can organise effective learning experiences for their students.

N. Taylor et al. (eds.), Educating for Sustainability in Primary Schools, 135–175.

While environmental aspects of sustainability and, more recently, its economic facets are commonly discussed, other important considerations need to be addressed. These include the political and social aspects of sustainability involving language, cultural beliefs and practices, and religious beliefs. Cultural diversity as well as biodiversity is needed to help people adapt to changes in the resources available to them (IUCN, 2002). Having a greater range of ideas and attitudes to draw on during decision-making offers extra options for solving sustainability problems.

Societies form when groups of people recognise commonalities between themselves that enable them to see an identity distinct from that of others (Bulbeck, 1993). It may relate to a territory over which they exert political authority. A society regulates how its common goals will be achieved. This involves the development of norms, social values, modes of behaviour and cultural practices, accompanied by a language that embeds the society's cultural knowledge and mores and enables their transfer to new generations. These *institutions* of a society are the rules that maintain its cohesion, and they include sanctions that discourage people from acting contrary to the rules. Institutions regulate the way people behave in relation to one another and to the territory they control. Our society's institutions are thus a significant factor in determining whether we live sustainably.

Societies everywhere are changing due to the rapid growth of information and communication technologies, increases in the scale of capacity to extract raw materials, the rise of multinational enterprises and global trade, and the growth of world population. Expectations have emerged that people everywhere should be able to live at a standard equivalent to that enjoyed by people in the economically wealthy nations. However, the resultant damage to ecosystems and the unequal distribution of the increased global production currently indicate that further change is urgently needed. The idea that people must accept a level of sustainable consumption rather than an ever-increasing standard of living is put forward as a value that should be reflected in our social institutions (Millennium Ecosystem Assessment [MEA], 2005a). That would require a shift in cultural values and understanding for many, involving an educative process in which teachers of social sciences and humanities can share responsibility (Australian Government Department of the Environment, Water, Heritage and the Arts [DEWHA], 2009).

Economic growth in industrialised economies has been fostered by institutional factors such as the reliance on markets to make economic decisions, private ownership or use of property, ideas of free enterprise, and relatively stable democratic systems of government. Innovation of new technologies, especially digital systems, and the growth of large-scale production and distribution systems, along with policies that promote free trade, have supported the economic integration of the industrialised economies and expanded the exploitation of natural resources, raising expectations of continued growth of living standards. While many people are better off, and there is potential for the benefits to be spread more widely, the increasing production and consumption has had social, environmental and economic impacts ranging in scale from global to local that show it is unsustainable without change to its processes (MEA, 2005a). This is evidenced by concerns about climate change, global warming, water rights, non-renewable energy sources and environmental degradation, with proposed solutions being strongly debated. The disparity between rich and poor continues to grow within and between countries. Eliminating poverty requires political will and institutional conditions that enable people to generate income and produce livelihoods (IUCN, 2002). Property and resource rights determine whether people have secure access to natural resources, and those rights must be supported by education, participatory governance and appropriate business practices and attitudes. Social, economic and environmental sustainability must be addressed together if sustainability is to be achieved.

Fundamentally, the concept of *sustainability* involves human *agency*. The decisions people make about what they do and the consequences of those decisions affect the quality of our lives now and of generations into the future. Unsustainability is recognised as being caused by human activity. Policies to increase sustainability should involve preserving peace, remedying poverty, addressing population growth, conserving and enhancing the resource base, changing the relationship between economics and the environment, and sharing the costs and benefits of economic development equitably. The breadth of the concept is apparent: *sustainability* involves, but is more than *ecological sustainability*, *conservation*, *preservation*, or *heritage*. It involves *quality of life*, *standards of living*, *production*, *consumption*, *distribution*, *equity* and *social justice*. The concept takes account of the explanatory power of the *past* but is mostly concerned with how people act in the *present* and in anticipation of the *future*, as they meet their current *needs*. Sustainability is a *dynamic* state of being. *Change* is expected in our various environments and in the way we do things; the constant is being prepared to consider the implications of our actions to ensure we choose a sustainable way to *act* in every aspect of our *lifestyle*, and to be willing to change when change is needed. A *disposition* that is both flexible and resilient is needed.

USING ECONOMICS IDEAS TO FRAME THINKING ABOUT SUSTAINABILITY

Those of us teaching in the learning areas of humanities and social sciences use concepts and understandings from those disciplines to explain the need for all people, including our students and their communities, to learn to live sustainably. The deeper our understanding of these concepts, the more easily we will be able to plan effective learning sequences for our students. Publications such as *The Ecological Footprint Atlas 2010* (Ewing, Moore, Goldfinger, Oursler, Reed, & Wackernagel, 2010) offer fascinating reading for teachers preparing to teach for sustainability, and there is an abundance of information on the web.

One of the pillars of sustainability is economics. When someone asks what economics is about, the general response usually involves the idea that economics studies the way people use the limited resources available to meet their unlimited wants—labelled as "resolving the problem of scarcity". It is immediately apparent, then, why economics is one of the pillars of sustainability. If we are to meet the needs of people now and in the future, we should ensure that we create and use resources in ways that ensure sufficient resources will be available. This consideration is two-sided. On the one hand, we have to decide what needs should be met, that is, what standard of living we should aim to have and how we can ensure a fair distribution of what is produced. On the other hand, we have to organise the production of the goods and services that will satisfy those needs. How can we ensure a continuing stream of resources when many of our technologies use resources that are non-renewable? Can the invention and innovation of new technologies create new renewable resources? How can we manage the waste created by our production of goods and services and our use of them?

In order to help explain how resources can be used sustainably, ecological economists define resources somewhat differently to how neoclassical economists define them. Ecological economists regard all resources as forms of capital and claim that one requirement for preserving the options of future generations is for us to develop and maintain our capital assets. Capital generates a stream of useful services to satisfy needs over a long period of time. Provided we do not use up our capital faster than it is created, we can have an ongoing stream of benefits from it indefinitely to produce the things people want.

Several types of capital make up the total stock of capital (Daly & Farley, 2011; Porritt, 2005). Each one is important for sustainable living:

– *Manufactured capital:* This includes producer goods (e.g., machinery), publicly owned infrastructure (e.g., roads, communication systems), and durable consumer goods (e.g., houses, cars, furniture). It provides services to the users. For example, a truck provides a transport service; a house provides a shelter service. If the capital item is maintained in working order, the service it provides is what users use up.
– *Human capital:* This includes the knowledge and skills people have learned and the health of the population. Both increase the capacity of people to work, produce and solve problems.
– *Social capital (institutional capital):* This includes rules and regulations as well as society's values, customs and norms. Better social capital produces better social cohesion and order, enabling better production and equitable distribution among people of what is produced.
– *Natural capital (stocks of natural resources):* This form of capital includes renewable resources, non-renewable resources and environmental services. If renewable resources, such as forests and fisheries, are managed sustainably, they will provide a continuing flow of resources to use as they reproduce. In contrast, non-renewable resources such as oil deposits and minerals are gone once used. Of particular importance in meeting our needs are the services that the environment provides us. For example, the environment breaks down waste and assimilates the components back into itself, it absorbs carbon-dioxide (CO_2) and releases oxygen, and it provides supplies of water. It also provides climates, forms soils, offers recreational spaces and contributes to spiritual well-being and cultural identity.
– *Financial capital (money in its various forms):* This form of capital of itself has no intrinsic value for real consumption and production. It is used because it enables transactions to be made and allows valuation of the other types of capital.

To ensure that the stock of capital is maintained, we must ensure that a proportion of everything the economies of the world produce constitutes capital of some sort—at least enough to replace the capital that is used up in producing other goods and services. Achieving this aim is especially problematic with respect to non-renewable resources and environmental services, and it is in these areas that the problems of sustainability are most urgently felt.

If we are to live sustainably, we must:

– Use renewable resources at rates that do not exceed the ability of the ecosystem to regenerate the resources. For example, we need to harvest wild fish at rates equivalent to or less than their breeding rates. If we replant forests harvested for timber, we need to take into account the time it takes for the trees to mature.

– Deplete non-renewable resources only at rates that do not exceed the rate of development of renewable substitutes, thereby ensuring that we are not left without the benefits they provide. For example, we need to use coal and oil resources only at the same rates that we develop alternative energy sources.
– Increase the efficiency of how we use natural resources so that we use less material and energy for each lot of goods and services produced;
– Limit the use of all resources to the level where the waste produced can be absorbed by the ecosystem. Global warming is an example of this need not being met. The volume of carbon dioxide we are producing is more than the atmosphere can absorb without deleterious effects.

Achieving sustainability through maintaining the capital stock does not imply keeping everything, including the natural capital, in its original condition. The concept of sustainability is dynamic. It anticipates change as people provide for their needs. However, it also recognises that other values, such as those that lead to choices about conservation and preservation of assets, need to be weighed against economic values.

The Australian and New Zealand economies mostly rely on systems of markets to decide how goods and services, including resources, will be used, and by whom. Through markets, buyers and sellers of goods and services negotiate the price at which they exchange items of value. The price reflects the value both parties place on the items at the time. Higher prices signal to producers which items consumers want most, and hence what resources should be used for. People pay more for goods and services that provide greater value to them. However, it is well recognised that markets are not a perfect means of allocating resources and goods among users. Prices do not always reflect the full costs of producing some commodities, or the full benefit of them to consumers. For example, at times, waste materials have been disposed of by simply pumping them into local waterways or into the air. This may be a cheap method for whoever is doing the disposal, but it imposes a cost on other users of the waterways and air because the benefit to these users from using those resources is impaired by the presence of environmental pollution. Indeed, until the latter part of the 20th century, air and water in nature were described in economics as "free goods", so abundant that they were not priced and allocated through markets, and so were not included in cost calculations. The economic services provided by the atmosphere and water bodies are now better understood, as is their limited supply, and more realistic pricing is being attached to their use, such as water licensing and moves towards paying for carbon emissions. Conversely, prices may not reflect all the benefits that come from particular goods and services if some benefits accrue to the community in addition to those benefits obtained by the individuals who buy the goods. For example, the members of a community may enjoy the appearance of gardens that surround where they live even though those areas are owned and maintained by individuals. How does the community pay for a benefit such as that?

Economists call costs and benefits not reflected in market prices by a range of names including *externalities*, *spillovers*, *external costs and benefits*, and *non-market costs and benefits*. For people to be able to rely on price signals to help them make decisions about what and how to produce goods and services and about what they want to consume, market prices must measure the total value involved. Making prices include the value of externalities can be achieved by government regulation, such as requiring anti-pollution devices to be used, fitting insulation to limit noise levels, recycling garbage rather than using landfill, and imposing special taxes to ensure that the people or firms responsible pay these costs. The increased prices cause people to consider the real costs of their actions when deciding whether they want particular commodities produced.

A third important consideration put forward by ecological economists is that we should view the macro-economy as a sub-system of human society, which in turn is a sub-system of the global biosphere. We draw from the biosphere (the natural environment) the resources we use to produce goods and we return to it the waste from production and consumption (Daly & Farley, 2011; Porritt, 2005). Such a conception is cognisant of what economists refer to as *opportunity cost*: by using resources for a particular purpose, we must forego the next best possible use. It also acknowledges that models of economic growth must be consistent with scientific principles such as laws of thermodynamics (Porritt, 2005). Unless we take into account the full costs and effects of our economic activity on the biosphere, its capacity to continue to satisfy the future needs of humankind will diminish.

PURPOSE AND STRUCTURE OF HUMANITIES AND SOCIAL SCIENCES EDUCATION

Debate about the purpose and the structure of humanities and social sciences education in schools has engaged commentators for more than three decades (Gilbert, 2003, 2011) and is still ongoing, as evidenced by debates about the content and structure of humanities and social sciences in the Australian Curriculum. There is argument about what knowledge students need to learn and why they need to acquire this knowledge, about how it should be learned, and about how it relates to other parts of the curriculum. Understanding sustainability is foremost among the goals desired by some leading humanities and social sciences educators (Tudball, 2007); other commentators emphasise the benefits of learning the traditional disciplines (e.g., history, geography and economics) for the descriptions, explanations and disciplined thought they provide (Marsh, 2011). Current articulations of these long-running arguments may yet result in changes to how humanities and social sciences subjects are included at primary school levels in the Australian Curriculum. The principles put forward in this chapter should apply to the curriculum detail that may ensue.

Many high-level concepts are associated with *sustainability*, each with a sophisticated meaning. How can young children deal with these ideas, and how can teachers structure learning to enable them to do so? Several principles pertinent to organising curriculum in humanities and social sciences education can help us answer these concerns.

First, the sequencing of topics and learning activities often follows an *expanding environments* approach so that very young children learn through using examples drawn from familiar environments such as their homes and families, their school and local community. With age, a child’s experience is assumed to broaden, and examples are drawn accordingly to take in regional, national and, eventually, international examples. This approach enabling students to link new understandings to their prior knowledge and experiences is used in each of the humanities and social science subjects of the Australian Curriculum and is implicit in the social sciences learning area of the New Zealand Curriculum. The strength of an expanding environments approach lies in its intention for students to develop meaningful understanding of their familiar circumstances, and because they are dealing with examples commensurate with their experience, they will be able to use inquiry to learn and then act to apply what they have learned. However, given the prevalence of family migration, recreational travel, consumption of imported goods and mass communication within Australian and New Zealand communities, it may be appropriate at times to vary the scale of examples used to illustrate key ideas by using relevant global examples with young students who have that breadth of experience.

Second, the notion of *spiralling* of concept development complements the idea that more complex understanding can be developed through experience over time. Spiralling refers to a process where a concept is introduced to students in a simple example, and revisited in subsequent learning using examples that provide for more complex and varied meanings to be developed. Nuthall (1999) found that students in a New Zealand primary school social sciences class needed to deal with an idea three times in order to remember it. Time is needed to learn complex subject matter, that is, to understand its meaning so that it can be transferred to new problems and settings. As Bransford, Brown, and Cocking (2000) point out, knowledge learned in a variety of contexts is more likely to be conceptual and transferable.

Third, each subject requires students to learn using *inquiry* processes, that is, through an active investigation process which teachers organise with the intention that the children not only learn significant social knowledge and develop conceptual understanding that they can transfer to new situations, they also learn how to learn and to solve problems which they subsequently encounter. Inquiry can thus be used to develop both knowledge and values understanding.

There are several models of inquiry put forward for use in schools with some variation between them in the way student learning activities are conducted (for a summary, see Reynolds, 2014, pp. 52–55). Each of the humanities and social sciences subjects of the Australian Curriculum and the social sciences in the New Zealand Curriculum put forward well-organised inquiry as the basis for engaging students in learning. Essentially, the process for developing conceptual knowledge through inquiry involves students and teachers implementing a study that follows the order of these steps:

1. Deciding that there is something to find out.
2. Establishing a question to answer.
3. Deciding how the inquiry question can be answered: What information is needed? How can it be obtained?
4. Gathering the information.
5. Processing the information—organising, categorising and classifying the raw data.
6. Drawing conclusions from the processed data in order to directly answer the inquiry question.
7. Considering the quality and generalisability of the knowledge developed through the inquiry.
8. Communicating and acting on the new knowledge.
9. Deciding what new questions the inquiry has raised.

Clearly, this process is one requiring time and thought to ensure the inquiry is implemented well. However, the time spent is time well spent, as the process accords with well-established understanding of how children learn (see Bransford et al., 2000, pp. 16–21 especially). The outcome of the process should be students extending what they know and developing knowledge that is new to them in the form of generalisations. These will include elaborated statements of understanding that may involve conclusions, predictions and inferences about the subject matter, incorporating new or refined understanding of the meaning of relevant concepts.

A teacher planning an inquiry-based learning sequence first needs to clearly articulate the generalisations that are the intended outcomes, as well as the concepts that are needed to build those understandings. The teacher needs a deep understanding of the subject matter (in our case, of sustainability from the perspectives of the three pillars—environment, economics and society) so that they can plan the outcomes and content of the learning sequence (Bransford et al., 2000). Using those details as criteria, the teacher can then choose case studies, information resources and activities that will enable their students to work through the inquiry process to develop the specified outcomes.

Generalisations with respect to sustainability that you might want your classes to understand are:

- Living sustainably means meeting the needs of people at present without compromising the ability of future generations to meet their own needs.
- Our present-day consumption uses resources that are both renewable and non-renewable. The nature of that consumption will affect what is available for people to use in the future.
- Our lifestyles and production systems affect the world's ecosystems, some of which are breaking down because of our use. The services the ecosystems provide are consequently failing.
- Our actions as individuals have an effect on how sustainable our communities are. Each person is part of the global systems.
- New technologies can provide new products for us to use and new ways of producing goods and services. We can choose which ones to use to make our lifestyles sustainable.
- We can make choices about our consumption and lifestyle, and those choices affect how we will be able to live in the future, and how future generations will be able to live.
- There are great inequalities in lifestyles and well-being among people. Improved education and poverty elimination measures that reduce inequality will help to increase sustainability.
- Maintaining both cultural diversity and biodiversity contributes to sustainability.

The language that students use to express these "big ideas" will be simpler and will vary between students. They are able to understand such ideas if they investigate multiple examples that illustrate them, and if they are prompted to look at such aspects among the many facets of each situation.

GEOGRAPHY AND EDUCATION FOR SUSTAINABILITY

Learning through well-taught geographical study can make a significant contribution to understanding sustainability at whatever level of education a student is engaged. As the rationale for geography in the Australian Curriculum explains:

> Geography is a structured way of exploring, analysing and understanding the characteristics of the places that make up our world, using the concepts of *place*, *space*, *environment*, *interconnection*, *sustainability*, *scale* and *change*. It addresses scales from the personal to the global and time periods from a few years to thousands of years.

> Geography integrates knowledge from the natural sciences, social sciences and humanities to build a holistic understanding of the world. Students learn to question why the world is the way it is, reflect on their relationships with and responsibilities for that world, and propose actions designed to shape a socially just and sustainable future. (ACARA, 2014q, italics inserted)

The emphasis placed on using the central concepts as the basis of structuring learning in this construction of geography as a school subject provides a guiding framework for teachers preparing school programs. It also provides evidence of the importance of learning about sustainability. In the Australian Curriculum: Geography, *sustainability* is core knowledge, as well as being a cross-curriculum priority as in other subjects in the national curriculum (ACARA, 2014p).

The New Zealand Curriculum similarly includes in the social sciences subject for primary schools, the conceptual strand called *place and environment*, which involves students in learning geographical concepts and skills "about how people perceive, represent, interpret, and interact with places and environments. They come to understand the relationships that exist between people and the environment" (New Zealand Ministry of Education [NZMOE], 2014b). This understanding is developed within the general framework of the integrated social sciences learning area through which "students develop the knowledge and skills to enable them to: better understand, participate in, and contribute to the local, national, and global communities in which they live and work; engage critically with societal issues; and evaluate the sustainability of alternative social, economic, political, and environmental practices." (NZMOE, 2014d). That both curriculums highlight environmental, economic, social and cultural sustainability in their succinct *aims* (ACARA, 2014o) or *vision* (NZMOE, 2007e) statements indicates how highly regarded this learning is.

The Australian Curriculum: Geography does not directly address the central concepts of *sustainability* and *change* until Year 3 (ACARA, 2014n). However, sustainability is flagged as a cross-curriculum priority in both Foundation and Year 1 levels in geography. What appears to be an anomaly is resolved if one considers how an understanding of the central concepts of *place*, *space*, and *environment*, which are addressed in Years F to 2, and *interconnection*, introduced in Year 2, can contribute to understanding the concepts of *change* and *sustainability*.

An efficient and practical way to decide what to include in planned learning for classes is to look closely at the statements of what students are expected to learn. Expectations for student achievement in each year of school in the Australian Curriculum: Geography (ACARA, 2014n) and each level in the social sciences learning area in the New Zealand Curriculum (NZMOE, 2014a) provide guidance for teachers to scope plans and construct programs and activities within schools. For example, the Australian Curriculum: Geography Year 4-level description takes as its premise "the Earth's environment sustains all life" (ACARA, 2014n). The level description defines sustainability and sets out how students at Year 4 should develop that concept. The key inquiry questions provided for Year 4 indicate that the focus for the year's study should be on how people use environmental resources and how they can do that sustainably.

An example of a unit of work in the Australian Curriculum: Geography for Year 4

The description that follows provides an example of a unit of work that responds to the framework provided for Year 4 in Australian Curriculum: Geography (ACARA, 2014n).

Having selected as the focus for a substantial part of the year's work two key inquiry questions from those listed in the Australian Curriculum Geography for Year 4:

> *How does the environment support the lives of people and other living things?*
> *How can people use places and environments more sustainably?* (ACARA, 2014n)

and having completed with the class a unit of work addressing the content description:

> *The location of the major countries of Africa and South America in relation to Australia, and their main characteristics, including the types of natural vegetation and native animals in at least two countries from both continents (ACHGK020).* (ACARA, 2014n)

a teacher might move on to address two additional content descriptions in a new unit of work to enable students to provide responses to the two selected key inquiry questions. Firstly, to ensure that students have essential background knowledge and concepts to draw on for the latter part of the unit, the teacher selects the content description:

> *The types of natural vegetation and the significance of vegetation to the environment and to people* (ACARA, 2014n)

with the elaborations:

> *Identifying the main types of natural vegetation, including forest, savannah, grassland, woodland and desert, and explaining the relationship between climate and natural vegetation* (ACARA, 2014n) and

> *Exploring how vegetation produces the oxygen all land animals (including people) breathe; protects land from erosion by water or wind; retains rainfall; provides habitat for animals; shelters crops and livestock; provides shade for people; cools urban places; produces medicines, wood and fibre; and can make places appear more attractive* (ACARA, 2014n) The teacher adds to this second elaboration an additional point: *Vegetation provides food for people and animals.*

In a unit constructed within that framework students can practise a range of geographical skills, including developing geographical questions to investigate; collecting, evaluating and recording geographical information; interpreting geographical data to identify distributions and patterns and draw conclusions; communicating in written, graphic and tabular forms; and proposing individual action in response to a contemporary geographical challenge.

A unit of work addressing "the types of natural vegetation" and the first elaboration above should be completed so that the relationship between climate and vegetation is understood before the unit outlined in Table 8.1 is implemented. The unit in Table 8.1 incorporates five learning sequences, to be done in the order set out, which address the second elaboration above so as to highlight the essential role of vegetation in biophysical and economic systems and its contribution to people's social and cultural well-being.

Table 8.1. A unit of work for Year 4 students addressing sustainability as a central concept in the Australian Curriculum: Geography.

Inquiry question (for this unit): *Does vegetation matter?*	
Geographical concepts: sustainability; ecological sustainability; economic sustainability; social sustainability; place; environment; location; change; care; natural features; managed features; constructed features; responsibility; significance; vegetation; natural vegetation; cultivated vegetation; conflict; consensus; common good; benefit, cost, trade-off; well-being	
Relevant part of the Year 4 achievement standard [S]tudents … identify and describe the interconnections between people and the environment. … Students recognise the importance of the environment and identify different views on how to respond to a geographical challenge. Students develop geographical questions to investigate and collect and record information and data from different sources to answer these questions … They describe the location of places and their features … Students interpret data to identify … simple patterns and draw conclusions. They present findings using geographical terminology in a range of texts. They propose individual action in response to a local geographical challenge and identify the expected effects of their proposed action.	
Learning activity sequences	**Geographical knowledge and understanding**
1. *Jigsaw research to establish the many ways vegetation is important to people and the environment.* a. *Information gathering*: Students research using internet and library sources to identify ways that vegetation is important to people and to the environment. b. *Analysis*: Classify into three categories: environmental importance, social and cultural importance, and economic importance. Record on a large chart (or concept map) that can remain on display for the rest of the unit. Mark cross links, e.g., between the biophysical examples and the economic examples, and the biophysical and social/cultural aspects. c. *Draw conclusions*: Joint construction of a text that generalises the significance of vegetation to people, animals and the environment. Display with the chart so it can be read from student work areas.	*Content description*: … the significance of vegetation to the environment and to people *Elaboration*: Explore how vegetation produces the oxygen all land animals (including people) breathe; protects land from erosion by water or wind; retains rainfall; provides habitat for animals; shelters crops and livestock; provides shade for people; cools urban places; produces medicines, wood, fibre; can make places appear more attractive (ACARA, 2014n); provides food for people and animals. ***Geographical inquiry and skills*** *Observing, questioning, planning* • Develop geographical questions to investigate (ACHGS026). *Collecting, recording, evaluating and representing* • Collect and record relevant geographical data and information, e.g., by observing *or* from sources such as maps, photographs, satellite images, the media and the internet (ACHGS027). • Represent data by constructing tables and graphs (ACHGS028) *Interpreting, analysing and concluding* • Interpret geographical data to draw conclusions (ACHGS030). *Communicating* • Present findings in a range of communication forms, e.g., written, oral, digital, graphic, tabular and visual, and use geographical terminology (ACHGS031).
2. *Investigate local examples of the use of vegetation—at school, at home and in the local area.* a. *Information gathering*: Use photographs and student knowledge of the three places to develop lists of examples of how vegetation is used locally. b. *Analysis*: Have each student construct a concept map for each place that shows the vegetation use and the benefit derived from that use—both particular instances and general benefits. c. *Draw conclusions*: Generalise how vegetation contributes to the local community and environment. Make the connection to personal well-being explicit.	

Table 8.1. A unit of work for Year 4 students addressing sustainability as a central concept in the Australian Curriculum: Geography (contd.)

3. *Moral reasoning values education activity: Clearing of vegetation in a South American country.* **a.** Students analyse a dilemma text to identify the major issues. **b.** Students compare benefits and costs of the vegetation clearing to the stakeholders involved. **c.** Each student considers ways to resolve the dilemma. **d.** Discuss proposed solutions in the light of the ideas developed in Activity 1 above regarding the significance of vegetation. **e.** Each student writes a persuasive text putting forward their advice for resolving, or at least improving, the sustainability of the situation.	*Reflecting and responding* • Reflect on their learning to propose individual action in response to a contemporary geographical challenge and identify the expected effects of the proposal (ACHGS032).
4. *Application of understandings developed: advice to decision-makers regarding a local vegetation issue.* **a.** Using a local media report of a situation involving differing views about the use of vegetation as the basis for a problem-solving learning activity, students identify that a problem exists and what the concerns of the various stakeholders are. **b.** Students identify what information they need to build their knowledge towards proposing a solution, and then obtain that information. **c.** Students use values analysis to infer the range of values stakeholders hold in relation to the situation. **d.** Each student decides their personal stance: What is important to them about this issue? What would they choose to do? **e.** The class as a whole discusses and decides what should be done and why. Support that outcome in sustainability terms and acknowledge trade-offs that would be involved. **f.** The class as a whole considers the options for action by the class in relation to the example situation.	
5. Each student responds to the inquiry question in the light of the four learning sequences completed: *Does vegetation matter?*	
Assessment: Compare student work with the achievement standard to identify which aspects of the standard are demonstrated.	**Teacher reflection:** • Are students expressing understanding of the desired concepts orally and/or in their writing? Are students considering values positions in relation to the case studies? • Has the reorganisation of the collected information during analysis helped students focus on the targeted ideas? • Have the activities enabled students to develop the targeted geographical skills? • Have the central concept *sustainability* and the general capabilities been adequately addressed in student work?

In order to help students complete the unit's learning activities successfully, the class teacher will need to find or construct the necessary information resources for students to use. These include:
– a list of tested internet search queries;
– a range of coloured photographs of vegetation at the school, in local gardens and in the local area (including natural and urban and agricultural or industrial uses);
– a narrative or report text on competing uses for land in one of the vegetation case study areas in South America and the consequence for the vegetation on that land; and
– a media report about a local situation involving vegetation, such as a heritage listing of significant trees, planting of commemorative trees and gardens, tree removal, planting of windbreak and habitat belts, preservation of remnant native vegetation, establishment of wildlife corridors, establishment of a community garden, or consideration of a fire hazard due to the proximity of vegetation and dwellings.

Very large sheets of chart paper will be needed at the analysis stage of each sequence.

AUSTRALIAN CURRICULUM: HISTORY AND EDUCATION FOR SUSTAINABILITY

As part of the Australian Curriculum taught from Foundation to Year 10 the Australian Curriculum: History is currently required to incorporate *sustainability* as a cross-curriculum priority. Consequently, what is a primary school teacher to make of that curriculum for Years F to 6 when an initial perusal of its year level content description pages reveals an absence of the icon denoting sustainability? Delving further, we find among the many content elaborations provided to assist teachers develop understanding of the content descriptions for Years F to 6, there are only two acknowledging the relevance of sustainability to the specified content. Does this mean that history in the primary school curriculum cannot contribute to a student's understanding of *sustainability*?

A little reading and reflection suggests that this is not the whole story. As pointed out in the curriculum's overview, cross-curriculum priorities "provide dimensions which will enrich the curriculum through development of considered and focused content that fits naturally within learning areas. They will have a strong but varying presence depending on their relevance to the learning area" (ACARA, 2014f). A study of Australian Curriculum: History by primary school students can contribute to their understanding of sustainability through the development of their understanding of the central concepts and inquiry processes set out for Years F-6. This curriculum is organised so that the subject matter students deal with can be supported using examples drawn from their life experiences, with the concepts developed at each level being expanded and applied in subsequent years (ACARA, 2014w).

The rationale and aims of the Australian Curriculum: History posit that the subject develops transferable skills and dispositions, such as "capacity and willingness to be informed and active citizens", "capacity to undertake historical inquiry, including skills in the analysis and use of sources, and in explanation and communication", and "an appreciation of the past and the forces that shape societies" (ACARA, 2014s). Once developed, such capacities can be applied broadly. Suppose a student, presented with a statement that the world cannot support all people at the levels of per capita consumption enjoyed in developed economies, were to ask, "Why not? Could it ever? What changed?" Immediately, concepts, knowledge and skills learned through a study of history are called for, along with those contributed by geography and economics, to explain the problem and answer such questions.

The central concepts to be developed through a study of history as put forward in the Australian Curriculum: History are “evidence, continuity and change, cause and effect, perspectives, empathy, significance and contestability” (ACARA, 2014s, 2014t). From an adult perspective, an understanding of each of these would assist a person to understand the concept of sustainability, and to understand how and why it has come to have the significance it now has and is expected to have in the future so that the person has the knowledge on which to base decisions about their values, lifestyle and political participation. These concepts are particularly pertinent to an understanding of the social, cultural and economic facets of sustainability in general and in particular, to explaining the emergence of unsustainability at the global scale, to analysing colonisation and conflict over resource use, and to elucidating the contestation of responses to measures that could reduce unsustainable practices and increase equity in the distribution of wealth. Further, development of the general capabilities *intercultural understanding* and *ethical behaviour* (ACARA, 2014v) through the study of historical incidents aligns with understandings necessary for social and cultural sustainability.

As a teacher concerned that students develop dispositions to live sustainably, how can you implement a history learning experience to support this curriculum priority? As you plan learning activities for students, choose examples for them to investigate, select and create information resources for them to use and devise questions to prompt their thinking, you can make sure that they consider the implications of what they find out about the past and how that relates to how they live now. One of the benefits from studying history is to see the patterns within society over time.

For example, in the foundation year, students investigate “Who the people in their family are, where they were born and raised and how they are related to each other (ACHHK001)” (ACARA, 2014r). The associated elaboration suggests that, as a class, students show on a world map the places where family members were born and raised. An empathetic awareness of the links between one’s self and friends with other places begun in Year F provides a positive base of benefit to an investigation in a later year when global income inequalities and sustainability are directly addressed. Similarly, in Year 1, when students inquire into “differences and similarities between students’ daily lives and life during their parents’ and grandparents’ childhoods” (ACHHK030) (ACARA, 2014r), they could be asked, “Would you like to live like that now?” This question opens the way for students to consider differences in levels of consumption in terms of the happiness and well-being experienced by the different generations, or the fairness of the lifestyle opportunities available.

The level description for Year 2 requires students move on to study the history of their local area “by examining the remains of the past and considering why they should be preserved” (ACARA, 2014r). For the historical skill “explore a point of view (ACHHS052)” (ACARA, 2014r) an elaboration (one of the two elaborations marked with a sustainability icon) is provided: ‘examining a point of view about changes to the built and natural environment and to daily lives over time’ (ACARA, 2014r). Awareness that a range of perspectives exists about any change contributes to social sustainability when decisions have to be made about the preservation of historical remnants, built or natural.

In Year 5, the focus of study is colonial Australia in the 1800s, that is, a study of the founding of British colonies, the development of one colony, and "what life was like for different groups of people in the colonial period" (ACARA, 2014r). The content description "The nature of convict or colonial presence, including the factors that influenced patterns of development, aspects of the daily life of the inhabitants (including Aboriginal Peoples and Torres Strait Islander Peoples) and how the environment changed" (ACHHK094) (ACARA, 2014r) provides fertile scope for developing understandings about sustainability that are applicable today. The suggested elaboration "investigating the impact of settlement on the environment (for example comparing the present and past landscape and the flora and fauna of the local community)" (ACARA, 2014r) acknowledges relevance to sustainability but rather underplays the potential of the subject matter. The impact of the colony at Sydney on the D'harawal people and the struggle the colony had to provide itself with food teach much about sustainability beyond changes to the environment due to settlement, important though that is.

A study of history by primary school students contributes to EfS by building the children's conceptual frameworks involving the historical concepts of *continuity and change*, *cause and effect, significance* and *perspectives*. All of these are relevant to an understanding of sustainability, as is the development of students' world views and their skills to inquire, interpret and analyse evidence: "[M]aking decisions about sustainability to help shape a better future requires an understanding of how the past relates to the present, and needs to be informed by historical trends and experiences" (ACARA, 2014u).

AUSTRALIAN CURRICULUM: ECONOMICS AND BUSINESS AND EDUCATION FOR SUSTAINABILITY

The subject economics and business is currently being introduced into the Australian Curriculum for students in Years 5 to 10; final endorsement of its published content is pending (ACARA, 2014x). The inclusion of this subject responds to calls for a population that understands economics and business-oriented concepts and ideas and has the skills to participate effectively in various roles as consumers, in business settings and the economy. As the rationale for the Australian Curriculum: Economics and Business points out:

> The study of economics and business develops the knowledge, understanding and skills that will inform students about the economy and encourage them to participate in and contribute to it. The curriculum examines those aspects of economics and business that underpin decision-making at personal, local, national, regional and global levels. Students learn to appreciate the interdependence of decisions made, as well as the effects of these decisions on consumers, businesses, governments and other economies. … This will enable them to contribute to the development of prosperous, sustainable and equitable Australian and global economies, and to secure their own financial wellbeing. (ACARA, 2014k)

As is required for all learning areas in the Australian Curriculum, the subject of economics and business must address the cross-curriculum priority *sustainability* where it is relevant to the content description and where it is appropriate given the learning activity, example, issue or case study the teacher selects (ACARA, 2014j). Since economics is one of the pillars of sustainability, we should not be surprised that the outline in the rationale for the Australian Curriculum: Economics and Business of how the subject supports learning to live sustainably is consistent with the views of the Brundtland Report (United Nations Department of Economic and Social Affairs, 1999) and subsequent United Nations' positions. However, an examination of the subject's aims and its content descriptions reveals that the substance of what students are to learn focuses less directly on sustainability than we might expect given the imperative for economic activity to become more sustainable. Like the history curriculum, but unlike that for geography, the economics and business content descriptions and elaborations across Years 5 to10 have few icons denoting *sustainability*. However, there are points where the designation would be appropriate in addition to where it appears. Teacher planning decisions will determine how well sustainability is actually addressed. They will need to take into account how the concept is addressed in other subjects and in Years F to 4 as well as in economics and business.

The Australian Curriculum: Economics and Business is to be taught only in Years 5 and 6 in Australian primary schools. During these years, students are introduced to the central concept of economics: *scarcity*. The notion of choices being made to decide which *unlimited wants* will be met from the *limited resources* available is fundamental to both economics as a discipline and to sustainability as a practice. As outlined in the subject's overview of the content structure, "economics and business concepts and skills are introduced early in the curriculum; their complexity increases as students move through the year levels" (ACARA, 2014i). Knowing both the concepts and skills of economics and business is necessary to enable the active participation in the economy envisaged to promote sustainability.

Examples of units of work for Years 5 and 6 in the Australian Curriculum: Economics and Business

For Year 5, the key questions focus attention on personal and family decisions about consumption. The first of these—"Why do I have to make choices as a consumer?" (ACARA, 2014h)—provides a broad focus for an initial unit of work wherein several inquiry questions can be put to students to shape their thinking as they develop their concept of scarcity. By beginning to develop an understanding of the meaning in Economics of the basic concepts, students can move towards a position from which to think about sustainability-related aspects.

The inquiry sequences outlined in Table 8.2 lead students towards questioning how the disparity between unlimited wants and limited resources could be adjusted. If, through the activities of the two sequences, students have grasped notions such as why wants are unlimited, why it may be more important to meet some than others, and why there are limited volumes of goods to satisfy wants, they might suggest solutions that include increasing the volume of resources used, changing the technology of production so more is produced, reducing the number of consumers or altering what each person wants. These ideas are central to the concept of sustainability and, once raised, a foundation is formed for their further development and evaluation as solutions. At this point in their learning, it is not necessary to explicitly use the term *sustainability*, although students might recognise it from learning in other subjects and hence use it. Ensuring that students consider the implications of satisfying consumer wants relevant to sustainability is enough, so they can draw on that understanding in subsequent learning activities.

In Year 6, one of the key questions (ACARA, 2014h) for inquiry is “What are the possible effects of my consumer and financial choices?” The economics and business skill of “questioning and research” states that students should form “questions to guide an investigation of an economic or business issue or event, and gather data and information from observation, print and online sources”, with a suggested elaboration, “developing questions that will investigate how decisions affect others, for example, “How does what I buy affect other people and the environment?” (ACARA, 2014h). An inquiry based on those criteria follows on well from the unit *Why do I have to make choices as a consumer?* set out in Table 8.2 for implementation in Year 5. It provides the opportunity to advance students’ understanding of sustainability in Year 6.

Table 8.3 sets out a learning sequence that addresses concepts relevant to the key question, the cross-curriculum priority sustainability, and economics and business skills. It could also be relevant to other subjects such as Australian Curriculum: Design and Technologies. This learning sequence uses for its main sources of information an onsite interview and observation of production at a local firm, with students later drawing inferences about who else is affected by the production activity. By using a consequence chart to organise stated and inferred connections extracted from the information provided at the business, the connection will be made between students wanting the product and the flow-on effects of its production to others and the environment. A consequence chart is a form of graphic organiser that makes the outcomes of production decisions easy to see. Having constructed it, students will be easily able to support their generalisations with multiple examples about the effects of their consumer choices that link to the range of inputs and outputs of the production activity.

Subsequently, students’ awareness of the significance of the consequences of their consumption decisions can be increased by applying the concept of their *ecological footprint* to their consumption activity. Before students use one of the online ecological footprint calculators (e.g., WWF Australia, n. d.) to estimate the impact of consumption patterns like theirs on the global biosphere, you will need to carefully explain to them the meaning of what is being measured (for teacher background information, see EPA Victoria, 2008; Ewing et al., 2010). After the students have used the footprint calculator, you could add a values education activity to the learning sequence, perhaps in the form of a values clarification process (see the section on this process later in this chapter), as this would help them think about the implications of their ecological footprint score.

Table 8.2. Economics and Business, Year 5: Example of an inquiry unit comprising two sequences introducing economic concepts relevant to sustainability.

Unit: Why do I have to make choices as a consumer?

Sequence 1: Are needs and wants the same for everyone?
Concepts for vocabulary wall: needs, wants, consumer, preference, basics, necessities, luxuries, goods, standard of living, unlimited wants

SEQUENCE STAGE	STUDENT LEARNING ACTIVITY	QUESTIONS TO PROMPT THINKING
Initiate the inquiry	On the electronic whiteboard, show pictures of a range of people doing a range of activities. Move through the pictures quite quickly; flick through again to hypothesise orally each person's likely desired items.	Direct the students to look at these people and think about what each might think is important to own. Briefly canvas suggestions until it is apparent that a great many items could be desired. To transition to the next stage of this sequence, ask students: If you could go shopping today, what would you buy?
Gather information needed to produce desired knowledge (1)	Have each student write on a prepared form the names of 3 items that they would like to buy if they went shopping today.	What three things would you like to buy if you could go shopping today? Encourage students to be specific about the items—e.g., "strawberry milkshake" rather than "a drink".
Analyse and organise the collected data (1)	Collect the forms. Tally the items. Note each different item. For example, count a blue tee-shirt separately to a red tee-shirt. (To keep things moving along in class, counting is best done by several pairs of students, who each process some of the survey forms before transferring their information to a central tally sheet to aggregate the tallies.) Rank the grouped items. Record them (with the score) from highest to lowest on a butcher's paper wall chart.	What items are most wanted by our class? Which items are wanted by few people? How many different items did our class want? Can we group the items in any way? (e.g., types of food, types of games, types of pets; presents for other people; types of clothes) Which classes of items are most popular? Least popular?
Synthesise and conclude (1) (form generalisations)	Complete this sentence (joint construction): A tally of information from a survey shows that in our class ….. (e.g., many different things …; a range of…; the most wanted …; the least wanted …).	What could we say about the information from our class survey? What does it show about what people in our class want?
Gather information needed to produce the desired knowledge (2)	Ask each student to list, on a prepared form, all the things they have used or eaten so far today. After allowing time for some items to be recorded, prompt students to think about items they might have overlooked, e.g., their bed, their home, the school bus	What items have you used today? What have you eaten?

Table 8.2. Economics and Business, Year 5: Example of an inquiry unit comprising two sequences introducing economic concepts relevant to sustainability. (contd.)

Sequence 1 (contd.)

SEQUENCE STAGE	STUDENT LEARNING ACTIVITY	QUESTIONS TO PROMPT THINKING
Analyse and organise the collected data (2)	Tally the items listed. Group like items. Rank the grouped items. Record them (with the score) from highest to lowest on a butcher's paper wall chart.	Are any items used by everyone? Why is that? Which items are used least within our class? Why is that?
Synthesise and conclude (2) (form generalisations)	Complete this sentence (joint construction): A class survey of what students used or ate today showed that…	What can we say about what the class uses each day? What reasons can you put forward for the difference in use between the most used and least used items?
Synthesise both sets of data	Display both charts so that they can be compared.	How many different things does our class use or want to have? What are the similarities between the lists on our charts? What differences are there? Are there some things shown on one chart but not the other? What reasons can you suggest for these differences? Which items on our lists are essential for us to have? Which items are not so necessary but are nice to have?
	Distinguish between needs and wants and relate that to each person's scale of preference (very short teacher exposition).	
	Each student to classify their personally listed items as needs or wants by locating them on a scale of preference continuum with points from left to right: • Must have to live (high preference) • Good to have • Might be nice to have • Not necessary really (low preference)	Think to yourself: Are the items you listed that you would like to buy a need or a want? Would you prefer them to any of the items you have used today?
	Answer the question that heads this sequence. Each student to write a short paragraph response.	Are needs and wants the same for everyone? How many needs and wants are there?

Table 8.2. Economics and Business, Year 5: Example of an economics inquiry unit comprising two sequences introducing economic concepts relevant to sustainability. (contd.)

Unit: Why do I have to make choices as a consumer?

Sequence 2: How are our needs and wants satisfied? Why can't all needs and wants be satisfied?
Concepts for vocabulary wall: resources, limited resources, scarcity, choices, allocate, inputs, outputs

SEQUENCE STAGE	STUDENT LEARNING ACTIVITY	QUESTIONS TO PROMPT THINKING
Initiate the inquiry	Display examples of two of the most popular items from the student generated lists of wants. Ask the class to suggest ways they have been created.	How are these things created? What goes into producing them?
Gather information needed to produce desired knowledge	Working in pairs, students select one of the most preferred items and search the internet for information about its production. Google "How is [item name] made?"	What materials are needed to make [item name]? What processes do people making [item name] do? Where is [item name] made? How does it get to where you can buy it?
Analyse and organise the collected data	Still in pairs, students organise the information obtained into a concept map/flow chart to show a production process, inputs that go into the production, outputs coming from the production (including waste), how the product gets to the point where it can be bought. Display the charts. Selected pairs explain their diagram. (Select charts that show an appropriate order of production and a range of inputs.)	Why have you arranged your information this way? What are the steps to produce [item name]? How far away is [item name] made? How does it get to you? What is used to make [item name]? Can these items be categorised? (Identify and name natural resources, manufactured capital, human resources.)

Table 8.2. Economics and Business, Year 5: Example of an economics inquiry unit comprising two sequences introducing economic concepts relevant to sustainability. (contd.)

Sequence 2 (contd.)

SEQUENCE STAGE	STUDENT LEARNING ACTIVITY	QUESTIONS TO PROMPT THINKING
Synthesise and conclude (form generalisations)	Students orally suggest answers to the inquiry question to the class group; note key points on whiteboard. Each student to write a response to the question.	Answer the inquiry question: How are our needs and wants satisfied? (Prompt so students express the idea of an orderly production process, using different types of resources.)
	Pose the second sequence inquiry question: Why can't all needs and wants be satisfied? Brainstorm reasons until the idea emerges that at any point in time there are limited volumes of resources available.	Do you always get the things you would like? Why/why not? What prevents us from having everything we want? (Link lack of income to spend to not having enough labour or other resources to sell to into production) If individuals can't have everything they want, can whole communities? Why?
	Define scarcity. Briefly outline that the goal of economic activity is reducing the impact of scarcity (brief teacher exposition).	
	Each student to construct a diagram to illustrate scarcity. Display and discuss selected diagrams.	How does this diagram illustrate scarcity? What causes there to be scarcity according to this diagram? Could changes to the system of satisfying wants reduce the problem of scarcity? What would you suggest? (Listen for answers that suggest changing the volume of resources used, changing the technology of production, reducing the number of consumers or what each wants.) Is that possible? What would happen if we tried that solution?
Overall concluding generalisation for the unit (synthesising understandings from both sequences)	What would you say now is the answer to the question: Why do I have to make choices as a consumer? Students make a written extended response explaining the need for choice.	Response could be used to demonstrate meeting part of the Year 5 achievement standard: "… students distinguish between needs and wants and recognise that choices need to be made when allocating resources. … [They] use data and information from different sources. Students present their findings using economics and business terms." (ACARA, 2014h)

Table 8.3. Economics and business, Year 6: Example of inquiry sequence addressing effect of consumer choices on production and sustainability.

Sequence inquiry question: ***How does what I buy affect other people and the environment?***
Concepts for vocabulary wall: production, producer, consumption, consumer, resources, raw materials, regulation, waste, consequence, ecological footprint

SEQUENCE STAGE	STUDENT LEARNING ACTIVITY	QUESTIONS TO PROMPT THINKING
Initiate an investigation	1. Brainstorm the inquiry question; note answers; group ideas; form a simple concept map summarising the categorised ways consumer purchases are thought to affect others and the environment.	When you go shopping and buy something, who else is involved? How are they affected by your purchase? What else is affected? What is your item made of? How was it made? How did it get to you? How did you pay for it? Does that suggest any other effects to you? In other words, what are the consequences of you wanting a product?
	2. Outline how through a site visit students will investigate the production of [name a locally produced food or fibre item that they commonly buy] as an example of the effects of our purchases on others and the environment. Students have to develop questions to conduct the investigation.	Our purpose is to construct a detailed answer to the question "How does what I buy affect other people and the environment?" What questions should we seek to answer by interviewing the owner/manager of [name of enterprise] about how [item name] is produced and distributed?
Gather information needed to produce desired knowledge	Visit to [name of enterprise]. Students use their observations at the site and prepare questions to obtain and record desired information. By prior arrangement with owner/manager, students could also photograph salient aspects of the enterprise.	*Examples of questions to obtain information:* • What do you produce? Why do you produce that? How do you choose what to produce? • How do you produce [product names]? What are the steps needed to produce [product names]? • How many people do you employ? What jobs do they do? Do they live locally? How do they get to work? • What raw materials are used to produce [product names]? Where do they come from? Who supplies them? • Does producing [product name] require much water? Where do you get it? • What tools/ equipment/machinery do you need to make [name]? Where does it come from? • What sort of power/energy do you use for production? • Where are your products sold? How do you sell them? • How are the products transported away? • Are there any rules/regulations about producing [product name]? Why are there such requirements? • How do you manage waste materials? What happens to them? • How do you know what people want to buy? • How has producing [product name] changed while you have been in business?

Table 8.3. Economics and business, Year 6: Example of inquiry sequence addressing effect of consumer choices on production and sustainability (contd.)

SEQUENCE STAGE	STUDENT LEARNING ACTIVITY	QUESTIONS TO PROMPT THINKING
Analyse and organise the collected data	Sort information to construct a consequence chart to show the range of ways that production and distribution of a product affects: • inside the business (e.g., tasks of employees, tasks of owners/managers, organisation of the premises, storages, organisation of time and tasks) • outside the business (e.g., infrastructure needs, supplies of materials, supplies of capital resources, sources of workers, disposal of waste, provision of regulation, appearance of the area, provision of services to enable production, buyers of the product, distributors of the product). • include some of the effects of other firms supplying inputs to this firm.	How does production by [firm name] affect other people and firms? Who does it affect? What categories could we make to distinguish between where and ways it has effect? What are the effects? *(This stage of the sequence is essential. By transforming the data to a new visual format and structure, students form the desired concepts from it, if asked appropriate questions to prompt their thinking towards those concepts.)*
Synthesise and conclude (form generalisations to answer the inquiry question)	Generalise to answer the sequence inquiry question.	Why does [name of firm] produce? Do you think other firms would have the same reason for their production? What would you say now to answer the question we started with: "How does what I buy affect other people and the environment?"
Apply this generalisation to another situation	Explain that economists and ecologists developed the concept "ecological footprint" as a way of measuring the impact of people's consumption on the environment. Provide students with a short exposition (written by you) of what "ecological footprint" means and some examples of national measurements. Students to read. Have students use an online ecological footprint calculator to indicate the environmental impact of consumption patterns such as theirs.	What is meant by "ecological footprint"? What does a score of 1 mean? … above 1? … below 1? What do you usually consume each week? Use the ecological footprint calculator to measure the impact on the global environment of consumption patterns like yours at <http://www.wwf.org.au/ our_ work/people_and_the_environment/human_ footprint/footprint_ calculator/> What is your score? What reasons are suggested for it? If you acted on the suggestions, what would be the effect on businesses you buy from? What might they do? What would be the effect on the environment now? In the future?

Table 8.3. Economics and business, Year 6: Example of inquiry sequence addressing effect of consumer choices on production and sustainability (contd.)

SEQUENCE STAGE	STUDENT LEARNING ACTIVITY	QUESTIONS TO PROMPT THINKING
Reflect	Students write a response to the question: Does what you buy matter? Why? As an alternative to an exposition, why not suggest they write a poem or song to express their view?	Does what you buy matter? Why?

A ROLE IN EFS FOR AUSTRALIAN CURRICULUM: CIVICS AND CITIZENSHIP

Since the most effective outcome of engaging in EfS is that our students develop the knowledge and dispositions to live in sustainable ways, the inclusion of civics and citizenship as one of the four subjects of the humanities and social sciences learning area is welcome. Knowing the civic processes by which decisions are made and influenced at community, state and national levels, and how individuals can participate in making those decisions, is the base from which people can exercise their citizenship, broadly understood to be their willing participation in and contribution to their society in the context of agreed rights and responsibilities.

The Australian Curriculum: Civics and Citizenship focuses primarily on developing students' capacities to actively participate in Australian democratic processes. Thus, it aims to develop each student's:

– sense of identity as Australian in the context of a diverse society;
– skills and dispositions to participate; and
– "knowledge, understanding and appreciation of the values, principles, institutions and practices of Australia's system of democratic government and law, and the role of the citizen in Australian government and society" (ACARA, 2014b).

The contribution of the subject to sustainability is made clear in its rationale (ACARA, 2014e) where we see that the study of civics and citizenship offers students an opportunity to learn to be "active and informed citizens who participate in and sustain Australia's democracy", are aware of "how individuals and groups can influence civic life" and of "Australia's position, obligations and the role of the citizen today within an interconnected world", so that they can "positively contribute locally, nationally, regionally and globally" (ACARA, 2014e). Acquiring these qualities enables students to contribute to achieving sustainability, environmentally, economically and socially.

The curriculum provides opportunity for addressing sustainability via its status as a cross-curriculum priority. It provides a context "for developing students' civics and citizenship knowledge, understanding and skills", through "explor[ing] sustainability issues as they relate to government services and the different levels of government", and through "explor[ing] contemporary issues and develop[ing] action plans and possible solutions to local, national and global issues which have social, economic and environmental perspectives" (ACARA, 2014d). In other words, by choosing examples, case studies and activities that involve sustainability issues and actions, teachers can teach about sustainability in conjunction with civics and citizenship knowledge, values and skills.

The Australian Curriculum: Civics and Citizenship is taught across Years 3 to 10. It is anticipated that students coming into Year 3 will bring relevant, simple understandings (e.g., knowing some rules and responsibilities) with them from their Years F to 2 learning and from their home and community experiences. In Years 3 to 4, emphasis is placed on developing understanding of "how decisions can be made democratically, the purpose of government, rules and laws, community participation, and identity" (ACARA, 2014c). In Years 5 to 6, students learn about Australian parliaments and the origins of their structures and procedures, as well as "civic issues and develop[ing] their understanding of citizenship in local, national, regional and global contexts, and the skills that enable active and informed citizenship" (ACARA, 2014c). In addition to ensuring that students develop the basic descriptive civics knowledge outlined in the curriculum, teachers have the freedom to enliven lessons by using examples of sustainability issues to illustrate the specified aspects of our systems of governance and civic participation.

As an example, for Year 3, the focus of study is democratic decision-making in the context of the need for rules and personal participation in one's community. At this level, attention to sustainability manifests in the form of actively participating in the community, such as helping to reduce pollution or food packaging waste, or by using a sustainability issue as the focus of students developing their skills to construct questions (ACARA, 2014a). In Year 4, the sustainability icon does not appear in the content descriptions and elaborations. However, one of the focuses for the year is local government, among whose purposes is the management of waste and the local environment, especially the built environment. Hence, local sustainability issues, concepts and contestations can be introduced as examples of what local councils do.

The conceptual depth increases in Year 5 where the focus is on democracy and the associated values of freedom, equality, fairness and justice, voting processes, the law, and the role of groups in the community. Many of these concepts are integral to social sustainability; people need an understanding of them if they wish to change institutional arrangements towards more sustainable practices. Year 6 sees a further increase in the depth of understanding of government in Australia and an expansion to the global scale through consideration of obligations beyond national borders. Having learned that the different levels of government in Australia have different roles and responsibilities, students will be able to propose which parliament should take action (or could be lobbied) about a particular instance of unsustainability. They should also be able to evaluate proposals put forward by government bodies. Extending the concept of citizenship as practised by individuals to encompass global citizenship provides an opportunity to further investigate sustainability concerns such as forest depletion, fisheries depletion, sweatshop production and the costs of transporting food globally instead of relying on local production. These studies could be integrated with other subjects such as geography or economics and business.

The strength that the Australian Curriculum: Civics and Citizenship brings to EfS is the knowledge it builds of the processes, institutions and organisations that people wanting to make change need to engage with. This knowledge moves "active participation" from being desirable to being feasible and practical. Further, understanding how to influence decisions of government through inclusive, lawful and peaceful means, such as by voting in a fair electoral system, is in itself a means of promoting sustainability. The practical knowledge and consideration of values provided by learning in the civics and citizenship subject supports the investigations of sustainability included in other subjects across the Australian Curriculum. As students become more adept at identifying sustainability concerns and proposing solutions, and at applying the understandings generated by civics and citizenship learning, they will become more able to shape their proposals toward desirable and achievable outcomes.

EDUCATING FOR SUSTAINABILITY THROUGH NEW ZEALAND'S SOCIAL SCIENCES CURRICULUM

Learning about sustainability and to live sustainably is one of the central tenets of the New Zealand Curriculum. The *vision* underpinning the curriculum states the desire that, through their learning, young New Zealanders will become "confident, connected, actively involved, and lifelong learners … who will seize the opportunities offered by new knowledge and technologies to secure a sustainable social, cultural, economic, and environmental future for our country" (NZMOE, 2007e). The vision elaborates on what those attributes entail, including among the descriptors several that relate directly to sustainability, for example, seeing young people as positive in their own identity and as members of communities. Further, the principles underpinning the curriculum to guide schools' planning, prioritising and review processes include "community engagement" and "future focus" intending that "the curriculum has meaning for students, connects with their wider lives, and engages the support of their families, whānau, and communities", thereby encouraging them "to look to the future by exploring such significant future-focused issues as sustainability, citizenship, enterprise, and globalisation" (NZMOE, 2007b).

This outlook is supported by the emphasis given in the national curriculum to learning values in the interests of being "able to live together and thrive" (NZMOE, 2007d). One of the prioritised values is ecological sustainability. This, in conjunction with the values of respect, community and participation, equity, integrity and diversity that are also listed, indicates that EfS can contribute significantly to the learning intended from the national curriculum. This is the curriculum context in which the social sciences learning area is to be planned and delivered. Each school designs a curriculum, based on the national curriculum vision, principles, key competencies, values, learning area statements and achievement objectives, that is, "meaningful and beneficial to their particular communities of students. In turn, the design of each school's curriculum should allow teachers the scope to make interpretations in response to the particular needs, interests, and talents of individuals and groups of students in their classes" (NZMOE, 2007c).

In the New Zealand Curriculum, "the social sciences learning area is about how societies work and how people can participate as critical, active, informed, and responsible citizens. Contexts are drawn from the past, present, and future and from places within and beyond New Zealand" (NZMOE, 2014c). Among the reasons justifying the inclusion of the social sciences is that through their study students learn to "engage critically with societal issues; and evaluate the sustainability of alternative social, economic, political, and environmental practices … [so that] they develop understandings about how societies are organised and function and how the ways in which people and communities respond are shaped by different perspectives, values, and viewpoints" (NZMOE, 2014d).

Reflecting the breadth of knowledge and understanding encompassed by the social sciences disciplines, four conceptual strands are included in the structure of the learning area: identity, culture and organisation; place and environment; continuity and change; and the economic world. Schools must draw on all four strands in the programs of learning they devise. Clearly, the disciplines of geography, economics, history and sociology contribute to the conceptual base of each school's social sciences program. However, it is not these disciplines, per se, that are being taught. Rather, teachers are encouraged to respond to the needs of students and their communities, and to draw on the resources of those communities as they implement the principles, values and key competencies of the national curriculum. One planning option is to structure the school program around central themes, integrating values, competencies, knowledge and skills drawn from a number of learning areas (NZMOE, 2007c), and allowing a focus on real-life sustainability issues (as well as those of citizenship, enterprise and globalisation) along with the spiralling of concepts carried through the learning levels as children progress through primary school.

While a range of approaches to learning could be used, the learning area statement for social sciences suggests a social inquiry approach is suitable.

Using a social inquiry approach, students:

– ask questions, gather information and background ideas, and examine relevant current issues;
– explore and analyse people's values and perspectives;
– consider the ways in which people make decisions and participate in social action;
– reflect on and evaluate the understandings they have developed and the responses that may be required. (NZMOE, 2014b)

Such an approach is consistent with students investigating sustainability and a future focus, if the examples, issues or case studies selected relate to students' current experiences and localities. The success of this approach rests on teachers organising for students to use and evaluate multiple sources of information and to consider a range of applicable—and likely competing—values and perspectives, with the communicated expectation that students will endeavour to develop deep understandings, to reflect on what and how they have learned and the implications that knowledge has for what they should do in relation to the situation they have investigated (Aitken & Sinnema, 2008).

A perusal of the achievement objectives for each learning level (NZMOE, 2014a) provides initial direction for planning learning activities within the overall context of the curriculum principles, values and key competencies. Knowledge and conceptual understandings, skills, and the exploration of values relevant to sustainability can be built up over the years that a student attends primary school if an appropriate series of related achievement objectives is selected to structure the whole school program. As an example, Table 8.4 on the next page presents a selection of achievement objectives across Levels 1 to 5, with sets of concepts relevant to understanding sustainability listed alongside.

The choices teachers make about which concepts will be addressed, and when, will depend on many factors. These include:

– the synergies between the issues and concerns relevant to sustainability of the local community;
– the information resources that are available from the community, in the school or accessible from other sources for use by students;

– the coverage of the strands of the social sciences learning area; and
– the contribution that could be had from integrating these with other learning areas in order to supply the knowledge needed to understand particular sustainability situations in depth.

Teachers' choices will also reflect the depth of their own knowledge about sustainability, and their prior learning in the disciplines contributing to the social sciences.

Table 8.4. Selected achievement objectives for Levels 1 to 5 in New Zealand's social sciences curriculum matched to concepts related to sustainability.

Level	*Achievement objectives*	*Relevant sustainability concepts*
1	Understand how places in New Zealand are significant for individuals and groups. Understand how the past is important to people.	Care of places Personal identity with a place Livelihood, well-being Heritage due to connection with place Community Identity
2	Understand how places influence people and people influence places. Understand how people make choices to meet their needs and wants.	Environment, interaction, interdependence, aesthetics, feelings, recreation, identity, security, belonging, respect for life, biodiversity, regeneration, change, community, sharing, making, buying, livelihood, needs, unlimited wants, limited resources, scarcity, choice, preference, conservation, waste, system, impact
3	Understand how people view and use places differently. Understand how people make decisions about access to and use of resources.	Lifestyle, worldview, culture, equity, responsibility, choice, competition, cooperation, democracy, interaction, interdependence; change, valuing, importance, environment, biodiversity, cultural diversity; stewardship/guardianship, impact, standards of living, quality of life
4	Understand how people participate individually and collectively in response to community challenges.	Democracy, governance, interaction, interdependence, agency, conflict, cooperation, conflict resolution, law, change, social justice, community, citizenship, responsibility, cultural sustainability, social sustainability, social institutions, disposition to act, quality of life, Treaty of Waitangi
5	Understand how people's management of resources impacts on environmental and social sustainability. Understand how economic decisions impact on people, communities, and nations. Understand how the ideas and actions of people in the past have had a significant impact on people's lives.	Resources, capitals, renewable and non-renewable resources, management, production, consumption, waste environments, environmental services, regulation, law, control, participation, responsibilities, costs, benefits, distribution, standard of living, quality of life, intergenerational equity, ecological footprint, technology, globalisation, stewardship, guardianship, economic, social, cultural and environmental sustainability, consequence, cultural diversity, social justice, Treaty of Waitangi, impact

Case studies exemplifying unsustainability will be useful because they provide students with opportunity to propose solutions and action in addition to the new knowledge, skills of inquiry and conceptual development generated. Fortunately, when illuminated by well-chosen examples, such studies readily align to the teaching mechanisms shown to be effective in generating learning in the social sciences:

- Connection: Make connections to students' lives
- Alignment: Align experiences to important outcomes
- Community: Build and sustain a learning community
- Interest: Design experiences that interest students. (Aitken & Sinnema, 2008)

Education for sustainability is prioritised by the principles underpinning the New Zealand Curriculum. As an integrating framework, *sustainability* provides coherence and a future focus to school programs, allowing for students to be active participants in their communities through their learning activities while retaining the conceptual integrity of the disciplines that contribute to the subject of social sciences.

EDUCATION FOR SUSTAINABILITY AND VALUES EDUCATION

People relate to the environment and sustainability in a range of ways reflecting the values that they hold. A continuum of views can be identified which ranges from seeing that all ecosystems and life forms have an intrinsic right to exist independently of people through to seeing the purpose of the environment as being to provide resources to support human life and endeavours, with advances in technologies resolving issues of depletion and extinction. Conceptions of the role of people in the environment such as guardianship and stewardship fit between such extremities. Understanding that a range of attitudes and values underpins people's behaviour enables explanation of both unsustainable and sustainable activity.

The central purpose of EfS is for students to develop a disposition to act—to choose to live in a sustainable way. To do this they have to know how to live sustainably, why it is necessary to do so and how their situations relate to those of others. An appreciation that they have powerful knowledge to apply gives them confidence to use that knowledge and to seek more: it both underpins and provides direction for the action they can take, during their childhood and later.

How they act will be influenced by the values, attitudes and beliefs that they hold. Such values reflect the culture they live in and are evident in the institutions of their society. Children learn about their culture and social institutions at school, but they learn values and attitudes (and a great deal of knowledge) from family and the community as well. Children come to school with sophisticated conceptions about how the world works. These may facilitate or slow down their development of the understandings teachers intend (Bransford et al., 2000). It is therefore important to explicitly plan how to incorporate values education if we really do want to help our students to have a disposition to act sustainably. Implicit in that is the idea that students will develop a capacity to critically analyse situations and to make decisions by applying their values and beliefs in conjunction with their knowledge.

The New Zealand Curriculum is very explicit that values are central to all aspects of schooling, stating that "every decision relating to curriculum and every interaction that takes place in a school reflects the values of the individuals involved and the collective values of the institution" (NZMOE, 2007d). The curriculum sets out the broad objective that, across the curriculum, students will learn about:

– their own values and those of others

– different kinds of values, such as moral, social, cultural, aesthetic, and economic values
– the values on which New Zealand's cultural and institutional traditions are based
– the values of other groups and cultures
[It intends that] through their learning experiences, students will develop their ability to:
– express their own values
– explore, with empathy, the values of others
– critically analyse values and actions based on them
– discuss disagreements that arise from differences in values and negotiate solutions
– make ethical decisions and act on them. (NZMOE, 2007d)

The Australian Curriculum allows that understandings of relevant values will be achieved through the content described for each course and the application of the general capabilities and cross-curriculum priorities across all learning areas. Unlike the New Zealand Curriculum, there is not a separate, specific statement regarding values education in the current structure of the Australian Curriculum documents. However, within each of the humanities and social sciences subjects, values that are intrinsic to the particular subject are mentioned. In the cross-curriculum priority *sustainability*, several aspects to be valued are referred to: protection of the environment, social justice, ecological justice, balance, being informed, diversity, local and global equity, intergenerational equity, fairness, care, respect, responsibility, and consideration of the future (ACARA, 2014g). In relation to social and economic sustainability, we could add the following from the general capabilities of ethical understanding and intercultural understanding: ethical integrity, honesty, resilience, empathy and respect and responsibility, reciprocity, open-mindedness, and critical awareness (ACARA, 2014l).

Strategies for teaching values

There is a range of strategies available to teachers of the social sciences and humanities to implement learning of, about and to act on values. These can be differentiated according to the degree to which each allows students agency to determine personal stances and worldviews, with the range extending from comparatively limited control in values transmission, through values analysis, moral reasoning, values clarification, to action learning where a student's perspectives will be influenced by factors arising from their interactions and reflection within the learning activity. Selecting which values education strategy to use involves choosing one that fits the purpose and subject of the learning sequence.

• *Values analysis*
Values analysis uses a logical and analytical process to identify the range of perspectives and value positions held by people involved in a situation. Its use is appropriate when the curriculum asks that people's values be explored or compared. The analysis relies on the assumption that people act on the basis of their values—what is important to them—which can be inferred from what they say or do. It recognises the significance of differences in values among people, in that based on the same information, people may see quite different solutions to issues. Values analysis is very useful in class because it allows students to discuss a value-laden situation, and the values conflict within it, without having to reveal

their own position. They have the opportunity to see that a variety of values and value positions are possible without having to defend their personal position to their peers.

Using values analysis requires information sources for students to use that report what people said or did in relation to a case study. For example, garbage management is a perennial issue in local communities. Finding a new landfill site and alternatives to landfill, disposing of toxic waste, implementing rules about recycling, reducing the use of plastic bags for shopping, or deciding whether to provide bins for litter are examples of local sustainability concerns reported regularly in local media. These reports not only provide some factual information for developing knowledge about the issue, they also indicate the opinions and activities of the various people and organisations involved, thus providing information from which inferences can be drawn about those people's values in relation to the issue. Through values analysis, students learn about relevant values, that a range of values may be relevant, and about the role that values play in shaping how people resolve issues including the need to compromise when important values conflict.

The steps for implementing a values analysis are:

1. Teacher selects a case study relevant to the program topic involving sustainability concepts.
2. Teacher selects and prepares a stimulus resource exemplifying values-related behaviour relevant to the case study, for example, a newspaper report of a meeting that reveals a range of opinions and behaviours about the issue, or a video clip containing such information.
3. Students use the information resource to (a) identify the people or groups involved; (b) identify what each said or did; and (c) infer reasons for the behaviour (what each person thinks is important is inferred from their statements or actions, i.e., what motivates them). Recording this information in a comparison chart is useful.
4. Students infer values held by each person or group from their reasons and behaviour and (a) group individuals or groups with similar values; and (b) identify values differences and/or conflicts.
5. Students generalise about the values held and their effects on possible solutions to the issue involved.

• *Values clarification*

Students analyse their own values when using a values clarification process. They may compare their values to the values apparent in society (as revealed by a values analysis task, perhaps, or assertions by a cultural leader). The aim in class is to provide students with an encouraging, non-threatening situation within which each of them can reflect on their own responses to a situation. By making their own position clear personally, each student is in a better position to decide how to act.

Given that a person will hold a range of values, and that these will at times conflict, it is important that students learn how to weigh up their value responses. Values clarification is a helpful strategy when dealing with controversial issues, as it is the student's view, regarded as private and legitimate, that the student deals with. However, this apparent strength is also the major criticism of values clarification as a values education strategy: not judging the "clarified values" risks giving tacit approval to hold any value, and clearly there are some that are unacceptable. For example, with regard to sustainability a view that the wealthy can consume extravagantly, with associated high levels of resource depletion and pollution, simply because they can pay for it, is not tenable. Some justification of value positions along with clarity about them is needed to support students knowing how to behave ethically.

To implement values clarification, students:

1. First need to be aware of a range of possible value positions related to the subject of the learning sequence they are engaged in, and of the implications of acting according to those value positions. This awareness may come from a values analysis process they have completed in class and must be based on knowledge about the situation. Accordingly, some preliminary learning of the details of a particular situation must precede students exploring values related to it.
2. Should individually reflect on what is personally important to them with respect to the example.
3. Choose/identify their own values position in relation to the particular case.
4. Recognise the implications (for themselves and others) of acting according to that value.

Students' reflection and choosing can be assisted through engagement in various activities such as rank-ordering of conflicting values, writing journal notes, role-playing, discussing, and creating artefacts such as personal coats of arms that illustrate what is important to them.

• *Moral reasoning*

Moral reasoning provides students with an opportunity to justify their values positions and to increase their ability to make value judgements. This type of reasoning helps them to take responsibility for their behaviour by articulating how it is based on their values. During the process of discussing the options in a moral dilemma situation, students can confront alternative value positions and clarify their own.

Moral dilemma scenarios should present realistic and valuable but challenging choices in a relevant context for students to discuss. Choosing one option should mean that other possible options are lost. Many sustainability situations involve choices that are suitable for creating moral dilemma scenarios. For example:

– How should water be used?
– Who or what should be entitled to the water of the Murray Darling Basin?
– Should recycled water be used for drinking water?
– Should old-growth forests be harvested for woodchips to create jobs for people whose families have lived in an area for generations?
– Who should have use of marine environments?
– Should rainforests in developing countries be harvested for furniture timber used in industrialised countries?
– Should farmland be used to grow pasture for livestock or crops to make biofuels?
– Should mining be allowed in Antarctica?
– Should coal seam gas be extracted in farming areas?

Each of these questions offers potential to construct a dilemma text by putting forward the competing claims of the multiple stakeholders and the potential loss or gain that each alternative would yield.

Use of the moral dilemma strategy requires:

1. The teacher to construct (or obtain) a moral dilemma (actual or hypothetical). A narrative involving the dilemma but without a resolution and written to suit the literacy capabilities

of class members is one option; a news report illustrating conflicting propositions is another.
2. Students analyse the dilemma to identify the major issues. Whole class discussion to ensure the issues are clear to all is useful to conclude this step.
3. Each student thinks about/notes their solution and the reasons for that choice.
4. The teacher forms the students into groups, with the members in each group having different views so there is potential to discuss competing value positions. Each group discusses the dilemma, and states and justifies its conclusion. The resolution may reflect different views; a consensus is not required.
5. Teacher probing to ensure each group has considered the reasons for its decision about how people should act. For example: What do you mean by…? How would you feel if the decision was…? Why is…more important than…? Why is…less important than…? Who would gain if…were chosen? Who would lose most?

Several activities are suited to making the comparisons and predictions students need to use to resolve a moral dilemma. These include constructing comparison tables, consequences wheels and network diagrams showing impacts, writing impact statements, conducting costs and benefits analysis, and role-playing.

• *Values transmission*

Values transmission is used when the purpose of the teaching is for students to learn particular values deemed desirable by the group/s to which they belong. A range of strategies can be used, such as direct instruction about the desired values, lecturing, modelling of roles and of practices, exhortation, having sets of rules in place, immersion in situations where the values are practised, and construction of examples to exemplify the particular values as desirable. Rewards and punishments may be used to reinforce behaviours related to the desired values.

Proponents of values transmission point to the need for children to learn the values inherent in the culture of their family, community and nation if they are to fit in and behave as expected. The passing on of accepted beliefs is an obligation of those responsible for a child's welfare. One of the gains from transmitting values is said to be social cohesion. Questions that arise in this regard are which values should be transmitted and who decides what they are? These questions are particularly pertinent in a pluralistic society where different cultural groups may differ with respect to some values.

Where the rapid adoption of particular values is desirable, as in the current exploitation of ecosystems to meet consumption demands, transmission is an appropriate approach. For example, transmission techniques such as the use of exemplars (MEA, 2005b) and regulations to shape business decisions have been used to change entrepreneurial attitudes to how businesses use resources. Households have been encouraged to *reduce*, *reuse*, *repair* and *recycle* for some time. Many businesses now report similar changes to make their practices more sustainable. They have been encouraged to *redesign* the goods they produce so they can be repaired and recycled and to *revise* the way they produce these goods so as to increase the potential for everyone to live sustainably.

The transmission of values is widely regarded as a responsibility of schools and is evident in what happens in schools (NZMOE, 2007d). Curriculum documents and policies indicate sets of values that students will be "encouraged to value" (NZMOE, 2007d) become "aware of" or "identify and describe" through the content of the course (e.g., ACARA, 2014n). Governments promulgate sets of values to be taught (Commonwealth of Australia, 2005; NSW Department of Education and Training, 2004). Religious beliefs dictate some of the values positions taught in church schools. The "hidden curriculum" inherent in school culture and procedures provides values-based understandings. Seeing schools as part of the way children develop affiliation for their culture and communities, and allowing for them to engage with that process in an inquiring, critical way, provides for appropriate use of transmission as a values education strategy (Hill, 1994). Values about and contributing to sustainability are needed to underpin urgent action from personal and local to global levels; each of these sources of direction to schools about the values they are expected to teach includes values that relate to sustainability.

• *Action learning*

Because the goal of EfS is for students to choose to act in sustainable ways, and thus act as a catalyst for others to adopt sustainable practices, it makes sense that students learn how to implement their understanding. Action learning, also referred to as experiential learning or service learning (Commonwealth of Australia, 2010; Gilbert, 2014; Marsh & Hart, 2011), is the values education strategy that provides the most agency for students forming values. Through their experiences as they take action, students gain insights that may cause them to refine their understanding and value positions.

New Zealand's social sciences learning area encourages teachers to engage their classes in activities in their community which provide experiences that help students form beliefs and values (NZMOE, 2007a). In Australia, teachers are encouraged to provide for students "exploring values and principles through authentic situations" (ACARA, 2014m), and this is consistent with the principles of the Sustainability Curriculum Framework (DEWHA, 2010). Jensen's *action competence* model, outlined in Chapter 3, is an alternative model which suggests what to do when it is not feasible for students to actually engage in activities outside the school due to time, cost and safety constraints or because of the scale or location of the case they are learning about. The model shows how students can still engage in forms of action in class, with the activities extending the understanding they have developed using the values education strategies outlined above, and creating a greater sense of agency for them.

On the basis of the information that students gain about and from an authentic situation they are involved with and on the basis of the relevant values they hold, students consider what actions could possibly be taken and whether they should act. This process, consistent with civics and citizenship learning, relies on them learning decision-making strategies and ways to participate in society.

Having engaged in a process of values analysis, clarification or moral reasoning, students apply their conclusion to the situation. At this point, they should:

1. List all of the alternative actions that could be taken in that situation, including the "do nothing" option.
2. For each possible action, predict the consequences/implications of taking that alternative.
3. In the light of their predictions, choose which of the actions they favour and rank these actions. (This step involves ethical as well as practical considerations.)
4. Decide whether to take action, and justify the decision.
5. Act, and evaluate/reflect.

The level of action can vary from activities such as poster displays or performances at assembly aimed at raising awareness within a school, to letter writing, changing personal practices and lobbying others to change, to quite large-scale projects in the community. A significant consideration is to select a course of action that is feasible for students, the teacher and their school. For example, for young students, social sustainability could be promoted by building a "sister-school" relationship with a school in a developing economy to assist it materially as well as providing for the exchange of cultural information between the two schools. As part of a study of change in the local built environment, ecological sustainability could be promoted by students taking responsibility for creating favourable local habitat conditions for displaced wildlife such as frogs, lizards and birds in urban areas. They could do this by providing nesting sites, water supplies and food sources through native plant plantings and by limiting hunting by their domestic pets. Economic sustainability could be advanced among students when, in response to an investigation of the use of non-renewable resources, they choose to use reusable food containers for their lunches, or to reduce their electricity consumption at home by turning off power to appliances when not in use.

PROBLEM SOLVING WITHIN THE HUMANITIES AND SOCIAL SCIENCES AS A STRATEGY FOR EDUCATION FOR SUSTAINABILITY

Problem solving incorporates the processes of cognitive inquiry, which produces knowledge about a situation, and values inquiry, which provides the basis for making decisions to solve problems inherent in the situation. Given the emphasis on preparation for responsible participation in society in the aims of humanities and social sciences education curriculums, problem solving can be a very fruitful strategy. This is because it provides for students to act immediately to improve the sustainability of a situation at the same time as they are learning how to live sustainably through investigating it. Problem solving is consistent with the futures focus and social inquiry approach of the New Zealand social sciences curriculum and the inquiry processes of the subjects of geography, economics and business, and civics and citizenship in the Australian Curriculum. History, with its emphasis on explaining the past, can contribute to problem solving in the present by suggesting reasons why a problem currently exists, thereby providing a context in which knowledge from the other disciplines can be applied.

Problem solving must involve students working from a strong knowledge base so that the solutions they propose are reasonable. The Australian Sustainability Curriculum Framework (DEWHA, 2010) provides a framework of three organisers, named as *sustainability action process*, *knowledge of ecological and human systems*, and *repertoires of practice*, which integrate to structure problem-solving learning experiences, although some schools may wish to increase the weight given to the values component. In general, the steps of a problem solving sequence are:

1. *Identify and state the problem:* Examine information/evidence that a problem exists. What is happening? Establish exactly what the class will address. For example, distinguish and select an aspect of a larger issue as the problem.

2. *Develop knowledge about the problem:* Inquire into the situation. Find reliable background information to build knowledge of the situation. Ensure students use good information sources.
3. *Values analysis:* Identify the parties involved in the problem and what they think is important. Identify value differences and conflicts, and alternative value positions.
4. *Values clarification:* Students identify/decide their own value positions in relation to the problem to provide criteria for their decisions.
5. *Make a decision:* Identify the people or groups who could act in resolving the problem. Identify alternative actions that could be taken. Predict consequences/implications of each alternative. Rank the alternatives—consider desirability and feasibility.
6. *Take action:* Choose what action to take. Could it be taken by the class as a whole or is individual action more appropriate? Should the action be referred to other bodies? Can students engage in action in the community? Establish roles and responsibilities for the action chosen.

Although many sustainability concerns are described as problems, they are not all equally suitable for use in class in problem solving sequences. Better examples provide for local action so that students feel that they can contribute, and learn the skills to do so. It must be feasible for students to take action once they have decided what the course of action should be. Problems suitable for use in class:

– are meaningful and of interest to the students (they can understand the details and see a connection to themselves);
– are reasonable for students to be involved in (actually have potential for action by the particular class);
– are possible to investigate (accessible and suitable information resources are on hand for students to use);
– allow both knowledge and values aspects to be addressed;
– involve a range of perspectives and values positions;
– have alternative possible solutions;
– are a local example of a bigger sustainability issue;
– have potential for community involvement;
– are relevant to a topic in the school program; and
– are ones the teacher is informed about but is able to step back from when solutions are being proposed (i.e., the students choose how the problem could/should be solved).

Some problem-solving activities initiated in schools have become mainstream activities, with support for implementation from external bodies. When taken up, such activities should still be linked directly to the content descriptions and achievement standards/objectives of the relevant curriculum and organised as problem solving learning activities for the class. One such initiative is the *Travelsmart* program which encourages people to make their travel arrangements more sustainable (Sunshine Coast Council, n. d.; WA Department of Transport, 2014). Another is the *Stephanie Alexander Kitchen Garden Foundation* (SAKGF, n. d.) and its affiliate in New Zealand, *Garden to Table* (GTT, n. d.). Such activities provide authentic, experiential learning opportunities relevant to humanities and social sciences education curriculums and to living sustainably.

CONCLUSION

Humanities and social sciences education is ultimately about sustainability—sustainability of persons, their families and communities, and of civil society, now and in the future. People decide how they will live, individually and in groups. They establish societies and cultures with particular ways of behaving and beliefs. The decisions that individuals and societies make about meeting their needs affect other people and the world's ecosystems and resources. People have had significantly more impact on the world's ecosystems in the last half-century than over many centuries before, so much so that the way societies view those ecosystems has to change. For such change to come about, the institutions of societies and the expectations of people have to be changed to ensure an agreeable and sustainable future.

Humanities and social sciences education (including geography, history, economics and business, social sciences, and civics and citizenship) prepares children to create and participate in their future. By developing a strong base of knowledge and understanding, skills to inquire, learn and communicate, and values that fit with actively participating in their multiple communities and with resolving problems, students will be enabled not only to live with change but also to influence the direction of that change. Those of us who are teachers have a responsibility to plan for significant EfS learning. We need to know about the reality of unsustainability and the details of current environmental, economic and social examples. We also need to know how to structure learning sequences for our classes that enable our students to develop high-level, transferable knowledge. Then we will be able to include learning about sustainability wherever it is relevant in the curriculum.

Learning to live sustainably is currently one of the highest purposes for education. By teaching for sustainability so that children look past the concerns to seeing how they can help to resolve them and to lead their associates to do likewise, we will contribute to resolving issues about sustainability because of our part in creating citizens who are resilient, flexible, informed, optimistic and confident to act.

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PENELOPE SEROW

9. EDUCATION FOR SUSTAINABILITY IN PRIMARY MATHEMATICS EDUCATION

Four mathematics-related issues of common concern to both Australia and New Zealand all reside in the need for students: (i) to have a deeper understanding of mathematical concepts; (ii) to develop the skills they need in order to transfer mathematical understandings across varied contexts and settings; (iii) to be presented with mathematical tasks that are student-centred; and (iv) to develop an understanding of the breadth of sustainability issues that enable them to take positive action in their daily lives. These needs were emphasised in a national numeracy review background paper (Department of Education Science and Training, 2007, p. 20), which outlined three distinct dimensions in reference to numeracy curriculum needs in Australia. These were:

1. the various processes, procedures, skills and abilities that numeracy involves and which thus need to be emphasised and developed;
2. the essential mathematical content that forms the foundation of the models to be understood, applied and analysed; and
3. the variety of situations and contexts within which numeracy practices are experienced and developed.

When addressing the third dimension, primary teachers are in a premium position to focus on issues concerning sustainability because these can serve as a stimulus for mathematics activities and understanding in the classroom. Of particular interest to development in this area is the new Australian mathematics curriculum (Board of Studies NSW, 2012), which describes three cross-curricular priorities, namely, Aboriginal and Torres Strait Islander histories and cultures; Asia, and Australia's engagement with Asia; and sustainability. These priorities "enable students to develop understanding about and address the contemporary issues they face" (p. 41). It is encouraging that the new curriculum acknowledges and supports the foundational role that mathematics fulfils.

In relation to exploration of issues of sustainability, mathematics equips students with the skills to "investigate data, to evaluate and communicate findings, and to make predictions based on those findings. They can measure and evaluate sustainability changes over time and develop a deeper appreciation of the world around them through such aspects of mathematics as patterning, three-dimensional space, symmetry and tessellations" (Board of Studies, NSW, 2012, p. 42). The curriculum also recognises that an understanding of mathematical concepts is required in order to "monitor and quantify both the impact of human activity on ecosystems and changes to conditions in the biosphere" (p. 42).

The mathematical activities presented in this chapter are drawn from the broad curriculum strands of measurement and geometry, number and algebra, and statistics and probability. While each of these strands is applicable nationally not only to Australia and New Zealand but also to many other countries, the syllabus document specific to you may have a different

N. Taylor et al. (eds.), Educating for Sustainability in Primary Schools, 177–193.

method of organising the content. Despite this, the general nature of the mathematical content in Australia and New Zealand has many similarities. For example, the National Australian Curriculum (2012) now merges measurement and geometry, with geometry divided into subsections titled three dimensional (3D) space, two dimensional (2D) space, angles, and position. The New Zealand mathematics curriculum with regards to geometry is divided into various levels that cover 2D and 3D shapes within the contexts of environment, everyday objects and practical problems. The material presented as stimulus for the mathematical tasks and, in many instances, the catalyst for problem-based learning, concerns issues of sustainability. Table 9.1 presents a summary of the activities and corresponding target strands in each country. Various developmental frameworks and research into pedagogies in the mathematics classroom are incorporated into the description of each activity, and each strand acknowledges key research findings in each area. I have included, as examples, the cognitive frameworks in the areas of geometry and measurement that inform the design of corresponding activities.

SPACE AND GEOMETRY

The activities within the strand of space and geometry aim to assist students develop conceptual understandings that demonstrate progression through the five levels of thinking in geometry, known as the van Hiele levels of geometric thinking (van Hiele, 1986). The five levels of the framework thus describe geometric thinking, and the first three levels of these are pertinent to primary education.

Level 1

Figures are judged by their appearance. A figure is recognised by its form or shape. The properties of a figure play no explicit role in the identification of a figure.

Level 2

Figures are identified by their properties. The properties, however, are seen to be independent of one another. For example, the properties are not organised in such a way that students realise that a square is a rectangle.

Level 3

The properties of figures are no longer seen as independent. What is seen instead is an ordering of the properties, with one property preceding or following on from the others. Relationships between different figures are also understood. The activities presented later in this chapter target 2D and 3D figures as well as concepts related to position.

Table 9.1. Summary of mathematics activities.

Mathematics sub-strand	*Activity*	*Target level*	*Focus concept*	*Sustainability context*
Measurement	Packaging	Upper	Volume and surface area of right prisms	Optimum use of materials
	Worldmapper	Middle	Formal area units	Wealth, poverty, population
	Toilet roll timeline	Middle	Timelines	Environmental impact/Indigenous issues
Space and geometry	Solar passive home design;	Middle/ upper	3D construction and properties of 3D figures	Solar energy
	Dynamic geometry software floor plans;	Middle/ upper	Quadrilateral figures and properties	Solar passive housing
	Travel comparisons	Lower	Position	Modes of transport and purchasing local food
Number	Around the world in 20 hands	Middle	Fractions, percentages and decimals	Water conservation
	The flush	Upper	Mental computation strategies	Water conservation
	Chemical responsibility	Upper	Ratios	Chemicals entering the waterways
Statistics	Survey	Middle	Statistical design and investigation	Water management
	Power bill analysis	Upper	Interpreting data	Energy usage and solar power solutions
	Wastage audit	Lower/ middle	Collection and display of data	Reducing waste
Patterns and algebra	Garden beds	Upper	Relationships among variables	Class garden
	Glacier melts	Lower/ middle	Relationships among variables concerning rates	Greenhouse effect
	Fuel consumption of your dream car;	Middle	Connection between variables of consumption and distance travelled	Making an informed choice concerning fuel consumption
	Fast food: from egg to table	Upper	Exploring relationships between two variables from self-collected and researched data	Sustainable food production

Incorporating sustainability issues and emerging technological tools in the primary classroom also provides teachers with an avenue for using information and communication technology (ICT) as a teaching tool as opposed to a presentation tool in the numeracy classroom. Examples of technology used in the activities include dynamic geometry software and interactive, web-based tools. According to Fitzallen (2005), teachers need "to gain an understanding of how ICT can be used to extend students' thinking and problem-solving skills, rather than [to serve as] just a publication and research tool" (p. 253). Many classroom teachers confidently use technology as a presentation or display tool but remain unaware of the potential for ICT to promote concept development in mathematics (Serow & Callingham, 2008) and, more specifically, to link mathematics to sustainability issues. Together, ICT and a focus on education for sustainability (EfS) "can change the nature of school mathematics through engaging students in active mathematical practices such as experimenting, investigating, and problem-solving (Serow, Callingham, & Muir, 2014, p. 218).

MEASUREMENT

The activities incorporating measurement skills are considered within the following framework provided by the Board of Studies NSW (2012, p. 91). This structure underpins all syllabus documents associated with the measurement strand and is not particular to New South Wales. The conceptual levels of the measurement framework are:

1. identification of the attribute to be measured;
2. informal measurement (use of informal units to make comparisons);
3. structure of the iterated unit;
4. measurement using conventional units;
5. relationships between formal measurement units; and
6. knowing and representing large units.

Many students are comfortable with applying measurement formulae in routine situations where they are able to follow a procedure. It is not until they are placed in a non-routine situation that the level of understanding of particular measurement concepts becomes apparent. I urge you to consider non-routine tasks in cross-curriculum contexts such as social practice situations, where students are required to apply higher-order problem-solving skills. Many opportunities exist to explore the rich data associated with sustainability. Such data can be used to assess the development of measurement concepts and to inform future teaching activities in this area.

NUMBER, STATISTICS, PROBABILITY, AND ALGEBRA

The number activities in this chapter focus on developing mental computation as well as the initial concept as opposed to a focus on algorithmic procedures. The statistics activities are developed in a similar manner, that is, by encouraging students to gain a feel for an interpretation of the data that enables them to make more informed choices. In the context of patterns and algebra, the activities target the relationships among the variables and the need for students to take ownership of the mathematical relationships they identify and describe. Algebraic notation is not introduced until the individual student identifies a need for it.

TEACHING FRAMEWORK

Effective teaching in today's mathematics classroom requires us, as teachers, to consider teaching strategies that provide opportunities for learners to discuss the mathematical concepts. A teaching framework that addresses this need was the basis of work by Dina van Hiele-Geldof, and it is highly applicable to framing activities with cross-curricular fertilisation, such as sustainability issues. The five teaching phases (van Hiele, 1986) represent a framework within which to facilitate students' cognitive development as they transition from one level to the next. The phases' heavy emphasis on communication (teacher and students, students with one another) helps students move through the levels because the children have plenty of opportunity to talk about their numeracy concepts and to hear others talk about them.

The five-phase process also lends itself to many teaching styles, with each phase having a specific and important purpose. The summary of phases that follows draws on Serow (2007).

1. *Information:* Students become familiar with the working domain through discussion and exploration. Discussions take place between teacher and students, with these always stressing the content and context to be used.
2. *Directed orientation:* Students identify the focus of the topic through a series of single teacher-guided tasks. At this stage, students are given opportunity to exchange views. This discussion leads to a gradual, implicit introduction of more formal language. Although the tasks are described as teacher-guided, it is important that they remain student-centred.
3. *Explication:* Students become conscious of the new ideas and express these in accepted mathematical language. The concepts now need to be made explicit through the use of accepted such language. Care is taken to ensure that acquisition of the technical language goes hand in hand with understanding gained through the exchange of ideas.
4. *Free orientation:* Students complete activities that require them to find their own way through the network of relations. Students are now familiar with the domain and are ready to explore it. Through their problem-solving, students further develop the required language, especially as they begin to identify cues to assist them in this regard. This phase is an optimum one for exploration of sustainability issues while applying mathematical processes.
5. *Integration:* Students build an overview of the material investigated. Summaries concern the new understandings of the concepts involved and incorporate the language of the new level. While students now have clear ideas of the purpose of the instruction, you, the teacher, will still need to assist them during this phase.

Throughout the five phases, the main aim is to maintain student ownership of the mathematical ideas. As is obvious from the above, language plays a central role. It is only after students have identified and described concepts using their own language that the more technical or formal language is introduced.

The following activities are presented in five sections depicting the five content strands that can be found in some form or another in primary mathematics syllabus documents. Each section presents three activities that vary in complexity across the lower, middle and upper primary stages of development. These stages are not age dependent, and I would not presume to use ages as categories. Your challenge is to design your sequence of activities within the light of the van Hiele teaching phases described above. Many of these activities fit comfortably within the sequence as free orientation activities. Because EfS has a core interest in educating students for taking action towards sustainability, each activity includes ideas for action-taking that could be incorporated as part of that activity. It may not be possible to take action with every activity, but possible actions could at least be discussed.

Measurement activities

Activity 1: Packaging As discussed in Chapter 1, human activity in the form of packaging alerts us to the optimum use of our resources. Packaging is critical to marketing, and designers use many strategies to enhance product appeal while ignoring the ratio between the surface area and the volume of a particular package. This ratio influences the amount of material that is used. Given that much packaging ends up in landfills, this amount represents a huge sustainability issue in terms of waste production and the energy used to produce and transport excessive packaging that may not even be necessary. Consequently, the concept of ratio is important in designing packages for optimal conservation of materials.

When exploring concepts associated with calculating the surface area and volume of right prisms and cylinders with your students, ask them to calculate the surface area of different packages that have the same capacity. Students may like to estimate the capacity of similar products before exploring the relationship between the surface area and volume. Also ask them to consider the elements they found appealing about the packaging and the factors that determined the choice of packaging for a product, as well as what designs might be suitable for reducing amounts of packaging. At this stage, students should also consider if a product's marketing strategies might prevent them (the students) from making an informed choice as to what to recommend in terms of reducing that product's packaging.

This activity provides students with excellent opportunities to integrate their conceptual understanding with outcomes in the area of technology education. Action components that could be considered in this activity range from students talking with their parents and/or their peers about products they buy with excessive and hard-to-recycle packaging through to writing to a particular manufacturer responsible for a product which features packaging that the students' mathematical explorations have shown to be excessive and that could either be not used at all or redesigned.

Activity 2: Worldmapper Many activities focus on the progression from the use of informal units through to identification of the need for formal units and, finally, on to the use of formal units. Because such activities often involve measuring classroom or household objects, they provide opportunity during investigation of formal area units to explore sustainability issues such as wealth, poverty and population on an international scale.

One such activity centres on an interactive website known as Worldmapper, developed by the SASI Group (University of Sheffield) and Mark Newman (University of Michigan) in 2006 (Worldmapper.org, 2006). Worldmapper allows students to compare the area of particular countries and continents using a transparent overlay of one centimetre-squared grids to contrast aspects such as size, population, poverty and gross domestic product (GDP). This activity also supports investigation of issues of social justice, which is an EfS concept vital to enabling identification of present-day world problems and possible solutions for effecting a sustainable future. Students can also link these matters to relative levels of consumption in different countries and how these and not just population size can contribute to environmental degradation. One action that students could take in relation to this task is to design posters that show these relative levels of consumption against population size and then display the posters around the school. Figure 9.1 depicts a population cartogram, which enables students to consider issues concerning population density. Consideration of these issues becomes particularly powerful when students begin making comparisons with other cartograms depicting wealth and poverty.

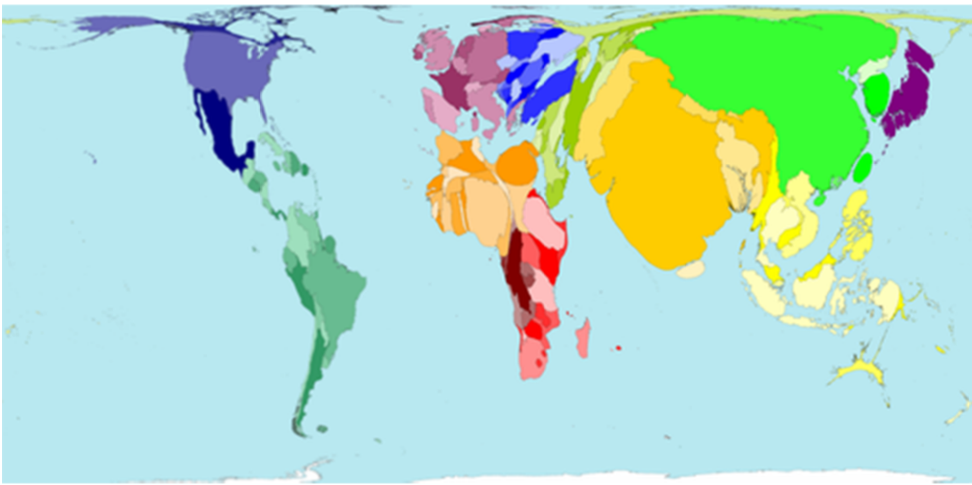


Figure 9.1. Worldmapper population cartogram from Worldmapper.org (2006).

Activity 3: Toilet roll timeline of Australia (context can be changed for any country) A considerable amount of time in the primary mathematics classroom is spent on reading and recording time and comparing the duration of daily events. An activity of relevance in this regard can help our young people appreciate the impact that Europeans have had on the Indigenous peoples of Australia and New Zealand is one that can be part of the creation of a timeline that highlights the important scientific and historical events of the students' respective countries. Rolling out toilet paper along the timeline readily shows the length of time that the first people (Aboriginal) of Australia have existed in their land (about 50,000 years) compared to the time that has passed (a little over 200 years) since the European discovery of Australia. Students can also use toilet paper to compare Aboriginal habitation of Australia with the much more recent Māori habitation of New Zealand, thought to be around 700 to 800 years ago. As an indirect action, consider displaying the timelines in a visible area of the school.

Space and geometry activities

While recognising and naming 2D and 3D shapes is an element of the primary mathematics syllabus, we need to build upon these concepts by helping our students explore the properties of shapes. Some students at the upper primary level will require activities that extend this exploration to an extent that facilitates their understanding of the relationships among the figures and properties. Generally, primary students in any age category are motivated by activities that allow them to construct their own learning objects. Such objects let students explore their mathematical ideas and so gain ownership of these ideas. The following two activities align with this premise. They can be carried out either as connected or separate tasks.

Activity 1: Solar passive home design Discussion of renewable and non-renewable resources is ever present in today's world, and we are also constantly on the lookout for energy-saving devices in our homes. One resource that many households are utilising is solar power. While we can install devices that harness solar energy, such as solar-powered hot-water services, we can also utilise solar energy by designing our homes to passively harness the warmth and light of the sun. One commensurate activity that can be adapted for the classroom is that of designing and constructing a passive home that is positioned and developed to make optimum use of this natural light and heat.

The activity requires students to investigate the position of the sun at different stages of the day and time of year before they design and construct their home. You may find it necessary to require and prompt them to use particular 3D shapes in their designs, such as a range of prisms, pyramids, cylinders, spheres and cones. The properties of these shapes as well as the solar passive design form the foci of the activity.

In a school in New Zealand, groups of students expanded on this "construct a house activity" when they worked with an architect to design a prototype classroom. The students are now fundraising to build the classroom. This is a huge project, but the building of a model for display can satisfy mathematics, technology and education for sustainability (EfS) objectives, and also include indirect action.

Activity 2: Dynamic geometry software floor plans For learners, developing spatial and measurement concepts can be facilitated through mathematical tasks that allow them to control their individual problem-solving environment (Hoffer, 1983, p. 205). Dynamic geometry software (DGS) provides the potential for student-centred problem-solving tasks that remain under the control of the individual student. DGS allows the "continuous real-time transformation often called 'dragging'. This feature allows users, after a construction is made, to move certain elements of a drawing freely and to observe how other elements respond dynamically to other altered conditions" (Goldenberg & Cuoco, 1998, p. 351). Goldenberg and Cuoco also found that the "dynamic nature of these tools makes them both exciting and accessible, even to elementary students" (p. 396). Dynamic investigations enable students to focus on the mathematical ideas within a numeracy task rather than undertake constructions that they are likely to find tedious.

The DGS floor-plan activity requires students to further develop their solar passive home design by focusing on one family room area. Students can use DGS to represent an appropriate floor plan of the room that is sensitive to harnessing natural light and heat. Prompt the students to use all of the quadrilaterals that are familiar to them in their design.

Various forms of DGS are available. One such, named GeoGebra, can be downloaded free (Geogebra Ltd., 2014). This activity could lead to students and their families together investigating how they could trap and use more natural light and heat at home.

Activity 3: Travel comparisons The space and geometry strand includes concepts of position. Primary school students need to develop their representation of position through language and communication in a range of mediums. One such is a focus on today's modes of travel, many of which have a huge impact on our fuel consumption, which, in turn, affects carbon dioxide production and ultimately climate change through global warming. We need to help students develop an awareness of fuel usage and consider the various modes of travel available to us.

Ask your students to describe and draw their route to school or to another place of interest. Build upon this task by placing a selection of fruit in front of the class, with each fruit bearing a sticker depicting its country of production. Ask the students to describe the journey of the different fruits on a world map and to brainstorm the sustainability implications of fruit travelling around the world, compared to the implications of these fruit being locally grown and purchased. This activity could lead to an action such as a locally-produced foods day, during which students are encouraged to bring locally-grown foods to school for display so that they can highlight what is grown near the school.

Number activities

Activity 1: Around the world in 20 hands We are constantly reminded in our daily lives of the need to conserve water and to treat our waterways with respect. If primary school children are to accord this matter the level of importance it deserves, they need to develop an awareness of just how large the percentage of the Earth's surface area that consists of water is. Because the mathematical concepts that sit under the "umbrella" of probability are often used to inform us and help us interpret the future of our environment in terms of sustainability, children can explore the issue of water conservation by comparing chance events in social and experimental situations.

For this activity, you will need an inflatable globe of the world that is approximately the size of a basketball. Ask your class of students to spread out around the room, or somewhere suitable outside. Throw the ball to one student and ask them to take note of where their index finger on the right hand lands when they catch it. Is it on land or water? Keep a tally of the results as you throw the ball around the class of students 20 times. Students should find it easy to convert 20ths to percentages; however, you may find it useful to continue collecting data until your experimental probability gets closer to a land coverage of approximately 30 percent and water coverage of approximately 70 percent. It is important that you and the students discuss the difference between the water composition of the Earth and the planet's water coverage in terms of surface area. However, stress also that most of this water is salty, undrinkable seawater and that only about three percent of the Earth's total water resource is fresh water.

Activity 2: The flush We strive in the classroom to develop sound mental computation strategies in our students. Our students are better equipped for life's numerical challenges if they are armed with a repertoire of strategies that enable them to compute numerically without the need to pick up a calculator or pen and paper. To help our students remain motivated when developing these skills, we need to access contexts for problem-based learning that interests them. While many teachers use the context of sweets, shopping and sport, mental computational activities lend themselves to employing issues of sustainability as stimuli. For example, ask the students to consider the amount of water they use in one flush of the toilet or per minute in the shower. Collecting water along a fraction of the toilet rim (you will need to wear disposable gloves to do this, and collecting this water is not a suitable activity for the children) or collecting water running from the shower for one minute in a bucket, will provide you and the students with an observable means of addressing numerous problems such as:

– How much water does our class use if we each flush the toilet twice per day at school?
– How much water do we use when we have a five-minute shower, 10-minute shower or 20-minute shower?

The questions and discussions that follow questions like these are endless in this problem-based approach to learning.

To add impact to this activity, students could research the question of water globally by writing an empathetic story about a child who has to walk a considerable distance to collect water for his or her family's domestic use, an event that is common among the poorer sectors of society in many developing countries. This activity also suggests a number of possible lead-on actions, including water conservation-based strategies at home and at school, and discussing with fellow students the amount of water their town/school uses each day and the costs of treating this water for human consumption.

Activity 3: Chemical responsibility The concept of ratios is often taught in an abstract manner, making it difficult for students to apply this concept to everyday life, even though their homes are likely to be filled with various containers that include information described as "a ratio". A simple starting point in this regard for your students is for you to display a bottle of cordial accompanied by the instruction to mix four parts water and one part cordial for each drink of the cordial. Many mathematical questions spring from this ratio-based stimulus and will also bring in fractions and measurement.

Having set the context of this activity, ask the students to bring from home, or to copy from the label, 10 different examples of labelling that include information in the form of a ratio. You could ask the students to include five household chemicals, but be aware of age, stage and safety matters in this regard. With younger children, labels should probably be the preference. Use this collection as the stimulus for problems concerning chemicals in our waterways, with information about these problems supported by mathematical calculations. Students could explore different brands of detergents, for example, in terms of amount and strength, as suggested by the manufacturer's instructions. To create an action for this activity, you could extend students' thinking by introducing chemicals that are harmful to the environment, so gaining their understanding of how much (or how little) is needed to harm an environment and the animals and plants that inhabit it. This information, in turn, could provide the basis for some form of indirect action aimed at changing people's behaviours towards the use and disposal of chemicals.

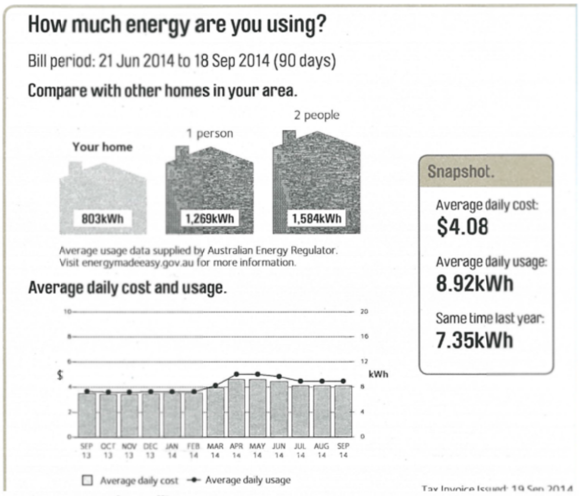
Statistics activities

Activity 1: Survey This area of mathematics has the potential to draw on any issue related to sustainability. If, for example, you remain centred on the issue of water management, you could tackle a statistical investigation via a class-designed survey or you could tap (excuse the pun) into material that is available online and is free. One example is CensusAtSchool (Australian Bureau of Statistics, 2014), a resource that gives you access to a multitude of information collected from Australian schools and allows you to compare data collected internationally. The information on offer ranges from eye colour, through to modes of travel to school and hours spent watching TV per day, and on to student opinions concerning water use and actions taken to conserve water. These data can be transported into statistical-exploration software programs, such as TinkerPlots (Konold & Miller, 2005), which are designed for primary school and lower-secondary school students. Among the avenues you and your students could explore are producing a sticky-note box and whisker plot from data pertaining to the students' class, creating TinkerPlot graphs using class data and exported data, engaging in TinkerPlot-based report writing, and undertaking letter writing that articulates each student's local concerns in regards to water management. Where appropriate, these letters could be sent to local authorities to demonstrate students' concerns.

Activity 2: Power bill analysis The statistics strand includes activities relating to gathering, organising, displaying and interpreting data. We often collect simple data that does little to meaningfully aid our understanding of the world and the relationships between and among its elements. An activity that offers meaningful data focuses on power bills.

In many homes, we can enter the kitchen and see the electricity and/or gas bill attached to the fridge with a magnet. Students can use the information contained on such bills (you might want to bring along your own ones in case parents and caregivers are loathe to share the information contained on them) as stimulus for a range of mathematical activities. This is also a good opportunity to help students make an explicit link between electricity generation (particularly by burning coal) and the production of greenhouse gases and consequently climate change.

In addition to analysing the statistical data the bills contain, you and your students could analyse the power usage for the time of year, predict future use, discuss household tasks that would actively reduce the amount used, and visit relevant websites (e.g., GGas, 2009). The information provided in the example bill provided in Figure 9.2 could also act as a stimulus for primary-age children to explore issues related to solar energy action. Throughout the many opportunities for mathematical explorations and presentations that the bill provides, encourage your students to investigate energy-saving measures in their own homes and to work towards reducing their own energy use. Students could report their efforts back to the class.



New charges and credits.

Usage and supply charges	Units	Price	Amount		
Peak	88kWh	$0.3272	$28.79		
Supply charge	10 days	$1.3125	$13.13		
Price change - 1 Jul 14 to 18 Sep 14 (80 days)					
Peak	715kWh	$0.3131	$223.87		
Supply charge	80 days	$1.3453	$107.62		
Total charges				+	*$373.41*
Credits					
AGL Solar Buyback*	33kWh	$0.08	$2.64cr		
AGL Solar Buyback*	269kWh	$0.08	$21.52cr		
7% Guaranteed Discount			$17.69cr		
Total credits				-	*$41.85cr*
Total new charges and credits				=	*$331.56*
Total GST				+	*$35.57*
Total due (includes GST)				=	**$367.13**

Figure 9.2. Excerpts from an electricity bill for a home that utilises the solar buyback system.

Activity 3: Wastage audit Conduct a home, class or school audit of concepts such as waste produced, power usage and water usage. Various elements of statistics are evident in these activities. Engage your students in data collection, appropriate display of the data and interpretation of the results, which they can then apply to the notion of resource use. If you are teaching upper primary students, extend their activities to include spreadsheet design and further application of TinkerPlots software (Konold & Miller, 2005). Students can interpret and present their audit data in a professional manner using the report-writing facility within TinkerPlots. This activity provides another good opportunity, particularly at the upper primary level, to make links to consumption patterns, waste production and energy use. It can also offer children the chance to discuss the concept of "needs" versus "wants". This activity leads easily into actions aimed at reducing wastage mentioned earlier in this chapter.

Patterns and algebra

Activity 1: Garden beds Many primary-school teachers design activities for their students that involve a class garden, and this overarching theme has many positive benefits, including numerous opportunities for cross-curricular activities, for everyone involved. Often, the mathematics activities surrounding this theme do not extend beyond numbers. The activity described here, known as “garden beds”, targets the strand of patterns and algebra. It focuses on recording, analysing and describing geometric and number patterns involving more than one operation. You might like to extend this approach by using letters to represent numbers and to translate between words and algebraic symbols.

Begin the activity by asking your students to imagine themselves involved in a paving business that specialises in designing and paving square garden beds. As representatives of the business, the students provide each of their customers with a graph that determines the number of tiles required in relation to the garden-side length of the square garden bed. The measurement is done in terms of number of pavers. At this point of the activity, ask the students consider the following paving design (Figure 9.3).

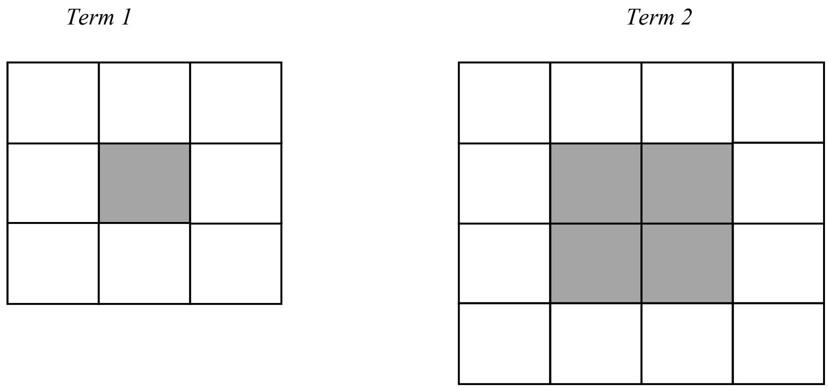


Figure 9.3. Tiles representing garden beds (shaded squares) and paving (white squares).

Next, have the students represent the gardens via coloured plastic tiles, and then record the diagrams for a garden side length of one tile (Term 1), a garden side length of two tiles (Term 2), a garden side length of three tiles (Term 3), and so on. The students could then consider and discuss the two elements that keep changing, namely, the number of tiles needed to pave the garden and the length of the garden bed. After this discussion, ask the students to tabulate the changing values of the two variables. Table 9.2 presents an example of such a table.

Table 9.2.Garden bed table of values.

Length of garden bed in tiles (l)	*Number of tiles needed to pave garden (p)*
1	8
2	12
3	16
4	20
5	24

Now ask the students to find any relationships between the length of the garden bed and the number of pavers needed (the two variables). You may find the responses range from "It goes up by one" or "You always add four to this one" to a response similar to "You multiply the length of the garden bed by four and then you add four." Eventually, you can introduce, for those students who are ready to use pronumerals, the algebraic sentence of $p = 4l + 4$. This step will empower the students to calculate the number of pavers required for very large gardens and could lead to an exploration of equations. After this, you and the students could graph the relationships using grid paper or a graphing program.

There are many versions of the garden beds mathematics lesson. An extensive version involving rectangular garden beds can be obtained from the Maths300 site, an initiative of the Curriculum Corporation and the Task Centre Collective (Maths300, 2010). As with this activity and all others, it is important that you ensure the children can link the garden beds activity explicitly to sustainability issues and thereby increase their relevance. Discussions at the beginning or end of this activity can therefore focus on exploring why producing food locally has particular environmental benefits. Action can also easily be incorporated here, namely, designing and building a garden at school or home.

Activity 2: Glacier melts This activity involves a similar pedagogical process to the garden beds activity. The difference lies in the initial data collection; different because you will need to use an experimental process. You can use various ways to reconstruct the glacier melt scenario that will require your students to identify relationships between time and the amount of water changing from a state of solid to liquid. Brainstorm the different approaches for collecting the data with the class. Students may wish to measure the amount of liquid in different conditions and begin with different volumes of frozen water. Because this task is open-ended, it is accessible across a range of conceptual understandings. An activity such as this one also allows for enhanced assessment of those learning activities that integrate assessment into the teaching and learning sequence.

Activity 3: Fuel consumption of your dream car Primary students of all ages tend to be very aware of the range of new cars on the market and have a good idea of what their dream purchase might be. Given this motivation, introduce the idea of all present and future car owners now being required to consider low fuel consumption as a number one priority when purchasing a car.

Further mathematical investigation concerning fuel alternatives could stem from this activity. Similar to the manner in which we focused on the relationships among variables in the two previous activities, students can consider the variables of fuel and distance travelled for particular makes of car. They can collect the data via an internet search, or you may wish to collect a series of brochures from a local dealer so the children can investigate the specifications. They could graph these to aid further investigation of variables and straight-line graphs.

For your more able students, you might like to have them consider fuel consumption over a journey that has a car travelling at different gradients, which means the rate of fuel consumption changes over time. These data will need to be collected in advance and could lead into discussions on the merits of cruise control and rate of consumption when a car is travelling at a higher speed. An action component here could see students researching the fuel consumption of their family's car(s) and discussing how its consumption rates with that of other fuel-efficient vehicles. Some discussion about peak oil and carbon emissions may be possible here, depending on the age and capabilities of your students.

Activity 4: Fast food, from egg to table One of the most incredible food production stories comes from the humble chicken. A primary school teacher does not need to search far to find some very interesting mathematics ideas that facilitate investigation of egg and poultry production. Reeve and Beswick (2013) describe an exploration of relationships between two variables that involved finding facts about birds and their breeding habits and using TinkerPlots as a technological tool.

The potential for using information related to poultry farming is endless. Classroom explorations could begin with a brainstorm of questions the children might like to explore, such as the following:

- How does the time from hatching to processing compare to the growing time of other consumed meat?
- Is the larger egg always the heavier egg?
- What is the average weight of eggs laid by a chicken over a five-day period?
- How fast does a chicken grow?
- How much does it cost to set up a class-based chicken farm with 10 chickens?
- How much feed and water does a chicken consume after hatching in an incubator over a four-week period?

Egg-production related activities also provide a hands-on and practical strategy for enabling primary school children to explore food production on large and small scales. The context furthermore provides a link to considering the food situation in developing nations and strategies for providing food through poultry farming.

CONCLUSION

Each of the 16 activities described in this chapter utilises equipment and resources that are readily available in most primary school classrooms. The range of activities provided here are by no means exhaustive, of course. Also, the mathematical tasks as described render them flexible and adaptable to the needs of the students within your class. Developing an awareness of sustainability issues and an associated responsibility to take action requires us to make informed choices. As members of the teaching profession, we must get involved. Mathematical understandings have the advantage of providing yet another set of tools we can draw on to aid us in this matter.

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10. EDUCATION FOR SUSTAINABILITY IN PRIMARY ENGLISH EDUCATION

In English-speaking countries, such as Australia and New Zealand, English language forms the basis for communication and understanding about the world in which we live, the way we communicate to others and how we seek to make sense of what is happening around us. In all areas of the curriculum, including education for sustainability (EfS), students' skills in using and manipulating spoken and written language will determine the quality of their understanding and beliefs, and support their efforts to take reasoned action for the future.

Students need to know about, and be able to use, appropriate language for specific purposes across all eight learning areas. This chapter presents some of the recent curriculum developments in primary English education in the Australian and New Zealand contexts. It reviews situated literacies of place, provides some curriculum models as examples for developing language and literacy so that students can take action, provides examples of literature that focus on environmental issues which can be incorporated into studies about EfS, and highlights the language knowledge and skills that students require to develop conceptual understanding about the environment and sustainable practices.

CURRENT DIRECTIONS AND CHALLENGES FOR ENGLISH IN THE AUSTRALIAN AND NEW ZEALAND CONTEXTS

Without a doubt, one of the most exciting and important aspects of being a primary teacher is the teaching of English. No other subject area seems to create as much passion and debate, both as a subject in its own right and its role in the teaching of all subjects across the primary curriculum. English education in Australia underwent significant changes throughout 2009, with these changes including the development of a national curriculum. Past attempts to develop a national curriculum for Australian schools had been beset with difficulties and differences arising between the states and territories and the federal government.

In Australia during 2008, the federal government implemented a consultation process with the education community to determine directions for a national curriculum. Throughout 2009, the National Curriculum Board continued its consultation process. In its initial discussion paper, *The Shape of the National Curriculum: A Proposal for Discussion* (2008a), the board made some reference to the environmental issues facing the planet: "Increasingly complex environmental pressures that extend beyond national borders such as climate change pose unprecedented challenges, requiring countries with different priorities to work together in ways never before achieved. They also demand all Australians engage with science and approach problem solving in new and creative ways" (p. 1).

N. Taylor et al. (eds.), Educating for Sustainability in Primary Schools, 195–219.

In the *National English Curriculum: Framing Paper* (National Curriculum Board, 2008b), there was virtually no mention of links between English and environmental sustainability, nor suggestions as to how English language, literacy and literature could contribute to EfS. However, in the current version of the Australian Curriculum, sustainability is one of three cross-curriculum priorities embedded in all learning areas. Within the Australian Curriculum: English (ACARA, 2014), the "priority of sustainability provides rich and engaging contexts for developing students' abilities in listening, speaking, reading, viewing and writing" This priority area provides opportunities for students to investigate texts that will help to shape their decision-making abilities in relation to sustainability.

In New Zealand, the *New Zealand Curriculum for English-Medium Teaching and Learning in Years 1–13* (New Zealand Ministry of Education, 2007), with its strong focus on diverse social, cultural and language aspects of learning, and a clear vision of "young people who will be confident, connected, actively involved, lifelong learners" (p. 8), covers areas similar to those in the Australian Curriculum. Throughout the New Zealand document, there are explicit references to environmental sustainability, with emphasis on developing young people "who will be creative, energetic, and enterprising" and "who will seize the opportunities offered by new knowledge and technologies to secure a sustainable social, cultural, economic, and environmental future for our country" (New Zealand Ministry of Education, 2007, p. 8).

When referring to English, the New Zealand Curriculum emphasises students using and enjoying language and literature, with this emphasis based on three strands: oral, written and visual. These strands are similar in detail to the previous, and now superseded, Australian state-based curricula. The focus, however, within English education in New Zealand is on the social responsibility of its students and their developing ability "to think critically and in depth … [and] to deconstruct and critically interrogate texts in order to understand the power of language to enrich and shape their own and others' lives" (New Zealand Ministry of Education, 2007, p. 18).

The contrast between the previous Australian and New Zealand contexts may well have been due to the Australian political climate, the negative appraisal of English language teaching in the media, and the comparative size of populations. In the New Zealand context, curriculum documents appear to have a more visionary focus on EfS. However, the inclusion of sustainability as a cross-curriculum priority in the Australian Curriculum and its expression in the English curriculum presents a more encouraging shift.

Which approaches to English?

The Australian media continue to focus on the debate about which approaches to teaching English language and literacy are the most effective. Seeing through this media hype can sometimes be daunting, especially for parents, but also for beginning and experienced teachers alike. In the past, many educators felt the need to align with one particular theory or another. However, while conflicting theories advocate "skill and drill", "whole language", "genre teaching", "systematic and explicit teaching" and, more recently, a "multiliteracies" approach, teachers need to use their professional judgment and choose appropriate methods, drawing on the strengths of various theories to address the needs of students at a particular time, rather than using a one-size-fits-all approach.

In order to implement an effective literacy programme, valuing and understanding our students' backgrounds is essential. Literacy does not mean simply being able to read and write; it encompasses the ability to elicit information and to interpret texts. Students must be able to infer, interact, relate and creatively respond when reading texts. They must also, in order to operate effectively in our complex and demanding society, develop fundamental literacy skills. As teachers, we need to use appropriate assessment tools and teaching and learning activities that cater for all students; it is our role to teach children in a manner that empowers them to become successful, active members of society.

The notion of situated literacies and place

According to Barton and Hamilton (2000, p. 7), the "basic unit of a social theory of literacy is that of *literacy practices*" (emphasis original). In other words, literacy events occur within a social context, and these events are activities where literacy plays a part. Barton and Hamilton suggest that the study of literacy is partly a study of texts whether spoken or written, and of how these texts are produced and used. Because literacy events use a range of semiotic systems (mathematical symbols, non-text based images), Barton and Hamilton explored the notion that there are many different literacies. These include, for example, computer literacy and visual literacy as well as the different literacies relating to different domains such as school, home, the workplace and (in the context of this text) the environment.

In the context of the course "language and ecology" taught at the University of Gloucestershire, Stibbe (2008) identifies additional literacies specific to EfS, such as "environmental literacy" and "ecological literacy", and the more recent "sustainability literacy". He suggests that while sustainability literacy can be interpreted in terms of a more general sense of literacy as "the common quest for a sustainable future", rather than as reading and writing, his interpretation of sustainability literacy is "an ability to read critically, in ways which connect what is being read with the systems which support the lives of current and future generations, as well as being able to write in engaging and creative ways which can contribute to social transformation towards a more sustainable society" (Stibbe, 2008, p. 3)

In the report prepared for the Australian Government's Department of the Environment and Heritage, *Whole School Approaches to Sustainability: An International Review of Whole School Sustainability Programs*, the Australian Research Institute in Education for Sustainability (ARIES) stated: "EfS differs from traditional approaches to EE [environmental education] in that it focuses sharply on more complex social issues, such as the links between environmental quality, human equality, human rights and peace and their underpinning politics. This requires citizens to have skills in critical enquiry and systemic thinking [in order] to explore the complexity and implications of sustainability" (Henderson & Tilbury, 2004, p. 8). Developing "skills in critical enquiry and systemic thinking" and changing attitudes and accompanying practices to environmental sustainability is a challenge for all of us as teachers. Our primary discourse (i.e., our home discourse) embeds beliefs about the world in which we live. Changing or challenging these beliefs can undermine and undervalue the "cultural capital" of many of our students (Bourdieu, Passeron, & Nice, 1990).

Because literacy is always situated within a social context, and because these social contexts are informed by the people involved in them—their values, attitudes, feelings and social relationships—students come to school with opinions about the environment that are based in their home (primary) discourse (Gee, 1991, p. 7). These social contexts or "domains", as Barton and Hamilton (2000) call them, "are structured, patterned contexts within which literacy is used and learned" (p. 11). Further, the domains where literacies are situated, for example, schools, regulate the literacy by social pressure and, more formally, by penalties. Socially powerful institutions, such as schools, use a "secondary discourse" that ideally should build on and extend our primary discourse. However, for many social groups their primary discourse is not compatible with the school's language use, which is the "dominant discourse" (Gee, 1991, p. 8).

Studies by both Gee (1991) and Luke (1993) on the hidden curriculum and dominant discourses provide challenging and supportive arguments for reviewing in-school literacy practices and give powerful messages to teachers and administrators to make changes. We need to consider what pressures and penalties schools impose on students to conform to acceptable literacy practices. A major challenge for teachers is to ensure that each student's cultural capital (Bourdieu et al., 1990), and primary discourse (Gee, 1991) are not dismissed or undervalued. While there may well be a disjuncture between the child's family values and the values of the school, our challenge as teachers is to encourage local action in a way that does not disenfranchise our students from their parents and community but rather involves the whole family and the community in the action.

The "Special Forever Project" and its impact on EfS A key event that ran for many years in Australia was the Special Forever Project (2009), a collaborative initiative that began in 1993 between the Primary English Teaching Association (PETA) and the Murray-Darling Basin Commission (MDBC). The initial project involved teachers and students based in the Murray-Darling Basin (MDB). It provided a forum for students to express concerns about the environment and, in particular, consider the past mistakes and the resultant condition of the MDB. After its inception, the project grew from students merely writing about the MDB to a point where schools, teachers and students were using their knowledge and experiences about their environment to initiate school-based projects and to take action in their local area (Comber, Nixon, & Reid, 2007).

The project was last published in 2010, and in 2012 the Primary English Teaching Association Australia (PETAA) had to archive the site with a view to possibly extracting and re-using some the valuable materials for primary educators, in the future. One of the last publications, the anthology and DVD *Rivers We Share* (Figure 10.1) contained 300 works of art and writing selected from a total of 1,000 sent to Sydney from regional coordinators located throughout the Murray-Darling Basin. This project is an example of how communities and schools can work together to take positive action and change. For more information, go to the following link: http://www.petaa.edu.au/.

The notion of literacies in place Hand in hand with situated literacies is the notion of literacies in place. In the publication *Literacies in Place: Teaching Environmental Communications* (Comber et al., 2007), primary teachers living and working within the Murray-Darling Basin shared their involvement in the "river literacies" research study and reported on the impact of their school projects. The publication explores the teachers' "commitment to the sustainability of their own particular, local, place in relation to larger concerns of the Murray-Darling Basin as a whole, and for national and global concerns for the environment" (p. 9).

Figure 10.1. The "Rivers We Share" book and CD.

The river literacies study set out to examine the Special Forever Project described above. A particular purpose of the study was to identify the discourses or language use of the students who contributed to the publications about the MDB. The study identified "nine major discourses that shaped how place was represented by the children" (Cormack & Green 2007, p. 91). These were literacy-English, conservation, tourism and recreation, historical, family, industry-agriculture, geo-scientific, Indigenous, and industry-other (Cormack & Green, 2007, pp. 91–92). One of the key outcomes of the river literacies study was its expanded view of literacy. According to Comber et al. (2007), literacy is no longer a single written mode. As such, teachers need to "increase the potential for students" by engaging them in the "new literacies" and teaching them "to understand the design and communication power of multi-modal text" so that they become more involved in "active communications practice" (pp. 12–13).

Multiliteracies, multimodal meaning making and EfS

Over the past decade, the terms "multiliteracies" and "multimodal meaning making" have emerged to describe the multiple ways that we use language. According to Cope and Kalantzis (2003), literacy can no longer be seen as a singular entity. Today, many different forms of English are used in different situations, such as the dialects of English (Englishes), and professional language. Modern communications include multimodal texts or multiple ways of presenting and receiving information. For example, present-day communications are often a mixture of audio, spatial, linguistic, gestural and visual elements (Cope & Kalantzis, 2003) that combine to create sophisticated texts which young people need to be able to interact with and interpret in increasingly complex environments such as the world wide web. Information about and pertaining to sustainability is increasingly being shared and generated by young people online through organisations such as GetUp and the Australian Youth Climate Coalition.

We interact with multimodal texts in all aspects of our daily life, and active engagement in using and manipulating these texts by young people can be seen in their use of digital devices and networking spaces such as MySpace and Facebook, emails, text messages and video games, to name but a few. Gee (2003) points out that games engage young people because they provide a stimulating use of learning and literacy within environments that promote and require the acquisition of high-order thinking. This, he claimed, would develop innovators and lifelong learners able to deal with the challenges of the 21st century and beyond.

The world wide web provides many opportunities for teaching about EfS and developing English and literacy skills; however, such practice is not simply a matter of using computers in the classroom to explore these opportunities. As Leu, Kinzer, Coiro, and Cammack (2004) point out, reading online, although similar to reading print-based texts, also involves a number of different skills that need to be taught in the curriculum. While students are engaging with digital technologies, research indicates that many young people do not have the skills required to effectively interpret and analyse online texts. Reading comprehension on the internet, according to Leu et al. (2004), needs to encompass "problem identification, search strategies, analysis, synthesis, and the meaning construction required in email messages and other communication technologies" (p. 1602). Likewise, when we consider online authoring, young people appear to be highly proficient at using digital technologies but need explicit teaching about how to use the technology effectively for communication purposes (Adlington & Hansford, 2009).

Students thus require explicit and systematic teaching to develop the skills they require in order to be accomplished users of the internet and the web. "Critical literacies and analytic skills," according to Leu et al. (2004), are crucial to the "literacy curriculum", because when accessing the "internet where anyone may publish anything", young people need to be able to "critically evaluate that information, sorting out accurate information from inaccurate information, essential information from less-essential information, and biased information from unbiased information" (p. 1576). Consequently, when using the internet and the web to engage with sustainability issues and promote activism, as many of our young people are already doing, we need to prepare our students to be critical users, and this ability involves critical reading and effective authoring.

The power of visual texts and critical approaches to EfS One example of a website that could be explored is Canadian Seal Hunt (2009) (Figure 10.2). Whether you agree or disagree with the killing of seal pups in Canada, this website provides an opportunity to explore using images and placing items on a website in ways that make communication more effective.

Figure 10.2. Segment of the Canadian Seal Hunt homepage.

At the top of the Canadian Seal Hunt homepage is a banner featuring three images. On the left of the banner, we see a seal looking directly at the viewer. The seal's eyes implore us to interact with the seal and its situation. The eyes, being large, and the seal, being a furry animal, appeal to the viewer. In the middle of the banner is a photograph of a seal hunter holding a club above a seal pup's head. On the right of the banner is an adult seal (presumably the mother) looking towards the dead, bloodied bodies of seal pups. The use of colour here is also important. The words Seal Hunt are in bright red, the cap and the gloves of the hunter are also red, and there is bright red blood on the ice, with the darker red blood covering the dead seal bodies. This website sends a powerful message to the viewer/reader through its selection of images that are both appealing and shocking, empowering the viewer to take action.

Skills and strategies needed for online reading When planning to use the internet or web to search for information about EfS, we need to consider students' computer literacy and prior online experiences. We should therefore:

– reflect on the differences between reading online and hard copy texts (e.g., the multimodal nature of online texts);
– explore the elements that make online texts effective in getting their message across and so raise students' awareness; and
– explore the reading demands of online texts.

As teachers, we also need to consider the reading strategies and skills used for navigating around a website and sourcing information. To identify what knowledge and skills students need to access online information, you might like to do the following:

1. Go to a website. You might like to visit, for example, www.canadiansealhunt.com.
2. Look around to see the different resources, activities and information that can be accessed and with which you can interact.
3. Record all of the reading strategies and skills you used as you navigate around the site. In particular, consider the following: scroll bars, headings, advertisements, links, menus, search features, images, text, Really Simple Syndication (RSS) feeds, sound, movement, sign-in, layout, and any other features on the webpage.
4. Ask yourself these questions:
   – What information did I need to filter out and ignore in order to find what I was looking for?
   – What reading strategies did I use?

Using picture books to teach EfS One way to engage children in environmental issues is through the use of picture books. Literary works that can be included in EfS units with an English/literacy focus are many, so the choice is a difficult one. Nevertheless, I provide an annotated list of fiction and non-fiction texts (for enhancing our understandings about global environmental issues) at the end of this chapter, along with the general themes and issues they address. The selected texts listed immediately below have been published in the past few years and are suitable for use with primary through middle year students. They include:

– John Heffernan (author) and Freya Blackwood's (illustrator) *Two Summers:* suitable for Kindergarten to Year 6 students (ages 4 to 11);
– Gary Crew (author) and Gillian Warden's (illustrator) *Cat on the Island:* suitable for Years 4 to 6 students (ages 8 to 11);

– John Marsden (author) and Shaun Tan's (illustrator) *The Rabbits:* suitable for Years 5 to 8 (ages 9 to 13); and
– Alison Lester (author) and Coral Tulloch's (illustrator) *One Small Island*: suitable for Years 4 to 6 (ages 8 to 11).

These age levels are suggestions. Decide which texts to use with reference to teaching and learning outcomes and, in particular, students' interests and level of understanding.

E-literature for EfS Approaches to studying literature in the past have predominantly involved reading, interpreting and analysing the text in book form. Many authors and publishers today use multiple modes to present texts and enhancements of the text and author details in order to engage their audiences. Amongst this material are texts relating to sustainability issues.

Unsworth (2006) alerts us to the affordances of the web contexts and websites of authors and publishers. In his chapter titled "Learning through web contexts of book-based literary narratives'" (pp. 37–45), he explores some of the classroom learning opportunities that these sites offer. For example, he shows how websites extend traditional approaches to "reading literature in book form" to the "expanded dimensions of the experience of story" offered in electronic forms. He groups these websites into four contexts aligned with their respective purposes: composition, invitation, appreciation and interpretation. These contexts offer a variety of language opportunities and a useful planning framework for considering the specific language and literacy skills that students require in order to access and interact with these websites.

Some authors, according to Unsworth (2006), invite readers to sample their work, some encourage their fans to participate in discussions to show their appreciation, and others provide opportunities to interpret and communicate about the texts. Shaun Tan (Tan, 2009) is one such author whose website is highly visual and worth visiting. I consider his website later in this chapter.

Visual literacy of print-based and digital texts and EfS Today's students are bombarded with images from many different sources. This situation affects their understandings about society, culture and environmental problems, as shown by the fur seal images above.

Kress and van Leeuwen (1996) expand our understanding about meaning-making by exploring the power of the visual image. They claim (for those of us who are not "visually literate") that the impact of this power on our survival, both at school level and in the workplace, will be significant (p. 3). The challenge for us as teachers is to ensure that we give students opportunities to develop the skills to analyse, interpret, reflect and react to images in print-based, digital and online texts.

The adaptations from Kress and van Leeuwen (1996) and Simpson (2004) presented in Tables 10.1 and 10.2 on the following pages show ways in which those of us who are teachers might consider interpreting and analysing images, both print-based and in digital form. Table 10.1 is based on categories we can use to analyse the meanings in an image. Images can be examined according to the ideational (who and/or what), the interactive (what is going on and the relationships between the various components), and the overall composition of the image (what parts are most prominent and how they are made prominent). Table 10.2 sets out the elements we need to consider when analysing images in texts.

Table 10.1. Categories for analysing images from print and digital texts.

Ideational	*Interactive*	*Composition*
Participants: Who? What? Processes: Happenings Circumstances: Where? When? How?	Modality Offer/demand Social distance: close, medium, remote? Vertical angle: high, eye level, low? Horizontal angle: parallel, oblique?	Salience Framing

Table 10.2. Elements to consider when analysing images from print and digital texts.

General element	*Specific aspects of element*
What are the illustrative elements of this picture book?	Consider the design: Size Shape Title page Cover dust jacket: do illustrations wrap-around or are they separate? Single or double-page pictures Placement of the gutter Decorative or silent pages Framed, unframed or edge to edge
What are the artistic devices used in this picture book?	Line Texture Colour Perspective Point of view
What is the relationship between the images and the words?	Images may take longer to read than the text Images show what the words say, and more Colours may show mood Pictures may carry a second story
What are the images in this text doing?	Are they: illustrating confirming adding action contradicting the text?

TEXTS FOR SUSTAINABILITY

1. *The Rabbits* (2000): John Marsden (author) and Shaun Tan (illustrator), published by Lothian Children's Books, an imprint of Hachette Australia (suitable for Years 5 to 8)

Shaun Tan's website (Figure 10.3) provides many opportunities to develop skills in visual literacy and to engage in meaning-making exercises using Kress and van Leeuwen's (1996) visual grammar.

Figure 10.3. Shaun Tan's website homepage.

Tan describes his picture books as suitable "for older readers rather than young children because they deal with relatively complex visual styles and themes." While this is true for *The Rabbits* and its theme of "colonial imperialism", the text is suitable for use with middle-year students (Figure 10.4).

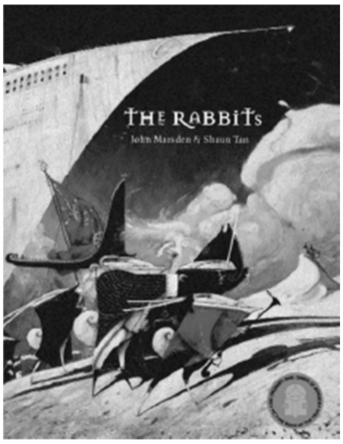

Figure 10.4. Cover of "The Rabbits".

The sophisticated illustrations match the themes of environment and sustainability, "with both text and image conveying an overall sense of bewilderment and anxiety as native numbat-like creatures witness environmental devastation under the wheels of a strange new culture".

At first we didn't know what to think. They looked a bit like us.

There weren't many of them. Some of them were friendly.

They didn't live in trees like we did. They made their own houses.
We couldn't … understand the way they talked.

They ate our grass. They chopped down our trees and scared away our friends…

2. *Two Summers* (2003): John Heffernan (author) and Freya Blackwood (illustrator), published by Scholastic Press (suitable for Kindergarten to Year 6: children ages 4 to 11)

While this text (Figure 10.5) is aimed at young children in the early years, it could also be used with older students, especially when considering the visual and grammatical features of a text. A number of contrasting themes run through this text. They explore, through both the text and images, concepts such as city/country, drought/abundance, life/death and wet/dry. Depending on your teaching focus, you could relate these themes to global warming, climate change, water conservation and other EfS issues. You could also use the text as a focus for a literature-based, skills-based or thematic unit covering several learning areas such as English, science and technology, history, geography, and creative and practical arts.

Figure 10.5. Cover of "Two Summers".

2.1. Teaching *functional and traditional grammar* using "Two Summers"

The following examples, based on the text *Two Summers*, show how we can use a key piece of literature to teach grammar within the context of EfS. The ideas below are based on aspects of both traditional and functional grammar.

Acknowledgement: This section was developed in collaboration with Dr Susan Feez, University of New England, in 2009.

2.1.1 *Text level:* When looking at the whole text, ask the following questions.

Genre or text level	What type of text is it? What is its purpose? What are the parts of the text?
The variety of language	What is it about? Who is it written for? How is it written?

2.1.1 *The wordings:* When looking at grammar, draw students' attention to the following parts of sentences and clauses, using examples from the text.

<table>
<tr><td colspan="8">He's staying for a whole week</td><td>sentence/clause</td></tr>
<tr><td>He</td><td colspan="3">'s staying</td><td colspan="4">for a whole week</td><td rowspan="2">group/phrase</td></tr>
<tr><td>He</td><td colspan="3">'s staying</td><td>for</td><td colspan="3">a whole week</td></tr>
<tr><td>He</td><td>'s</td><td colspan="2">staying</td><td>for</td><td>a</td><td>whole</td><td>week</td><td>words</td></tr>
<tr><td>He</td><td>'s</td><td>stay</td><td>ing</td><td>for</td><td>a</td><td>whole</td><td>week</td><td>word parts</td></tr>
</table>

a Sentences—simple, compound or complex?
Rick is coming to stay again. (Simple)
It takes him seven hours on the train from the city. (Simple)
He's staying for a whole week. (Simple)
Last year I showed him how to ride a motorbike. (Simple with embedded clause)
He bent the handlebars once, and nearly broke his arm when he crashed it in a wombat hole. (Compound/Complex)
But by the end he could jump logs and scramble up muddy hills. (Compound)
On his last day he even beat me home. (Simple)

b Clauses

Rick is coming to stay again. But by the end, he could jump logs and scramble up muddy hills.

c Phrases: prepositional phrases of place, time, etc.

<table>
<tr><td>on the train</td><td>from the city</td><td>for a whole week</td><td>in a wombat hole</td></tr>
<tr><td colspan="4">in the big dam where Dad keeps his old boat</td></tr>
</table>

d Groups

Noun groups	Rick	the city	a whole week	a wombat hole
	the big dam where Dad keeps his old boat			
Verb groups	is coming to stay	takes	’s staying	could jump

e Words

Nouns	Rick	city	week	hole
Adjectives	seven	muddy	last	good
Articles	a	an	the	
Pronouns	him	he	I	me
Verbs	is	coming	takes	showed
Adverbs	again	back	too	now
Prepositions	on	from	for	in
Conjunctions/ connectives	and	but	though	before

2.1.2. Teaching *visual grammar* using “Two Summers”

The images in the picture book *Two Summers* provide many opportunities to explore meaning through image. Similar to the words in the text, the images show contrasts between the good season and the bad season.

During the good season, the colours highlight the lush, green grass and abundance of water compared to the bad season, where the brown earthy tones and treeless images signal the drought. The images of the cattle in good and bad seasons present a stark contrast of life and death. The use of the past and future tense in conjunction with the images provides scope for exploring the grammar, in particular, the happenings (processes) within the text.

3. *Cat on the Island* (2008): Gary Crew (author) and Gillian Warden (illustrator), published by HarperCollins (suitable for Years 4 to 6 children)

Based on a factual event, the extinction of the Stephens Island wren, *Cat on the Island* by Gary Crew and Gillian Warden (Figure 10.6) presents a picture book tale of the loss of a species, with some confronting images in narrative form. The main theme of the text is that of "introduced species" and the damage they cause to both flora and fauna. The affordances and demands of the text and images allow us to explore visual literacy and grammar, the grammatical structure and features of the text, both functional and traditional, and also the literary techniques used to appeal to the readers' emotions about the loss of a species.

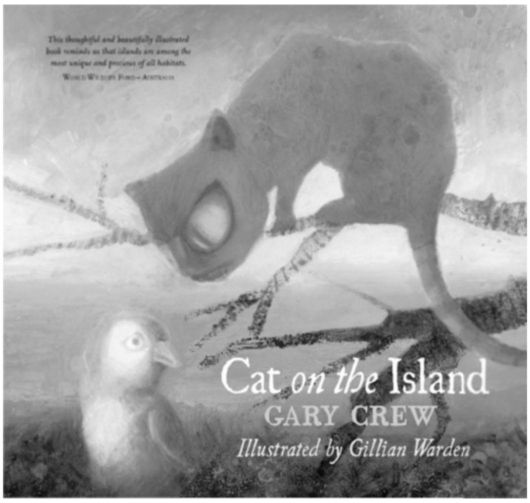

Figure 10.6. Cover of "Cat on the Island", reproduced by kind permission of HarperCollins.

Initially, the deliberate choice of blue and pink pastel colours portrays a tranquil image of small birds flying around a tree. This image is contained by a thick frame, which, we could assume, represents the island as pristine and unique. On the left-hand side of the next two-page spread we are confronted by the image of a red cat, with yellow glaring eyes, staring but not quite looking directly at us, the reader. On the right-hand side is an image of the grandfather, head bowed, eyes nearly closed, recounting to his grandson about how he had come to live on Stephens Island in Cook Strait, New Zealand. The grandson has a shocked look on his face, and his eyes are wide and staring—just like those of the cat.

Throughout the picture book, the images and text continue to contrast the tranquil and the shocking, using visual techniques to make the impact. Of particular note is the image of the small bird, sitting on the stump of a felled tree, staring at the woodcutter chopping down the last tree—its habitat. Previously, this tree had soft colours, but now, in the later image, the leaves have turned to red. In the past, the drops of rain were foregrounded, softening the image of the birds behind. In this later image, the drops have turned into cats' eyes and signal the coming of destruction. While this text presents a gruesome picture, it has great possibilities for exploring the issue of endangered species and extinction with children in the middle years of schooling.

4. *One Small Island* (2011): Alison Lester (author) and Coral Tulloch (illustrator), published by Penguin Australia (suitable for Years 4 to 6 children)

This picture book (Figure 10.7) features Macquarie Island, which lies in the Southern Ocean, between Antarctica and New Zealand. In the book, the island is described as follows: "A speck of green in the vast, windswept sea, it is a haven for many creatures that live above and below the waves." Alison Lester and Coral Tulloch bring us the story of this remote and precious World Heritage Site. Together, they explore the island's unique geological beginnings, discovery and degradation at the hands of humans, and the battle to restore it today.

We can describe this text as a hybrid text because it is made up of different genres, from a number of sources. The main text and images provide an historical account. In addition, there are newspaper reports, bibliographies and accounts from past visitors and workers on the island. These texts provide a rich source of models for students' writing.

Several resources based on this text have been developed for Years 5 and 6. One such, developed for English in the Australian Curriculum, provides sequenced units of work and can be found at the following link: http://e4ac.edu.au/units/year-5/index.html.

The Primary English Teaching Association of Australia's (PETAA) notes for teachers based on the book can be found at this link: http://www.petaa.edu.au/teaching-resources/literature-singles/small-island.

These resources provide rich ideas for addressing the sustainability cross-curriculum priority within the English learning area.

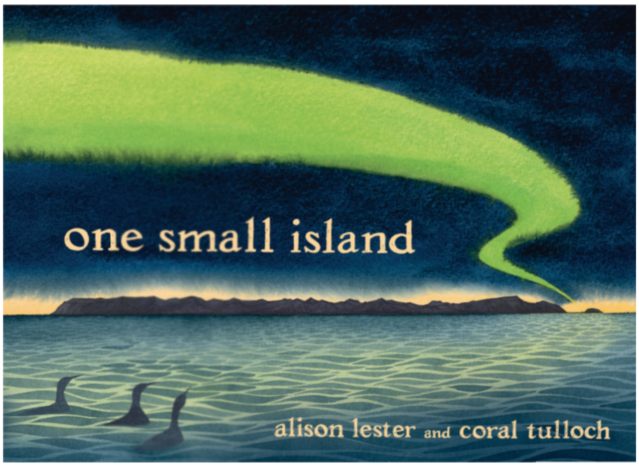

Figure 10.7. Cover of "One Small Island" (2011), reproduced by kind permission of Penguin Australia Pty Ltd., Melbourne, Australia

LEARNING MODELS FOR PLANNING ENGLISH AND LITERACY FOR EFS

The calls to shift from the notion of environmental education (EE) to the notion of education for sustainability (EfS), as discussed in Chapter 1 of this book, is an important change and one that English and literacy is able to support in practical ways. If students are required to develop a "socially critical" view of the world, to "question actions" taken by societies that have led to the degradation of the planet and to "take positive action", they need to have the ability to use language in all its forms (text and image). Planning to use and develop students' language is a crucial part of taking action.

This section of the chapter includes three suggested learning models that teachers will find useful when planning for EfS.

1. Five principles for planning (Comber et al., 2007)
2. The Geralton model (Reid, Green & English 2003)
3. The curriculum cycle (Rothery & Callaghan, 1988, cited in Knapp & Callaghan, 1989).

Chapter 2 of this book promoted the importance of shared, constructive and reflective learning. Each of the three learning models promotes these elements in different ways by focusing on slightly different aspects of English.

1 Five principles for planning (Comber et al., 2007)

These five planning principles, shown in Figure 10.8, are useful for teachers considering pedagogy and teaching and learning about the environment. The authors of the model point out that the principles require teachers to take risks but also to provide time to develop students' understandings. Their advice is similar to that offered by the authors of the Geralton model and the curriculum cycle model.

More specifically, the principles that Comber and colleagues offered as a result of their research were the following:

1. Communicating with experts and scrutinising "significant text-based research" from both print and web-based sources;
2. Providing extended periods of time to fully build and develop concepts about the environment and sustainability;
3. Planning for experiences that are not bound by the classroom;
4. Using language and literacy as the key to students accessing information and creating texts via a number of modes; and
5. Taking up opportunities as they arise so that students can fully develop authentic texts.

Given the pressures of a crowded curriculum, the last principle is often seen as a "big ask" of classroom teachers who are already under significant stress to perform and be accountable.

Figure 10.8. Five principles for planning (adapted from Comber et al., 2007).

2 The Geralton model

This model (Figure 10.9) focuses on the development of language from spoken to written form through the use of group work and selection of appropriate tasks. Its developers based it on a number of theories relating to language and learning.

One key aspect of this model is that it emphasises developing students' home language through the use of small group learning, in a non-threatening environment, and allows for teachers to plan for moving students from spoken language to more formal, written language or more technical language, thus developing students' stronger understanding about the concepts being explored. Moving students' language from informal to formal, from home language to school language, or from everyday language to more technical language can equip students with the literacies they need to engage with environmental issues such as global warming and climate change. In order to advance these language skills, teachers need to begin with informal, home or everyday language when discussing, explaining and interpreting within the "risk-free" environment.

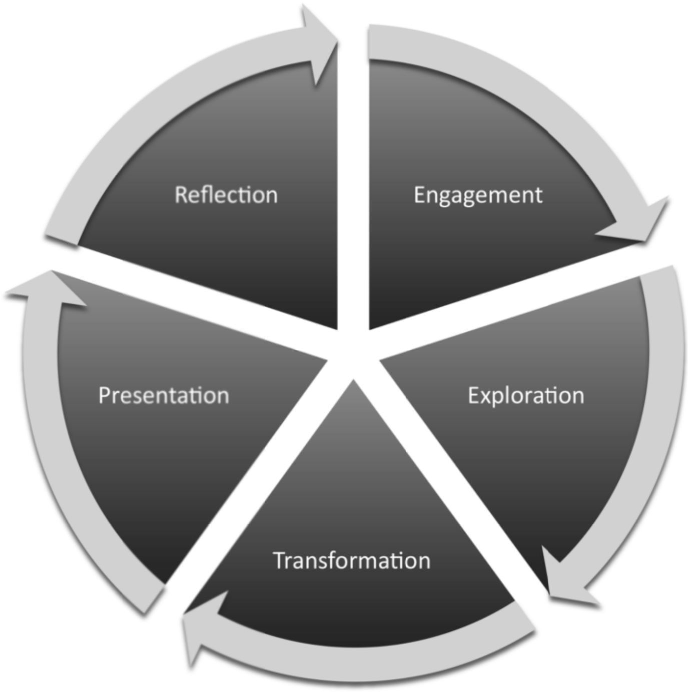

Figure 10.9. The Geralton model (adapted from Reid, et al. 2003).

3 The curriculum cycle

A model now widely used and adopted by a number of organisations and groups (including the NSW Department of Education and Training) is the curriculum cycle (Figure 10.10), originally developed by Callaghan and Rothery (1988; cited in Knapp and Callaghan, 1989). The model provides a framework for developing the sophisticated writing skills students need both for accessing texts about environmental sustainability and for producing these texts; in other words, the writing skills needed to take action. The model provides us with a structure that can develop students' knowledge and understanding about powerful ways of constructing texts that can potentially influence the future sustainability of the planet.

The original curriculum model presented three stages in the cycle involved in teaching different written genres or text types:

1. Building the field (developing the language concepts associated with the particular area of study);
2. Jointly constructing texts (teacher and students developing texts from spoken to more sophisticated written language, i.e., technical texts); and
3. Independent construction of texts (students independently constructing texts using a spoken to written continuum).

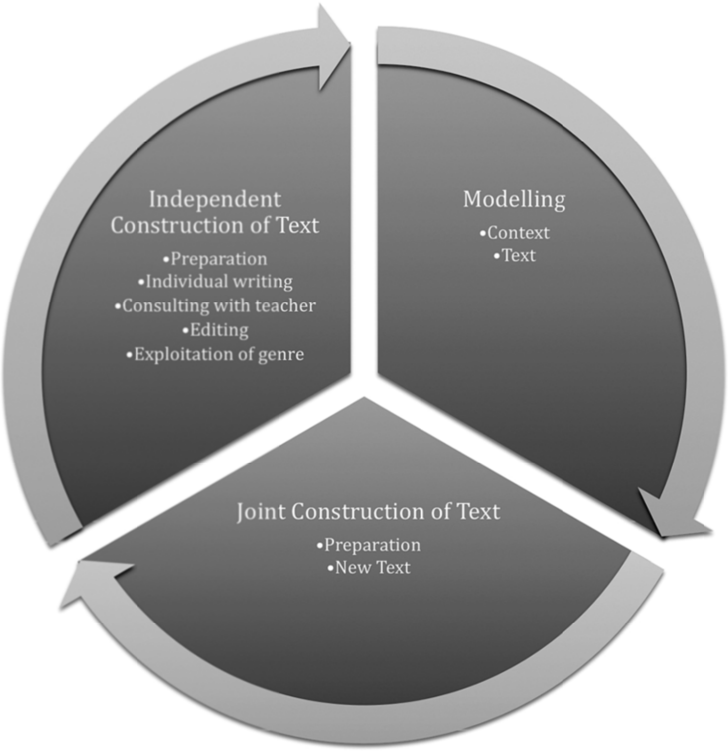

Figure 10.10. The curriculum cycle (adapted from Callaghan & Rothery, 1988, cited in Knapp & Callaghan, 1989).

The model is an important one because it recognises that it takes time to develop conceptual understanding about any context, including, of course, the complexities of concepts about the environment and the serious environmental issues facing our planet, such as climate change. The main focus of this learning cycle is on genre or text types and their purpose and structure in both oral and written modes. A detailed plan for using this model can be found in *The Report Genre* and *The Discussion Genre*, which were part of a project undertaken by the Metropolitan East Region of the New South Wales Department of Education and Training (Knapp & Callaghan, 1989).

CONCLUSION

If young people growing up in the 21st century are to take informed action into the future, teachers need to ensure their students have the necessary skills for discussing and debating, for putting forward their points of view, for reading and viewing, analysing and interpreting texts in all their forms, and for authoring print-based, digital and multimodal texts. In addition, students need to be "net savvy" in order to make sense of their world and to take action so that the environment and its societies *will* have a future. As indicated earlier, I end this chapter with an annotated overview of books relevant to the chapter's topic and themes.

SOME GOOD BOOKS FOR EFS IN THE ENGLISH LANGUAGE
AND LITERACY LEARNING AREA

Fiction

Author	*Date*	*Title*	*Publisher*	*Topic/themes*
Baker, J.	1988	*Where the Forest Meets the Sea*	Walker Books, UK www.jeanniebaker.com/picture_books.htm	Future development and its effect on the natural environment of a tropical rainforest.
Baker, J.	1991	*Window*	Random House, UK www.jeanniebaker.com/picture_books.htm	Time and change, human growth, changing uses of land, impact of human activities.
Baker, J.	1995	*The Story of Rosy Dock*	Random House, Sydney www.jeanniebaker.com/picture_books.htm	Desert areas and introduced plant species from European settlement.
Baker, J.	2000	*The Hidden Forest*	Walker Books, UK www.jeanniebaker.com/picture_books.htm	*The Hidden Forest* is set underwater in the giant kelp forests off the south-east coast of Tasmania. Key themes: exploitation, exploration.
Baker, J.	2004	*Belonging*	Walker Books, London www.jeanniebaker.com/picture_books.htm	*Belonging* explores the re-greening of the city: the role of community, empowerment of people, and significance of children, family and neighbourhood in changing their urban environment.

Fiction

Author	*Date*	*Title*	*Publisher*	*Topic/themes*
Base, G.	2003	*The Waterhole*	Puffin www.graemebase.com/	Water usage and conservation. This ecological book encourages children (and adults) to think about our most importance resource, our vulnerability without it, and the cycle of dry and wet.
Cheng, C., Woolman S.	1997	*One Child*	ERA Publications	Shows how one person can make a difference.
Crew, G., Warden, G.	2008	*Cat on the Island*	Angus & Robertson	Introduced species. *Cat on the Island* is a disturbing and important picture book for older children. It tells the story of Stephens Island, between the North and South Islands of New Zealand, where the introduction of domestic cats led to the extinction of the world's only flightless wren.
Flynn, P.	2006	*The Tuckshop Kid*	University of Queensland Press www.patflynnwriter. com/	Obesity, bullying and difference; self-perception and over-eating; friendship and its role in developing self-esteem; family relationships and self-esteem.
Heffernan J.	1998	*Rachael's Forest*	Margaret Hamilton, Sydney www.spudplus.com/	Forest degradation; individuals can make a difference.
Heffernan J.	1998	*Rachael's Forest*	Margaret Hamilton, Sydney www.spudplus.com/	Forest degradation; individuals can make a difference.

Fiction

Author	*Date*	*Title*	*Publisher*	*Topic/themes*
Heffernan, J., Blackwood, F.		*Two Summers*	Scholastic Press www.spudplus.com/	Climate change, sustainable practices and water conservation.
Marsden, J., Tan, S.	1998	*The Rabbits*	Thomas Lothian, Melbourne www.shauntan.net/books/the-rabbits.html	Colonisation, told from the viewpoint of the colonised, environmental devastation.
Tan, S.	2001	*The Red Tree*	Lothian Books Australia www.lothian.com.au	Personal sustainability
Wheatley, N., Rawlins, D.	1996	*My Place*	Longman, Melbourne	Indigenous and Australian history; depiction of passing of time; use of a Morton Bay fig tree that is constant and a point of reference in the ever-changing landscape.
Wright-Simon, M., Wright-Simon, J., Green, R.	2006	*Rusty Loses His Loop*	Red Murray Urban Users Local Action Planning Committee www.murrayusers.sa.gov.au	Endangered species; water conservation and water quality.

Non-fiction

Author	*Date*	*Title*	*Publisher*	*Topic/themes*
Lucas, D. & Searl, K.	2005	*Walking with the Seasons in Kakadu*	Allen & Unwin, Australia	Wet/dry seasons; observation of the birds, plants and animals that inhabit the unique environment of Kakadu; six Aboriginal seasons and their characteristics; flood plains—gathering plant specimens.
Mills, A. (Ed.)	2005	*Animals Like Us*	DK Books www.arkive.org	Endangered species.
Arthus-Bertrand, Y.		*The Earth from the Air for Children*	Thames & Hudson www.newint.com.au/shop/earth-from-air-for-child-381.htm	Images from the air showing the complexity of Earth, its systems, as well as the diversity of our world's people and places. Showcases the magic and beauty of our planet.
Hope, T., with NASA	2008	*Earthcam Watching the World from Orbit*	David & Charles, UK www.mightyape.co.nz/product/Earthcam-Watching-the-World-from-Orbit/2588939/	Earthcam presents a collection of images. Global warming: changing the environment. Produced in cooperation with NASA.
David, L., Cambria, G.	2007	*Down to Earth Guide to Global Warming*	Scholastic, Australia www.scholastic.com/downtoearth/index.htm	Global warming; changing weather patterns; protecting the environment.
Mackay, R.	2005	*The Atlas of Endangered Species*	Earthscan, London	*Endangered Species* locates/identifies different species of wildlife and shows how human survival depends on biodiversity. Major threats to biodiversity; conservation

Non-fiction

Author	*Date*	*Title*	*Publisher*	*Topic/ themes*
Flannery, T., Schauten, P.	2001	*A Gap in Nature: Discovering the World's Extinct Animals*	Text, Melbourne	Endangered species.
Chiras, D.	2005	*Ecokids: Raising Children Who Care for the Earth*	New Society Publishers	Hopeful and inspiring guide for parents: taking action, positive solutions, developing environmental values, generating hope and combating apathy; global warming.
Tonkin, R.	2006	*Leaf Litter: Exploring the Mysteries of a Hidden World*	Angus & Robertson	Highlights inter-connectedness of life and death by exploring the world under leaf litter. The illustrations show how leaf litter provides nutrients to feed trees and how vital this is for survival of our planet.

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11. SUSTAINABILITY AND THE CREATIVE ARTS

> If we cannot imagine things differently we will not be able to bring about any alteration in our circumstances. (O'Neill, 1995, p. 152)

THE ARTS AND SUSTAINABILITY

The power of the Arts in promoting education for sustainability (EfS) lies in the affective nature of children's learning when they are engaged in artistic pursuits. As noted in Chapter 1, research shows that having knowledge is not sufficient to create behavioural change. Also needed are an awareness of our connections with and in the world and an attitude of caring (Fien, 2003). Sustainable living is a disposition that can be communicated and understood through engagement of the affective in an artistic or creative project. Teaching through the Arts links the emotional to the cognitive; it engages the heart as well as the mind and provides opportunities for children to explore issues, solve problems, collaborate and develop their ideas through creative experiences. The importance of this approach is well articulated in an early National Curriculum Council (NCC) document from the United Kingdom:

> Without curiosity, without the inclination to question, and without the exercise of imagination, insight and intuition, young people would lack the motivation to learn, and their intellectual development would be impaired … Were they not moved by feelings of awe and wonder at the beauty of the world we live in, or the power of artists, musicians and writers to manipulate space, sound and language, they would live in a spiritual and cultural desert. (NCC, 1990, p. iv)

The Arts offer universal languages that connect people with big ideas. They enable us to see the world around us in new ways and give us a rich set of tools for envisioning a better future for our world. They have the power to challenge our thinking, to inspire us into action and to engage us in dialogic and dynamic ways that enable us to think more deeply about our environment. The United Nations Environment Programme (UNEP) recognises the potential of the Arts to engender reflection on the environment and prompt human actions. Through its Art for the Environment initiative, the UNEP hopes that "sharing artists' deep sensitivity to the plight of the planet … [will] play a significant role in inspiring people to preserve the natural world" (Steiner, 2007, p. 8).

The Arts can help to "create inspiration" by encouraging positive relationships between people and place. In the face of global problems such as environmental degradation and social injustice, children can become overwhelmed and feel powerless to achieve positive change. The Arts have an important role to play in sustainability and in affirming the

N. Taylor et al. (eds.), Educating for Sustainability in Primary Schools, 221–245.

processes of care and repair. Traditionally, cultures have celebrated their relationship with the environment through seasonal rituals, harvest festivals, and events that honour specific plants or animals. In certain parts of China, for example, the arrival of migratory swans is marked by the local people, who call the birds "winter angels". In Japan, an ancient myth tells of a carp that swims up the face of a waterfall. This story has become the central metaphor for an annual children's festival, which is celebrated with the hope that the children will grow up embodying the carp's qualities of strength and perseverance.

These kinds of events provide us with opportunities to reflect on our relationship with the Earth, to connect more meaningfully with the natural environment and to nurture the ties that bind communities together. Such festivals are a celebration of belonging to place and to one another, of affirming our place in the world and in our society. They foster our connections to place. They serve to remind us of the world in which we live, prompting us to re-affirm and periodically renew these relationships.

In the classroom, celebrations can be held in small or large ways. They can take simple forms such as marking moments of wonder, delight, awe, excitement or reverence, all of which can be experienced when children encounter earth, water, flora and fauna. They can take the form of a class planting a tree and marking that event in some way. Celebration can involve a whole-school festival, which might also connect to events in the local community. By engaging with the natural environment in a celebratory way, we can help children experience positive thoughts, feelings and associations with place and community. In these ways, the Arts can affirm our beliefs, celebrate our achievements and inspire further action (Curtis, 2007).

Sohail Inayatullah (1998) proposed the theory of "causal layered analysis" (CLA) as a method for achieving different futures. In exploring the application of CLA, Bishop and Dzidic (2014, p. 16) used the example of environmental sustainability problems in the Australian farming sector. They suggested that CLA facilitates "critical thought as to what the deeper, underlying causes of an issue are". Thought, in turn facilitates action directed towards creating alternative futures. CLA suggests action on four levels of analysis:

1. the litany (official, unquestioned views);
2. social causation (the data and systemic perspective);
3. discourse (ideological and discursive assumptions); and
4. myth and metaphor (unconscious, emotive dimensions).

Analysis of myth and metaphor most often appears in the work of artists and visionaries. It is engagement with this work that enables the challenging of long-held beliefs: "This level provides a gut/emotional level experience to the worldview under inquiry. The language used is … more concerned with evoking visual images, with touching the heart instead of reading the head. This is the root level of questioning" (Inayatullah, 1998).

In Chapter 3 of this volume, Kathy Jenkins discussed how using Jensen's model *of action competence* can engage children in "realising their visions for a sustainable future". Of Jensen's four facets of knowledge, enabling students to create visions of alternative futures can be particularly difficult. As we have done here, Jenkins cites Sohail Inayatullah's work as key in underpinning this facet. It is in assisting this sometimes difficult process of creative visualisation that the creative arts come to the fore. This level of engagement, of analysis of myth and metaphor through the Arts, has the potential to challenge and extend children's understanding of the world and how people can work towards sustainability.

THE ARTS AND EFS IN THE CURRICULUM

Both the Australian Curriculum (Australian Curriculum, Assessment and Reporting Authority [ACARA], 2013) and the New Zealand Curriculum (New Zealand Ministry of Education, 2014) divide the Arts into distinct subjects. In the New Zealand Curriculum, the Arts comprise four disciplines (dance, drama, music/sound arts, visual arts), and in the Australian Curriculum five (dance, drama, media arts, music, visual arts). Both curriculums address exploration of sustainability through the Arts. The Australian Curriculum notes that students, when studying the Arts, will explore both sustainability of arts practices and the broader issues of people's relationships to their environments:

> The Arts provides opportunities for students to express and develop world views, and to appreciate the need for collaboration within and between communities to implement more sustainable patterns of living.
>
> In this learning area, students use the exploratory and creative platform of the Arts to advocate effective action for sustainability. This action is informed by a range of world views, and the need for social justice and ecosystem health. Students choose suitable art forms to communicate their developing understanding of the concept of sustainability and to persuade others to take action for sustainable futures. (ACARA, 2013, p. 25)

The New Zealand Curriculum lists ecological sustainability ("which includes care for the environment") as a value to be taught across all learning areas. By enabling engagement of the expressive and affective in learning about sustainability, the Arts play a very important role in developing the attitudes and beliefs necessary for children to make decisions about living sustainably.

In Australia, documents relating to EfS move beyond the general notion of engagement of the affective by explicitly suggesting that learning to care for the environment has a spiritual element. The most recent draft of the Australian geography curriculum (ACARA, 2014, p. 33) acknowledges the "spiritual value of environments (the Earth's 'spiritual' function)". In terms of teaching EfS, reference to and, where appropriate, the use of indigenous arts (both Māori and Aboriginal Australian) can assist in developing a spiritual focus. The strong connection to place, which is embedded in the culture of these indigenous peoples, illustrates how other cultures can develop a sense of place. Curriculum and cultural documents in both countries regard the use of indigenous stories and art in the curriculum. Teachers should consult these documents before drawing on indigenous art and art forms in their classrooms.

SUSTAINABILITY AND CONNECTION WITH PLACE

> [W]e require a ground, a connection, even in exile, to places on the Earth … it is precisely the difficulty of living in a specific place, with specific people, under specific conditions that inspires the need for reflection and a deepening of our understanding of what we truly need to live. (Smith, 1997, p. 2)

Relationships with and in place are central to the issue of sustainability. To understand how to live sustainably in terms of environmental, economic, political and sociocultural practices, we must first understand place and the influences of people on place and place on people. Place consists of things both human and non-human; of things animate and inanimate. We have a relationship with all things, and all things exist in relation to all other things. Teachers and children need to understand and foster their own relationships with place if they are to understand the effects that their actions have on place.

Gaining understanding of our relationship with place thus requires us to *learn* about place—to be aware of the many different elements that make up place and the relationships among them. As Smith (1997) points out, because we live in specific places, deepening our understanding of them helps us to recognise what it is that sustains us. Aboriginal Australians have long told us that connection with place is vital for social, environmental and economic sustainability. Developing connections with place involves knowledge of place, but connection is more than knowledge: learning about place, coming to know place, necessitates a *sense of place*.

Sense of place is an embodiment of place, that is, we know place with and through our senses. Abram (1996) tells us that developing a sense of place requires us first to be receptive to place and then it requires the ability to respond appropriately and creatively to that place. We cannot respond appropriately if we do not first have a sense of place and of the interconnectedness and interdependence of all things in place. Also, as Gruenewald (2003) points out, places themselves have something to say. These ideas suggest that we should listen to place. With respect to the indigenous culture of Australia, "Aboriginal people speak to land—the human and the non-human attend to each other" (Rose, 1999, cited in Bonyhady & Griffiths, 2002, p. 3). Place, moreover, is not static but constantly changing, and our relation with place is mutual: "[P]eople make places, and places make people" (Gruenewald, 2003, p. 621). The challenge for us today is to understand who we are and how we can affect the changes that happen in and to our place. We therefore need to be able to imagine a sustainable future. But what we can imagine depends on what we know and sense.

The Arts offer an important medium for enabling both the sensing of place and the imagining of new and different sustainable futures. Through the Arts, children can create visions of the future that assist them to develop ways of being in the present and, in turn, enable emotional sustainability. Our imagining of the future is something we do in the here and now; it also influences the way we live in the here and now. The children in our classrooms will have varying levels of understanding of place, and various abilities to be receptive to and to respond to place. Because our sense of place is influenced by past and present experiences of different places, as well as by future imaginings of place, the sense that each of us has of place is unique. Each of us also has unique ways of acting in the present and unique visions for the future.

The activities in this chapter focus on children and teachers developing their collective sense of place through sharing their experiences and their visions, so enabling development of this collective sense of place and of creative visions that show us how we (our community, our country, our world) can live sustainably. A powerful example of creative teaching with regards to "a sense of place" comes from a school in England, where the majority of children have Indian heritage. At this school, the teachers decided to use all government funds allocated for professional development to send the entire staff to Southern India, the region where most of the children's parents were born. The teachers visited the children's relatives and friends, and there was a mutual exchange of gifts, messages and photographs. By travelling and experiencing the places that were so important in the lives of their students, the teachers made strong place-based connections, and relationships flourished. The events had a profound positive effect on the children, their families and the local school community.

DEVELOPING AND EXPLORING CONNECTIONS WITH PLACE AND UNDERSTANDINGS OF SUSTAINABILITY THROUGH THE ARTS

The Arts can develop an awareness of place, foster an attitude of caring and contribute to teachers' and children's engagement with ideas and actions pertaining to sustainability. Children and teachers can engage in authentic learning experiences by having experiences *in* the environment, by learning *about* place and by acting *for* sustainability. These types of activities are not mutually exclusive because activities *about* place and sustainability may be conducted *in* the environment and may result in a public display *for* sustainability.

In the environment

The Arts activities considered here relate to those conducted in the built and natural environment or those used to inspire arts activities in the built and natural environment. As we have already stressed, learning in the creative arts can help students develop a positive attitude to and an authentic valuing of the environment, as well as a personal relationship to place. Arts activities conducted in the natural environment aim to develop increased sensory awareness and appreciation of and for the natural beauty of the environment. These kinds of activities work with values and attitudes because they encourage empathy with the environment. Practical outdoor experiences can be supported through interpretation activities during which students express their feelings and impressions via a variety of media in drama, dance, music, visual art and media arts (e.g., artworks, soundscapes, music composition) and embodying aspects of the environment through role-play and movement activities.

About place

The Arts activities of relevance here explore connection to and mutual relationships with place and the impact of these activities on the environment, society and the economy. Activities also include those that explore specific scientific concepts and social concepts. In this way, the Arts can support the development of *knowledge and understanding* of topics related to sustainability in science, history and geography. The Arts can serve as pedagogical tools for learning about concepts and processes related to environmental issues (e.g., modelling and role-playing in drama, artworks depicting environmental processes such as energy cycles, ecosystems and global warming).

For sustainability

Arts activities (or products of arts activities) can address issues of sustainability and can be presented in a public sphere for the purpose of advocating for sustainable practices. Learning can encourage *action to protect and conserve the environment*. Techniques such as process drama can give students an embodied experience of working in a proactive way to protect or repair natural heritage. Artworks can depict transformation of environment from devastated to renewed; music and song composition can focus thematically on environmental renewal.

EFS CREATIVE-ARTS LEARNING SEQUENCES

The Arts involve both processes and products. The activities described in this chapter focus on the processes of the Arts as well as on the development of understanding necessary to inform action for sustainability. Often, the creation of a product may be secondary to the engagement of the children in the creative activities themselves. Other activities may focus on the product, particularly the activities *for* sustainability, which aim to produce some form of public display. The activities also focus on the development of the knowledge and skills of the Arts. For this reason, we present the activities as *learning sequences*.

Each sequence begins with a focus on developing an awareness of (a sense of) place, and moves towards securing a deeper understanding of the mutual relationships between people and place, and among all things. The later stages of the activities endeavour to engage the children's creativity in terms of imagining how places can and might change, and how the children can influence that change.

Each sequence is also designed to be taught over a period of time. The time taken will vary from one class to another, depending on the children's and your (the teacher's) experiences and confidence with the various artistic skills, and on the flexibility or otherwise of particular classroom programmes. The activities are adaptable for various age groups. Much depends on the children's prior experiences with the various artistic forms of expression, and on their abilities to be receptive to place. We have chosen to present only a few in-depth learning sequences as examples, and trust that you can use these as models for exploring other aspects of place with other media.

Figure 11.1 provides a diagrammatic representation of the learning sequences described in this chapter. It shows how each learning sequence focuses on a particular art form and place. You might like to start with the learning sequences described here or you might prefer to experiment with the various art forms and different places (see the resources listed at the end of the chapter for more ideas). You might also choose to mix and match the art forms and the places; for example, you could explore a special place through poetry, or the school playground/yard through dance.

So that you can facilitate the development of appropriate and meaningful learning sequences, we suggest that you will find it useful to consider the following questions:

- What connections do I have with place?
- What are the histories of the place where I live (European settlement, indigenous, geological)?
- What local sustainability issues relate to the place where I live/teach?
- What connections to other places do my students have?
- What is the cultural make-up of my class?
- In what ways do the students' cultural practices and stories relate to the Arts and to place?
- What art interests do my students have?
- What local art resources are available?

Figure 11.1. Learning sequences: developing "a sense of place" through the Arts.

Learning Sequence 1: Exploring place through installation art (Margaret Brooks)

In this section, I (Margaret) look at how teachers and children can collaborate with visual artists to explore elements of their environment. Christine McMillan, an Australian environmental installation artist, also works to engage young children in artistic processes relevant to environmental issues. One of the media Christine works with is gauze. Gauze is a very flexible and versatile medium that can be used to make elements of the environment visible. Figure 11.2 shows some of the many ways that Christine uses gauze.

Figure 11.2. Christine McMillan's use of gauze (McMillan, 2008).

As the images in the figure show, careful placement of gauze draws one's attention to something and raises awareness. Christine wraps, threads, hangs and lays gauze over and around objects. She creates passageways, enclosures, spaces, windows, screens, barriers and carpets. Essentially, she uses gauze to highlight elements of the environment, and she invites an interaction with her art through holistic engagement. We are invited to walk through, around and over her art, which creates new spaces and places for us to inhabit. We can experience the history and impact of human and natural elements as her art ages.

Symmetrical planting When Christine exhibited her installation "Symmetrical Planting" during an artist-in-residence event at the New England Regional Art Museum, Armidale, NSW, I teamed up with her, a class of 13 four-year-olds and their teacher. Christine shared the process of developing the installation with the children and helped them to create their own. The process was a multi-step one that you could apply to your own teaching contexts.

Christine's installation (shown in Figure 11.3) explored the issue of introduced species in our environment: in this case, poplar trees outside the art museum. These trees were planted in a symmetrical formation. Emphasising that symmetry through gauze wrapping creates an experience of ordered space that is imposed on the environment. The trees, along with other introduced species, have overtaken the local native species and choked the adjacent creek land.

Figure 11.3. Christine's McMillan's Symmetrical Planting installations (McMillan 2008).

Introducing the children to Christine's ideas In her studio overlooking the installation, Christine explained her ideas and how she had prepared for building the installation. She showed her planning sketches and preliminary models. (It is important for children to know that art is about "big ideas" and that it involves much preliminary research, exploration and preparation.) She then asked the children to begin their work by drawing the installation from a distance. Such drawing focuses children's attention.

Next, Christine invited the children to experience the installation and to make more drawings. (Drawing from close observation helps children notice details and engage with the installation; see, in this regard, Brooks, 2009.) The children noticed things like insects and shadows. Inside the installation, the children came to understand how different spaces could be created and how these spaces changed the way in which they saw the trees and the world around them (Figure 11.4).

Figure 11.4. Children exploring the installation (McMillan, 2008).

Developing fluency with the media Christine, the teacher and I spent much time preparing the classroom environment and art materials, and sequencing and timing the experiences that would enable the children to create their own installations in the playground. The classroom was uncluttered and focused. We displayed drawings and photos of the installation and reviewed and discussed them with the children, so helping them remember and refocus after their visit to the art museum. Once Christine had demonstrated possibilities for the art materials provided, we tried to replicate explorative studio processes with the children (Figure 11.5).

Figure 11.5. Developing media fluency (McMillan, 2008).

The children explored the potential of the materials and gained a degree of fluency with them that became important knowledge and experience for when they began creating their larger installations in the playground. Gauze was wrapped, layered, connected, pulled apart, tied and coloured. Each exploration was drawn, revisited and then shared with peers and the large group. The representation and sharing of ideas helped the children consolidate their learning and build a collective understanding. We were moving children from an initial, superficial encounter with materials to a deeper understanding of a process that engaged them with more complex ideas and processes (Brooks, 2006).

Children planning Christine reminded the children of her preliminary plans and models for the installation. She invited the children to consider elements of the playground that concerned, intrigued or surprised them. The children worked in groups to discuss and draw plans for their installations in their schoolyard. Drawing gives form to emergent ideas and facilitates discussion. Drawing also allows children to integrate different ideas into a common plan—to develop a shared understanding and a common goal (Figure 11.6).

Figure 11.6. Planning the installations for the schoolyard (McMillan, 2008).

One group of boys noticed that one tree in the yard looked as if it were several trees. Together they worked to link multiple trunks with gauze so that they were rendered as one tree. A group of girls highlighted their ambivalence about the fence surrounding their yard. They saw the fence as both restrictive and protective. One girl worked alone to mend the trunk of a tree that was weeping sap. Another group wanted to see what a row of trees might look like if planted between two big trees. They used gauze to represent the line of imaginary trees. As each installation was finished, the children modelled Christine's practice and used cameras to record their finished work. The children also shared and discussed their installations and the ideas they embodied with one another.

At the end of the project, the children created a display featuring their learning stories and carefully selected samples of their work. They shared this display with families, friends and peers as a celebration of their work (Figure 11.7). This sharing represented a form of action for sustainability, because it enabled the children to highlight their place and their relationship to it and to draw attention to sustainability issues warranting consideration.

Figure 11.7. The children's installations in their schoolyard (McMillan, 2008).

Learning Sequence 2: Responding to place through musical composition (Ros Littledyke)

Music is fundamental to human existence. In our electronic and digital world, the paradox is that outstanding music of all types and varieties is available for us to listen to, yet opportunities for children to make music compete with the increasing academic demands of the school curriculum. Music is a language that feeds the soul. It adds richness and meaning to our cultures and marks our most joyful and solemn occasions. Opportunity to share it, to participate, perhaps even to understand some of its complexity and many delights, should be a part of every child's heritage. Music also lends itself well to cross-curricular teaching and learning and provides opportunities for developing transferable skills that can be applied across a curriculum (Figure 11.8). The skills and curriculum links identified in Figure 11.8 are not exhaustive but merely a starting point for further exploration and experimentation.

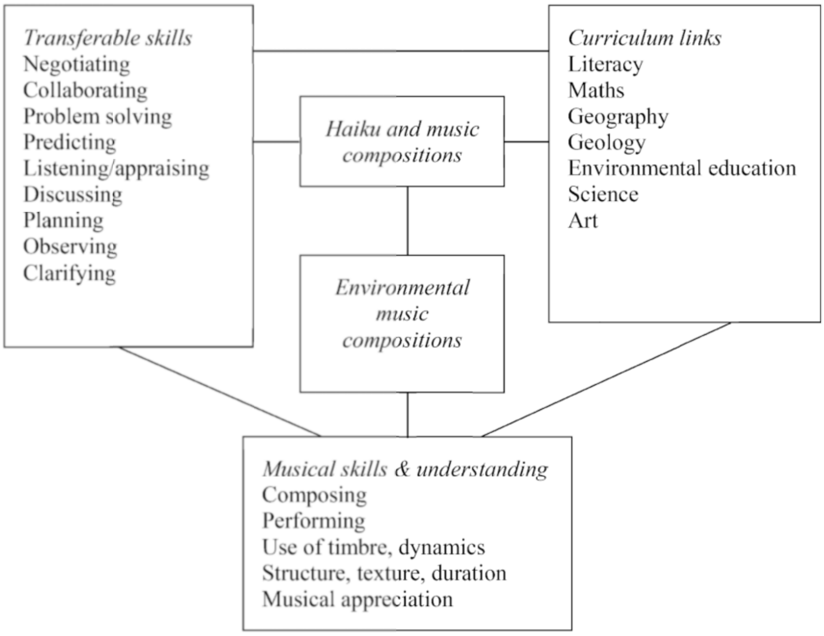

Figure 11.8. Curriculum links, music skills and transferable skills that can be developed through teaching music.

The learning sequences below (Tables 11.1 and 11.2) suggest two ways of encouraging children to respond to place through musical composition. The haiku and composition sequence offers a more structured approach, as it uses an established poetical form to reflect a place, while the composing from found objects sequence challenges children to create a composition based on what they see, hear and gather from an immediate environment. Such an approach to composition encourages children to look closely and become aware of an environment. It can also be used in such a way that children are able to make comparisons between different environments and heighten their sense of both a single place and the differences between places.

Additional activities The children can:
– express their compositions through dance, visual art, drama or literacy;
– record their compositions through graphic notation; and
– share their compositions and environmental messages with other classes or community members.

Table 11.1.Music experiences.

Haiku and music composition	*Curriculum links*
Children work in groups to draft a haiku about a place they have visited as a class or a place that has meaning for them	Literacy Cross-curricular skills Problem solving, collaborating, negotiating, writing within a given form
Children share their haiku with the rest of the class group and appraise/suggest ideas for improvement for one another	Critical literacies Maths Cross-curricular skills Listening/appraising, collaboration, problem solving
Children re-draft haiku	Critical literacies Cross-curricular skills Drafting, redrafting, collaborating, problem solving
Children compose music with un-tuned percussion to reflect haiku	Literacy, maths Cross-curricular skills Collaborating, problem solving, negotiating, drafting/redrafting/listening/appraising Music skills and understanding Composing, understanding of timbre, duration, dynamics, structure, texture
Children share compositions and appraise one another's work	Critical literacies Cross-curricular skills Problem solving, collaborating, listening, appraising Music skills and understanding Composing, performing
Children add a simple pitched composition using a pentatonic scale	Maths, literacy Cross-curricular skills Collaborating, problem solving, negotiating listening/appraising Music skills and understanding Composing, performing, understanding of timbre, pitch, duration, structure, dynamics, texture

Table 11.2. Composing from found objects.

Composing from found objects	*Curriculum links*
Children compose a musical composition from objects found in an environment suggested by the teacher or one they choose themselves. The environment does not necessarily have to be a natural one; often, a built environment can offer great scope for children's imagination and inventiveness. Audio recordings of sounds can also be used to reflect the chosen environment	Critical literacies, geography, art, science, ICT, environmental education Cross-curricular skills Discussing, collaborating, negotiating, observing, investigating
Children or teacher choose an environment	Science, environmental education, geography, geology Cross-curricular skills Discussing, collaborating, negotiating, observing, investigating
Children work in groups to find objects to create a sound	Science, environmental education, geography, geology, ICT Cross-curricular skills Observing, collaborating, discussing, problem solving, negotiating, listening/appraising, sorting, classifying Music skills and understanding Understanding of timbre, duration, dynamics
Working with teacher and whole group, children discuss the planned structure of the composition and how it can reflect the environment from which the objects are drawn; e.g., how would they musically reflect busy ants?	Critical literacies Cross-curricular skills Negotiating, problem solving Music skills and understanding Composing, appraising
Children work collaboratively to create a composition reflecting the environment from which the objects have been drawn	Maths Cross-curricular skills Problem solving, collaborating, listening/appraising, negotiating Music skills and understanding Composing, performing, understanding of timbre, duration, dynamics
Children perform compositions to the rest of the class group	Cross-curricular skills Listening/appraising Music skills and understanding Composing, performing

Learning Sequence 3: Expressing place through drama (Lynn Everett)

In this section, I explore how teachers and children can engage in drama activities that encourage a deeper understanding of the interdependent relationships existing between living creatures and their environments. The sequence relies on direct interaction with flora, fauna and habitat in the local area. The children learn about specific creatures in a local ecosystem by embodying them through dramatic role-play. As Lecoq (2000, p. 22) points out:

> [M]iming is a fundamental human action, a childhood action: children mime the world in order to get to know it and to prepare themselves to live in it … To mime is literally to embody and therefore to understand better.

By identifying with specific creatures, both physically and emotionally, children can develop empathy and understanding for the wildlife they are portraying and are therefore better able to see the world from another's perspective. In pretending to be a plant or animal, children "step into another's shoes" and gain an insight into that organism's day-to-day life. Encourage the children to adopt an attitude of caring and protection towards the individual animal/plant and the ecosystem as a whole.

The interactions between the life forms within the ecosystem also offer opportunities for the children to reflect on positive social relationships in terms of the ways in which different plants and animals depend on one another and often work symbiotically. These understandings can be seen as metaphors for building sustainable communities.

Web of life: ecosystem This activity involves the following steps:

1. Teacher researches an ecosystem that exists in the local area, for example, desert, forest, or rock pool community—consult National Parks and Wildlife, Landcare and/or Coastcare (Australia), Department of Conservation (New Zealand).
2. Class discusses ecosystems and food webs, especially interdependence of life forms in the system in terms of providing food, protection and places to live and reproduce.
3. Class goes on an excursion in the local area to observe interactions among the life forms in the food web and/or invites representative from National Parks and Wildlife or another expert to discuss local ecosystems.
4. Class creates a physical representation of the environment's food web/ecosystem. If the environment is a rock pool, for example, the class creates a "sculpture" of the pool using their bodies. Students sit in a large circle and discuss what is typically found in a rock pool environment—rocks, seaweed, sandy floor, crabs, rock caves. Teacher emphasises the pool's different levels. One at a time, students enter the circle and freeze their body into the shape of something in a rock pool. When all the children have taken up their frozen position, the teacher photographs the sculpture.
5. Teacher and students select five or six specific examples of flora and/or fauna in an environment that live and depend on one another in terms of feeding relationships. For example, life forms in a rock pool community might be (i) green algae (seaweed), (ii) reef heron, (iii) blue-ringed octopus, (iv) pipefish, (iv) reef crab, (vi) anemone.
6. Teacher invites indigenous elder and/or national parks ranger to talk to the class about these local flora/fauna. What is the significance of the animals/plants within the local indigenous culture? What human interactions threaten this ecological community?

7. Using the "jigsaw strategy", the class divides into six "expert groups". Each group is allocated one life form in the food web.
8. Each group researches their life form using books and/or the internet:
   - What does it look like? What shape and colour is it?
   - How does it move (when stationary and when moving from place to place)?
   - What words describe the way it moves (darts, slides, scuttles)?
   - Does it make a sound (either on its own or when moving through the environment)?
   - What does it eat, and what eats it?
   - Where does it live? Where/how does it hide from predators and prey?
   - What does it do when it is threatened?
   - How long does it live? How does it reproduce?
   - Does it have any interesting behaviour or special characteristics?
   - Where else is this creature found?
9. Each group develops a set of movements for their life form. These might relate to hunting, hiding, camouflaging, eating, reproducing and/or moving from place to place. For example:
   - The reef crab pretends to be dead when threatened by a predator.
   - The sea anemone tucks in its tentacles to avoid drying out at low tide.
   - The pipefish hides from predators by grasping the seaweed as camouflage.
   - The blue-ringed octopus, when threatened, shows its bright blue rings to frighten its attacker away.
   - The reef heron spears its prey with rapid lunges of its sharp beak (Pyers, 2004).
10. Each "expert group" presents a dramatic presentation to the class by performing the set of movements they have developed for their life form. This step can be done using the drama convention of "hot seating", in which the children take on the roles of the sea creatures/plants, allowing them to develop their voice and movement skills as they create their characters. The rest of the class pose questions to the group that is presenting, such as "What do you eat?" etc.
11. The class then forms "food web groups" by having one student from each expert group join a new group, thus creating a food web. Each student in the group thus becomes an expert on one of the six life forms in the ecosystem.
12. The food web groups discuss how the creatures interact with one another and what the relationships are among them. Each group creates a small dramatic piece about life in the rock pool and the interactions among the creatures in terms of hunting, hiding, eating and moving around the rock pool.
13. Groups present their dramatic pieces, accompanied by music. Part of the classroom could be used as the habitat, with a group of chairs serving as seaweed and rocks.
14. After watching the performances, the teacher and children appraise them and discuss what worked well and what might be improved for future performance.
15. Working together, students and teacher create a whole-class movement piece by combining the best aspects of all the group work.
16. Teacher and class discuss the interdependence of life in the food web and what would happen if something disappeared—seaweed, for example. Discussion can also focus on a real local or global issue that could affect the delicate balance of the food web, such as rising ocean temperatures. What are some possible solutions?

17. The class can also develop the drama to demonstrate the consequences of human actions that have a negative impact on the system. From there, they create a performance that depicts the problem and possible solutions. Use a real local issue. Have the children present the drama to other classes, the school or the community as a form of action for sustainability.

Learning Sequence 4: Exploring our place through movement and dance (Genevieve Noone)

Dance is integral in the Arts curriculums of both New Zealand and Australia. The dance aims in the Australian Curriculum include:
– body awareness and technical and expressive skills to communicate through movement confidently, creatively and intelligently;
– choreographic and performance skills and appreciation of one's own and others' dances; and
– making and responding to dance.

All levels of the curriculum contain cross-curricular priorities for dance, including sustainability.

In the New Zealand Curriculum, students:
– explore and use dance elements, vocabularies, processes, and technologies to express personal, group, and cultural identities, to convey and interpret artistic ideas, and to strengthen social interaction; and
– develop skills in performing, choreographing and responding to a variety of genres from a range of historical and contemporary contexts.

This learning sequence focuses on connecting the children to their local environment (natural and built) by having them explore the properties of the environment, now, in the past, and in the future, with and in their own bodies. The sequence begins with simple body sculpture and moves to free-flowing dramatic and dance movements.

Being comfortable with our own bodies helps us to connect with other bodies, as well as with non-human elements in our physical, social, cultural, economic and political environments. *Knowing* our bodies assists us to understand (i) how our bodies are connected to both the physical and metaphysical elements of place, and (ii) the influence of our bodies on place, and of place on our bodies. This knowledge also facilitates understanding of how our bodies can live sustainably with and in place. We gain this understanding by learning about how our actions influence place and how place influences our actions.

Once children are comfortable in their bodies—comfortable exploring their own body's movements, and comfortable creating movements that connect with and involve other bodies and other things (both animate and inanimate)—they will be ready to engage more meaningfully with various forms of drama including mime, puppetry, clowning, masks, improvisation, role-play and theatre, as well as with varied forms of folk, classical and modern dance, both choreographed and free. Confidence and competence in the various forms of dance and drama enable children to make creative use of these art forms and so engage meaningfully in exploring the often unconscious, emotive, spiritual and visionary aspects (the myths and metaphors) of sustainability.

If you are teaching children who are already experienced and competent in exploring and creating movement with their own and others' bodies, you could take the ideas in the following sequence and replace the basic movement activities with more complex and challenging drama and dance processes. You might also want to view the Bangarra Dance Theatre (2014) educational videos, either as background for yourself, or you could view them with your students to encourage exploration through modern dance theatre techniques.

1. Begin with students taking an observational walk in the schoolyard, making notes/drawings about (a) something (animate or inanimate) on the ground, and/or (b) something in the sky, and/or (c) something in between. The notes are to include how the thing looks, what sounds it makes (if appropriate), what it feels like and how it moves. Before setting out on the walk, discuss with the students how they could record these observations in a way that will enable them to recall them when they are back in the classroom (e.g., written notes, sketches, text–image combinations). (See Hinchman, 1997, for a detailed exploration of journaling place.) On returning to the classroom, the children can share the different ways they recorded their observations.
2. After the students have completed some preliminary warm-up (body awareness) exercises, have them, in pairs, sculpt each other into still images of the things they observed in the schoolyard. Encourage the children to discuss how the sculptures might be improved. For example, in what other ways could they show the height of the tree or the rough surface of the asphalt? The whole class can experiment with different ways to represent these things. Repeat this step with the children in groups of four or five, and one student sculpting the others.
3. After exploring various movements, ask the students to repeat the above process, but this time adding movement to their sculptures and focusing on how the movement can be represented rather than replicated. Ask the children such questions as: How else could you show the movement of the swings or the flight of the grasshopper? Also ask the children to explore different ways of representing these various movements. (See Meiners, 2004, for ideas about developing students' range of movements.)
4. Divide the class into groups. Each group choreographs a movement piece (dramatic movement, or dance, or a combination of both) of the schoolyard. Discuss with the students the relationships between the various elements of the schoolyard that they have chosen to include in their piece and how these relationships can be represented. For example, how can they show the relationship between the wind and the trees, or between the children playing and the grass/dirt/concrete, or between the children and the birds, or between the birds and the concrete?
5. Explore with the students how the schoolyard has changed and continues to change. Old photographs of the yard and stories or descriptions from past students would be useful here. The children can create sculptures and movement sequences to represent these pictures and stories. Then, using the movement exercises described above, they create sculptures/tableaux/movement pieces of how they would like the schoolyard to change in the future, paying careful attention to how changes to any one aspect of the school environment may affect other aspects of this place. For example, would changes to the natural environment (more or less garden) influence the insects, birds and other animals that do or do not currently visit the school yard?

6. Depending on the children's levels of understanding, you could encourage them to discuss issues concerning culture, economics and politics. For example, if the children envision a schoolyard where there is either more grass or more concrete, what materials would be required for the changes? Where would these materials come from? What resources would be used in creating the change? Who would pay for the upkeep? Who would decide what to change? What would be the advantages and disadvantages of the changes? Given all these questions, it is important to ask the children to consider answering them from many different perspectives.

Extension These movement pieces can be used as a basis for developing a dramatic or dance performance: visuals can be created and, if appropriate, the students could create musical accompaniments from found objects, following steps similar to those described in Learning Sequence 2.

Learning Sequence 5: Multi-arts exploration of place (Lynn Everett, Margaret Brooks, Ros Littledyke and Genevieve Noone)

This section provides an integrated, multi-arts learning sequence wherein children explore their local area/neighbourhood. The activities aim to develop a sense that places are not static but dynamic. Children gain insight into how places change over time and how humans make decisions that impact on and shape places now and into the future. As part of the sequence, children have an opportunity to contemplate and envisage a future for the place in which they live. Although this integrated project is most suitable for upper primary school children, it can be adapted for a range of ages.

Our town/neighbourhood This activity involves a number of thematic steps.

1. Being there

- Class discussion: Brainstorm what the class knows about the town or the local neighbourhood around the school, including the built and natural environments. Consider the following points:
  - What are the major geographical features (hills, mountains, watercourses and bodies of water, gullies, creeks, rivers, lakes, dams, oceans, canals, large drainage systems, swimming pools, caves or rock formations, quarries, skate parks, major roads, bridges, etc.)?
  - Where do the creeks or rivers come from and where do they go? Where is the catchment area?
  - In relation to the school, where does the sun rise and set? Where is north, south, east, west? Where do the prevailing winds come from at different times of the year? What are the weather patterns?
  - What are the areas of vegetation and animal habitation? What are the major flora/fauna?
  - What are the areas of human habitation, community services and industry?
- Excursion around the town/neighbourhood or specific parts of the neighbourhood: As the children walk around the area, have them record the sights, sounds, smells and textures. Drawing on the processes outlined in Learning Sequence 1, invite the children to make installations using gauze in a particular area of the local environment. These "records" can

be in the form of writing, drawing, texture rubbings, audio-visual recordings and so on. Visit the local lookout or tallest building and encourage the children to draw what they see from this vantage point. You and/or they could also create a soundscape made up of a compilation of the sounds they identify during the excursion.

2. The shape of this place

- Exploring maps: Find a topographical map or aerial photo of the town/neighbourhood. Ask at your local council, Department of Lands, or search the internet (see Google maps). Hold a class discussion aimed at identifying the features discovered through observations during the class excursion.
- Have the children, as a class, make a map of the town/neighbourhood and create symbols for the map's major features. Examples of symbols could be a triangle for hills and mountains, a circle for trees, a squiggly line for a creek or river and a square for the shopping centre. It is important that the class invents its own symbols rather than adopts symbols used by indigenous peoples of the area because these are an integral part of their spiritual traditions. Extension activity: ask the children to make a model of the town/neighbourhood using clay or plasticine and found objects.
- Tell the class you want them to (i) research how local land and water forms were created millions of years ago, and (ii) create a dance/movement piece that demonstrates the geological processes that occurred. For example, the class could portray volcanic events or the processes of erosion.
- Ask the children to use their bodies to represent the various features of the town/neighbourhood by creating a group sculpture. For example, three children could stand facing one another in a circle, with their arms stretched upwards to create a hill; individual children could sit with hands together above their heads in order to depict houses; two children could sit holding a piece of cloth at either end to represent a river or road.
- You could also have the children, in their groups, write a haiku or an acrostic poem form for each of the environmental features. Haiku examples:

> Water dance and sing
> Over rocks and down gullies
> Creeklands give things life
>
> Cars zooming around
> Lots of concrete straight and curved
> Roads moving us around town

The children could furthermore compose a tone poem that reflects the geological history of the place.

- Guide the children into presenting a dramatic performance of their town/neighbourhood using the class sculpture, and with each landscape "feature" saying their poem. Children from another class could compose music to accompany the performance.

3. Changing places—back to the future

- Encourage the children to talk to parents/grandparents/caregivers about the town/ neighbourhood to find out how it has changed over time (other elders from, for example, the Country Women's Association or aged-care homes, could be interviewed).

– Invite a representative from Landcare, Coastcare, National Parks and Wildlife (Australia), Department of Conservation (New Zealand) to talk to the class about changes that have occurred over time to local flora, fauna and habitat.
– Have the class research old photos of the local area from family members or the local library, historical society, or newspaper archives.
– Help the class explore the history of European settlement in the area.
– Now ask the children to review their class sculpture and to alter it to reflect the changes that have occurred over time. For example, the children who depicted houses could transform into trees, forest or animals.

4. Creating places

– Talk to your students about stories from different cultures that explain how geographical features were formed (e.g., cultural creation myths, indigenous stories).
– Guide the children into developing a story that tells how the natural geography of the town/neighbourhood was created. Make sure they relate their story to specific local flora and fauna. For example: a giant brown snake made the river; the mountain was formed by a giant echidna that rested there; a group of boulders are people who have been transformed. The story should be the class's own invented story and not a local indigenous story.
– Ask the children to make a list of the sights, sounds, smells, tastes and textures that are important in the story and to incorporate these into the narrative.
– Let the children develop the story as a drama performance, with a narrator. Tell the children they are to make the shapes of the land features with their bodies and to do the same for characters such as the animals, plants and/or people.
– Have the class perform the piece for an audience. Encourage them to compose a piece of music employing percussion to accompany the storytelling. The children could also record their compositions in graphic notation.

5. Indigenous places

– Invite a senior indigenous advisor to talk to the class about the local Aboriginal or Māori people's relationship to the town/neighbourhood. Encourage the children to ask questions such as these:
  - What was/is the local indigenous relationship to place before and after white settlement in terms of food gathering, hunting, water, totems, social structure, spirituality?
  - What are some of the Aboriginal/Māori stories related to the area?
  - What is the work of local indigenous artists?

6. Visions of place

– Hold discussions centred on this question: How do we want our town/neighbourhood to be in the future?
– Lead the class in a guided relaxation and creative visualisation activity in which each member of the class envisages the town/neighbourhood in the future. Have the class discuss the children's visions of place.
– Set a task in which the students work in groups. Each group chooses a specific arts medium to work with. This can be visual art, music, drama, poetry or dance.
– Each group uses their chosen media to create an artwork that conveys their vision for the future of their town/neighbourhood.

- Have the groups present their art works and facilitate a class discussion based on the question of how appropriate their art form is in terms of presenting their vision.
- Begin another class discussion around this question: How can we get there from here? That is, how could we go about creating this vision of place for the future? What things would we need to do to bridge the gap between the present situation and our future visions of place? What actions would we need to take?
- Discuss with the children activities occurring in different parts of the world that are moving towards a sustainable future. Have the children conduct research using books and the internet to explore some of these activities. Search terms could include vertical gardens, reducing food miles, sustainable cities, green spaces, rooftop gardens, sustainable energy.
- End by having students consider possible actions that could be taken to address one or some of these issues. Help them to plan these actions and, where possible, take some action of their own for sustainability.

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Pyers, G. (2004). *Life in a gum tree*. Port Melbourne, VIC, Australia: Echidna. ISBN: 9781740707961
Pyers, G. (2004). *Life in a rock pool*. Port Melbourne, VIC, Australia: Echidna. ISBN: 9781740704380
Pyers, G. (2008). *Life in a creek*. Port Melbourne, VIC, Australia: Echidna. ISBN: 9781740704410

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12. EDUCATION FOR SUSTAINABILITY IN PRIMARY HEALTH AND PHYSICAL EDUCATION

Health and physical education is a combined and integrated curriculum area in Australia and New Zealand. While this approach is not always the case in all learning contexts (e.g., the UK), for the purpose of this chapter, we have positioned health education as the main focus for education for sustainability (EfS). Health is a fundamentally important concept for the sustainability of society. For a healthy society, we need healthy individuals who are living, learning and functioning within a healthy environment. What we choose to put into our bodies and our outlook and lifestyle choices have a direct impact on our health status, as well as having social and environmental implications.

Because choices concerning one's health can also have major implications for sustainability, students will benefit from learning experiences that help them understand the consequences of outlook and lifestyle on their inner and outer environments. Education for sustainability through health education involves developing an understanding about our bodies, our emotions and our interactions so that we can understand how health can be developed, maintained or damaged. Such understandings are influenced by the social, economic, political and environmental factors in our society. In this respect, health education for sustainability is essentially cross-curricular, linking scientific knowledge with social and environmental impact through the ethics and consequences of various forms of action. In order to promote meaningful learning to inform action for health, teachers will find the constructivist model of teaching valuable because it requires them to draw on children's views and experiences (Littledyke & Huxford, 1998; Skamp, 2012). This approach also challenges children to extend their understandings through enquiry and investigation (see Chapters 3 and 6 in this regard).

WHAT DOES IT MEAN TO BE HEALTHY?

Views about health have changed over the years. At the beginning of the 20th century, when life expectancy was much lower, specifically, 55 for men and 59 for women in 1910, compared to 79 for men and 84 for women in 2010 in Australia (Australian Institute of Health and Welfare, 2012), health was seen as the absence of disease. However, contemporary definitions view health in a broader and more holistic way. For example:

> Good health implies the dynamic balance between individuals (or groups) and their environment. To the individual, good health means improved quality of life, less sickness and disability, a happier personal, family and social existence and opportunities to make choices at work and recreation … To the community, good health means a higher standard of living, greater participation in making and

N. Taylor et al. (eds.), Educating for Sustainability in Primary Schools, 247–265.

implementing community health policies and reducing health care costs. (Better Health Commission, 1986, cited in Pecujac, 1998)

This definition highlights the dynamic nature of health across the lifespan and further recognises that health affects both individuals and communities. Health can be seen as composed of four broad dimensions—physical, social, emotional and spiritual. Maintaining an optimal level of health and wellbeing requires a balance and interaction across all four (see Figure 12.1).

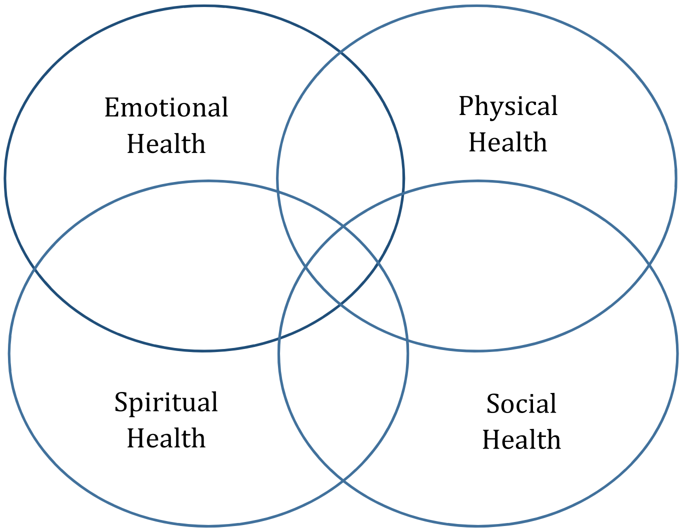

Figure 12.1. The dynamic interplay between emotional, physical, spiritual and social health.

This model of dynamic interplay is well accepted in the Australian and New Zealand health education context because it illustrates the intersections between the various dimensions of health and highlights a multidimensional approach to health education.

– *Emotional health* refers to ability to manage and express emotions. Because our emotional health is influenced by self-esteem and confidence, an important aspect of health promotion is that of developing confidence and emotional balance in children. This balance has a direct impact on learning, given that confidence, self-esteem and motivation are closely linked with achievement (Coopersmith, 1964; Marsh & O'Mara 2008). A supportive environment is important in helping children cope with social pressures to make unhealthy lifestyle choices, and deal with stress and anger.
– *Physical health* refers to how well our bodies function, with that functioning affected by nutrition, physical activity, use of drugs, genetic makeup and environmental conditions. It is measured through factors such as heart rate, blood pressure, body size and fitness.
– *Spiritual health*, the basis of which can be religious, humanistic or environmental, is underpinned by a caring outlook and feeling part of a wider world. It gives a sense of purpose and belonging. EfS promotes such values because a sense of connectedness is

part of supporting empathy for and a sense of responsibility to other people and to other living things; both are precursors for action to support others and the environment.
– *Social health* is affected by our interaction with other people, including family, friends and school colleagues. It influences our ability to form relationships, interact with others, enjoy social relationships and feel a sense of belonging. School plays a very important role in social health in terms of promoting and modelling caring, supportive relationships.

HEALTH EDUCATION IS A WHOLE-SCHOOL RESPONSIBILITY

It is widely recognised that health education is most successful when it is implemented across the broader school environment (Nutbeam, 2000). Other areas of the curriculum, along with wider school policies and practices, can reinforce students' learning of health-related knowledge and their gaining of understanding and skills in this area. This "broad sweep" means that health education affects everyone in the school and its community, from students, teachers and non-teaching staff to parents, governors and community members. This whole-school approach to health education, known widely as the "health-promoting school" (Lakin & Littledyke, 2008), endeavours to engage whole school communities in health-promoting policies and practices across three inter-related components: curriculum, teaching and learning; school ethos and environment; and partnerships and community links. The health promoting school has been broadly advocated and implemented in schools across Australia and New Zealand.

As set out by the World Health Organization (1989), a health-promoting school aims to:
– develop good links between associated primary/secondary schools in planning a coherent health education curriculum;
– actively promote the self-esteem of all students by demonstrating that everyone can make a contribution to the life of the school;
– develop good staff/student and student/student relationships in the daily life of the school;
– make clear to all staff and students the social aims of the school, including through provision of stimulating challenges, made up of a range of activities, for all students ;
– take every opportunity to enhance the physical environment of the school;
– promote staff and student health and wellbeing;
– consider the exemplar role of staff with regard to health-related issues;
– consider the complementary role of school policies to health education (e.g., policies on smoking, bullying, healthy eating);
– develop good school/home/community links and shared activities;
– use the potential of specialist services in the community for advice and support with respect to health education; and
– develop the education potential of the school health services beyond routine screening and towards active support for the curriculum.

While a health promoting school has such aims at the core of its activity, effective health policy will be specific to the school and best developed through wide consultation with members of the school community. This approach ensures that health-promoting efforts are responsive to contextual demands and are understood and acted on by everyone involved. Successful implementation of such a policy into effective practice depends on how well the school community is committed to the aims of the policy. Strong commitment is evident in schools that reinforce health education as a whole-school community responsibility.

HEALTH EDUCATION AND THE CURRICULUM

The health education curriculums of both Australia and New Zealand incorporate all four broad dimensions of health. Most recently, the development and release of the Australian Curriculum for Health and Physical Education (Australian Curriculum, Assessment and Reporting Authority [ACARA], 2014) has brought in a set of educative outcomes for students that can be consistently applied across the country. At present, the individual states and territories are facing the challenge of negotiating and adopting this curriculum. However, many professionals remain hopeful that a more cohesive, comprehensive approach to health education will be implemented across Australia. As Dodd has pointed out:

> The curriculum should be seen as evolving and dynamic, adjusting to social, political, technological and cultural change as it occurs … Australian states have developed their own curriculum frameworks with great variations from the Statements and Profiles of 1994 … Indeed, we have a parade of curriculum frameworks each with their own personalities and faces working alongside the notion of a national framework. (Dodd, 2000, pp. 38–40)

Fundamental to the Australian health and physical education (HPE) curriculum is a strengths-based approach, characterised by a strong focus on helping students develop the knowledge, understanding and skills required to make healthy, safe, active choices (ACARA, 2014). This approach is a shift away from the deficit, risk-based model of teaching health that has long dominated the school context. Rather than teaching the dangers of engaging in risky behaviours (drug use, smoking, poor nutrition), the new approach stresses developing students' ability to enhance their health and that of others. Within the HPE curriculum, health content is embedded in the personal, social and community health strand and incorporates such aspects as being healthy, safe and active; communicating and interacting for health and wellbeing; and contributing to healthy, active communities (Table 12.1).

In New Zealand, the HPE curriculum strands are nationally consistent and framed around developing the wellbeing of students beyond the classroom (New Zealand Ministry of Education, 2007; New Zealand Ministry of Health, 2012). Students develop their understanding of the factors—lifestyle, economic, social, cultural, political, environmental—influencing the health of individuals, groups and society. Students develop not only competencies for mental wellness, reproductive health and positive sexuality, and safety management, but also understandings of nutritional needs. They build resilience by strengthening their personal identity and sense of self-worth, managing change and loss and engaging in processes for responsible decision-making. They learn to demonstrate empathy, and they develop skills that enhance relationships. Students use these skills and understandings to take critical action to promote personal, interpersonal and societal wellbeing.

Table 12.1. Health and physical education strands in Australian and New Zealand HPE curriculums.

State/country	*Health and physical education strands*
Australian health and physical education curriculum	*Strand:* Personal, social and community health *Sub-strands:* – Being healthy, safe and active – Communicating and interacting for health and wellbeing – Contributing to healthy and active communities *Focus areas:* Alcohol and other drugs, food and nutrition, health benefits of physical activity, mental health and wellbeing, and relationships and sexuality *Strand:* Movement and physical activity *Sub-strands:* – Moving our body – Understanding movement – Learning through movement *Focus areas:* active play and minor games, challenge and adventure activities, fundamental movement skills, games and sports, lifelong physical activities, and rhythmic and expressive movement
New Zealand curriculum	*Strands:* – Personal health and physical development – Movement concepts and motor skills – Relationships with other people – Healthy communities and environments *Underlying concepts*: wellbeing, health promotion, the socio-ecological perspective, attitudes and values *Key areas of learning:* mental health, sexuality education, food and nutrition, body care and physical safety, and sport studies and outdoor education

HEALTH EDUCATION FOR EFS

The health education curriculums of both Australia and New Zealand offer numerous opportunities through which to implement the broad aims underpinning EfS. Sustainability is highlighted as a cross-curricular priority in the Australian Curriculum (Foundation to Year 10), wherein "students explore how they connect and interact with natural, managed and built environments and with different social groups within their social networks and wider communities" (ACARA, 2014, p. 15). The roles young people can play in sustainability through choices relating to active transport, food options and the capacity to advocate and act for a sustainable future are key to how curriculum planners and teachers can use health education to enhance EfS.

Constructivist approaches to teaching facilitate meaningful learning because they take into account students' prior views and experiences; hence, a good place to start a health education for EfS programme is to ask students what it means to be healthy. Have the children form small groups and ask group members to share ideas (thus promoting social constructivist learning) on producing a group poster that includes annotated drawings showing the factors that contribute to optimal health. Younger children could select and cut out images from a wide selection of magazines to reflect *positive* images of health, or you could scribe what they say about their drawings so as to summarise their ideas. Initially, it is likely that the children will focus on physical health, so it may be necessary to encourage them to think as widely as they can in order to include content on how our bodies work best (physical health), how we feel about ourselves (emotional health), how we get along with others (social health) and how we care for other people and other living things in the world (spiritual health) (see Figure 12.1).

Any programme of activities for effective health education for EfS should ideally develop the following:

- positive attitudes towards the four dimensions of health—physical, emotional, social and spiritual;
- understanding of factors that contribute to good health, including behavioural, environmental (social and physical) and political;
- understanding of student "agency" in relation to health;
- awareness of the social pressures that can influence health choices and possible strategies for overcoming them;
- health-enhancing skills;
- positive connections and interactions with the environment, including the natural, managed and built environment;
- responsible actions to promote healthy communities and environments;
- appreciation of the link between the health of people and the health of the environment;
- understanding of sustainable methods of living, including travel and nutrition;
- skills in growing, sourcing and choosing sustainable food products; and
- understanding the benefits of immersion in the natural environment through active transport and outdoor recreational pursuits.

APPROACHES TO TEACHING

Healthy relationships

As teachers, we need to take into account students' learning needs, which are influenced by their experience and maturation as they move from learning through concrete experiences to increasing ability to consider abstract ideas. However, no matter what their age, students need to have their social and emotional health supported by a positive classroom ethos, so that they learn to interact positively with one another and feel confident and secure about themselves. You can also emphasise caring for other living things by having students investigate local environments, treating them with respect, handling animals and plants carefully and returning animals to where they were found if they are temporarily moved for observation (Lindemann-Matthies, 2005).

With younger primary children (e.g., K to Year 2: four- to seven-year-olds), a focus on their direct experience provides the ideal basis for activity. Accordingly, we need to centre health education for EfS on the children's immediate world. Circle time or drama activities provide good opportunities to boost and nurture self-confidence and caring actions, further supporting emotional, social and spiritual health, the development of emotional intelligence (Golman, 1996) and multiple intelligences (Gardner, 1993), and hence ultimately the sustainability of the children's local social systems.

Circle activities As the name suggests, these activities are conducted mainly while the children are in a circle formation.

- *I'm special:* Children say their names first time round and then add something they enjoy or are good at next time round.
- *You're special:* Children take turns to be the focus. The other children say something they like or admire about the special person.
- *Finish the sentence:* Begin (i.e., you, the teacher) with the sentence, "I'm happy today because …" Children complete, in turn, with their reasons, or pass if they prefer. After some experience of this activity, children can start their own sentences with what they are feeling; for example, "I'm excited, eager, cheerful, contented, sad, miserable, nervous, worried (etc.) because …" An alternative is to make a large dice with such terms on it and to have the children take turns throwing it and then completing the sentence that appears on the up side of the thrown dice.
- *Web of friendship:* Pass a ball of string to a child, who then calls out another child's name and passes the ball to that child, so continuing on until a web of friendship emerges.
- *Web of life:* Have the children wear stickers featuring the names or pictures of plants and animals found in a local ecosystem. Guide them into passing the ball of wool around in a way that shows what depends on what for food until they have built up a food web.
- *Recognising emotions:* Hand around a series of cards that represent a wide range of people in different situations. Ask students, one at a time, to identify the emotion they believe is being expressed by the person in their picture and to provide a scenario that may have contributed to this emotion (e.g., fear—being chased by a dog; excitement—having a birthday party; sadness—death of a grandparent).
- *Qualities of a friend:* Race around the group, asking students to contribute one quality that is important in a good friend. Next, discuss with the class and record in a Y chart what a friend "looks like" (what actions they show), "feels like" (how they make you feel) and "'sounds like" (things they might say).
- *Case studies:* Read out a series of relevant and age-appropriate case studies to students. After you have read each one, ask students to discuss with the person next to them how they think the character could act in order to appropriately manage the situation.
  - Example 1: Joe is playing basketball with his friend Alexis when an older student comes along and demands that they give her the ball. When Joe and Alexis refuse, the older student grabs the ball and runs with it to the other side of the yard.
  - Example 2: Melissa is putting the finishing touches on her art project. Her younger brother runs into the room and accidentally knocks over a bottle of paint, which splashes all over her work.
- *Network collage:* Tell students you want each of them to create a collage that highlights the various relationships in their life. Each student should be at the centre of the page and should surround that figure with drawings or photographs of the important people in their

life. Have the students, in circle formation, share their network collage with their classmates.

Moving in the room activities These activities can be conducted in the classroom or a large school space such as the hall, or they can take place outside in the schoolyard.

– *Greeting*: Ask the children to walk around the room and shake someone by the hand when they meet and greet them. Children can devise their own greetings, or they can use other languages to show how people greet one another across the world. Have children work in pairs, walking side by side and telling their friend their favourite food/activity/sport/how they got to school/where they like to play, etc.
– *Exploring similarities and differences:* Create a worksheet that contains a series of statements beginning with the words, "Find someone who …" Here are some examples.
  - Find someone who was born in the same month as you.
  - Find someone who had toast for breakfast this morning.
  - Find someone who has travelled outside of their home country.
  - Find someone who shares the same favourite colour as you.
  - Find someone who follows the same sports team as you.

  Students move around the room with their worksheets, talking to one another in order to find someone who matches each of these statements. Once a match is identified, the "matching" student signs the worksheet next to the corresponding statement. This activity encourages positive social interaction and communication amongst students. It also provides scope for discussing similar and different personal characteristics.
– *Leading the blind:* Ask the children to form pairs. One child in each pair is blindfolded or asked to close their eyes. This child then leads the other child around the room. This activity builds trust and affirms the idea of friends as people who keep us safe.
– *Guiding the blind:* Children stand in a close circle with a blindfolded (or with eyes closed) child in the middle. This child moves towards the edge of the circle and is gently guided back into the middle. Alternatively, the circle can be made as close as possible to the middle child, who sways while the circled children prevent that child from falling.

This last activity is also particularly good for building trust. It and the preceding activity can be adapted for older primary students (e.g., Years 3 to 6; ages 7 to 11), who will engage in the activities at their own level.

Drama activities are particularly useful for exploring the complexities of relationships. The example that follows focuses on exploring problems that can arise in relationships.

1. Begin by asking the children in pairs or groups of four to produce a "still image" (also called a "photograph" or a "freeze frame") of an event where the students are fictitious characters. Ensure the issue is not about known people so as to maintain a safe environment. The still image should represent a significant moment encapsulating a problem at school, at home or in the community (e.g., bullying, stealing, teenagers tempting others to smoke or binge drink, wasting water or electricity by leaving taps and lights on).

2. Designate a student to a particular issue or "problem". This student outlines what they are doing, after which you question the student to help them build up the "story" of the problem. Feelings and attitudes to other characters and possible solutions can be explored though such questions as: What do you feel about … (other person in role)? Do you think it is fair … and why? What do you think should happen?
3. Make sure the story is played out to completion so that a resolution is achieved. The resolution will need to show actions that could help solve the problem. The event can be repeated so that each person has a turn at being the central character. After exploring the situation, students will be in a position to understand how each person in role is affected by the problem and what responsibilities and possibilities exist for resolution. A useful way for students to report back while still in role is via, for example, a TV talk show, education pamphlet, newspaper article or even a simulated school policy that explains the problem and what might be done to resolve it.

Drama techniques such as the above offer powerful ways to safely explore simulated real-life issues as well as different characters' experiences and points of view. Consequences of actions can also be made explicit and possible action for positive resolution identified (Littledyke, 1998; McNaughton, 2004).

Healthy bodies

The main issues to explore are how our bodies work, the effects of diet, activity patterns, hygiene, illness and drugs, and sex education and safety, all of which are linked with family life. These issues also bring in the psychological and environmental aspects of health education. Because it is not possible here to outline approaches to each of these topics in this large curriculum area, we refer you to Littledyke, Ross, and Lakin (2000) for background and approaches. However, approaches for younger children (K to Year 2; ages 4 to 7) will emphasise what is immediately accessible, such as identifying external body parts, feeling heartbeats, noticing chest movements during breathing and muscles during movement, and noting changes during activity in physical education sessions in order to find out how the body is made and how it works at a broad level. During their investigations, older children (Years 3 to 6; ages 7 to 11) can construct body outlines and draw on them what is in the body and what its various organs do. A useful mnemonic for older children that helps them remember the functions of all living things is MRS GREN. This mnemonic links into the descriptions of the functions and health of organs in Table 12.2. It can also serve as a summary of ideas developed with a Year 5 class (ages 9 to10) on the properties of living things, why they are necessary for survival, how humans carry these functions out and what is healthy or unhealthy. You can, of course, develop more details during your teaching. However, developing links in this way helps to establish the "big ideas" about health among children and shows which choices act to the benefit or detriment of good health.

Table 12.2. Parts of our body and keeping healthy.

What are all living things able to do? They can all (MRS GREN):	*Why do animals need to do this?*	*Which parts of our body do this?*	*What can we do to keep these parts healthy?*	*What will make these parts unhealthy?*
Move	To find the best places to live, find food, find a mate, look after young	Skeleton and muscles	Exercise, eat food that makes bones strong (e.g., calcium in milk/ dairy products)	No exercise or poor diet
Use oxygen and fuel for energy (**R**espire)	To get energy to live and do everything else listed	All body cells (e.g., lungs take in oxygen, gut takes in fuel)	Exercise, breathe clean air	No exercise; smoking affects oxygen intake
Be **S**ensitive to surroundings	Do everything listed under movement	Brain, eyes, ears tongue, nose, skin	Good food (e.g., Vitamin A in carrots helps eyesight); be active and alert	Being lazy, poor food
Grow	To grow into an adult and have young	All over body	Eat a balanced diet of carbohydrates, fat (fuel foods), protein (growth foods), vitamins and minerals (for health)	Unbalanced diet
Have young (**R**eproduce)	So they continue through their young and don't die out	Reproductive organs	Keep clean, good food	Not washing, poor food
Get rid of wastes (excrete—includes urine and carbon dioxide)	They would be poisoned and die	Kidneys, bladder, lungs (and skin, which has some urea in sweat)	Drink plenty of liquid	Not enough liquid, excess alcohol
Get food (**N**utrition)	To grow, replace worn-out cells, provide fuel for respiration	Digestive system (blood transports food, oxygen for respiration and removes wastes)	Balanced diet: not too much (obesity) or too little (anorexia); eat plenty of fibre (in fruit and vegetables)	Unbalanced diet, not enough fruit and vegetables

Note: Table developed with Year 5 students and adapted from Littledyke et al. (2000).

In addition to the MRS GREN learning activity, consider incorporating the following curriculum topics ("active transport" and "sustainable food choices") into your programme, as both offer approaches to teaching of health education for sustainability. They also demonstrate the interrelated nature of the two areas of health and physical education.

Active transport Active transport refers to the various modes of travel that involve physical activity and so include walking, cycling, riding a scooter, rollerblading and skateboarding. The health benefits of engaging in regular physical activity are well publicised; active transport has the potential to make an important contribution towards the recommended 60 minutes of daily physical activity for children. In New Zealand, 47% of children 5 to 14 years of age regularly use active transport to get to and from school (New Zealand Ministry of Health, 2012). However, in Australia, car travel remains the most frequently used form of transport. Data from the 2007 Australian Children's Nutrition and Physical Activity Survey (Commonwealth of Australia, 2008) found that only 32% of Australian children 9 to 16 years of age met the daily recommended guidelines for physical activity. Given that individuals who are physically active in childhood are more likely to lead active adult lives, providing opportunities for students to develop the skills, knowledge and understanding to safely and regularly engage in active modes of transport has important health implications now and into the future.

In addition to the health benefits, many environmental benefits are associated with primary school children using sustainable and active modes of transport, particularly as they journey to and from school. Some of these benefits (see also Garrard, 2012) include:

– reduced pollution and greenhouse gas emissions;
– reduced traffic congestion around schools;
– increased participation in physical activity and improved health outcomes;
– increased road safety knowledge and skills;
– greater connection to the local environment;
– strengthened social interaction and sense of community within local neighbourhoods; and
– improved community safety because "peopled" places are safer places.

These health and environmental benefits can be promoted through a range of learning activities for children. As the following examples show, active transport in health education curriculums provides particularly good scope for learning activities that can be adapted for a range of developmental stages from early childhood through to secondary school. Because children under eight years of age rarely have the capacity to fully assess the danger of moving vehicles, safety management should underpin all of these activities.

– *Transport diary:* Ask students to record all transport used across the period of a week, including both the mode (e.g., car, bus, walk, bike, etc.) and approximate length of each journey. Compile and graph the entire class's results to determine the most and least common modes of transport. Discuss the positive and negative elements of each mode.
– *Active transport for a healthy heart:* Ask students to record their heart rate before and after going on a class walk. Discuss the results.
– *Stop, Look, Listen, Think safety poster:* Discuss the steps that should be followed in order to safely cross the road. Have students create a safety poster highlighting the key message of Stop, Look, Listen, Think! Hang the posters around the classroom or somewhere within the school grounds.
– *Crossing the road:* In a large open space, ask students to estimate the width of a standard two-lane road. Have them mark their guess with two cones and then measure the distance using a tape. Explain that the width is approximately eight metres and have students

move their cones to signify this distance. Now ask the students to estimate how long it will take them to cross the road, but beforehand discuss with them the importance of walking straight across and at a brisk pace. Students can practise crossing the road while a friend times them. Discuss why it is important to walk quickly across the road, but without running. Combine this activity with the Stop, Look, Listen, Think safety activity. Students practise Stop, Look, Listen, Think, verbally endorse that it is now safe to cross the road, and then cross at a brisk pace.

- *Out and about:* Plan a class walk in order to investigate safe places to cross the road near the school. Students can photograph any pedestrian or road signs that they come across. Once back in the classroom, have students research and record the meaning of each sign. Discuss with students what factors contribute to assessments deeming one place as safe and another place as less safe.
- *Road-sign matching pairs:* Explain to the children that this activity involves a card game and that you want them to make the cards. To prepare the cards, students should draw or print out photographs of five to eight different road signs and paste each one onto a separate card. Students then research the meaning of each road sign and include that information on another set of cards. To play, cards are shuffled and placed face down on a table. Students take turns to lift two cards. If the cards are not a pair (i.e., a road sign matched with its meaning), they are replaced face down again in their position. If a pair is found, the successful student keeps the matching cards and has another turn. The game continues until all pairs are matched.
- *Plan a safe route to school:* Ask students to draw a map of the local area and to highlight on it a safe walking or bicycle route to and from school. The map should include any footpaths/bike tracks and pedestrian crossings along the way. Accompany the map with a written description outlining why this is the safest route to take.
- *Proposal to local council:* Have students write a letter to the local council proposing a series of changes in the local environment that would enhance the safety and appeal of active transport for community members. The letter should include a set of plans/drawings and a written justification of the proposed changes, supported with relevant statistics.
- *Mulga Bill's Bicycle:* Have the class together read out loud the poem "Mulga Bill's Bicycle", written by Banjo Patterson. Discuss the factors that may have contributed to Mulga Bill's accident (e.g., reckless riding, environmental hazards). Ask the students to write a letter to Mulga Bill that outlines some important safety considerations for anyone riding a bike.
- *Correctly fitting a bicycle helmet:* Model and have students practise the procedure for correctly fitting a bicycle helmet. Outline the relevant laws and the safety reason for legislating that all bike riders must wear a helmet.
- *Safety clothing and equipment collage:* Tell students that you want them to use newspapers, magazines, catalogues or flyers to create a collage highlighting the safety clothing and equipment needed for "safety on wheels"—bike, scooter, skateboard, rollerblades (e.g., bicycle helmet, bright reflective colours, etc.).
- *Visit from a local police office:* Invite a local police officer to talk to students about the laws and important safety considerations associated with riding a bike or using a scooter or skateboard.

– *Safety continuum:* Place the signs "Safe" and "Unsafe" at opposite ends of the room. Read out a range of statements to students and ask them to stand at a point along the continuum that reflects their response to the statement. Examples of statements include riding a bike without doing up the strap on your helmet, ringing your bell as you approach a group of pedestrians, riding on a footpath, and so on. Ask students to justify their position on the continuum.
– *Active transport snakes and ladders:* Help students create a game of "active transport" snakes and ladders. The game-board should highlight both hazards and important safety considerations when using active transport. Allow students to play one another's games.
– *Role play:* Ask the students to form groups and then create and act out a scenario that highlights safe and effective use of active transport. Groups can share their respective scenarios with the rest of the class.
– *Environmental impact heads and tails:* Students respond to a series of statements relating to the environmental impact of transport by placing their hands on their head for "agree" or on their tail (bottom) for "disagree". Discuss responses with students. Examples of statements include:
  - Australia is one of the world's biggest polluters.
  - Road transport contributes around half of Australia's greenhouse gas emissions.
  - Due to its environmental impact, the sale of leaded petrol was banned in New Zealand in 1996.
  - In New Zealand, land transport has a significant impact on local air quality.
  - Cycling produces no greenhouses gases.

Ride2School and the "walking school bus" As we mentioned earlier in this chapter, health education is most successful when implemented as part of a whole-school approach. In addition to being encouraged through classroom teaching activities, active transport can be promoted through the school environment and ethos by involving parents and other members of the community in health-enhancing strategies.

The Ride2School programme is one example of how schools are endeavouring to create an active transport culture. This programme promotes safe, enjoyable and regular cycling to and from school through the implementation of a range of strategies. These include the national Ride2School day, which celebrates the many benefits associated with bike riding, ensuring that schools are equipped with adequate bike racks, working with local councils to create or improve bike paths in the local area, and establishing online tracking systems (that students can log onto in order to record their bicycle travel) and incentives for children who ride to school.

The walking school bus is another example of an established programme that aims to enhance the health of primary school children. The walking school bus involves a group of children walking to and from school along a safe and enjoyable route. The walking bus picks up passengers at designated meeting stops along the way, with parents actively engaged in supervising the children. In addition to providing the benefits associated with increased physical activity, this programme promotes increased social interaction and a sense of connection to the local neighbourhood.

Sustainable food choices

Good nutrition is important for the healthy growth and development of children, and it remains an essential component of good health throughout life. However, making healthy food choices goes beyond good nutrition. The choices we make about what we eat have impacts on individual and community health as well as on air, water and climate. In Australia, the production, transport and waste disposal of food has significant environmental impacts, contributing to 26% of national greenhouse pollution and 47% of water use (Blue Mountains City Council & Sydney West Area Health Services, n.d.). Choosing sustainably sourced and unprocessed foods and minimising food travel, food wastage and food packaging can therefore have a positive impact on local and global environments.

The shopping bag game: health choices and their impact Shopping choices have a direct impact on our personal health, but they also have social implications and an environmental impact. The shopping bag game is a way of making clear the impact of buying various types of goods, including food, the focus of the game as presented here. The game can take place in a local shop, where students make notes and/or take photographs of their food choices, place them in a shopping bag, and then report back on them in school. Packaged items should have the details of the packet's contents visible so students can make suitable judgements as to which type of shopping bag their purchases represent. These bags (see the list below) focus on taste, cost, and health, as well as environmental/social impacts and ethics. To ensure representation of all the bags listed below, consider grouping the children and having each group make choices based on one of the bag categories.

However you decide to set up this activity, it is important that the children explain the effects of their choices to their classmates. A useful drama strategy is to have some of the children assume the role of reporters interviewing shoppers about their selections. They can write up the results as reports discussing the relevant issues and publish them in *Shopping Times* (a fictitious newspaper). Also, students could themselves investigate the implications of the various bag categories and provide their own descriptions of them.

1. *Tasty foods:* Taste is an individual matter, but highly influential in choice. (You may want to establish what students prefer to eat before they get underway with this activity.) Our senses are tuned to fat, sugar and salt and overeating because of evolutionary pressures in times when our ancestors had restricted access to food. Today, with an excess of food choices surrounding most of us, our challenge is to choose carefully what we eat, with the understanding that some foods are unhealthy when eaten in excessive amounts.
2. *Cheapest and most convenient foods:* These are characterised by low price and convenient preparation instructions (i.e., easy to prepare and eat). Despite these "attributes", such foods do not necessarily support health or reduce adverse social/environmental impacts.
3. *High in fat, salt, sugar, low in fibre, processed and no fresh food versus low in fat, salt, sugar, high in fibre, wholefood and fresh food:* The latter are healthy options, which may be more costly, but not necessarily so in a healthy, balanced diet if it is planned well.
4. *Fair-trade versus big-business-produced food:* Fair trade means the money goes to the growers of food rather than to large companies, where growers get minimal wages. A

fair trade logo will be displayed on the packaging. Fair trade tea, chocolate and bananas are examples.

5. *Locally produced versus far-away foods:* Locally produced foods involve the least transport and so reduce the amount of carbon dioxide emissions, while foods from more distant places lead to high levels of greenhouse gas emissions because they have to be transported to their markets. Place of origin is indicated on the packaging. Local markets are the most consistent source of such local foods.
6. *Organic versus non-organic foods:* So-called organic foods are grown by fertilising the soil with organic matter and are free of artificially-added chemicals such as pesticides, herbicides and fertilisers—a process that also supports soil health and biodiversity on farms. Non-organic foods are intensively grown. They are called non-organic because of the chemicals used in their production, and they can be cheaper than organic foods. The chemicals used in producing non-organic foods commonly involve high use of artificial fertilisers, which help plants to grow but lead over time to soil damage due to reduction in organic matter and soil bacteria, with resulting erosion. Fertilisers can also run off into waterways that then become overgrown with algae (water plants), leading to an increase in bacteria that remove oxygen from the water and killing off fish and other organisms (a process called eutrophication). Pesticides (killing crop pests) and herbicides (killing weeds) are poisons that can build up in foods, especially in fat in the living tissue of animals, and so become concentrated in food chains, potentially harming humans at the top of the food chain. This process is particularly evident today in regard to pesticides (such as DDT, which was used extensively but is now mainly banned), even though manufacturers insist they are safe. Also, while pesticides and herbicides kill plant pests and weeds, they also kill other non-harmful species, leading to loss of biodiversity.
7. *Foods that involve the least harm to animals:* Choices include vegan (no animal source) and vegetarian (including dairy products). Some people will eat fish rather than birds or mammals (arguably fish, which have been swimming free, have a "normal" life until they are caught and killed, although farmed fish present an ethical problem), or "free-range" animal products rather than products from "battery" or intensive farms. Free-range animals are kept in more natural conditions than exist in intensive, battery farms, which can involve considerable animal suffering. Public awareness of intensive "farming" practices has recently been heightened by some high-profile media personalities, and the situation is improving with better labelling and stocking by some supermarkets of more free-range or RSPCA-approved products. Battery farm products are, however, cheaper than free-range products because of the large number of animals that are packed into the space. Intensive farms also produce considerable pollution from animal waste run-off into waterways. In addition, methane produced by the huge number of farmed ruminants, a group of mammals that include cattle, sheep and goats as well as camels and buffalo, is a significant problem: methane is over 20 times more powerful than carbon dioxide as a greenhouse gas. (Ruminants have a unique, four-chambered stomach that can digest plants with the aid of bacteria able to break down a specific compound called cellulose.) Even if vegetarianism is not followed, reduced consumption of animal products is much more sustainable ecologically than is the present high levels

of animal food consumption. (For informative analyses of these choices, see Nestle, 2002, 2007; Nestle & Dixon, 2004; Singer & Mason, 2006; Smil, 2000).

8. *Foods with least energy impact:* Intensive agriculture of non-organic plants and animals uses high levels of energy for fertiliser, pesticide, herbicide production and fuel for machinery, which are linked to high greenhouse gas emissions through fossil-fuel-driven power stations. Organic foods involve low energy use. Also, eating foods low on the food chain, which means less meat and more plant sources, is considerably more efficient energy-wise because animal production is very inefficient, especially when prime agricultural land is used. We can produce over 20 times more plant protein than animal protein in the same area of land; hence, animals need far more land than crops. We would use considerably less land if we ate less animal produce, which also opens up the possibility of retaining important wilderness areas. Present levels of consumption of animal produce also require significantly large amounts of water irrigation, which is wasteful and agriculturally inefficient in drought-prone countries such as Australia.
9. *Foods involving reduced use of resources:* These foods come with minimal packaging and are typically carried home in reusable bags. Effort is also made to recycle any food waste, including through composting. The cost of the packaging is passed on directly to the consumer, while the costs to the environment brought about by wastes that are non-biodegradable (do not decay), such as plastics, are not included in any pricings. It is useful, with regard to this category, to encourage discussion on the implications of advertising and packaging, and on how manufacturers tempt us to buy their products.

Other activities The following activities provide useful follow-ons from the above activity, especially in terms of solidifying understandings.

- *Organic farming practices:* With the children, research or visit a local organic farm in order to learn about how organic farming practices differ from more traditional farming practices. Ask the children to create a poster that highlights the associated benefits of organic produce (e.g., reduced energy emissions, chemical-free produce). Discuss with them the conditions surrounding organic certification.
- *Exploring food travel:* Collect a range of food packages and disperse them amongst your students. Tell the children to examine the label on their piece of packaging to ascertain where the food was produced and packaged. Ask each of them to place a pin on a large world map to show their food's country of origin, and then attach another string from their pin to a larger pin identifying the location of the school. Use the questions below as the basis of whole-class discussions.
  - Which foods have travelled the longest and greatest distance?
  - Which foods have travelled the least or shortest distance?
  - Why do you think these particular products are imported?
  - What are some consequences for the environment of importing food products?
- *Sustainable menus:* Ask students to create a restaurant menu based on healthy, sustainable, ethical food choices.
- *Cooking with seasonal and local produce:* Tell students you would like them to create a fruit salad or pizza using local produce that is in season. Produce can be harvested from the school garden or purchased during a trip to the local market.

Kitchen garden programmes

Kitchen garden programmes have becoming increasingly popular in primary schools as a means of promoting environmental sustainability and healthy food choices amongst children. In New Zealand, many Enviroschools develop school gardens as part of their focus on living landscapes (see Enviroschools Foundation, n.d.).

Many different programmes also exist in Australia; the Stephanie Alexander Garden Kitchen is perhaps the best known (see Alexander, 2014). Established in 2001, this programme operates in approximately 600 schools across Australia and provides students with opportunities to actively engage in food experiences and to develop positive lifelong eating practices. The specific aims of the programme are to:

– encourage fun, flavour and texture through food experiences that engage all the senses;
– model good food choices without resorting to food pyramids or labels of "healthy" or "unhealthy";
– reinforce techniques repeatedly, thus providing children with the confidence to plant seeds or cook simple dishes at home;
– plan menus featuring the fresh, seasonal produce growing in the garden;
– use ingredients at their peak—seasonal herbs, crisp veggies, fresh fruits;
– expand culinary horizons by presenting food-related cultural differences as fascinating rather than strange;
– expand vocabularies for describing foods, flavours, textures, plants and processes;
– introduce the notions that food should be delicious and the cooking of fresh fruit and vegetables should be timed with great care; and
– have the children enjoy coming together at the end of the cooking process to share meals around the table.

Building and maintaining an organic school garden are central to this programme. Students are actively involved in the growing and harvesting of produce such as vegetables, fruits and herbs. As well as requiring the physical maintenance of the garden, the programme incorporates classroom learning activities across a range of curriculum areas. In the kitchen, students learn to prepare a range of dishes that incorporate their harvested produce. They finish each cooking session by enjoying a shared meal time. (Chapter 15 of this book provides more detailed coverage of this topic.)

CONCLUSION

Health and physical education for sustainability is firmly embedded in the new Australian Curriculum, with the cross-curricular priority of sustainability, a welcomed alignment with current and ongoing concerns over the health and wellbeing of individuals. HPE for sustainability is most overt in those parts of the Australian and New Zealand curriculums pertaining to health education. The intersections of physical, social, emotional and spiritual dimensions of health development evident in this educational provision highlight the complex interactions of approaches to teaching health within a sustainability framework. The whole-school approach is also well supported through the concept of health promoting schools. In this chapter, the suggestion of using active transport and sustainable food choices as two means of teaching health for sustainability brings elements of the HPE curriculum into alignment with the key aims of education for sustainability. Such approaches not only satisfy curriculum requirements of a strengths-based approach (ACARA, 2014) but also incorporate the holistic educational outcome of wellbeing that underpins the New Zealand Curriculum.

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CROSS-CURRICULAR APPROACHES

BRUCE MCMULLEN AND PETER FLETCHER

13. AN INQUIRY-BASED CROSS-CURRICULUM APPROACH

In this chapter, we reflect on the past, consider the present and develop conversations of the future. Previous chapters emphasised that activities and experiences defined by traditional school "subjects" can be drawn upon to promote life-long learning and decision making in a sustainable way: "Instruction begins when you, the teacher, learn from the learner; put yourself in their place so that you may understand … what they learn and the ways in which they understand it" (Soren Kierkegaard [1813–1855], cited in Breen, 2005, p. 4).

Our aim in this chapter is to provide teachers with a flexible and responsive framework within which to facilitate and assess an inclusive inquiry-based approach to teaching and learning within the context of education for sustainability (EfS). Across all learning areas (LAs), students need to make personal decisions that will direct their actions and inquiries about the issues they consider of personal relevance as learners. To be successful, this process requires some connectedness between the learner's existing knowledge/experience, the new knowledge/experience gleaned from lesson(s), and real situations where this new knowledge has been, or can be, applied.

We also, in this chapter, present two scenarios that show how you, the teacher, can utilise an inquiry-based approach to effectively meet a range of syllabus objectives and outcomes as they relate to learning associated with sustainability issues. The scenarios cover the planning process and are designed to prompt you to consider the interrelationships between the components of the process holistically. Each scenario highlights different approaches to preparing and conducting theme-based or thematic units, and points out how the processes involved can be constructed to reflect real-life sustainability issues across several LA contexts. When students can make connections between classroom learning and real-life issues, that learning is consolidated and reinforced through meaning they find relevant.

The framework we outline here explores the interaction between components concerning curriculum integration (with reference to the curriculums of both Australia and New Zealand), project management, pedagogy, activity selection, engagement, stimulus and assessment. Negotiation is central to the framework and likely to be of significant value to teachers, other school staff, students, parents and community members in terms of promoting an interactive, cooperative and respectful educational experience.

TEACHING EFS THROUGH INQUIRY-BASED THEMATIC UNITS

EfS, by its very nature, has no "subject" boundary. A cross-curricular approach to teaching and learning assists in avoiding compartmentalising knowledge, skills and attitudes; and it takes into account key aspects of relevant subjects. This approach fits with the teacher's role of empowering students to seek, identify and consolidate connections between their learning and their actions. The promotion and active support of a climate of teamwork, cooperation and interaction—associated with the shift towards teachers facilitating rather than directing

N. Taylor et al. (eds.), Educating for Sustainability in Primary Schools, 269–302.

student learning—is integral and essential to the evolution of inquiry-based approaches, during which students can work individually or in groups of any size and composition.

Inquiry-based learning can be effectively conducted within thematic contexts. These themes allow students to be personally engaged in learning by providing them with opportunities to make decisions about that learning, so facilitating the development of personal responsibility. Lipson, Valencia, Wixson, and Peters (1993, p. 256) described characteristics of thematic activities as follows:

> Thematic units capitalize on students' natural interests; adapt to a wider range of reading and writing abilities; provide more varied activities; and involve students in a variety of whole group, small group, and individual activities that are linked to one another. Because themes last over a longer period of time (one to several weeks), and because they directly involve students in a community of learners, they are advocated as a positive approach to instruction.

By adopting a thematic approach, teachers can help students make meaningful, real-life connections between LAs. Content can be reinforced, the needs and interests of students more ably catered for, and time used more efficiently. Several educational researchers, including Hinde (2005), Lake (1994), and Lewis and Shaha (2003), found that students' knowledge, engagement and/or attitudes towards learning improved when they were engaged in thematic units.

Perhaps the most compelling reason to teach themes is that, if done well, they empower students to construct meaning relevant to them, and to make connections with other experiences that help consolidate their new understanding. Students derive insight from applying and refining new knowledge, skills and attitudes in response to activities they share with their peers and the wider community. As stated in the New Zealand Curriculum (New Zealand Ministry of Education, 2007, p. 34):

> Students learn best when they are able to integrate new learning with what they already understand. When teachers deliberately build on what their students know and have experienced, they maximise the use of learning time, anticipate students' learning needs, and avoid unnecessary duplication of content. Teachers can help students to make connections across learning areas as well as to home practices and the wider world.

Engaging students in the *construction* of inquiry-based thematic units thus enables them to see relationships and make connections between ideas and concepts in a broader context. This is a logical extension to the KWL learning cycle (Ogle, 1986): What do I **K**now? What do I **W**ant to know? How do I know I have **L**earned? Involving the students in this way provides a stimulus for them (and, importantly, information for the teacher) to identify individual strengths in the area under investigation: in short, there is something to build on. The involvement also asks students to think about—within the context of their own relevance framework—how they might consolidate their knowledge, understanding and skills in the area of investigation under consideration. This engagement not only motivates students but also encourages them to take responsibility for making informed decisions about their own learning.

A key element often present in successful community-inclusive projects such as those promoted by the Australian Sustainable Schools Initiative (AuSSI) and the New Zealand Association for Environmental Education (NZAEE) is the real, active engagement of students with the wider school community of parents, employers and service providers and organisations. Significantly, relationships and links between and across in-school “topics” and out-of-school experiences become more obvious and relevant to students in these kinds of project. The realisation of this relevance results in communication processes becoming authentic as learners and the wider community interact with one another using language that they hold in common and is thus meaningful. A sense of community develops as students create their cooperatively-designed activities, a process that may also involve parents, caregivers and the community. As students contribute to the planning and development of inquiry-based thematic units, ownership of their learning increases. This ownership, planning and implementation positions *assessment* as a demonstration and celebration of achievement, rather than a traditional end of unit “test”. Furthermore, the assessment becomes reflective, meaningful, authentic, continuous, and can be mapped readily onto both syllabus-defined and student-designed learning outcomes.

Features of an inquiry-based approach

As with all good things, inquiry comes in many flavours, including confirmation, structured, guided, open and coupled, and is founded upon a simple recipe: “Inquiry requires identifying assumptions, use of critical and logical thinking, and consideration of alternative explanations” (National Research Council, 2000, p. 23).

When utilising this definition, you, the teacher, can see how readily the student activities you facilitate (such as posing questions, reviewing what is known and planning investigations) can align with an inquiry-based approach. As a facilitator, you need to make decisions and select the appropriate kind of inquiry to address educational outcomes and the specific needs and requirements of your students. Often, methods of inquiry are placed on a continuum that ranges from teacher-centred to student-centred. Despite this appealing hierarchy, the foremost criterion for selecting an appropriate inquiry method should be that it is learner-centred. An appreciation of the commonly presented types of inquiry will help you vary the learning experiences to better meet the needs of your students.

– *Confirmation inquiry: verifying concepts by following a predetermined procedure*. The teacher provides a standard “cookbook”-type procedure with a known result and student(s) follows a specific procedure with no scope for deviation. The inquiry compares and reports results against the known result. This kind of inquiry is particularly common in science and mathematics LAs.
– *Structured (or directed) inquiry: following a dictated procedure to find an answer*. The teacher controls the scope and direction of the process and procedure. The student(s) follows teacher directions to come to a specific end-point or conclusion. Student engagement in the inquiry is limited to following teacher instructions.
– *Guided inquiry: teacher usually provides a question and students design an investigation to find an answer*. The teacher poses a question, and the students assist the teacher in planning the process and procedure that will allow them to proceed with the investigation. Students carry out the investigation and report their specific findings. A feature of this

inquiry process is that when complex, dangerous or impractical phenomena are being investigated, students may need to analyse data and results from existing investigations.
– *Open (or full) inquiry: students formulate the question, and then develop and conduct the investigation*. The teacher may provide stimuli or leave the students to totally formulate the question. The teacher can provide advice but not direct the investigation (except where relevant in relation to safety). Students are responsible for all aspects of the investigation, from inception through to communicating the findings and conclusions.
– *Coupled inquiry: a hybrid that combines a guided-inquiry investigation with an open inquiry investigation*. This approach begins with a standard guided inquiry that provides students with research and, where relevant, experimental skills. They may then use these skills to carry out a related open-inquiry investigation.

With respect to effective teaching of EfS, we recommend you consider a coupled inquiry approach because it allows specific concepts to be explored in a more didactic fashion, thus encouraging students to connect their concrete experiences to abstract concepts. This two-step approach also gives students time to build confidence and gives you time to provide appropriate and timely formative assessment. You can also adapt the approach to align with your school's commonly utilised learning cycles.

Linking the components of a thematic approach to learning

True to the approach espoused in previous chapters, units designed around a theme should accommodate the identified range of student differences, including interests, abilities, experiences, and rates and styles of learning. Common elements of a well-balanced thematic unit of work include:

– a selection of outcomes from a range of LAs that are linked to the central topic under investigation;
– a range of age-appropriate learning experiences; and
– a variety of appropriate class organisations that facilitate individual and group learning.

These elements provide opportunities and environments for metacognition (i.e., "thinking about thinking") and for ownership of the learning/knowledge—something that students can embrace and find empowering because of the value it places on their own learning.

LAs defined by their statutory education authorities often contain similar objectives and outcome statements across different syllabuses. Hence, mapping the outcomes to be achieved from each LA into a thematic unit of study minimises duplication and supports the development of links across LAs. As such, you and your colleagues can address an outcome that occurs in a similar form in several prescriptive syllabi just once and have the added benefit of increased opportunity to provide remediation activities when necessary and extension opportunities when possible. Moreover, because the process develops and enhances the skills you need to establish and maintain a cooperative learning environment, opportunity for students to decide what they would like to learn and how they would like to learn it shows similar growth. This approach can be further enhanced by application of the Scootle suite of digital resources (Education Services Australia, 2014), designed to directly complement the Australian Curriculum. Familiarity with this resource leads to identification of links between the targeted content and similar outcomes defined by other LA syllabuses. In addition, the search capability facilitates a direct identification of outcomes across a range of Australian syllabuses within the national curriculum. Scootle is also a very handy tool for identifying outcomes specific to sustainability. The Scootle site has 35 specific references to "sustainability" for Years 4 to 10 and from several LAs.

According to Hinde (2005, p. 108), while "there are times when teaching the subjects separately may be more appropriate than integrating them, it is also true that when teachers are knowledgeable about content areas and integrate them effectively, students' achievement increases". Although several approaches defining the steps necessary to construct a thematic approach to learning are detailed in the literature, few of them overtly engage the learner in the planning and preparation phases. The framework that we present in this chapter encourages a cooperative, negotiated approach to planning. It also encourages you (the teacher) to learn about your students' knowledge, skills and attitudes during the initial phase of the inquiry (i.e., at the same time as the learning theme is being developed and defined).

You can draw on a range of pedagogical tools, such as peer-group interaction and allocation of roles, to develop a cooperative environment within which students can achieve both syllabus-mandated and student-negotiated learning outcomes. These strategies promote the teacher as an equal participant in the process rather than a "director of learning" or a "transmitter of knowledge". The negotiated design and conduct of thematic learning activities strongly supports the old adage that "the best way to learn is to teach". Research into peer-group interaction identifies *student sharing of ideas* as an active ingredient in student discovery and consolidation of learning (Evertson & Weinstein, 2006). While you and your teaching colleagues can sometimes find this "back-seat" position difficult to accept, it enables students (albeit through negotiation with you) to select and present materials, experiences and assessment tasks that are meaningful to each of them and that are supported by the group structure required for student cooperation and interaction. Finding out about the students in a manner that shows an interest in them is an engaging activity in itself, and actively promotes a positive climate of collaborative learning because it reinforces the notion of the student at the centre of learning.

PREPARING A THEMATIC UNIT

Figure 13.1 describes a model for preparing a thematic unit of work; it provides a checklist rather than a sequence of events. Many factors can influence selection of the theme, and although it is placed at the centre of the model, the initiating circumstances guiding its design may come from any of the contributing phases. For example, the availability of particular resources, such as a visiting show or speaker, may suggest a theme. Similarly, the theme may be stimulated by a local event or series of student inquiries. As whole-school communities become increasingly aware of the value of sustainable practices, a thematic approach can be interwoven with whole-school priorities and projects, including those encouraged by such initiatives as the AuSSI and the NZAEE programmes. The stimuli are out there! Your job is to find a way to encourage involvement by using promotion, discussion, goals and enthusiasm that engage and excite the students about a theme and the consequences of the subsequent investigation. We now discuss some of these planning elements in more detail.

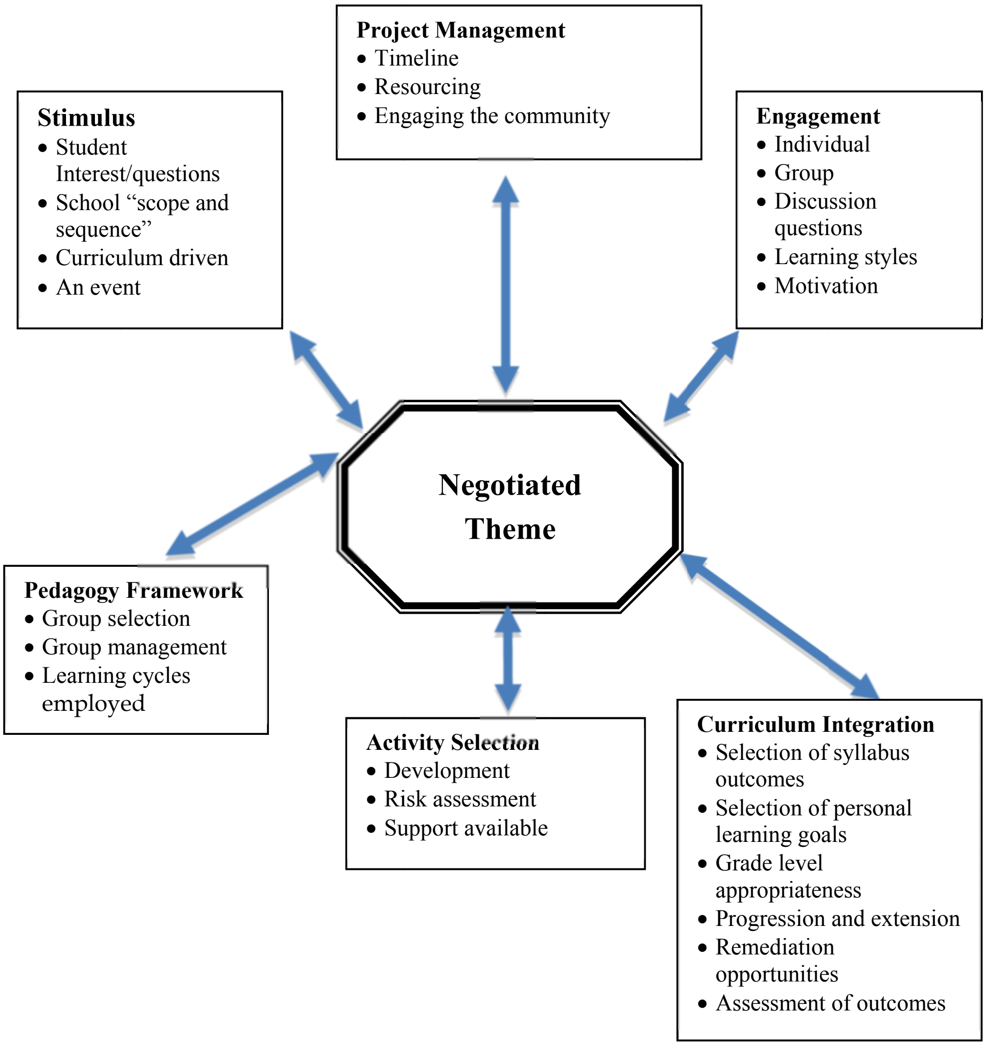

Figure 13.1. A model for preparing a thematic unit.

Select or, better still, negotiate a theme

As previously noted, many factors from within and beyond the classroom contribute to the ultimate identification of a theme for investigation by class members. For example, the AuSSI programme provides practical support for Australian schools and their communities to live and work more sustainably by fostering a whole-school approach to addressing sustainability issues. Table 13.1 sets out the nine AuSSI goals. While each of these deserves equal emphasis, Goals 8 and 9 are perhaps the ones most pertinent to establishing a thematic approach to exploring sustainability issues relevant to the school learning experience.

Similarly, as the New Zealand Ministry of Education's EfS approach emphasises, "Issues, topics and potential learning opportunities in sustainability and the environment are all around us" (New Zealand Ministry of Education, n. d., p.1). The New Zealand Curriculum itself identifies the need to focus on sustainability, stating that it is relevant to students' futures and involves "exploring the long-term impact of social, cultural, scientific, technological, economic, or political practices on society and the environment" (New Zealand Ministry of Education, 2014, p. 41).

Your skill in recognising the opportunities is a very important factor. Stimuli for an integrated, thematic, inquiry-based approach can include teacher-identified opportunities involving, for example, seasonal or occasional resources such as book fairs, travelling shows, environmental issues, local events, scheduled or needed changes to the school grounds or buildings, and discussions that occur between students. Unusual local, national or international phenomena, such as out-of-season or extreme weather events, natural disasters, or celebrations of individual and community success, also provide stimulus. All provide a starting point for consolidation of cooperative and collaborative practices in the classroom. Similarly, themes may evolve as a direct response to student questions and discussions relating to personal observation or experience of local, national or international events.

Table 13.1. Goals of the AuSSI programme in Australian schools (2014).

AuSSI aims to achieve the following:

1. Learning and teaching for sustainability as an integral part of school curricula.
2. Schools actively engaging in a continuous cycle of planning, implementing and reviewing their approach to sustainability as part of their everyday operations.
3. Schools using natural resources, including energy, water, waste and biodiversity, in more sustainable ways.
4. Schools and school authorities reporting on changes towards sustainability.
5. Schools working towards sustainability in partnership with their local communities.
6. Schools and school authorities implementing policies and practices that support effective education for sustainability.
7. Schools and communities developing values that support a sustainability ethos.
8. Young people sharing ownership of sustainability initiatives and decision making.
9. Individuals supported to make effective sustainability decisions and choices.

Differentiated learning

While the *student-centred* approach is preferable, you, as the teacher, should always strive to guide rather than direct discussion. This practice will help ensure that any theme developed reflects not only syllabus-defined content (curricular content) but also students' interests, experiences, issues and problems that they identify as important to them. The selected and negotiated theme becomes the "glue" that helps bring different understandings and apparently unrelated pieces of information together in meaningful ways. This holistic approach is critical to empowering students to learn by thinking around a piece of information, consolidating their own opinions about that information and seeking the opinions of others, be they classmates or within wider sources. This activity may involve sourcing information from any of a multitude of printed or electronic media or even, as the skills of the students develop, personally from "experts" in the community or further afield. The involvement of "local" experts adds to the ownership of the learning that inevitably occurs during the study of a thematic unit, in that the learner is more able to identify with the personal experience of learning from someone they may know.

The selected theme needs to be *inclusive* (of value to *all*), relevant and real to students. This stage of the planning process provides an invaluable mechanism for ascertaining your students' prior understanding of and attitudes towards the negotiated theme, and often also provides a guide for the other stages of unit planning. By seeking students' opinions about the central focus of the investigation(s) from the outset, you can empower students to assist in designing assessment strategies that they consider will qualify and quantify their own achievement.

Curriculum integration

Overall knowledge of the learners in your class is a prerequisite to successfully completing the planning process. Regardless of the range of variables making up your class (ability levels, age range, ethnicity, socioeconomic status, etc.), you are ultimately responsible for ensuring that the learning activities on offer address *syllabus outcomes*. Once you have determined the current level of understanding that each of your students has about the proposed themes and their component concepts, you are better able to map the following:

– the demonstrable and assumed outcomes achieved through participation in *learning activities during earlier stages or experiences*; and
– the desired outcomes for the LA syllabuses included in each of the *designed/identified activities* within the thematic "topic". AuSSI exemplifies this approach by integrating these activities with teaching and learning (including that relating to key elements of social sustainability) across the curriculum.

Most syllabuses are generally constructed to cater for the learning needs of a range of student interests, abilities, experiences and stages of development. You should therefore find the process of identifying outcomes demonstrating the range of achievement levels you would expect of your students relatively simple. You can also incorporate outcomes that are skills-based or attitudes-based and readily tie these to educational, authority-defined mandatory objectives and competencies. Given that several objectives and outcomes are similar across most LAs, you can keep the number to be achieved during the whole unit to a manageable level, thus avoiding over-addressing and over-assessing the intricate web of objectives and prescribed outcomes.

Identifying the tasks that will be used to determine the achievement of the learning outcomes (*assessment strategies*) should remain flexible during the planning phase. You may decide to specify one or more tasks (quiz, report, presentation, etc.), but doing this does not promote student ownership of the learning or celebration of their individual achievements. Instead, once a climate of cooperation or collaboration has been established and maintained, negotiate with the student(s) to identify tasks that they think will exemplify their achievement at an appropriate level.

When students know what the assessment tasks are, why they are being assessed and what is expected of them, the stigma attached to "testing" melts away. Students look forward to "showing off" their newfound skills via a multitude of mechanisms, which in themselves work towards achievement of specific outcomes. These mechanisms include identifying and using specific text types for specific purposes, discussing issues within and across student groups, presenting findings to the class, creating visual presentations, putting together working models, and so on.

Essentially, incorporating assessment as a project or activity within the learning sequence engages students in meaningful summation of their discoveries and leads to new ideas, understandings, connections and recommendations for additional (extension or remedial) experience. Interestingly, students who are engaged in negotiating the learning opportunities and assessment strategies offered by a hands-on, relevant thematic approach often exceed their teachers' expectations of them (Hurless & Gittings, 2008), an outcome that can only be seen as good.

Project management

Carefully working out how long to spend on each part of the process is important, but the *timeline* needs to be flexible enough to respond to the different directions that active learning might take. While the timing of the whole unit often depends on the overall school curriculum pattern, some forward planning directed to incorporating anticipated events can guide the planning process. The length of any unit will thus reflect the outcomes to be achieved as well as the activities and resources you have in place to achieve them. Although involving your students in the planning process is, of course, highly desirable, your professional intuition and experience is needed to guide student input at this time. Throughout the planning phase, consider "brainstorming" (with colleagues, community members participating in the thematic unit, *and the students*) as a highly useful means of identifying all necessary *materials and resources* that the study could incorporate. Doing this avoids the likelihood of limiting resources to those immediately available.

Once you have identified these materials, decide on their value/effectiveness. Valuable learning materials may be sourced from any or all of the following:

– *Printed resources*: for example, newspapers, travel-guides, maps, advertisements, brochures, flyers, encyclopaedias, dictionaries, magazines, professional journals and the like.
– *Electronic resources*: for example, educational software, games and simulations related to the theme, DVDs (movies and documentaries), data presentations (e.g., using Microsoft PowerPoint), audio recordings, and the internet (although remain mindful of safety matters with regard to internet use, particularly when students search using keywords that have not been screened).
– *Community resources:* this is an underutilised but extremely valuable source of inspiration. When tapped, local expertise and experiences add an element to the learning that learners can identify with, and this dramatically increases students' perceptions of relevance. Invitations to community members, as guest speakers or "experts", also have

the benefit of increasing community awareness of the types of activities the class are using to enhance their learning. In this way, "Education for sustainability enables individuals and communities to reflect on ways of interpreting and engaging with the world" (Australian Curriculum, Assessment and Reporting Authority [ACARA], 2014, p. 24).

– *External resources:* While there is always a great deal of paperwork associated with preparing and conducting excursions, they are a valuable part of the school routine when tied to specific learning objectives and outcomes. Excursions can raise the profile of *local* places of interest and increase the relevance of the local environment in terms of students' learning experiences. Rather than using such activities to simply confirm or consolidate learning, encourage students to identify and participate in excursion activities in ways that allow them to answer their own questions, either pre-prepared as part of their classroom activities or in response to an event or circumstance that arises before or during the course of the excursion. Again, from the student perspective, meaning and relevance is enhanced.

PEDAGOGY FRAMEWORK: SELECTING AN APPROPRIATE INQUIRY METHODOLOGY

As previously mentioned, adopting a single or hybrid inquiry-based methodology will assist you in bringing into play a framework that supports critical and logical thinking and allows for consideration of alternative explanations. Make sure that that the method you select is the one that will best support the size and scope of the intended investigation.

Group composition

Adoption of an inquiry-based thematic approach does not suggest abandonment of explicit teaching of the class, groups or individuals. Nor does it imply adoption of a complete group organisation. The approach can, and does, incorporate a balance of class, group and individual activities. There also needs to be acknowledgment that the relative proportion of each will vary from class to class and individual to individual. This determination, in turn, will depend on such factors as the students' ability to work independently, take responsibility for their own learning, and take risks in their learning and level of achievement.

When nominating students for inclusion in any group, remember that different learning styles can directly affect group dynamics. For example, reflective, social-individual learners learn more effectively alone than do active social-group learners, who prefer to share their learning experiences with others (Teaching and Learning Research Project, 2005). While you should consult students on the composition of their group, you still need to exercise your professional judgement to prevent some of them working in group settings unlikely to suit them. Well-structured, practiced, cooperative groups behave like teams. Remember, also, that although all the students in a group may not contribute equally to completing any particular component of the project at hand, peer interaction leads to students becoming increasingly aware of differences of understanding and opinion, and consequently an increased understanding of themselves—an outcome inherent in any group activity.

Engagement

This refers to the activities or situations that stimulate and hold student interest. Involvement in the unit planning process itself often enthuses students to become more involved in the identified investigations. The Australian Academy of Science (2007, p. 3) describes engaging activities as those that are "designed to spark students' interest, stimulate their curiosity, raise questions for inquiry and elicit students' existing beliefs about the topic"; they are activities that create a *yearn to learn*. In the primary school context, anything that produces excitement and enthusiasm for inquiry should be harnessed to create and maintain an engaging and active learning environment. Learner engagement ensures that students are keen and motivated to *find answers to specific (often their own) questions*. Given that you will be guided by the student-initiated questions, one of your key roles will be to construct a variety of open-ended questions that help students think about how to find answers to *their* questions in divergent ways. Your open-ended questions should ideally focus the student investigations and activities in a manner that empowers the students to find answers to a problem relevant to *their* interests and experiences. One way to approach this task is to bring a range of components into your prompt questions and then have the students select those components most pertinent to them. Mapping activities in a matrix against levels of learning and learning styles (McGrath & Noble, 1995) may simplify this process for you.

A word of caution

Look before you leap! As an educator, you are open to scrutiny. In regional areas, for example, there are likely to be "hot" EfS topics that you might deem worthy of exploration and debate. Such topics include tree logging, coal-seam gas extraction, water usage, and genetically modified crops. If you have been a long-time member of a community, you will be sensitive to "delicate" and/or highly controversial topics within the community, but if you are new to an area, you are unlikely to be aware of such matters. Think carefully before launching into a topic that you think will give your students and the community an opportunity to explore and debate. We highly recommend that you seek advice from your colleagues and always seek final approval from your school principal before you jump into a potential situation that might damage your reputation within the local community. So, always give appropriate attention to thoughtful planning, ethics, and ownership of issues, and have a heightened sensitivity to potential problems in relation to contentious issues.

Then, let the fun begin!

Now is the point at which the students truly run the unit while you (in the background) ensure that they complete the activities according to the terms negotiated and that they have the resources they need. If the investigation takes on a different course from that originally determined, negotiate with students the additional resources they need to ensure success. Also be mindful of opportunities for students to design (as negotiated with you) challenging, consolidating and/or remedial activities.

Another word of caution must be made here, though. Staying on task is not a characteristic of a significant number of primary school students, and for this reason their real-life learning may be piecemeal and fragmented. While the completion of some learning activities may leave unanswered questions in the minds of students, the challenge for you, at this stage, is to ensure that whatever subsequent activities they engage in are aimed at achieving pre-determined outcomes and objectives (i.e., ones the students are already aware of).

At this stage, probably the hardest thing for you to do is to step back and act as a guide, only having input when you observe that the activities are not being conducted in the way originally defined or negotiated. This "trust" (i.e., you treating learners with respect and not looking over their shoulder all the time or constantly telling them what to do) empowers the students to drive the process forward.

How does all of this relate to EfS?

As described in previous chapters, the objectives and outcomes of any LA may be structured to highlight and enhance EfS. As the authors of Chapter 1 observed, both the Australian Curriculum and the New Zealand Curriculum have EfS as a fundamental tenet and emphasise that EfS is characterised by a foundation (notion) of shared responsibility. No individual can assume responsibility for the current state of our planet, nor can any individual accept responsibility for developing an international culture of sustainable living. Adopting an inquiry-based thematic approach centred on environmental and sustainability issues enables students (individually and collectively) to work cooperatively or collaboratively towards shared and negotiated objectives. By its very nature, inquiry-based thematic learning seeks answers to questions. While these questions may or may not have obvious answers, all require cooperative investigation of issues deemed important to the student; hence, the need for teachers to model their passion for knowledge so that they can help incite engagement and excitement for an issue or cause amongst their students. The activities selected within the inquiry-based framework can also lead to action-orientated EfS projects that investigate, explore and put into place practices to address the sustainability issues the school and its community deem important.

Ownership is also important

While it is sometimes difficult to consider a perceived problem from all points of view, learners need to feel that they are part of a "big picture" project. Thoughtful planning, consideration of ethics (according to your education/school system's policy), ownership issues and sensitivity to potential problems in relation to contentious issues are all required. A balanced inquiry that considers the pros and cons of a particular course of action ultimately provides learners with opportunities to develop the life skills and values explicitly described in the Australian and New Zealand curricula and evident in the following extract from the New Zealand Curriculum (Ministry of Education, 2007, p. 10):

> Through their learning experiences, students will develop their ability to:
> – express their own values;
> – explore, with empathy, the values of others;
> – critically analyse values and actions based on them;
> – discuss disagreements that arise from differences in values and negotiate solutions;
> – make ethical decisions and act on them.

A final point

Over the course of any school year, teachers design and present learning experiences to facilitate the achievement of objectives set by the school curriculum. The teacher is guided by the school curriculum (scope and sequence, programme) and seeks to facilitate the achievement of syllabus-mandated outcomes. As described in the New Zealand Curriculum document (2014, p. 1), although "learning areas are presented as distinct, this should not limit the ways in which schools structure the learning experiences offered to students. All learning should make use of the natural connections that exist between learning areas" – in other words, the order in which the learning experience is offered is flexible!

An inquiry-based thematic approach is similarly flexible. As such, any theme, sequences of activities or events and/or "subject" (LA) does not need to be "covered". However, for purposes of tracking and recording the achievement of objectives, it is highly important to specifically identify and link the objectives in the "topics" or "content areas" defined by the syllabus to those that are included in the theme. This approach also lends itself to the incorporating such strategies as Gardner's (1983) multiple intelligences in order to cater for students' different learning styles, Bloom's revised taxonomy (Anderson & Krathwohl, 2001) to differentiate according to cognitive questioning, and de Bono's (1985) thinking hats, useful when identifying a range of activities/inquiries for varied thinking approaches and capacities in any one class. In so doing, the approach assists in achieving balance across any programme or learning/teaching sequence.

In the following sections, we present two scenarios relating to some often-discussed EfS themes and show how these can be used as vehicles to achieve EfS outcomes commonly identified in primary school syllabuses.

SCENARIO 1: WATER

The school: A public K to Year 6 school located in the northern tablelands of New South Wales. The school uses the new NSW K to 10 syllabuses based on the Australian Curriculum (2014). The school year is broken into eight blocks of time (two blocks per term, each of approximately four weeks in duration).

The class: Mixed ability, co-educational, Stage 2 (i.e., Year 4, ages eight to nine).

The teacher: Ten years' experience of teaching at the school and some degree of familiarity with class members. On meeting the class as a group for the first time, the teacher strives to establish a climate of trust, respect and personal goal setting for achievement as a component of the learning environment.

Back at school after the summer holidays, the teacher openly encourages the age-old discussion between classmates about what they did and where they went during the break as she strives to learn about her students. During this free but controlled exchange of recollections, the teacher notes that the students describe a range of experiences, many of which were situated near *water*, with some around freshwater inland lakes and rivers and others near the ocean.

Keeping in mind that the discussion could lead to a valuable four-week theme on managing water resources, the teacher suggests that, in order for the children to get to know one another a little better, each of them should choose a way to report to their classmates on something they really enjoyed during the vacation. She tells them that she wants each report to have at least one visual and one verbal component.

The teacher's objectives for this student activity are several. First, she wants to identify and explore:

– individual personalities;
– preferred learning style(s);
– communication skills; and
– group dynamics.

Second, she wants to identify a scaffold upon which she and the students can build a thematic approach to learning about sustainability and environmental issues associated with the study of water. And third, she wants to identify stimuli (ways of gathering and reporting information) for the activity. Table 13.2 presents the ones she suggests with respect to the curriculum LAs.

Table 13.2. Teacher's suggested methods for information gathering and reporting.

English	*Mathematics*	*Science and technology*	*Human society and its environment (HSIE)*	*Personal development, health and physical education (PDHPE)*	*Creative arts*
Write a story (report, recount), poem or acrostic about your holiday	Describe the length of your journey in kilometres and hours	List, draw and possibly categorise the fun things they did and learned	Tell us about the place you stayed and why you went there	Identify your favourite activity and explain why	Present and describe images of your favourite holiday place

Note: This example uses the current Australian Curriculum as applied by the Board of Studies NSW (2014). This example refers to the LA Human Society and its Environment (HSIE) and also references the anticipated future, standalone, geography syllabus.

The teacher tells the class they can adopt/adapt an information gathering and reporting method from her suggested list. However, she also encourages the students to develop their own ideas. Once the students have selected their respective methods, the teacher breaks up the class into groups whose members she has selected according to *similar methods* intentions. She then breaks any groups that she deems too big into smaller groups. The groupings enable her to bring into play reporting of similar experiences and ideas via different methods, thus appealing to different types of intelligence and emphasising the cross-curricular nature of the elements of the children's holiday experiences. The approach also provides the teacher with additional information regarding the overall balance of learning styles within the class as a whole.

To ensure the students include both the visual and verbal components in their reports, the teacher asks each group, or an individual from the group, to present their report as a short, illustrated speech. However, she explains that she first wants to see a transcript of the speech. Her aim here is to use each work sample as a source of diagnostic assessment data.

To elicit discussion during the presentations and prompt students to generate their own questions, she encourages them to ask questions of the presenters along the lines of what they still want to know about the aspects of water identified in each report. She also asks the children to submit their questions in writing, after which the whole class collaboratively constructs answers. Some of the questions cannot be answered immediately, and these form the stimulus for the negotiated design of activities that will allow the children to investigate, explore and find answers to them. The students themselves identify the unanswered questions and scribe them onto the smart-board (Figure 13.2). Using her professional expertise, the teacher injects a few other open-ended questions into the mix. She considers these questions will challenge the students while remaining relevant to their interests, experiences and the curriculum.

As evident in Figure 13.2, only a few issues relating directly to sustainability arise, although some of the matters listed could be expanded to enable a look at the effects of human activity on the availability of the resource; so, for example: Where does water come from? What will happen to the beach if the sea level rises? Why does it rain on some places more than on others?

Having as her reference the agreed-on list of questions, the teacher uses her expertise and experience to negotiate with her students the design of subsequent activities. She and the students strive to ensure the activities align with their questions and with available resources.

The teacher begins this process by mapping the focus activities onto a checklist table featuring the LA syllabi outcomes to be addressed. She also itemises specific ways to cater for the range of abilities and learning styles evident in the class and through which the outcomes could be demonstrated. This demonstration of achievement forms the basis of assessment tasks, which the teacher confirms with student(s) before they begin their investigations. Eventually, the teacher refines a total of 15 “student questions” from the smart-board (Figure 13.2) and refines them into a whole-class activity.

Table 13.3 describes in detail five of these questions as examples of the mapping process. The outcomes in the table are from the Australian Curriculum (2014) but include particular reference to the NSW syllabuses (2014). Note that the process can be applied equally well to any education system with prescribed aims, objectives and/or outcome/indicator statements, or as syllabuses are updated.

Inclusion of students in the planning and design phases of the thematic unit addresses several outcomes across many of the LAs. For example, those relating to communication, interaction, discussion, description, modelling, estimation, categorisation, classification, explanation, demonstration, and so on are common among several syllabus documents. Note, too, that the use of specific outcomes in Table 13.3 is meant as a guide only. This is exemplified by the teacher using specific indicator statements for individual students or referring to them in broader contexts so that students can define their own indicators of achievement.

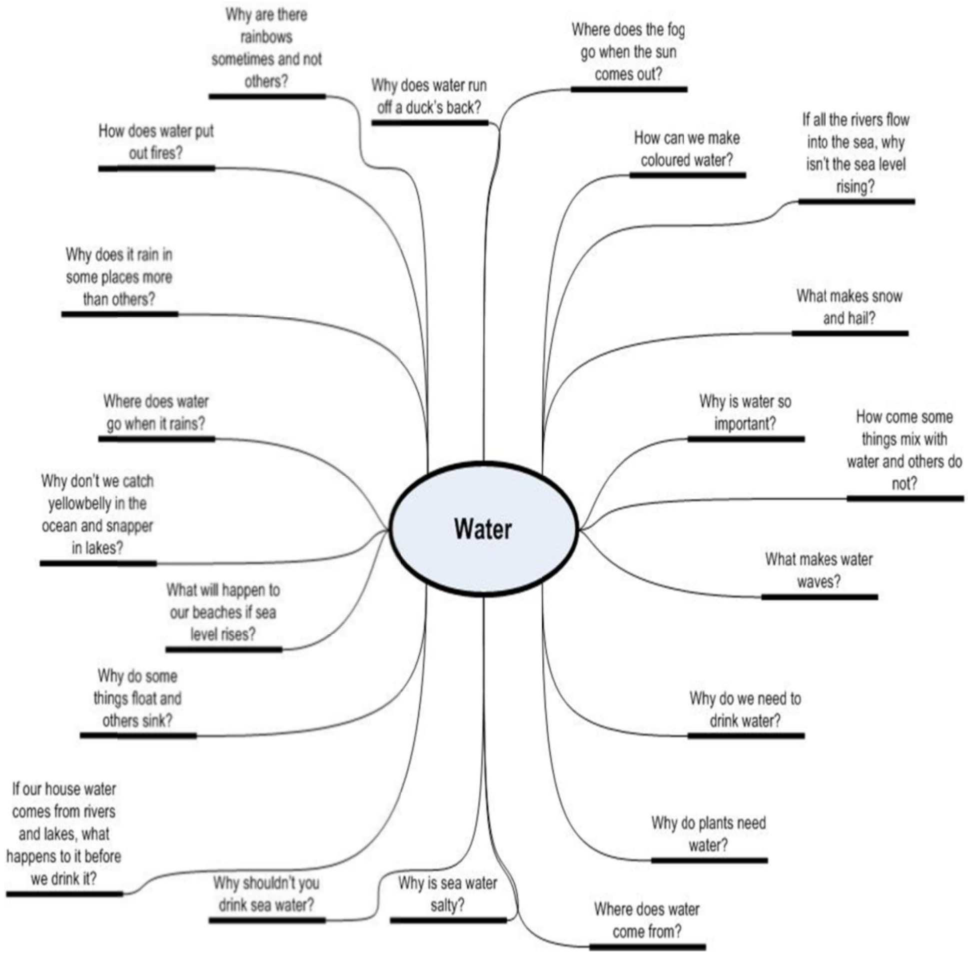

Figure 13.2. Students' questions arising from discussions on the theme of water.

Brought to the fore here is the teacher's skill in identifying with learners what more they could find out about a particular aspect of the investigation, and in helping facilitate an answer to a particular question of relevance to these learners. Instances such as these also provide the teacher with opportunity to guide the direction of the investigations. For example, if the emphasis is on water conservation, she can explore with them the possibility of conducting certain projects, such as harvesting rainwater for use on drought-tolerant, student-maintained gardens, or students re-vegetating a local area of bush with support from local businesses, thereby promoting cooperation within the community.

Table 13.3. Extract from teacher's planning matrix for the theme of water.

Question	***LA*** *(outcome)*	*Activity*	*Learning style/ intelligence*	*Assessment*
1. What happens to living things when they get thirsty? (investigate) *Further sustainability investigations may relate to minimising water use—conservation of other resources.*	Science (ST2-10LW) PEHPD (PHS2.12) Mathematics (MA2-11MG) English (EN2-3A)	Research by reading about and recording the effects of dehydration on living systems using specific examples from animal and plant kingdoms. Design and conduct a longitudinal experiment demonstrating water needs of different plants.	Visual, kinaesthetic Visual spatial Verbal linguistic Logical mathematical Bodily kinaesthetic Interpersonal Intrapersonal	Written report Verbal report to the class Experimental processes Team skills
2. How many ways can we use water? (compile a list) *Further sustainability investigations may relate to more efficient use of water in the uses identified.*	English (EN2-10C) Creative Arts (VAS2.2) Mathematics (MA2-19SP) HSIE (SSS2.8) Science (ST2-2VA)	Prepare a mixed montage of text, diagrams and pictures that describe water use in human society. Survey and report on household water use, containing tabular data and supported by a written and verbal presentation and/or video.	Visual, auditory Verbal linguistic Visual spatial Logical mathematical Interpersonal Intrapersonal	Artwork containing graphs, tables, short script passages, and various visual images (for display) and explanation (to class for assessment)
3. Where does our town water come from? *Further sustainability investigations may relate to water collection and treatment methods for the home and community.*	Science (ST2-11LW) Technology (ST2-3VA) HSIE (SSS2.7)	Research a water filtration or desalination project used to produce potable water. Design, construct and present a model demonstrating the process. Demonstration, diagrams or time-lapse photography may be used to explain the processes to the class.	Visual, auditory, kinaesthetic Visual spatial Logical mathematical Bodily kinaesthetic Interpersonal Intrapersonal	Research processes Model accuracy Accuracy of verbal presentation ICT usage

Table 13.3. Extract from teacher's planning matrix for the theme of water (contd.)

Question	*LA (outcome)*	*Activity*	*Learning style/ intelligence*	*Assessment*
4. What is an ecosystem? (make an aquarium) *Further sustainability investigations may relate to the fragility of ecosystems and natural disasters (e.g. global warming).*	Creative Arts (VAES1.1) HSIE (ENS2.5) English (EN2-4A) Science (ST2-10LW)	Research, design and build a pond or aquarium capable of sustaining a balanced ecosystem. Present a written and verbal description of the role each organism plays in the ecosystem.	Visual, kinaesthetic Visual spatial Logical mathematical Bodily kinaesthetic Interpersonal Intrapersonal	Aquarium design Aquarium construction Ecosystem elements identified Verbal presentation
5. Why is eating fish good for you? Describe, with text and diagrams, the ways to catch fish. *Consider what would happen if we caught **all** the fish.*	Creative Arts (VAS2.1) English (EN2-6B) PEHPD (ALS2.6) HSIE (ENS2.6)	Group choose to demonstrate with MS PowerPoint presentation, live demonstrations, or video to written script.	Visual, auditory Visual spatial Verbal linguistic Logical mathematical Interpersonal	Quality of script; participation Performed as class presentation activity

The next step for the teacher is to complete the checklist, sets down in a new table (Table 13.4), by ensuring that she includes the desired LA outcomes in the theme. By simply copying and pasting the identified outcomes from Table 13.3 into the fourth column of Table 13.4, the teacher easily completes registration of the students' achievement within her learning and teaching programme. The addition of the fourth column also provides her with an individual student theme plan and achievement reporting mechanism that both she and the students can negotiate and contribute to.

Note that the "demonstrated achievement" column in Table 13.4 can be negotiated with each student or as part of establishing the group dynamics for cooperative activities. Either way, the presentation in the table of detailed achievement outcomes for each student or groups of students helps demystify and dilute the stigmas often associated with "tests" and enables both teacher and students to regard assessment as a celebration of achievement.

The teacher and students find the "word wall" (a place that itemises words new to the class) is a valuable facilitation tool during the planned investigation. This tool not only requires students (and the teacher) to identify new words but also offers opportunity (along with a reward, such as stamps, stars, group points) to find out about the word. This process provides the teacher with a measure of student achievement and involvement during the unit, and serves to visually remind the students about their achievement thus far.

Once she completes the tables depicted in Tables 13.3 and 13.4, and bearing in mind that the unit takes up four weeks of classroom time (with the inevitable variations of routine), the teacher finds consideration of the other elements of the planning process a relatively simple task. She asks the students to choose four of the 15 activities and then to indicate (in writing) how these activities link to their own experiences and whether they would prefer to work individually or as part of a larger group. The final negotiations with the students as to the exact nature of the activities to be undertaken are subsequently established and defined.

Table 13.4. Teacher's cross-curricular mapping, theme plan and achievement reporting mechanism, including EfS.

LA/Syllabus	*Activity*	*Demonstrated achievement*
Creative arts	2, 4, 5	Components of visual displays
English	1, 2, 4, 5	Research skills, written reports in varying formats: group work
HSIE	2, 3, 4	Group presentation: explanations of uses of technology
Languages other than English (LOTE)		*Note:* this LA is not specifically referred to in this unit of work, although specific outcomes may be incorporated if the learning environment is suitable
Mathematics	1, 2	Volumetric calculations and presentations of data analyses
PDHPE	1, 5	Communication methods Personal health choices Safety
Science		Descriptions of interactions Experimental procedure
Technology		Application, design tasks
Education for Sustainability	*Linking them all together!*	*Using experiences of the environment to stimulate investigations, plan and take appropriate action*

During this negotiation phase of the planning process, the teacher characterises the strong class engagement as a reflection of her students' enthusiasm. She decides to further foster this enthusiasm by asking the students what resources they think they need to facilitate their investigations. Keen to involve the community, the students identify experts that they (with occasional prompting from the teacher) think will add to the quality of the investigations, not only in terms of enhancing interest but also in terms of having relevance to their own first-hand knowledge. The people the students identify include the local shire engineer (invited to speak on water catchment, purification and distribution), the community nurse (invited to detail the health benefits of including fish in the diet) and the local pet shop proprietor (invited to describe aquarium ecosystems for both native and exotic tropical fish as well as for crustaceans).

Whole-class discussions on how the students could celebrate (assess) achievement of their learning goals and the quality of their work lead to enthusiastic adoption of a plan to present the findings relating to each of the questions being researched to parents and interested community members at a special presentation ceremony.

For the teacher, finalising the nature of the activities includes a brief but very important one-on-one meeting with each student. Here, the teacher exercises her professional judgement in order to ensure that the student's participation in the chosen activities reflects that young person's preferred learning style. She also wants to reassure herself that the activities will indeed extend and develop a range of intelligences by requiring the students to exercise the skills needed to complete the investigations and/or present the findings to the class and community. As a result of these meetings, some students, with the teacher's advice, elect to work alone or in small groups. The teacher determines the composition of each group to ensure that its members bring together a range of complementary skills and personalities. She also assigns particular roles to each team member and makes clear that these roles will rotate around each member of the group over the course of the investigation.

The mixed ability nature of the class means that the teacher needs to develop different levels of indicator, again during one-on-one individual negotiation, to cater for the range of abilities. The benefits of this process include setting agreed goals as to how many activities each student is to attempt during the time available (to reflect their ability), and the type of involvement they will have in the activity (to reflect their preferred learning style and ensure the development of other styles).

Other project management issues dealt with at this stage relate to the availability of resources (ordering or purchasing a variety of materials), and the completion, by the teacher, of a risk assessment for each activity. The latter is particularly important with respect to ensuring safety. Safety refers not just to the materials to be used but also to the creation and inculcation of a classroom environment that actively promotes safe learning. Although the teacher encourages her students to take risks with their learning, she is adamant that they should do so within a safe learning environment.

Over the four weeks of activities, the students regularly report their progress to the teacher. The students, individually or in their groups, share what they have discovered. They ask questions about issues they do not understand, or find additional sources of information, suggest they discuss and compare findings with other groups, and tell the teacher of other lines of inquiry that have begun interesting them during the activity that they would like to follow up. At no stage does the teacher tell the students what to do. However, she does make sure that whatever activity students choose to pursue does happen. The excitement of the students as they share their newfound knowledge, skills and understandings is infectious.

As they near the end of their activities, the teacher encourages them to consider what actions they might take to address the sustainability issues they have learned about. She then guides them into deciding what actions are appropriate and achievable, and then into planning and taking these actions where possible. The actions the students identify range from creating sustainability messages for the class presentation described below to writing letters to the local authority about water use and discussing with the school grounds-person what plants are suitable for planting in the local climate.

Students who finish their selected activity(ies) with time to spare are given opportunity to assist other students, choose another activity or develop ways of promoting the upcoming community celebration. For those students electing to support other students, the principles of peer learning ("the best way to learn is to teach") offer remediation as well as extension. Promoting the final presentation event presents opportunity for defining and addressing several other outcomes that include taking indirect action for sustainability, such as preparing visual materials (e.g., posters), designing advertisements to be aired on the local radio station, and preparing items and articles for publication in class and in school newsletters and the local newspaper.

Needless to say, the presentation is a great success. The students are all proud of themselves, the parents are proud of their children, and the community members invited to participate feel honoured to have contributed their knowledge.

We designed this fictitious case study to prompt you, the teacher—at any level of experience or in any school situation—to actively consider applying a thematic approach to issues that may arise in the classroom, with those issues reflecting student interest, being relevant to each student and, in this instance, relating to EfS. Our discussion of this scenario also relates to the benefits of reflective evaluation, not only as the unit is unfolding but also, and specifically, at its completion. During the learning activities, make sure you have opportunity to gauge students' levels of enthusiasm for each activity, how well group members are interacting, and the extent and nature of their input and cooperative skills.

On completion of the presentation (and subsequent formal assessment of each student's achievement in terms of the negotiated outcomes), you should find actively reflecting on the overall effectiveness of the unit in achieving the desired outcomes a valuable practice. Checklists designed to facilitate such evaluative processes abound and are widely available. But rather than adopt a single approach/format, consider if each unit can be developed to have its own checking mechanism. For example, it could include opportunity for students to evaluate what they have learned (i.e. KWL Chart) and how the unit could be improved (and, dare it be said, your effectiveness as a facilitator of learning). By asking the students about their favourite activities, especially why they found them so enjoyable, you will again be encouraging them to reflect on the value they gained from the unit. As an important consideration with regard to EfS as a mechanism for transformative learning and critical thinking, encourage students to reflect on how their learning has led to change—for themselves and their environment.

Thematic approaches to teaching contribute in many positive ways to the classroom experience for both you and your students. However, remember that no teacher should expect to develop the perfect unit the first time they try. Collegiality, however, is a valuable support mechanism, so sharing the identified successes of such an approach with colleagues will contribute significantly to the confident implementation of future units. Evaluation in this collegially interactive way, among students and among teachers, again reinforces reflection as an integral component of the learning process.

SCENARIO 2: ENERGY

News and current affairs media continue to report on a variety of issues associated with energy, including climate change, carbon footprints, fluctuating petrol prices and pollution. During a weekly staff meeting at a large metropolitan primary school in New South Wales, Australia, one of the staff suggests a whole-school initiative focusing on energy use, including sustainable power generation and conservation, with the aim of bringing about change in students' behaviour, attitudes and awareness of individual responsibility. The idea is discussed, and there is general approval, but it is not until a planning meeting at the beginning of the next school year that Mr Chips, an early career teacher, offers to develop a relevant programme using the 5Es teaching model (Australian Academy of Science, 2007).

Mr Chips' idea is to plan an integrated, term-long learning and teaching programme suitable for each of the school's non-streamed, combined Years 5 to 6 (Stage 3) classes. However, the other three Stage 3 teachers are concerned that such a programme might adversely disrupt their scope and sequence preparations, as they were relying on teaching the same programme that had been in place for the last few years. In response, Mr Chips, with the enthusiastic support of the Stage 3 coordinator and the school's principal, suggests that the teachers allocate some time during the next stage meeting to discussing the benefits, drawbacks and overall implications of running an integrated thematic programme during Term 3 across all four Stage 3 classes.

Assigned responsibility for chairing the discussions, Mr Chips asks his colleagues to bring to the meeting ideas and concepts from each LA that could be covered in a comprehensive yet integrated thematic programme centred on energy. During this meeting, the teachers compile the following list:

– *English:* application of vocabulary (spoken and written) to a particular audience; reading and interpretation and evaluation of written and electronic texts for research purposes; understanding the purposes of imaginative, informative and persuasive text types and being able to use them appropriately (e.g., writing techniques expressing a variety of emotions for persuasive advertising and entertainment purposes).
– *Mathematics:* computational and representational interpretations of how energy is measured and charged to the consumer for components related to domestic, business, industrial and transport use; reading the family or school power bill; and vehicular fuel consumption and efficiency.
– *Science and technology:* investigation of the types, generation, storage and use of energy; investigation of ways to more efficiently use energy; present-day examples of mechanisms for minimising energy requirements, such as solar houses, insulation and building materials.
– *Personal development, health and physical education (PDHPE):* comparison of the personal energy requirements of chosen lifestyles such as active versus passive; evaluation of energy content of particular foods; energy required to perform particular physical tasks such as those used to ride a bike or run a particular distance.

- *Human society and its environment (HSIE):* find out if and how energy is used in different societies; examine the interrelationships between energy producers and energy consumers; evaluate the impact on the environment of fuel extraction, refining and energy production (including waste disposal).
- *Creative arts:* design and create a variety of advertising media to promote energy-efficient use in the community; represent using words, visual images and/or movement.
- *Education for sustainability:* take some form of direct or indirect action that could reduce energy consumption and promote the use of sustainable energy sources.

During the meeting, Mr Chips informs the team of the huge range of activities and the plethora of outcomes achievable across each of the LAs if they decide to adopt energy as the central theme of the programme. The healthy and sometimes heated discussion that follows highlights some of the perceived advantages and disadvantages of adopting this approach. These include classroom and behaviour management issues, availability of required equipment and resources, and how to develop a suitable mechanism for reporting to parents. Eventually, however, the team agrees on the value to students of learning content that they are highly likely to find personally relevant.

Present at the meeting, the principal offers her support to the idea, at the same time emphasising the opportunities it provides for collegial support and sharing ideas. Ultimately, the Stage 3 team agrees to design and develop an integrated (cross-curricular) programme for implementation in Term 3. They also establish a timeframe for conducting the unit, and agree that the programme will utilise all of the science and technology lessons as well as two lessons from each of the other LAs, with these lessons spread over the term.

The teachers also acknowledge the following important point: when integrating outcomes from the range of LAs, they need to allocate time within those LAs to the programme topic in order to ensure a flexible means of addressing the required outcomes. After considerable discussion, the team agrees to allocate a total of 25 in-school contact hours (lessons) to the programme, with this allocation enhanced by additional external involvement in the form of extra-curricular activities that include homework and self-directed and self-paced research.

The team also agrees to construct the programme in a way that will ensure a student-centred approach to enable individuals and groups to produce a variety of work that the whole school community can eventually see and celebrate. The teachers furthermore agree that assessment should take the form of an ongoing benchmarked approach, defined by agreed indicators of achievement and culminating in the presentation of the reports on the investigative projects to all three classes and to invited parents and community representatives.

Table 13.5 shows the matters the teachers consider during their preliminary planning of the thematic unit on energy.

Equipped with these negotiated parameters, Mr Chips sets about designing a programme sequence using the 5Es teaching model. Tables 13.6 to 13.12 present the planning tables that he develops. Each table is followed by a summary of the implementation process and the key components of each phase of the unit.

Table 13.5. Preliminary planning considerations for the thematic unit "energy".

Preliminary planning considerations		
Teacher planning actions	*Correlation with thematic unit model*	*Proposed activities*
Scope and sequence negotiated with colleagues, ensuring integration of LAs. Anticipate possible risks and assess to minimise.	Identification of a stimulus around which the activities are to be developed. Project management of time and resources available. Pedagogy framework with curriculum integration reinforced by defined learning cycles.	Planning meeting(s) Resource audit, including material and personnel. Allocation of responsibilities among the Stage 3 teachers for various matters, such as reporting to colleagues, reporting to parents, and presentation format and registration.

Table 13.6. The engage phase of the thematic unit.

ENGAGE PHASE (approximately one week)		
Roles: *Teacher/Student*	*Correlation with thematic unit model*	*Proposed activities*
T: elicit and assess student responses and generate curiosity T: assess group dynamics S: discuss initial ideas of the stimulus T & S: explore possible mechanisms for community involvement	Engagement: ensuring that the students are excited about, and looking forward to, the possible investigations. Student questions encouraged, recorded and developed as the basis for activity construction	Stimulate questions and discussion using an open-ended quotation [see next page]. Share and record discussion points to lead to the development of individual and group KWL charts.

The following quote from a famous Indigenous Australian writer and educator is printed in the form of a banner and hung in each of the classrooms: "*We cannot own the land. We are but the custodians of the land*" (Oodgeroo Noonuccal, aka Kath Walker). This action, and the subsequent recording of the same quote in the centre of each student's workbook page, forms the initial discussion stimulus for eliciting student perceptions, concerns and questions relating to the underlying themes of energy and sustainability.

As individuals, students are asked to construct mind maps (an activity the students are familiar with) around the quote. These summarise the students' knowledge and experiences and their understanding of the meaning(s) of the quote. This exercise also forms the basis from which Mr Chips and his colleagues help develop the activities in ways most likely to meet the learning needs of their students (i.e., in terms of identified gaps in students' knowledge and students' expressed wish for more, as well as specific, information and also skills development). Keeping the mind maps firmly in focus, the teachers engage in a cooperative brainstorming activity aimed at determining students' views and assisting with consolidation of possible activities that align with diagnostic tasks.

For the teachers, the desired outcome for this activity is to initiate and facilitate student discussion leading to the development of questions that they (the students) consider important, would like answered and can discuss with their classmates. The teachers record these questions in the form of personal KWL charts, which they then share with one another in order to construct a consensually agreed-on group KWL chart. The questions in this chart are encapsulated in the following sub-themes:

– Energy types and use: Is there a difference between solar and nuclear energy? Where does energy go after we use it? What do we use electricity for?
– Energy resource management: Where does our energy come from? How do we turn coal into electricity? What are the ways we can make electricity? What is carbon trading?
– Impact on current and future generations and the environment of energy production: What would happen if we ran out of energy we could use? What is the environmental threat of nuclear-generated electricity?
– Costs of energy (petrol, gas, electricity) to the individual and the environment: What are these? How can they be reduced?
– Carbon footprint: What is it? Can it be reduced?
– Efficiency of energy use: How do we read the "energy rating" on appliances? What does our electricity (or gas) bill tell us? Can we make engines run better on less fuel?
– Energy alternatives such as nuclear, solar, wind and geothermal: Can we generate electricity for us to use in other ways? What can we do to change things?
– Energy efficiency in houses and buildings: How does insulation work? Does it matter which direction the building faces?

The teachers present these student-based questions to their classes and ask the children to discuss them as a whole-class activity. From these discussions, the students select the questions they personally would like to answer.

The teachers tell their students that they will be spending all remaining Term 3 science lessons, as well as some additional time in class during other subjects, exploring and elaborating their identified questions around the theme of energy. The teachers also inform the students that they will have opportunity to present and share the results of their final elaborative investigations with the school community.

To assist with the planning and implementation process of the unit, Mr Chips employs a heptagon model (exemplified in Figure 13.3) to negotiate, map and sequence a range of LA and learning style-inclusive exploratory tasks. His mapping also includes conducting resource requirement negotiations with other teachers and addressing management issues associated with utilising external community resources (guest lecturers, excursion opportunities). His focus throughout the mapping is on identifying activities that will answer the range of student-initiated questions and achieve the identified curriculum requirements.

Table 13.7. The explore phase.

EXPLORE PHASE (approximately two weeks)		
Roles: Teacher/Student	*Correlation with thematic unit model*	*Proposed activities*
T: challenge current student understanding; listening and observing Facilitating the development of different learning styles S: work safely and cooperatively Explore alternative approaches to answering questions Discussing planning and findings with others (within and between groups, and with the teacher)	Resourcing Activity selection Identification of syllabus outcomes Negotiation of personal learning goals Involvement of community experts	Development and implementation of student-owned exploratory activities KWL charts updated

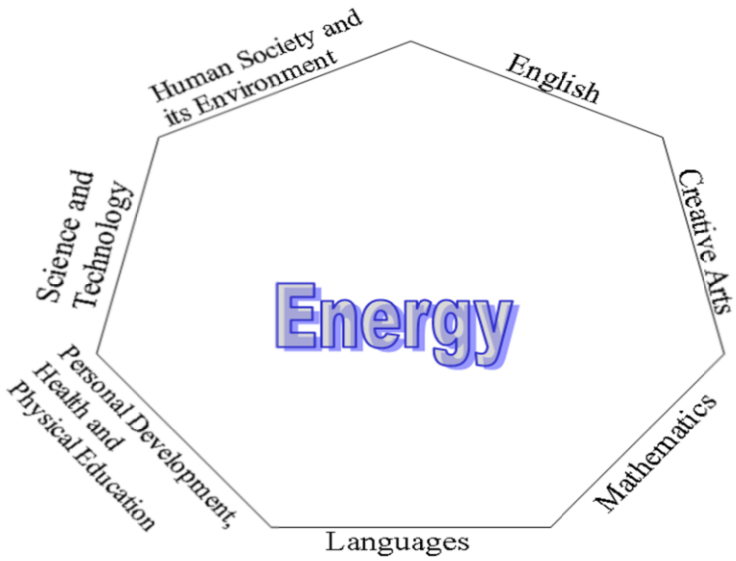

Figure 13.3. A planning heptagon for identifying the outcomes to be addressed by a particular thematic unit.

The overall process of negotiation and planning takes approximately three hours of class time spread over three days. Mr Chips is delighted to hear the other teachers confirm that the majority of students have spent a considerable amount of their out-of-school time discussing, sharing, preparing and planning ideas for their exploratory activities.

The outcome of these negotiations and planning experiences is the students' demonstrated confidence that they can fully develop 12 exploratory activities relevant to their experiences and interest that they can share across all of the Stage 3 classes. The participating teachers share among themselves any remaining proposed activities so that they can facilitate their further development and use in class.

The final set of activities includes the following:

– designing, building and testing solar energy heat collectors;
– researching and listing international energy initiatives;
– calculating the carbon footprint of each student and their family;
– researching coal, oil and gas mining and production;
– building and testing a solar-powered model car;
– developing a fire-protection plan;
– identifying energy-efficient building materials (manufacture and use);
– fair testing a variety of home insulation products (hot and cold environments);
– researching and designing sustainable home gardens;
– interpreting electricity, gas and petrol bills (graphing and analysing);
– setting up a "change wall" (for brainstorming and recording ideas about sustainable practices likely to "make a difference");
– exploring wind and water turbines (researching, designing and building models);
– measuring and calculating the efficiency of a range of popular family cars;
– researching and testing fuel cell technologies;
– exploring ways of making hydrogen from water;
– researching the impact on the environment of burning fossil fuels (video and internet);
– evaluating ways of storing energy (hands-on experiments);
– investigating ways of making electricity by pedalling a bike, using chemicals and solar cells; and
– investigating nuclear energy (video, hands-on simulations and mini-debates).

The teachers divide and set up the exploratory activities across the four Stage 3 classrooms. They also identify 50 percent of the activities that they think would be best explored by groups of different sizes. The teachers then invite the students to nominate five group activities, and another five activities they would like to complete while working alone.

During this initial "trial" of a thematic approach, the teachers decide they will determine the composition of the groups and the role each student is to take when working on the activities. For the teachers, this approach is an attempt to accommodate their students' favoured learning style(s) and to develop and enhance the skills they will need to employ during the unit.

Over the two weeks of the explore phase, the students circulate between the activities, completing at least 10 of the 18 available. Extension takes the form of an option to undertake additional identified activities or pursue other lines of investigation suggested by the student and arising out of the completed activities. The teachers use formative assessment and continue to encourage the students to participate and take ownership of the learning process. Students record their own work in their own way in their personal research diaries, and their teachers remind them, at the completion of each activity, to update their KWL charts.

The explain phase allows the students and teachers to share and discuss each of the activities. Together, they explore the KWL charts, ask additional questions and identify ideas. This phase helps the students clarify potential projects for additional investigation during the elaborate phase. Four main discussion topics emerge, at which point the teachers advise they will further clarify the requirements of each topic and find any additional information required.

Table 13.8. The explain phase.

EXPLAIN PHASE (approximately 4 weeks)		
Roles: Teacher/Student	*Correlation with thematic unit model*	*Proposed activities*
T: offers alternative explanations and additional terminology based on observations of student perceptions S: critically listens to other ideas and explanations	Engagement Stimulus Activity selection	Student-led class discussions Student-led reviews of the activities Clarification of ideas and concepts Discuss and negotiate ideas for the “elaborate phase”

The four topics agreed on are the following:

– aspects associated with world and politics;
– a balanced review of the nuclear energy debate;
– impact of sustainability practices in relation to other countries; and
– explanations of terminology associated with energy (e.g., watt, kilowatt, joule, kilojoule, calorie, kilocalorie).

During the mid-term Stage 3 meeting, Mr Chips and his colleagues evaluate what progress the students have made with respect to achieving the defined outcomes. The teachers note that once students came to terms with the logistics of moving around classrooms and sharing responsibility for the work required, the investigations proceeded with considerable enthusiasm. Students are sharing exciting findings and relevant pieces of information are being generated within and across the classes.

Table 13.9. Planning mid-programme evaluation.

Planning mid-program evaluation		
Teacher planning actions	*Correlation with thematic unit model*	*Proposed activities*
Consider whether the activities are achieving the desired outcomes. Evaluate resource/activity utilisation with personal and collegial reflection	Project management Curriculum integration	Progress report to students, community and colleagues Identification and resolution of resource issues

The mid-programme evaluation also provides Mr Chips with opportunity to discuss the value of collegial reflection as a mechanism to ensure the success of the approach. He is pleased to observe cooperation and collaboration during the lesson-time activities.

Table 13.10. The elaborate phase.

ELABORATE PHASE (approximately two weeks)		
Roles: Teacher/Student	*Correlation with thematic unit model*	*Proposed activities*
T: assist and encourage student-planned investigations S: draw conclusions from conducted investigations	Project management Engagement Curriculum integration	Students plan and conduct investigations to demonstrate their understanding of the concepts and achievement of the desired outcomes

Students, individually or in groups, work with the team of teachers to negotiate the design of their major presentation project. This indirect action empowers the students to seek out and address causes of sustainability problems identified within the thematic unit. As an integral component of each project, the teachers and students map the outcomes to be achieved for each LA addressed within the project. Initially, the students propose and have approved 33 investigative presentations. However, after two weeks, some students propose amalgamating apparently similar activities, a process that results in 28 investigations. The fact that the students propose these investigations and how to present their findings ensures that the essential requirement of relevance to student interest and achievement is achieved. Over the next two weeks, each student works enthusiastically and remains on track for completing their investigations in time for a peer review of their findings and results. This component of the elaborate phase enables the students to fine-tune how they will celebrate their achievement with peers, parents and the community during the formal presentation.

The students, with teacher facilitation, classify and group the 28 projects into a coherent presentation and display. The assembly hall and adjacent, shaded outdoor area are used to house the displays. The Stage 3 students rotate roles as presenters and guides, showcasing their work over a half-day open house to the school community.

Table 13.11. The evaluate phase.

EVALUATE PHASE (approximately three weeks)		
Roles: Teacher/Student	*Correlation with thematic unit model*	*Proposed activities*
T: looks for evidence of outcome achievement S: presents personal construction of concepts	Curriculum integration	Presentation of investigations Teacher, student and community review of presented work Assessment of negotiated outcomes Student forum

Table 13.12. Program review.

Program review		
Teacher planning actions	*Correlation with thematic unit model*	*Proposed activities*
Identification of student key achievement Considerations for future planning Identification of remediation required	Reflection of curriculum integration Reflection of pedagogy framework Reflection of activity suitability	Survey forum including community and student representatives Statement of celebration and recognition of achievement Reflective report compiled

In the few days remaining in the term, the Stage 3 teachers invite their students to state what value they, as individuals, gained from the unit. Comments include “fun”, “exciting”, “challenging”, “thought provoking”, “too hard”, and “not important”. These comments provide the teachers with valuable information, particularly in terms of helping them assess the degree to which the original aims of the unit have been met, namely, building student knowledge, changing student attitudes, and encouraging students to accept responsibility for their own sustainable actions. The teachers agree that the unit has also provided students with opportunity to reflect on whether the actions they took during their work and that their presentations on the identified topics were effective in addressing sustainability issues and helping them learn about taking appropriate action.

The final, yet essential, component of the thematic unit on energy for the teaching team is that of meeting and preparing a final evaluation of the thematic approach. The evaluation is shaped by individual reflection and collaborative and collegial comment. It is during this meeting that the opinions of students, parents and community members are considered. Overall, the teachers agree that, for a first attempt, the way the unit has been presented and conducted has been successful.

LINKING PLANNING, DEVELOPMENT AND ASSESSMENT

Curriculums and syllabuses require teachers to utilise a balanced suite of assessment strategies in order to ascertain the achievement of learning outcomes. As we near the end of this chapter, we would like you to consider how you could use taxonomies to provide a common language and tool to support the whole inquiry-based thematic process. We consider that any taxonomy ideally needs to:

– provide a framework within which to both plan and assess tasks;
– be able to be used by students as young as five so that they can reflect on their own learning outcomes and the learning outcomes of their peers;
– help inform future decisions;
– allow tasks and outcomes to be set at different levels of utility and achievement;
– possess a high level of inter-rater reliability; and
– align to levels of cognitive complexity.

We also advise consideration of the "structure of the observed learning outcome" (SOLO) taxonomy first developed by Biggs and Collis (1982). We believe this taxonomy is gaining support in educational research because it provides a systematic way of describing how learners' performance grows in complexity as they experience defined tasks, particularly the sorts of tasks undertaken in school classroom situations (see Table 13.13). It also offers a very applicable framework for supporting the planning and assessment of inquiry-based thematic units.

In New Zealand, Pam Hook, of HookED, is developing a classroom-based approach that uses the SOLO taxonomy (Figure 13.4). She and colleague Julie Mills have found that SOLO provides a powerful mental model for changing how students think about their own learning outcomes. Students are led to understand that declarative and functioning learning outcomes are the result of effort and the use of effective strategies rather than of "luck" or "fixed abilities".

In summary, it is our view that SOLO provides a very flexible and useful common planning and assessment strategy that both teachers and students alike can use effectively to support inquiry-based thematic units.

Table 13.13. SOLO categories related to student responses (adapted from Biggs & Collis, 1982).

Level of learning category demonstrated	*Examples of student response*
Prestructural	Student responds with expression of not having an exploration for the phenomenon in question, *or* student's explanations draw on pieces of apparently unconnected information without any of the organisation needed to make sense of the observations.
Unistructural	Student offers explanations that make simple and obvious connections between observations, past experience, and conceptual knowledge, only one of which is relevant to the context. The significance of the connections is not demonstrated.
Multistructural	Student explanation contains two or more pieces of relevant information, and student may make a number of connections between activity-driven observations and new and previous knowledge. There is no demonstration of the significance of the relationship between connections.
Relational	As part of the explanation to their peers, the student demonstrates a relevant relationship between the connections they are making with their observations and other knowledge related to the whole concept being explored.
Extended abstract	Student makes connections beyond the immediate phenomenon, thus demonstrating the application of connections to other personal observations. Student also demonstrates transfer of learning to personally derived explanations of other phenomena and offers analogies to aid their explanations to peers.

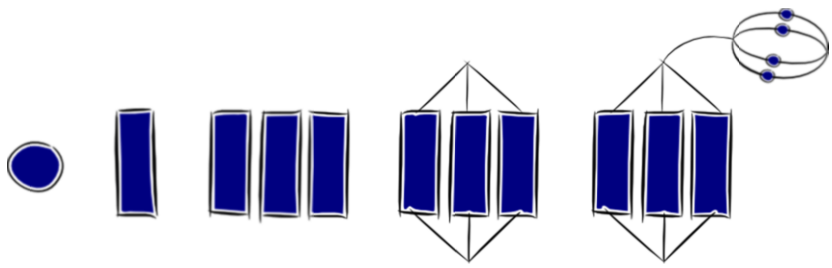

Figure 13.4. Pictorial representation of the SOLO taxonomy, courtesy of Hooked-on-Thinking's Pam Hook and Julie Mills (2009).

CONCLUDING REMARKS

Although we presented only two examples of thematic planning and implementation in this chapter, we wish to emphasise that many other highly tested, endorsed and successful models can be found throughout the available literature, and are exemplified in schools around the world. The NSW K to 6 Curriculum Planning Framework with Programming Support provides pertinent examples of thematic units, which are called connected outcomes groups (COGs) in the document (NSW Department of Education and Training, 2008). These collaborative, integrated and negotiated approaches involving students and colleagues in relevant and exciting syllabus-driven investigations are having positive impacts on student learning, teacher professional development, community support and satisfaction with the teacher. Through creating a *yearn to learn* model, the usually onerous task of preparing lessons becomes fun and interactive. Such a situation can only lead to increased student achievement and, within the EfS context, opportunities to address this area of educational provision while simultaneously working towards achievement of other required curriculum objectives. These approaches demonstrate that EfS can be seen not as an add-on value in the curriculum but as a fundamental part of a curriculum that provides quality teaching and learning in our schools.

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14. INDIGENOUS PERSPECTIVES ON EFS IN AUSTRALIA AND NEW ZEALAND

INTRODUCTION

The term "Indigenous" comes from Latin, in which it means "born of the land" or "springs from the land" (Cardinal, 2001, p. 180). Indigenous perspectives are generated from the land. As Cardinal explains: "Indigenous peoples with their traditions and customs are shaped by the environment, by the land. They have a spiritual, emotional, and physical relationship to that land. It speaks to them; it gives them their responsibility for stewardship; it sets out a relationship" (p. 180). UNESCO highlights the significance of Indigenous knowledge in relation to sustainability:

> Indigenous knowledge is the local knowledge that is unique to a culture or society. Other names for it include: 'local knowledge', 'folk knowledge', 'people's knowledge', 'traditional wisdom' or 'traditional science'. This knowledge is passed from generation to generation, usually by word of mouth and cultural rituals, and has been the basis for agriculture, food preparation, health care, education, conservation and the wide range of other activities that sustain societies in many parts of the world.
>
> Indigenous people have a broad knowledge of how to live sustainably. However, formal education systems have disrupted the practical everyday life aspects of indigenous knowledge and ways of learning, replacing them with abstract knowledge and academic ways of learning. Today, there is a grave risk that much indigenous knowledge is being lost and, along with it, valuable knowledge about ways of living sustainably. (UNESCO, 2010, p. 1)

The United Nations Decade for Sustainable Development (2005–2014) focused on a broad definition of education for sustainable development. The definition recognised the interdependence of environmental, economic, cultural, linguistic and social sustainability. Vital to this conceptualisation is the understanding that biological, linguistic and cultural diversity are integrally connected. The encroachment of the modern technological monocultures of agriculture and urban development on traditional peoples and their lands has had (and is continuing to have) a severe impact not only on ecological diversity but also on the languages and cultures of these peoples (Gorenflo, Romaine, Mittermeier, & Walker-Painemilla, 2012). Education for sustainability that incorporates Indigenous perspectives thus centres on environmental sustainability *and* the cultural and linguistic sustainability of Indigenous peoples.

N. Taylor et al. (eds.), Educating for Sustainability in Primary Schools, 303–321.

According to UNESCO, anyone adopting its approach to education for sustainability needs to use a series of lenses, which the organisation describes as follows:

> An *integrative lens*: taking on a holistic perspective that allows for integrating multiple aspects of sustainability (e.g., ecological, environmental, economic and sociocultural; local, regional and global; past, present and future; human and non-human);
>
> A *critical lens*: questioning predominant and/or taken-for-granted patterns and routines that are or may turn out to be unsustainable (e.g., the idea of continuous economic growth, dependency on consumerism and associated lifestyles);
>
> A *transformative lens*: moving beyond awareness to incorporate real change and transformation through empowerment and capacity-building that may lead to or allow for more sustainable lifestyles, values, communities and businesses;
>
> A *contextual lens*: recognizing that there is no one way of living, valuing and doing business that is most sustainable everywhere and always, and that although we can learn from one another, places and people are different and times will change. Therefore, sustainability needs to be recalibrated as realities and times change. (UNESCO, 2012a, p. 10)

The remainder of this chapter consists of two distinct parts, in which we examine the relationships between indigeneity and education for sustainability (EfS) within the context of curricula in *Aotearoa* New Zealand and then Australia. Each section ends with several suggested resources for teachers.

PART A. INDIGENOUS PERSPECTIVES AND EDUCATION FOR SUSTAINABILITY IN *AOTEAROA* NEW ZEALAND

Komuruhia te poioneone kia toe ko te kirikiri kotahi.
Ahakoa tana kotahi, e honoa ana ia ki te whenua,
mai i tewhenua ki te rangi, te rangi ki te whenua,
ki te maunga, ki te moana, ki te tangata e tu ake nei;
ko au tenei te kirikiri nei
Rub away the earthen clump to leave but one lone grain of dirt;
whilst it is but one, yet it is inextricably joined to the land,
from the land to the sky, the sky to the land, to the
mountain, to the sea, to the people;
tis I who is that one lone grain.
(Anaru Kira, as cited in Waitangi Tribunal, 2004, pp. 12–13)

In this section, we outline Māori conceptualisations in relation to sustainability. We then examine the New Zealand Curriculum, identifying its connections to sustainability in relation to indigeneity. The New Zealand Curriculum needs to be understood in relation to the historical and cultural contexts of *Aotearoa*. Important considerations are recognition of the country's Indigenous peoples and of the impact colonisation has had on them and their lands, rivers, seas and other natural resources.

Māori are the Indigenous people of *Aotearoa* New Zealand, the *tangata whenua*, or people of the land. In 1840, with the signing of the Treaty of Waitangi/*Tiriti o Waitangi*, Māori agreed to share this country with its British settlers. As part of the treaty agreement, the British Crown (and, by extension, subsequent governments) agreed to protect Māori lands, fisheries, villages and everything valued by Māori. The latter has since been found, by the government commission known as the Waitangi Tribunal, to include intangible things of value, such as Māori language. Māori, in adapting to the cooler climate and consequent different ecologies of *Aotearoa*, were able to exercise a capacity "to perceive underlying patterns in nature" (Roberts et al., quoted in Waitangi Tribunal, 2011b, p. 568). Traditionally, Māori had, and today continue to have, a strong sense of responsibility for living responsively and in tune with the environment. For Māori, the Earth is *Papatūānuku*, the Earth Mother, and the sky is *Ranginui*, the Sky Father. Humans live(d) closely on the land, drawing upon her resources and those of the rivers and the seas; they were(are) aware that these resources need(ed) to be protected and respected. The nurturing role of *Papatūānuku* is paralleled by the nurturing responsibility of the pregnant woman; the word whenua means both "land" and "placenta".

"*Kaitiakitanga* is a traditional cultural system that upholds ecological conservation" (Ritchie, Duhn, Rau, & Craw, 2010, p. 38). The concept of *kaitiakitanga* underpins "the mutual nurturing and protection of people and their natural world … it was and is fundamentally a matter of spiritual and physical survival" (Waitangi Tribunal, 2004, p. 8). *Kaitiakitanga* is more than a passive acknowledgement of guardianship, but an active responsibility to *care for* the environment (Waitangi Tribunal, 2004). *Kaitiakitang*a is thus the exercise of guardianship, stewardship and protection, a way of managing the environment based on the Māori worldview, whereby people are the descendants of nature and therefore are responsible to *tipuna* (ancestors) and *uri* (descendants) for caring for the environment.

Different tribes retain guardianship over their domains of rivers, coasts and lands, exercising their *kaitiakitanga* (care-taking) in order to sustain the wellbeing and health of the waters, lands, seas and all creatures that rely upon these, including humans. Professor Margaret Mutu explains this responsibility thus:

> In specific terms, each whānau [family] or hapu [sub-tribe] is kaitiaki [guardian] for the area over which they hold mana whenua [the authority over the land], that is, their ancestral lands and seas. Should they fail to carry out their kaitiakitanga duties adequately, not only will mana [authority, prestige] be removed, but harm will come to the members of the whanau or hapu. Thus a whanau or hapu who still hold mana in a particular area take their kaitiaki responsibilities very seriously. (Waitangi Tribunal, 2004, p. 8)

The Waitangi Tribunal clearly outlines that, as an honourable treaty partner, the Crown (and those of us acting as agents of the Crown, such as teachers) have the responsibility to support Māori in ensuring the protection of *mātauranga Māori* (Māori knowledge) and in exercising *kaitiakitanga* (Waitangi Tribunal, 2011a, 2011b). This expectation is outlined in the following words from an elder of the Tainui tribe, who are *kaitiaki* (guardians) of the Waikato River:

> It is not our mana [prestige] that makes the river great. It has its own mana. People get mixed up about that. What it should be about, today, is the wellbeing of that taonga [treasure]. And that's for all people. We should be addressing our environment right now as a total people. We should be looking at what we can do together, what we can learn from one another, right now, to restore the river. (cited in Kereama-Royal & Ashton, 2000, p. 35)

Wairuatanga (spiritual interconnectedness) is an integral aspect of *kaitiakitanga* (guardianship), which must be acknowledged for it speaks of the embedded emotional and spiritual connection with the environment. It is a principle of cultural integration that holds all things together and is both material/metaphysical and contemporary/ancestral. Māori perceive there to be no division between *te ao mārama* (the physical world), *te taiao* (the natural world) and *te ao wairua* (the spiritual realm). The role of Māori as *kaitiaki* is one of linking the past and the future, through responsible practices:

> Māori as kaitiaki are obligated not only to protect the interests of future generations but also stress the importance of ancestors to tribal identity. Only when you honour those who have come before you can you truly protect the interests of those yet to be. It is this continuum that makes development within the limits of sustainability more important than current economic realities. (Tipa & Teirney, 2003, p. 8)

The New Zealand Curriculum

The New Zealand Curriculum (NZC) contains sets of core values, principles and competencies that are to underpin the learning that takes place in New Zealand schools. The curriculum document lists "ecological sustainability" below "community and participation" and above "integrity" and "respect" as core underpinning values of the curriculum (New Zealand Ministry of Education, 2007, p. 7). The curriculum's principles are positioned below the values. They include the Treaty of Waitangi, community engagement, and future focus (New Zealand Ministry of Education, 2007, p. 7). The document's "vision" is that New Zealand school children "will seize the opportunities offered by new knowledge and technologies to secure a sustainable social, cultural, economic, and environmental future for our country [and] who will work to create an Aotearoa New Zealand in which Māori and Pakeha recognise each other as full Treaty partners, and in which all cultures are valued for the contributions they bring" (p. 8). The document also includes a number of "key competencies", among which are "participating and contributing":

> Students who participate and contribute in communities have a sense of belonging and the confidence to participate within new contexts. They understand the importance of balancing rights, roles, and responsibilities and of contributing to the quality and sustainability of social, cultural, physical, and economic environments. (New Zealand Ministry of Education, 2007, p. 13)

Te reo Māori, the Māori language, is a key concern of cultural and linguistic sustainability in Aotearoa New Zealand. The New Zealand Curriculum makes clear the following commitments:

> Te reo Māori is indigenous to Aotearoa New Zealand. It is a taonga recognised under the Treaty of Waitangi, a primary source of our nation's self-knowledge and identity, and an official language. By understanding and using te reo Māori, New Zealanders become more aware of the role played by the indigenous language and culture in defining and asserting our point of difference in the wider world …
>
> By learning te reo and becoming increasingly familiar with tikanga, Māori students strengthen their identities, while non-Māori journey towards shared cultural understandings. All who learn te reo Māori help to secure its future as a living, dynamic, and rich language. As they learn, they come to appreciate that diversity is a key to unity. (New Zealand Ministry of Education, 2007, p. 14)

Further contexts

Despite legislative acknowledgement of obligations to ensure responsivity to Māori in many spheres, including education, progress towards the realisation of culturally relevant education for sustainability has been slow, with the exception of the independent community-based movement, Enviroschools. Enviroschools/*Ngā Kura Taiao*, an eco-school programme imbued with a strong Māori philosophy, began in 1993 and now reaches into 30 percent of New Zealand schools (Enviroschools Foundation, 2014). One of the five core principles of this whole-of-school community-oriented approach is that of "'Māori Perspectives' which honours the status of *tangata whenua* [people of this land/Indigenous people] in this land and the value of Indigenous knowledge in enriching and guiding learning and action" (Enviroschools Foundation, 2014).

The New Zealand Ministry of Education's document *Guidelines for Environmental Education in New Zealand Schools* (1999) acknowledges "the special position of the Māori people in relation to the natural resources of New Zealand" (p. 11). Its specification of four key concepts (biodiversity, sustainability, interdependence, and personal and social responsibility for action) includes reference to key Māori concepts such as *mauri*, the life force in all things, *hauora*, wellbeing sourced from being in balance with nature, and *kaitiakitanga* (pp. 11–13). It asks that consideration of appropriate resources encompasses reflection as to whether Māori perspectives are "included in areas where learning about New Zealand is important?" It also asks, somewhat ambiguously, "If not, how will this be managed?" (p. 20).

A 2004 report by the New Zealand Parliamentary Commissioner for the Environment acknowledges the way in which Māori developed a sustainability consciousness through accumulated experiences over time:

> During this process tangata whenua began to weave a rich tapestry of narratives to teach and pass on their accumulated knowledge. These often embodied ecological messages and environmental ethics. They explained the interconnectedness of people with Ranginui and Papatuanuku and all the elements of the world. Identity became tied to whakapapa and a worldview developed with a strong sense of custodial occupation (kaitiakitanga)—a belief that the environment should be maintained in a fit state for future generations. (Parliamentary Commissioner for the Environment/*Te Kaitiaki Taiao a Te Whare Pāremata*, 2004, pp. 20–21)

A national survey of environmental education in New Zealand conducted in 2004 found that Māori knowledge and values had an intentional and visible role in the culture of four of the seven focus mainstream schools, although the examples given (e.g., use of Māori words and names throughout the school) are not specifically related to environmental sustainability (Bolstad, Cowie, Edwards, & Rogers, 2004). Some staff acknowledged that a stronger focus on including Māori perspectives was needed. It appears that environmental sustainability projects in New Zealand schools, in focusing on aspects such as gardening, composting and worm-farming, not only tend to be conducted in the absence of Māori perspectives but also lack a critical consciousness that might examine causal issues or engage "with the values, or the economic, social and cultural issues that shape our environmental behaviour" (Chapman, Flaws, & Le Heron, 2006, p. 287). Because "[b]eing culturally and place-responsive is a conscious pedagogical decision" (Cosgriff, Legge, Brown, Boyes, Zink, & Irwin, 2012, p. 231), teachers in Aotearoa New Zealand should "have a high level of cultural awareness, an understanding of the Treaty of Waitangi and its obligations, and a genuine interest in gaining other worldviews. This requires a willingness to learn about one's own cultural horizons and identity, in addition to accepting the limits of one's own cultural competence" (p. 232). Furthermore, in consideration of sustainability/outdoor/environmental education, it is important that curriculum development is inclusive of *te ao* Māori (Māori worldview) perspectives. It must also resist neoliberal incursion that allows for a degree of "strategic development of resources … [and instead] ensure that economic rationality is not privileged over social justice and environmental sustainability" (Eames, Cowie, & Bolstad, 2008, p. 41).

Despite the iteration of a comprehensive framework in the documents outlined above and despite the Decade for Sustainable Development having just drawn to a close, it appears that education that embraces the UNESCO definition of environmental, economic, cultural, linguistic and social sustainability is still in its infancy. These curriculum statements can therefore be viewed as containing an as yet unrealised potentiality and remaining "largely rhetorical" (Chapman et al., 2006, p. 288).

Kaitiakitanga practice

In order for teachers to be able to deliver Indigenous perspectives in an authentic, integrated manner, they themselves need to have been taught ways in which to do this. In this section, we describe how a teacher education programme in Auckland, New Zealand, incorporated the concept of *kaitiakitanga* (guardianship) into its teaching. Although this context was a tertiary education one, the general principles of incorporating Māori knowledges, histories and stories of local place and of then looking after that place (i.e., exercising *kaitiakitanga*) are directly transferable to the primary school setting.

Within the Bachelor of Teaching (Early Childhood Education) at *Te Whare Wānanga o Wairaka*/Unitec Institute of Technology (Unitec), *te ao* Māori conceptualisations were introduced to students via a series of three courses, one in each year of the three-year degree programme. These courses were called '*kete'* courses. *Kete* (woven flax bags), in *te ao* Māori, symbolise the baskets of knowledge that the demi-god Maui obtained from the heavens for people to use. During their first year of the degree programme, students participated in the course entitled *Te Kete Manaaki Tangata* (caring for people); in their second year, they engaged in *Te Kete Manaaki Whenua* (caring for the land), and in the third year in *Te Kete Manaaki Taonga* (caring for all things that Māori regard as precious). It was in the *Kete Manaaki Whenua* course that students experienced a particular *kaupapa* (focus) on *kaitiakitanga* (exercising guardianship) of the *whenua* (land).

During this course, students were introduced to Unitec's urban campus and surroundings. This opportunity saw them visiting the *maunga* (mountain) of the local *iwi* (tribe), identifying the surrounding environs, such as *moana* (oceans) and *awa* (rivers), and all the while learning of the Māori history of this particular *rohe* (area), known to Māori as *Wairaka. Wairaka* was an ancestral *wahine toa* (woman of courage) of the *Mātaatua waka* (an original tribal canoe), and it is from her that the name of the *whare wānanga* (tertiary institution) is drawn. On this whenua is an underground freshwater spring—a *puna* (a place of sourcing). This *puna* merges into a stream and travels through the campus grounds, eventually running into a larger river and then into the local *moana*. A *pūrākau* (legend) relating to this *puna* tells that it was created by the ancestress *Wairaka*, who was travelling with her *whānau* (family) through this *rohe* and became thirsty. She continually informed her father she was thirsty but was not paid attention to until, in frustration, she stamped her foot and water sprang from the *whenua*. Since then, the *puna* has been known as *Te Puna Unuroa o Wairaka* (the source of the long drink of *Wairaka*).

The lecturer running *Te Kete Manaaki Whenua*, *Whaea* Carol Smith, had observed that the *puna* and stream was overgrown with weeds and rubbish. She determined that an exercise in *kaitiakitanga* (guardianship) was in order, whereby students would be required to clean the *puna* to enable the stream to once again flow cleanly and without restriction. Before this work commenced, a *karakia* (blessing) was given to both *Papatūānuku* and *Ranginui*. The students collected rubbish, extracted weeds from the *puna* and cleared the banks. On completing this work, they were able to see *tuna* (eels) in the stream.

The final assessment of this course required the class of 32 students to prepare and present a *whakaari* (performance), which had as its *kaupapa* (focus), the *kaitiakitanga* (guardianship) of the *puna*. The performance offered the students a way of demonstrating their commitment to the *whakauka* (sustainability) of the *puna* and surrounding *whenua*. The students invited *tamariki* (children), teachers and *whānau* from the *wāhi kōhungahunga* (early childhood centres) with which they were associated to the *whakaari*, which was held on the campus *marae* (Māori meeting place), *Te Noho Kotahitanga*. By coming onto the *marae*, these *tamariki* and *whānau* had the opportunity to experience participating in a *pōhiri* (a welcoming process) and observe their student teachers presenting their sustainability-focused creation.

The students chose to relay the *pūrākau* of *Wairaka* in ways that demonstrated their very clear understanding of incorporating Māori ways of knowing, being and doing and also their creative ability. One group of students entered the *wharenui* (large house on the *marae*) in a *waka* (canoe) to relay the journey of *Wairaka* and her *whānau*. The student acting the part of *Wairaka* asked again and again for a drink but was ignored. Frustrated, she stamped her *waewae* (feet), which resulted in other students springing out from under a tarpaulin waving blue streamers to represent water and hence the birth of *Te Puna Unuroa o Wairaka*. At this point, the students invited children from the audience to collect the "rubbish" from around the *puna* and also to wave streamers in simulation of flowing water.

At the end of the *whakaari*, the students had permission to take the children outside, to the nearby actual *puna*, thus authenticating the *whakaari* and adding relevance to its *kaupapa*. Several of the *wāhi kōhungahunga* (early childhood centres) represented at the *whakaari* were situated in this immediate *rohe*, and so learning about this local *pūrākau* gave these children a sense of *mana whenua* (belonging) to this geographic area. They had opportunities to incorporate not only knowledge of a Māori worldview but also *te reo* Māori.

The *Kete Manaaki Whenua* students were required, as the second part of their assessment, to write a personal, critical reflection of this experience. In all instances, students indicated that the activity enhanced and incorporated all aspects of their teaching and learning, was authentic and allowed them to express their knowledge and skills in a meaningful and productive way, thus leading to transformative practice involving the use of integrative, critical and contextual lenses.

Resources and useful sites

- *Education for sustainability: The key concepts underlying environmental education. Te Kete Ipurangi* New Zealand Ministry of Education website of resources for teachers.
  http://efs.tki.org.nz/Curriculum-resources-and-tools/Environmental-Education-Guidelines/The-Key-Concepts- Underlying-Environmental-Education
- *The Enviroschools Foundation:* Enviroschools is a community-based organisation that promotes an action-based approach to education wherein children and young people plan, design and implement sustainable projects and become catalysts for change in their families and the wider community. Te Aho Tū Roa programme works in te reo Māori immersion contexts with *tamariki* (children), *rangatahi* (youth), *whānau, hapū* (sub-tribes) and iwi (tribes).
  http://www.enviroschools.org.nz/
- *Living Heritage:* Living Heritage is an online bilingual initiative that enables New Zealand and Pacific Island schools or individual students to develop and publish an online resource based on a heritage toanga (treasure) in their community.
  http://www. livingheritage.org.nz/About-Living-Heritage
- *See change: Learning and education for sustainability:* New Zealand Parliamentary Commissioner for the Environment *Te Kaitiaki Taiao a Te Whare Pāremata* (2004).
  http://www.pce.parliament.nz/publications/all-publications/see-change-learning-and-education-for-sustainability
- *Ko Aotearoa tēnei: A report into claims concerning New Zealand law and policy affecting Māori culture and identity. Wai 262. Te Taumata Tuatahi* (*Te Rōpū Whamakana i te Tiriti o Waitangi Waitangi* Tribunal report, 2011).
  https://forms.justice.govt.nz/search/WT/ reports/reportSummary.html?reportId=wt_DOC_68356054

PART B: AUSTRALIAN ABORIGINAL AND TORRES STRAIT ISLANDER PERSPECTIVES ON EDUCATION FOR SUSTAINABILITY

> Maintaining a balance with biodiversity is the very premise of First Nations belief systems. (Waters, cited in Sammel & Waters, 2014)

We begin this section by introducing the connection between sustainability and Australian Indigeneity and the treatment of this in the Australian Curriculum (Australian Curriculum and Assessment Reporting Authority [ACARA], 2014). We then discuss the potential of Aboriginal and Torres Strait Islander perspectives for sustainability education and how teachers might go about this important work. We (the authors of this section) acknowledge that New Zealand is certainly "further down the track" in this regard, as Māori perspectives for sustainability are recognised and embedded across that country's curriculum. However, we are pleased to be able to point readers to quality programmes and resources that support teachers to embed Aboriginal and Torres Strait Islander perspectives in education for sustainability (EfS) in Australia. Our aim here is to focus teachers on the *how* rather than the *what* so that their work is authentic and contributes to achieving reconciliation and recognition of Aboriginal and Torres Strait Islander knowledges.

For Australian teachers, EfS has been prioritised and prescribed through the introduction of the Australian Curriculum developed by a national body (ACARA) in consultation with state and territory education representatives and the wider Australian community. The curriculum is described as "setting consistent national standards to improve learning outcomes for all young Australians … [and determines] what students should be taught and achieve, as they progress through school" (ACARA, 2014).

The curriculum's cross-curricular priorities were identified through the Melbourne Declaration on Educational Goals for Young Australians (Ministerial Council on Education, Employment, Training and Youth Affairs [MCEETYA], 2008), which focused attention on the need for students in the 21st century to be knowledgeable and proactive in relation to relevant and contemporary local and global issues. Two of the three cross-curricular priorities designed to be embedded across the learning areas or subjects of the curriculum are *sustainability* and *Aboriginal and Torres Strait Islander histories and culture*. Sustainability is categorised under three organisers: systems, worldviews, and futures, while a conceptual framework has been developed to support the embedding of Aboriginal and Torres Strait Islander histories and cultures. This framework also uses three organisers: country/place, people, and culture. Both priorities state that the organising ideas are to be embedded in the learning areas as appropriate.

Lowe and Yunkaporta (2013, p. 12) point out, however, that the content descriptions of Aboriginal and Torres Strait Islander histories and cultures provided in the Australian Curriculum are "weak" and "do not provide teachers with the necessary tools to construct learning experiences" that match their intended purposes. Lowe and Yunkaporta's evaluation highlights the importance of this chapter as a reference for teachers seeking to embed authentic Indigenous perspectives in sustainability education. Because it is impossible to provide all that is needed in just one chapter of one book, our focus is on enhancing teachers' awareness and developing understanding of the importance, as well as the potential of the fundamental links between Aboriginal and Torres Strait Islander perspectives and sustainability. While not exhaustive, our content provides examples of high-quality practice and resources that support teachers to seek out relevant and authentic Indigenous perspectives through consultation with Aboriginal and Torres Strait Islander peoples.

Ironically, developers of the Australian Curriculum appear to have missed the interconnectedness of these two priorities and the valuable and logical insights that can be gained through the fundamental link between Aboriginal and Torres Strait Islander perspectives and sustainability. Sveiby and Skuthorpe (2006) explain that it would be difficult to argue against Indigenous perspectives in relation to sustainability, “because the period the Australian Aborigines have lived in Australia is immense; they have the longest continuous cultural history in the world” (p. 28). Indeed, scientific findings (Johnson, 1999) now place the first existence of humans in Australia somewhere between 66,000 and 78,000 years ago. This period of extended occupation has enabled Aboriginal and Torres Strait Islander peoples to acquire both comprehensive and site-specific knowledge as well as essential, life-sustaining awareness and understanding of sustainability, all of which is still evident in many communities today.

Bill Gammage powerfully and eloquently captures this understanding in his book, *The Biggest Estate on Earth* (2011). Through examination of Australian historical records, Gammage uncovered a plethora of evidence to proclaim that Indigenous Australians were incredibly adept at sustaining their environment and that, in contrast to popular belief, they were highly proactive in using complex land management practices to do so. Gammage identifies a “strict ecological discipline” (p. 4) that Indigenous Australians followed, and although his work lacks consultation with Indigenous Australians, he advises readers that he did not wish to “interrogate people over so great an area on matters they value so centrally” (p. xv).

In contrast, this chapter has been compiled through collaboration between non-Indigenous and Indigenous educators and elders. It mirrors the call for collaboration to achieve sustainability, pointed to by the editors in the preface of this text. It also reflects the necessary co-authorship in the “decolonizing” (Martin, 2008, p. 54) of collective Indigenous and non-Indigenous voices. Decolonisation is critical for fostering productive collaboration and the sharing of Indigenous peoples’ knowledge “because colonialism is what taught us negative strategies of difference … [and] habits of hierarchy and deference” (Findlay, 2003, cited in Martin, 2008, p. 54). While Martin discusses decolonisation in the context of Aboriginal research, she emphasises its importance at “the individual” as well as “the institutional level” (p. 54) for appropriately leveraging Indigenous peoples’ knowledge. Interestingly, Martin also points to sustainability (p. 55) as a catalyst in the emergence of worldwide recognition for Indigenous knowledges and knowledge systems.

Given that only about two percent of the Australian population identify as being Aboriginal or Torres Strait Islander, most of the audience for this text will be non-Indigenous educators. These statistics highlight a pertinent issue for the many Australian teachers who are non-Indigenous yet tasked with incorporating Indigenous perspectives in the curriculum. In the main, teachers have little, if any, background or knowledge about “how” to go about this important work. When it comes to educational practice for sustainability that takes account of Indigenous perspectives, many non-Indigenous teachers would likely rate themselves as relatively low in relation to awareness and understanding of what to do, let alone how to do it in an authentic and appropriate way. Recently, when reporting on sustainability education in relation to the Australian Curriculum, the Australian Education for Sustainability Alliance (2014, p. 14) stated the finding from its research that teachers generally exhibit “considerable lack of awareness and comprehension of sustainability as a cross-curriculum priority” much less the ability to also incorporate Aboriginal and Torres Strait Islander perspectives, especially those reflecting contemporary Aboriginal and Torres Strait Islander peoples. The alliance also listed limited curriculum resources, limited teacher professional development, and lack of pre-service programmes as contributing to teacher inability to attend to the sustainability priority.

Why is EfS incorporating Indigenous Australian perspectives important?

While EfS incorporating Aboriginal and Torres Strait Islander perspectives is about a philosophy and practices that promote sustainable environments, it is also much, much more than that. It is actually about a way of life; a way of knowing, doing and being that helps preserve Indigenous culture and language. It consequently makes clear that preservation of Indigenous culture and language is inextricably linked to sustaining the environment as well as sustaining connection to "place", and thus supports teachers and students to gain deeper insights into the unique cultural practices of Aboriginal and Torres Strait Islander peoples.

An example of this link is seen in *Treading Lightly: The Hidden Wisdom of the World's Oldest People*, where Tex Skuthorpe, as co-author, explains that the mission for his people, the Nhunggabarra, is to "sustain the earth (the plants as well as the rocks and soil), to keep the totems alive (the animals), and, last but not least, to sustain the mob (to keep the Nhunggabarra alive)" (Sveiby & Skuthorpe, 2006, p. 8). Australia's Indigenous peoples have long understood the imperative of educating for sustainability. As Skuthorpe suggests, it is integral to their survival and the survival of them and their culture. It is quintessential to their hunter-gatherer-cultivator (Keen, pp. 94–96) heritage, the preservation of traditional lands, flora and fauna through proactive land management techniques, and the preservation of cultural practices through intuitive and elaborate storying and dance.

For many Aboriginal and Torres Strait Islander peoples, their identity is closely tied to their country and its ecology and weather. The intricate and sustained adherence to totems across Indigenous Australian culture reflects life-sustaining cultural practices established over time. For example, an animal or bird may represent a person or a highly significant message. Importantly for sustainability education, "totems work as ecological alliances" (Gammage, 2011, p. 136) that help maintain biodiversity. In addition, Gammage's findings show that "Totems make clear how basic to the unity of creation an ecological perspective is" (p. 137). For example, where the totem has a physical form, touching, harming or killing it is prohibited, so caring for and nurturing the environment in which it is found is essential.

Given that traditional Indigenous groups criss-crossed the Australian landscape, it is not difficult to imagine how wildlife and fauna survived and, indeed, thrived because of these groups' adherence to the cultural practices associated with totems. For Aunty Vera Sullivan, co-author of this chapter, a sighting of the Bal Jan Mono (owl), her totem, is regarded as a powerful messenger signal that cannot be ignored, even though it is often associated with the arrival of bad news, such as the death of a family member.

In the introduction to *Treading Lightly*, Skuthorpe offers further insight into Indigenous Australians' unique relationship with the environment and the importance of sustaining that environment. Skuthorpe tells the reader that his people do not have a word for knowledge and do not need one. "Our land", he explains, "is our knowledge, we walk on the knowledge, we dwell in the knowledge … Everything is knowledge" (Sveiby & Skuthorpe, 2006, p. xv). And yet, regardless of not having a word for knowledge, the Nhunggabarra (like their fellow Indigenous Australians) and their model for sustainability are soundly predicated on a knowledge-based economy (p. xvii). Aboriginal and Torres Strait Islanders' traditional knowledge of their environment, their understanding of the interconnectedness of all things as well as of the principles underpinning successful social structures and the levels of complexity within their societies have much to teach us about educating for sustainability.

So, how do teachers go about this important work?

Teacher capacity to develop and implement embedded Indigenous perspectives across the curriculum can be considered along a continuum: from uninformed or naïve practice involving very little or no consultation with Indigenous peoples, to informed consultative and collaborative practice. Often, the focus of practice is only on the past, given that Indigenous perspectives were (are) "covered" largely in history or social studies curriculums. As such, this historical lens has given rise to stereotypical imagery of traditional life in the interior of the country, and might, for example, include images of an Aboriginal man standing on one leg in the middle of nowhere or of another man about to throw a spear or boomerang!

We have all seen those images and others portraying similar times. But Aboriginal and Torres Strait Islander peoples are very much part of 21st-century Australia and should be represented as participating to and contributing across all facets of contemporary society. The journey towards more informed and ongoing contextualised practice, involving consultation with elders and local community members begins as the teacher becomes aware of the "multiplicity of perspectives that are the reality of Australian classrooms" (Bull, 2008, p. 4). Prioritising development of "cultural competence" (Centre for Cultural Competence Australia, 2013) in teaching and learning will be the starting point that enables teachers to move onward to a more highly evolved practice as the "culture broker" (Aikenhead, 2001) in the classroom, facilitating, for example, "student movement between contemporary Science understandings and their cultural ways of knowing" (Sammel & Waters, 2014, p. 1245).

Developing intercultural understanding is one of the seven general capabilities identified in the Australian Curriculum deemed necessary to support students' ability to be part of a society that is "cohesive and culturally diverse, and that values Australia's Indigenous cultures' (MCEETYA, 2008, p. 4). The Australian Curriculum (ACARA, 2014) states that "students develop intercultural understanding as they learn to value their own cultures, languages and beliefs, and those of others … [and that] intercultural understanding is an essential part of living with others in the diverse world of the twenty-first century". Intercultural understanding moreover, according to the curriculum, assists students "to become responsible local and global citizens, equipped through their education for living and working together in an interconnected world".

What is missing in the Australian Curriculum is the support that teachers need to help them recognise where their practice sits in relation to intercultural understanding. The continuum diagram (Figure 14.1) aims to guide teachers with the first vital step towards developing "critical consciousness" (Phillips & Lampert, 2005) and their own intercultural understanding. Becoming "critically conscious" goes beyond focusing on resources and the what; it is, as we have kept emphasising, about discerning and implementing the how, which includes personal reflection on attitudes towards others and establishing respectful relationships. As John Bradley (2010, p. 24) found when he went to work as a "yet-to-be-tried school teacher of twenty" in an Aboriginal community in 1980, "sustained ignorance was not always a good position to work from". Bradley learned that although ignorance of

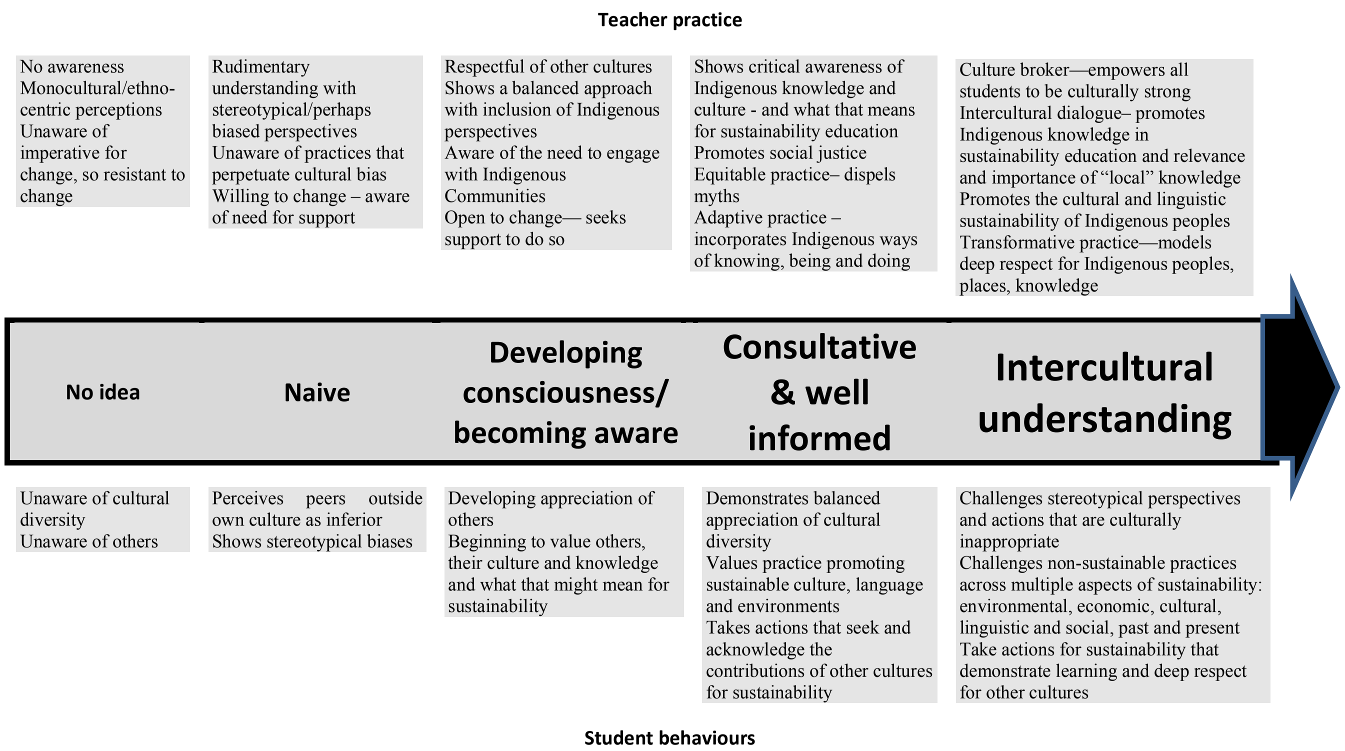

Figure 14.1. Continuum of teacher practice: Aboriginal and Torres Strait Islander perspectives in education for sustainability.

Yanyuwa culture was not entirely unacceptable because it also meant "having the potential to learn and to know", he importantly recognised there was also the expectation that learning would be pursued! Similarly, it is the responsibility of all educators (as professionals) to seek out genuine, meaningful relationships with local Aboriginal and Torres Strait Islander peoples where and when possible so as to authentically explore the potential and significance of Indigenous perspectives across the curriculum, as well as for sustainability education.

While development of the curriculum has occurred at the national level, responsibility for supporting its implementation in schools, including associated policies and resources, falls to state and territory governments and so varies widely across the states, territories and educational sectors. Some state and territory education authorities develop curriculum planning materials for schools; others rely on frameworks targeting specific curriculum components and/or initiatives. In conjunction with other educational organisations, each authority might also develop resources targeting specific learning areas or components of the curriculum. Some resources are available and used Australia-wide while others are exclusive to particular states, territories or sectors; thus, multiple approaches are used across the Australian educational landscape.

Given this variance, the steps within the following suggested resources is an approach that teachers throughout Australia might take to evolve their practice towards intercultural understanding and dialogue. This development is important because "the world's cultural wealth is its variety in dialogue. While each culture draws from its own roots, it must not fail to blossom when crossing other cultures" (UNESCO, 2012b).

Resources and useful sites

Getting on board

- A good starting place is the "share our pride" tab on the Reconciliation Australia website. It includes comprehensive, interactive information and resources that provide an excellent introduction to Aboriginal and Torres Strait Islander cultures. The site also explores how fortunate Australia is in having some of the "richest and oldest continuing cultures in the world". It is an ideal way to begin exploring the link between Indigenous knowledge and sustainability. The site also includes a guide to Aboriginal and Torres Strait Islander cultural protocols produced by Oxfam Australia, which can be downloaded at http://www.reconciliation.org.au/raphub/wp-content/uploads/2013/03/respect-aboriginal-and-torres-strait-islander-protocols-oxfam-australia.pdf. The document provides a comprehensive guide to consultation protocols and emphasises that "Aboriginal and Torres Strait Islander cultures are complex, dynamic and evolving … [which means that] consultation needs to take place on a case-by-case and ongoing basis" (p. 2). The document furthermore includes guidelines for visiting Aboriginal and Torres Strait Islander communities and lists key national community events.
- *Treading Lightly: The Hidden Wisdom of the World's Oldest People* is a book that has been described as a "signpost" with the potential to help contemporary leaders embed sustainability across all facets of education and business. Information about the book, the authors, the Nhunggabarra approach to sustainability and "walking the learning tracks" of these Aboriginal people can be found on the website http://treadinglightly.sveiby.com/index.html

– Digital resource repositories (e.g., Scootle) and state education departments' webpages may offer locally relevant resources. Western Australia, for example, has an Aboriginal Perspectives across the Curriculum (APAC) site available at http://www.det.wa.edu.au/aboriginaleducation/apac/detcms/navigation/lesson-plans/. Other states offer similar initiatives.

Getting going

– *Living Knowledge* is a comprehensive web resource developed as part of a research project looking at Indigenous knowledges and western science. It is an ideal way for you and your students to engage with Indigenous perspectives focused in particular on land and sea management practices. The site includes resources and links to information as well as research and is suitable for teachers, students and others: http://livingknowledge.anu.edu.au/index.htm
– The *8 Aboriginal Ways of Learning* website is a New South Wales Department of Education and Communities initiative based on Tyson Yunkaporta's "Eight Ways" (2009). The website discusses *8 Ways* as a framework that teachers can use "to start the process" of incorporating Aboriginal perspectives through "Aboriginal learning techniques … [since] Aboriginal perspectives are not found in Aboriginal content, but Aboriginal processes".
– The *Twelve Canoes* website and study guide by Robert Lewis (http://www.12canoes.com.au/downloads/studyguide/Twelve_Canoes_Study_Guide.pdf) is a visually stunning online resource with audiovisual clips, photographs and stories that "together paint a compelling portrait of the people, history, culture and place of the Yolngu people". The site explains that while *Twelve Canoes* concerns the Yolngu people of Arnhem Land, it can be used to support teachers' and students' engagement with and understanding of all Australia's Indigenous peoples. The site is divided into 12 sections to facilitate exploration of the use and management of Arnhem Land by the Yolngu and local non-Indigenous people and tourists. The site thus demonstrates the integral link between Indigenous knowledge and sustainability.
– The Primary Connections programme developed by the Australian Academy of Science includes Indigenous perspectives across a suite of science curriculum resources for Australian primary schools. The resources provide examples of ways that teachers can embed Aboriginal and Torres Strait Islander perspectives relevant to particular aspects of science. For example, in the Plants in Action unit, students consider how centuries of living on the land have provided Indigenous Australians with a deep and ongoing knowledge of Australian plants, including their use for food, medicines, utensils and shelter. In addition, Primary Connections provides a dedicated Indigenous perspectives website that includes a framework to support teachers' awareness and understanding of Aboriginal and Torres Strait Islander perspectives in the curriculum. The website also includes links to research and a DVD titled *Connecting Minds* that features teaching science in primary classrooms in Western Australia in a way that embeds Indigenous perspectives. There is also a professional learning programme for both pre- and in-service teachers. The Indigenous perspectives resources are accessible through the member section of the website at https://www.primaryconnections.org.au/member, which is free to join.

– Information on cross-cultural awareness workshops that provide an introduction to Uncle Ernie Grant's holistic planning and teaching framework along with various other resources and helpful information are provided on the Ingan education and training website (http://www.ingan.com.au/cross-cultural-awareness). Uncle Ernie Grant, an elder from the Jirrbal tribe in North Queensland, helped to introduce the Aboriginal and Torres Strait Islander Curriculum in Queensland schools. His approach has been highly beneficial, resulting in his educational philosophy and framework now being used all over Australia (see http://www.issutest.net.au/framework/framework.swf). According to discussion on the website, Aboriginal communities have become "increasingly aware of their place in a globalised world, in which their cultural knowledge can play an important role as a resource, not only for the maintenance of local identities, but also as a vehicle for intercultural exchange as well as the generation of creative solutions to modern problems, including environmental sustainability".
– Seasonal calendars developed by CSIRO in collaboration with six Aboriginal language groups from across northern Australia show how "Indigenous ecological knowledge can tell us much about the ecology of northern Australia". The calendars are an ideal way to discover how Aboriginal knowledges, past and present, are helping to inform "scientific understanding of patterns of aquatic resource use and relationships between people, subsistence use and river flows in northern Australia". To find out more about these quality resources, visit the CSIRO website: http://www.csiro.au/Organisation-Structure/Divisions/Ecosystem-Sciences/Indigenous-seasonal-calendars.aspx.

Gaining traction

– The *Oodgeroo Unit* at Queensland University of Technology provides information and activities relating to Aboriginal and Torres Strait Islander education, studies and research. The unit is focused on supporting the inclusion of Aboriginal and Torres Strait Islander knowledges and perspectives in schooling. It recommends making connections with the Aboriginal and Torres Strait Islander community as the "key to successfully embedding Aboriginal and Torres Strait Islander knowledges and perspectives in schools and classrooms". The Oodgeroo Unit also provides a website with links to national programmes, frameworks, units of work and classroom resources that support both pre- and in-service teachers. It can be accessed at https://www.qut.edu.au/about/oodgeroo.

Developing deeper understanding

– An article in the journal *Creative Education* (which can be downloaded from http://www.scirp.org/journal/ce) by Alison Sammel and Marcus Waters, both educators at Griffith University in Queensland, explores how dialogue and interdisciplinary practice with their students helped them in their journey towards more culturally equitable education, especially in terms of reducing the privileging of some students and marginalising of others. Sammel and Waters wrote the article as a dialogue so as to share their developing understanding of the power of dialogue to generate deeper understanding and new knowledge. They discuss culturally inclusive teaching practice that engages students in "cultural and intellectual exchange" and provide insight into how this dialogue has contributed positively to all of their students (e.g., "culturally stronger" and "more aware of an ever-changing world around them").

CONCLUSION

This chapter has provided discussion on the importance as well as the potential of Indigenous knowledges in relation to education for sustainability. In it, we have considered not only the benefits of helping to "sustain" Indigenous knowledges, languages and cultures for all citizens but also the necessity of bringing an embedded approach to this, in order to develop teachers' and students' intercultural understandings in relation to sustainability. Since "According to indigenous law, humankind can never be more than a trustee of the land, with a collective responsibility to preserve it" (Activity Four: A spiritual relationship with the land, UNESCO, 2010), teachers and teacher educators need to play a leading role in enhancing the intercultural awareness required to affirm and value the role of Indigenous knowledges in maintaining the sustainability of biodiversity and ecological systems, as well as human communities.

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Willi Willi woman

JULIE KENNELLY AND SUE ELLIOTT

15. SUSTAINABLE GARDENING ACROSS THE CURRICULUM

Making it Happen

It is impossible for a child to work [in a] garden without tuning himself to certain universal laws … while he is grubbing in the earth, stirring the soil untiringly so as to let in the moisture and the air, nature's secrets are sinking deep into his heart.

(Williams, *Gardens and Their Meaning*, 1911, p.7)

INTRODUCTION

In this chapter we describe some of the reported benefits of food growing at school, linking food growing to the purposes and content of the Australian and New Zealand Curriculums. We also provide examples of ways in which classroom teachers can use the garden as a teaching resource not only in a cross-curricular way but also in a manner that explores the Australian Curriculum conceptualisation of *sustainability*, the New Zealand curriculum principle of *future focus*, and the value of *ecological sustainability*. Beyond the scope of this chapter is information about how to grow food plants, how to organise the development and use of the food garden as a shared school resource, and how to link the garden to kitchen activities. These latter aspects are well explained in a number of practically oriented resources that include the *Kitchen Garden* website (State of New South Wales, 2012), the *Campaign for School Gardening* (Royal Horticultural Society, 2008a), *Asphalt to Ecosystems: Design Ideas for Schoolyard Transformation* (Gamson-Danks, 2010) and *Kids Grow: Munch and Crunch Garden* (Woodrow & Tyas Tunggal, 2011).

Food growing has become increasingly popular in Australian and New Zealand primary schools. In Australia, this popularity has in some part been fuelled by the Stephanie Alexander Kitchen Garden Programme (Yeatman et al., 2012), which has funded participating primary schools to establish food gardens as well as kitchen facilities and has required related cross-curricular teaching and learning. The New South Wales state government funded a similar programme as a pilot and reported many comparable findings (see State of New South Wales, 2013). In particular, students said they enjoyed participating in gardening activities and had developed a sense of pride and ownership through this opportunity. Teachers said they had noticed high levels of engagement amongst students during the activities. They also said students were showing greater respect for one another and for community volunteers and were meeting specific learning objectives across their learning areas (LAs). The report also noted that teachers had been successful in incorporating gardening activities relevant to all LAs into their teaching. Especially important were the findings that students had greater respect for the school environment and that parents and the

N. Taylor et al. (eds.), Educating for Sustainability in Primary Schools, 323–343.

community had increased their support for and participation in school activities as a flow on from their involvement in the kitchen garden programme. The report, available from the kitchen garden website (www.kitchengardens.det.nsw.edu.au), includes sections for teachers and for students and also offers abundant links to useful resources for teachers.

Not all Australian and New Zealand primary schools with food gardens are participants in funded programmes such as those described above. In the United Kingdom, an independent report on the Royal Horticultural Society programme *Campaign for School Gardening* (Passy, Morris, & Reed, 2010) identified that school-based gardening is not necessarily associated with food preparation Although the schools in this programme received resources in the form of excellent professional learning for teachers, web support and a few physical items, there was no funding for garden establishment. Nevertheless, these schools reported positive cognitive, affective, behavioural and social outcomes. Affective outcomes included enhanced student self-esteem, motivation, confidence and resilience, with students taking greater care of school grounds, with that care presumably arising out of pride in the garden and out of the calm environment it induced. Studies with pre-school children report that experiences in gardening support opportunities for these children to develop a sense of wonder about the world, construct understandings about their role in caring for the environment and develop early skills in literacy, mathematics and science as well as initiative and self-confidence (Miller, 2007). The report by Passy et al. (2010) noted above also offers detailed advice on establishing and using the garden as a whole-school enterprise, while the Royal Horticultural Society website provides abundant information to assist with garden design, teaching and learning activities, and more (Royal Horticultural Society, 2008b).

EXAMPLE

Rachel Carpenter, a teacher at Valentine Public School in NSW, when reporting on the Outdoor Learning Garden Area (OLGA) project in her school, had this to say: It has been a very rewarding project that I am so proud to be involved in. OLGA Duty is one of my favourite times of the day. We head off into the garden where students can get their hands dirty. This opportunity has given them the chance to interact with all children across the school, including interested infants students. They learn to co-operate, share equipment, be team players and most of all they learn to care and appreciate the environment. The OLGA has been a very successful project that has brought the school community more closely together and is a valuable learning tool for lifelong healthy eating, recycling and sustainability. (Carpenter, 2014, pp. 3–4)

From a health and nutrition perspective, one particularly encouraging outcome from the study by Passy et al. (2010) was schools reporting that their children were more willing to try new vegetables as part of their diet. Similarly, parents in a Danish study of a primary school gardening programme noted their children's increased knowledge of vegetables, interest in food preparation at home and healthy eating (Wistoft, 2012). During her outreach gardening study with youths 10 to 14 years of age, Libman (2007) documented changes in eating and nutrition, such as enjoying raw vegetables, appreciating the value and freshness of organic, home-grown food and exercising agency in cooking family meals. These are all welcome changes in an era of growing concern about childhood obesity and its potential long-term health implications. They also provide further impetus for integrating gardening into school programmes and as part of whole-school approaches to sustainability.

EXAMPLE

Stories from staff, students and parents involved in the edible gardening programme conducted in South Island schools in New Zealand

From the parents

"They never, ever before ate vegetables. Now they are learning from school, and they are eating it".

"Kids enjoy so much that they have helped achieve something that they will have no problem with eating veg and fruit".

"It [gardening] encourages a work ethic, participation, patience, persistence, self-esteem, independence and knowing they can make something happen. They learn that they can have a positive impact on others and the environment".

From the students

"We've learnt to share and take turns … we all together share the garden".

From the teachers

"The garden provides a great opportunity to re-establish in kids the habits and skills of self-sufficiency from the past which have been lost now that everything is in a packet. In this way children are learning that you can grow and make your own food and that you don't have to buy it. It also tastes better!"

"Working together, sharing gardening tasks, requires a lot of interaction … talking, negotiation and being aware of each other's needs … they have to work out how to fill a wheelbarrow with soil without getting in each other's way and throwing soil everywhere".

"It is easy to link the garden with teaching … it's common sense, natural. It's hands-on and outdoors; you go out and do things in the garden and then come back and write it up, or use it in maths. It's a natural way to teach".

SI District Health Boards' evaluation of edible gardens in education settings (final report May 2011): http://www.rph.org.nz/content/9f679791-c587-45e0-a968-180264657346.cmr

The significance of food growing in school is that it is, of itself, an enactment of a more sustainable way of living. Through the curriculum, and in association with gardening, students have opportunity to learn not only about sustainability and their connections to the natural, economic and social worlds, but also how to design and manage for improved sustainability in an applied way. Teachers across all year groups are able to exploit garden activity for curriculum-related purposes. In some schools, the food garden is but one focus in a whole-school approach towards sustainability (Henderson & Tilbury, 2004).

SUSTAINABILITY IN THE NEW ZEALAND AND AUSTRALIAN CURRICULUMS

One of the underlying principles of the New Zealand Curriculum is “focus on the future”. Guided by this principle, students explore the long-term impact of social, cultural, scientific, technological and economic practices on society and the environment (New Zealand Ministry of Education, 2007). Furthermore, in this curriculum, *ecological sustainability*, which includes *care for the environment*, is one of a number of values to be encouraged and modelled by the school and explored by students. In New Zealand, schools can decide to organise their curriculum around one of three aspects: values, key competencies or learning areas. There is an expectation that those two aspects not chosen as central to curriculum organisation will be woven throughout the school’s programmes. Leaving values as a “standalone entity” suggests that this aspect is seen as highly important because it means that the school has the option to organise its curriculum entirely in relation to particular values that include ecological sustainability. Values such as this one would then be evident in the school’s philosophy, structures, classrooms and relationships (New Zealand Ministry of Education, n.d.-a)

The notion of sustainability expressed in the Australian Curriculum is outlined in Chapter 2 of this book and described in more detail through the curriculum’s 10 organising ideas (Australian Curriculum and Reporting Authority [ACARA], 2014b). In this current chapter, we draw upon three of these ideas (design and management, interdependence, and action; see Table 15.1) to illustrate how pertinent use of the curriculum can establish food gardening as a conduit for learning to live more sustainably.

Education for sustainability (EfS) in New Zealand also incorporates key concepts, two of which are interdependence and responsibility for action. The New Zealand Ministry of Education (n.d.-a) positions education for sustainability as learning to think and act in ways that will safeguard the future well-being of people and the planet. The aspirations of these curriculum documents align well with Kemmis (2009), who proposes that sustainability is about thinking, acting and relating differently rather than simply implementing a few sustainable practices.

Table 15.1. Some of the organising ideas that reflect the essential knowledge, understanding and skills for the cross-curriculum priority “sustainability”.

Organising idea	*Amplification of the idea*
Interdependence	All life forms, including human life, are connected through ecosystems on which they depend for their well-being.
Design and management	Products, built systems and environments can be designed and/or managed to improve both people’s well-being and environmental sustainability. In this way, sustainable futures are shaped by our behaviours and by the products, systems and environments we design today.
Action	Sustainability action is designed to intervene in ecological, social and economic systems in order to develop more sustainable patterns of living.

Note: The organising ideas are embedded in the content descriptions and elaborations of each learning area in the Australian Curriculum (ACARA, 2014b).

LINKING SUSTAINABILITY, LEARNING AREAS AND ORGANISING IDEAS

The selected organising ideas noted above can be applied to food gardening activities at school for the purpose of exploring sustainability. The following tables present a selection of LA curriculum content descriptions and associated elaborations particularly relevant for promoting conceptualisations of sustainability. The elaborations in each content description illustrate the kinds of activities teachers can choose in order to explore the content. These selections are by no means exhaustive. Gardening activities are relevant across much of the Australian and New Zealand Curriculums, with garden experiences potentially linked to skills in every LA, thereby expanding learner conceptualisations of sustainability. We begin this section with an amplification of three selected sustainability organising ideas, namely interdependence, design and management, and action. All three are supported by the tables.

Organising idea: Interdependence

This idea is a thread strongly woven through the two countries' science curriculums and can readily be explored through gardening. Interdependence is about the intimate links between each living thing and the biotic (living) and abiotic (non-living) contexts within which it survives, taking what it needs from its surroundings and contributing in some way to those surroundings. Thus, the interdependence of life references the notion that all life, including human, relies on healthy ecosystems. This notion can be primarily, but not exclusively, developed through science. Table 15.2 provides Australian Curriculum science content understandings and New Zealand Curriculum achievement objectives that expand on this notion. The elaborations in the table encompass activities relevant to school gardens.

Organising idea: Design and management

The garden is a built system, the development and use of which can contribute positively to human well-being and environmental sustainability. Contributions of school food gardening to human well-being include the social benefits reported above as well as student willingness to taste a wider range of vegetables and fruits as their interest in food and nutrition develops through growing their own plants (Passy et al., 2010). The school food garden is a system of production which, assuming careful infrastructure design (e.g., an efficient watering system), can represent a shift towards more sustainable living. Similarly, well-designed systems, such as composting organic waste for use in soil enrichment, represent a more sustainable practice than transporting waste to landfill. It, too, is a step towards a more sustainable future.

EXAMPLE

A student story from Doveton North Primary School, Victoria, Australia

Students have learnt how to grow fruit and vegetables. They have learnt how to test the soil and plant from seeds. They have learnt garden safety. They have learnt how to manage the garden in environmentally sustainable ways … These experiences are captured in each class's garden diary. (Smith, Wheeler, Guevara, & Fein, 2012, p. 32)

Table 15.2. Notion of interdependence of life evident in Australian and New Zealand science curriculums and indication of how this notion can be encapsulated in gardening activities.

Content	*Elaboration*
ACSSU004: Daily and seasonal changes in our environment, including the weather, affect everyday life. **NZ Science, Level 4:** **Ecology** Explain how living things are suited to their particular habitat and how they respond to environmental changes, both natural and human-induced.	• Investigate how changes in the weather might affect animals such as garden creatures. • Investigate how seasonal and diurnal weather changes affect plants and their growth.
ACSSU211: Living things live in different places where their needs are met. **NZ Science, Level 4:** **Ecology** Explain how living things are suited to their particular habitat and how they respond to environmental changes, both natural and human-induced.	• Explore different habitats within the garden, recognising that different living things live in different places such as above and below the soil, under leaves, on stems, in moist cracks, on trees. • Explore what happens when habitats change and some living things no longer have their needs met (e.g., some plants may fail as other plants smother them, excluding the light).
ACSSU072: Living things have life-cycles **NZ Science, Level 4:** **Life processes** Recognise that there are life processes common to all living things and that these occur in different ways. **Evolution** Begin to group plants, animals, and other living things into science-based classifications. Explore how the groups of living things we have in the world have changed over long periods of time and appreciate that some living things in New Zealand are quite different from living things in other areas of the world.	• Group plant foods as fruit, leaf, root, flower, seed, stem. Identify fungi as food plants that are not flowering plants. Identify the life-cycle stage of each plant food • Make and record observations of living things (herbs, vegetables, fruit trees, pollinators, predators, weeds) as they develop through their life-cycles • Collect seed or allow self-sown seed to grow to perpetuate life-cycles • Describe the stages of life-cycles of living things in the garden such as butterflies, wasps, lizards, snails, aphids, vegetables, herbs, weeds. • Compare life-cycles of animals and plants. • Investigate how environmental factors can affect life cycles (e.g., low temperatures or dry conditions can delay germination or cause death; dry conditions can precipitate flowering and seed set; damp can precipitate growth of fungi).

Table 15.2. Notion of interdependence of life evident in Australian and New Zealand science curriculums and indication of how this notion can be encapsulated in gardening activities (contd.)

Content	*Elaboration*
ACSSU073: Living things, including plants and animals, depend on each other and the environment to survive. **NZ Science, Level 4:** **Ecology** Explain how living things are suited to their particular habitat and how they respond to environmental changes, both natural and human-induced.	• Investigate how plants provide shelter for animals. • Investigate the roles of living things in a garden habitat, for instance, producers, consumers or decomposers. • Observe and describe predator–prey relationships. • Predict the effects when living things in feeding relationships are removed or die out in an area (e.g., removal of snails). • Recognise that interactions between and among living things may be competitive or mutually beneficial (e.g., competition for light, invertebrate pollination, predation by frogs, lizards and birds, corn plants supporting pumpkin stems, companion plants).
ACSSU094: The growth and survival of living things are affected by the physical conditions of their environment. **NZ Science, Level 4:** **Ecology** Explain how living things are suited to their particular habitat and how they respond to environmental changes, both natural and human-induced.	• Investigate how changing the physical conditions for plants (e.g., adding salt water, using fertilisers, different soil types, addition or removal of mulch, shading, grey water) affects their growth and survival. • Observe the growth of fungi, such as mushrooms, or of alfalfa sprouts in a jar under different conditions.

Through practising food gardening, students experience more sustainable options than those posed through our familiar commercial systems of food production, storage, processing, distribution and marketing. Gardening at school is an opportunity for students to learn that their everyday human decisions (about how we use living and non-living elements of landscape, what we purchase, how we use energy and water) affect near and distant living things and landscapes into the future. As an example, the way in which we manage waste constitutes a system. In some communities, as volumes of waste increase, management systems are being continually altered towards more sustainable outcomes. In particular, many local government authorities are seeking more sustainable outcomes through recycling and reuse. Less prominent is the far more effective strategy of waste reduction via reduced purchasing and consumption, localisation through shortened production and consumption chains, and reconsidered packaging.

The aim of EfS is for people to think and make decisions with sustainability in mind, but the efficacy of that thinking depends on knowledge of connections between and among life forms, and of the present and future impacts of alternative decisions and actions that people may take.

Learning to think with sustainability in mind is a kind of meta-cognition. In a practical sense, it means, first, being consciously aware of the connections: the effects of decisions about actions, including what to eat and how to prepare food, what transport to use, how to clothe oneself, which energy sources to use, and then using that awareness to make choices in favour of a more sustainable environment for present and future generations of living things (Payne, 1995). This knowledge of the environmental connectedness and future consequences of human activity not only underpins the ethical notion of intergenerational equity (Australian Government Department of Environment and Heritage, 2005), but also characterises the intent of the Australian and New Zealand Curriculums and the views therein of sustainability. To align these different ways of thinking and acting with the curriculums, we offer, in Table 15.3 possibilities underpinned by the design and management and action organising ideas in the LAs of geography, English, science and mathematics. The elaborations offered expand upon the notions of sustainable design and management as well as action for sustainability. Again, they are illustrative and so in no way exhaustive.

Table 15.3. Elaborations relevant to school gardens of the Australian Curriculum LA content understandings and New Zealand Curriculum achievement objectives.

Learning area	*Content*	*Elaboration*
Geography		
Geographical inquiry and skills (reflecting and responding)	**ACHGS032:** Reflect on their learning to propose individual action in response to a contemporary geographical challenge and identify the expected effects of the proposal. **NZ Social Studies, Level 4:** *Students will gain knowledge, skills and experience to:* • understand how people participate individually and collectively in response to community challenges; • understand that events have causes and effects; • understand how producers and consumers exercise their rights and meet their responsibilities; • understand how formal and informal groups make decisions.	The relevant contemporary geographical challenge could be the impact of fossil fuel use on the capacity of the atmosphere to absorb carbon emissions or the capacity of community facilities to absorb waste. • Discuss what they have learned about (i) contemporary food production through the chain from farm to household, (ii) imported and locally produced food; and (iii) about different views related to the sustainability of food-production systems (Choice, 2008). • Explain ways in which localised food growing could contribute to social, economic and environmental sustainability. • Propose a range of different actions that could be taken, for example, with reference to their home, community or school. (This may be a proposal to start a school food garden or a proposal to change systems used in an existing food garden.) • Propose possible actions that could be taken to promote awareness about how people can reduce their impact on the environment through home gardening. • Undertake the proposed actions.

Table 15.3. Elaborations relevant to school gardens of the Australian Curriculum LA content understandings and New Zealand Curriculum achievement objectives (contd.)

Learning area	*Content*	*Elaboration*
Geography (contd.)		
Geographical knowledge and understanding	**ACHGK024:** The natural resources provided by the environment, and different views on how they could be used sustainably.	• Identify some of the resources produced by the environment and where they come from, for example, food, fibres, timber, plastics and metals that form the things used in the garden. • Investigate water as an essential resource for plant growth requiring ongoing sustainable usage in various ways from timed watering to mulch, more drought-tolerant plants and recycled water. • Identify, compare and evaluate in terms of sustainability a range of tools used to perform similar garden tasks • Find out how many different items are used to produce one commercially processed food product and where those items come from.
Geographical knowledge and understanding	**ACHGK025:** The sustainable management of waste from production and consumption. **NZ Social Studies, Level 4:** Students will gain knowledge, skills and experience to: • understand how people participate individually and collectively in response to community challenges; • understand that events have causes and effects; • understand how producers and consumers exercise their rights and meet their responsibilities.	• Design and implement a system for collecting organic waste at school. • Describe how natural processes can break down and recycle some wastes safely, for example, through composting and worm farming. • Use a consequences wheel to imagine the multiple effects of ever increasing volumes of waste. • Investigate and describe the local system of waste management, including landfill and community-based recycling, reusing and composting. How does home food production affect the community waste stream? • Compare and explain how composting is a more sustainable way of managing waste than alternative systems; include reference to the principles of reduce, reuse, recycle and replace. • Investigate, describe and critique local management of waste water and storm water. How might food gardening impact on local water management?

Table 15.3. Elaborations relevant to school gardens of the Australian Curriculum LA content understandings and New Zealand Curriculum achievement objectives (contd.)

Learning area	*Content*	*Elaboration*
Geography (contd.)		
Geographical inquiry and skills	**ACHGS030:** Interpret geographical data to identify distributions and patterns and draw conclusions.	• Interpret the data presented in picture, line, bar or column graphs, for example, information collected from a survey about waste produced in the school or students' homes. • Investigate the origins of commonly grown vegetables (Harrison, 2011) and illustrate this information on a map. What conclusions can be drawn? • Interpret graphics of climatic variation as found on seed packets to determine optimal planting times and plant species.
English		
Interpreting, analysing, evaluating	**ACELY1692:** Use comprehension strategies to build literal and inferred meaning to expand content knowledge, integrating and linking ideas and analysing and evaluating texts. **NZ English: Listening, reading, and viewing, processes and strategies, Level 4:** Students will: • integrate sources of information, processes, and strategies confidently to identify, form, and express ideas. INDICATOR: • integrates sources of information and prior knowledge confidently to make sense of increasingly varied and complex texts.	• Read and view a variety of texts from gardening publications and electronic media through to seed packets so as to gain required information about food growing (Australian Broadcasting Commission, n.d.; Royal Horticultural Society, 2008b).

Table 15.3. Elaborations relevant to school gardens of the Australian Curriculum LA content understandings and New Zealand Curriculum achievement objectives (contd.)

Learning area	*Content*	*Elaboration*
English (contd.)		
Creating texts	**ACELY1694:** Plan, draft, publish informative, persuasive texts containing key information and supporting details for a widening range of audiences, demonstrating increasing control over text structures and language features. **NZ English: Speaking, writing, presenting processes and strategies, Level 4:** Students will: • integrate sources of information, processes, and strategies confidently to identify, form, and express ideas. By using these processes and strategies when speaking, writing, or presenting, students will, with respect to: *Purposes and audiences* • show an increasing understanding of how to shape texts for different purposes and audiences.	• Create maps, labels, records, diaries, diagrams and flow charts to inform management of the garden. • Create texts to inform others about garden activities and to persuade others to join in with gardening and composting activities. • Create reflective works (e.g., narratives) about engaging with gardening, drawing on a range of perspectives (e.g., grandparents, parents, neighbours, peers, siblings).
Responding to literature	**ACELT1609:** Present a point of view about particular literary texts using appropriate metalanguage, and reflecting on the viewpoint of others. **NZ English Listening, Reading, and Viewing Ideas, Level 4:** Students will: • show increasing under-standing of ideas within, across, and beyond texts.	• Respond to literary texts containing food-growing themes. • Reflect upon and compares the viewpoint of the various authors of and characters in these texts. *Note:* Examples of useful texts can be found in the resources section at the end of this chapter.

Table 15.3. Elaborations relevant to school gardens of the Australian Curriculum LA content understandings and New Zealand Curriculum achievement objectives (contd.)

Learning area	*Content*	*Elaboration*
English (contd.)		
Responding to literature (contd.)	INDICATORS: • makes meaning of increasingly complex texts by identifying and understanding main and subsidiary ideas and the links between them; • makes connections by thinking about underlying ideas within and between texts from a range of contexts; • recognises that there may be more than one reading available within a text; • makes and supports inferences from texts with increasing independence.	(Same elaborations as on last row of third column on previous page)
Science		
Science understanding: chemical sciences	**ACSSU074:** Natural and processed materials have a range of physical properties. These properties can influence their use. **NZ Science, Level 4, Material World):** Students will, with respect to: *Properties and changes of matter* • Group materials in different ways, based on the observations and measurements of the characteristic chemical and physical properties of a range of different materials.	• Identify and compare properties of materials which are alternatives for a task, for example, varieties of pots, strings, plant supports, walking surfaces, fencing, protection from birds, garden labels, types of mulch, repellents and fertilisers.

Table 15.3: Elaborations relevant to school gardens of the Australian Curriculum LA content understandings and New Zealand Curriculum achievement objectives (contd.)

Learning area	*Content*	*Elaboration*
Mathematics		
Data representation and interpretation	**ACMSP069:** Collect data, organise into categories and create displays using lists, tables, picture graphs and simple column graphs, with and without the use of digital technologies. **NZ Mathematics, Level 4, Statistics:** *Statistical investigation* • plan and conduct investigations using the statistical enquiry cycle; • determine appropriate variables and data collection methods; • gathering, sort, and display multivariate category, measurement, and time-series data to detect patterns, variations, relationships, and trends; • compare distributions visually; • communicate findings, using appropriate displays.	• Conduct a class or whole-school waste audit (New South Wales Department of Education and Communities, 2011a) to determine the volume of organic material in the waste stream (New South Wales Department of Environment and Heritage, 2014). • Create displays of these data. • Compare the volumes of organic waste before and after implementation of composting and/or worm farming. • Use displays of data comparisons to inform others of the outcomes of recycling organic waste. • Compare the monetary cost per kilo of eating potatoes either as packet chips or home baked. • Compare the cost of class-made pizza (using some garden herbs and vegetables as well as purchased ingredients) with the cost of ready-made and packaged pizza. • Measure and display data related to weather, plant growth over time, volumes of produce, costs of garden inputs (e.g., seeds and tools), dimensions of different types of seed, and comparative times taken for seed germination.
	ACMSP118: Pose questions and collect categorical or numerical data by observation or survey.	• Pose questions about availability of water, collect data about tank capacity and weekly use, and calculate duration of supply. • Investigate application of different variables (e.g., watering, mulch, manure, sun aspect) to determine optimal local growth conditions.

Beyond the LA content understandings illustrated in Table 15.3, the sixth version of the Australian technologies curriculum (ACARA, 2014a) also affords opportunities for implementing the cross-curricular priority sustainability. Several of the listed content items within the strand "food and fibre production" are especially pertinent to food gardening. An example is the content item "Explore how plants and animals are grown for food, clothing and shelter and how food is selected and prepared for healthy eating". The technologies curriculum also requires students to create designed solutions, using a process made up of six parts: investigating, generating, producing, evaluating, collaborating and managing.

This process could be applied to the development of garden related technologies, with criteria for design evaluation being generated by students and including sustainability. Sustainable solutions are likely to involve reuse or recycling of existing materials, minimal water or energy use, durability, consideration of available labour, and the long-term effectiveness of the solution. In relation to the food garden, students could produce sustainable design solutions for the following everyday problems:

– Filling containers, without spilling, liquids and solids (e.g., pouring worm juice and/or soil into pots, using scoops and funnels);
– Watering without waste (consideration of containers to choose, hose set-ups, routines and responsibilities, individual plant waterers);
– Fertilising without purchasing (composting: compost container designs, designing elements of compost systems such as routines and responsibilities, communication about routines and responsibilities to the whole school, materials collection and storage, and product distribution);
– Eating without waste (of energy, packaging, and inedible garden products such as outer lettuce leaves, corn husks and apple cores);
– Heating and cooling without purchasing (e.g., warm houses or cloches for raising seedlings in early spring, designing shade systems for new transplants);
– Pots without purchasing (design modification and production of reused pots, paper pots, bio-pots); and
– Producing seed-raising mix (materials, sieves, containers).

In addition to these design tasks, students could be involved in overall garden design, which would require them to consider aspect, access, shading, soil, and water availability. They could also design planting schedules. Here, they would need to consider seasonality, plant variety, crop rotation, and companion planting. Other design tasks could focus on sharing garden space across classes in the school, watering routines, garden news promulgation and produce-distribution systems.

Creating designed solutions to garden problems is especially pertinent with respect to sustainability because it involves students in actively seeking ways to make their garden enterprise more sustainable in ecological, economic and social ways. Their enterprise in the present becomes a lens through which they can explore the long-term impact of social, cultural, scientific, technological and economic practices on society and the environment. As noted previously, this future focus is one of the key principles underpinning the New Zealand Curriculum (New Zealand Ministry of Education, 2007).

EXAMPLE

A student story from Port Fairy Consolidated School, Victoria, Australia

After the students have worked in the garden or on other environmental projects, they can post an “environ blog” on the school website; they can take photos and create a personal reflection and a photo story. (Smith et al., 2012, p. 32)

Organising idea: Action

Sustainability learning is very much about action, for example, growing one's own food and eating, sharing or trading it. Frameworks are available to assist teachers to implement teaching and learning that affords actions for sustainability. In New Zealand, the Ministry of Education provides a framework for *action competence*, which is described as students having the ability and willingness to take action on issues that interest them, that is, learning about environmental issues so they can plan and take informed issue-oriented actions (New Zealand Ministry of Education, n.d.-b). Australia also has its Sustainability Curriculum Framework (Australian Government Department of Environment, Water, Heritage and the Arts [AGDEWHA], 2010), while New South Wales schools have available to them a framework for action, which is offered under the name *Sustainability Action Process* (New South Wales Department of Education and Communities, 2011b). Ideas for applying this framework to a garden context can be found in *Kitchen Gardens: Students* (State of New South Wales, 2012) as well as in *Kids Grow: Munch and Crunch* (Woodrow & Tyas Tunggal, 2011).

Sustainability as a cross-curricular priority in the Australian Curriculum is about thinking, decision-making, planning and acting, a process that takes into account the environmental consequences of action. However, many factors, including convenience, monetary and social cost, habit and what is considered acceptable, influence everyday decision-making, with environmental consequences not necessarily taken into account. For this reason, the development of critical analysis of everyday choices and practices precedes action.

The intentional process of analysing a situation (such as contemporary food production systems, water management, waste management, energy use) in terms of sustainability, along with identifying areas of potential improvement and proposing possible actions is outlined at the beginning of Table 15.3 in relation to part of the Australian geography curriculum. A similar process, framed as action competence in New Zealand documents and consistent with the underlying principle of future focus, can be applied to a food gardening enterprise and organised as part of the school's curriculum centred on values, in this case the value of ecological sustainability.

FOOD GARDENING AND A WHOLE-SCHOOL APPROACH TO EFS

The term whole-school approach refers to approaches that broadly embrace the school's curriculum, its management of resources and grounds, and the human relationships within the school and with the broader community.

> Whole-school approaches to EfS aim to critically review practices across the whole life of the school with regard to educating for sustainability. The process of critiquing and changing aspects of unsustainability in a school becomes a focus for teaching and learning. Actions and the associated changes within the school and wider community are a result of investigation, review and participatory decision making, whereby the school becomes an evolving model of sustainability. (Eames, Wilson-Hill, & Barker, 2013, p. 14)

Eames et al. (2013) identify four key areas of school life for critique: *place*, *people*, *programmes* and *practices*. The following “snapshot” illustrates these areas in relation to a food garden.

- The *place* is a food garden that is accessible to the school community. The principles of reuse and recycling are evident in the design of the garden and the materials used. Student interest and ownership are also evident through student-constructed interpretive and creative signs and objects.
- *People* are encouraged to contribute to decision-making as well as to physically support the garden enterprise. The school invites all members of its wider community to take an active interest in the garden, and the contributions of students, teachers, parents and others are celebrated through prominent displays in, for example, school public areas as well as through media releases and special school events, such as vegetable tastings, learning-garden-skills days, and market afternoons.
- Teachers are encouraged to work jointly to construct *programmes* where the scope and sequence of learning across the school years is planned and mapped out in ways wherein the food garden can be formally incorporated into the curriculum (as illustrated in the tables in this chapter). Teachers have opportunities to participate in events that enhance their confidence, knowledge, enthusiasm and skills when gardening with students. Students are invited to express their knowledge and plans for their gardens through assemblies, displays, surveys and grant applications.
- The principles of sustainability are collaboratively determined and applied to the critiquing of *practices* within the school. Relevant practices may include watering, weed control, compost collection and procurement of materials needed. In practical terms, this approach makes sustainability a part of the school culture, where the growing of food is one key focus.

For more practically oriented information about a whole-schools approach, refer to the websites listed in the resources at the end of this chapter.

EXAMPLE

A community story from Montrose Primary School, Victoria, Australia

The Green Genies are involved in tree planting, mulching, gardening, watering and weeding activities … She explained that the students do this during Thursday lunchtimes. Students are allowed from all grades (Prep–6). They get a name tag and a green apron to wear … At the end of the year they have a Green Genies Party and all who have been involved at some point in the year are invited … once a month or so they will have a raffle for a box of fruit and vegie produce. (Smith et al., 2012, p. 35)

EMBEDDING SUSTAINABILITY IN TEACHING AND LEARNING

The earlier section on action in this chapter explained the importance of future thinking and sustainability action as a part of an embedded whole-school approach. It leads naturally into reflecting more specifically on how children, their families and broader communities can take action in order to realise transformative change for the whole-school community. But what pedagogical strategies, relevant in a garden context, promote more sustainable living, beyond the addressing of content knowledge areas indicated in the above tables? The New Zealand Curriculum (New Zealand Ministry of Education, 2007), the *Sustainability Curriculum Framework* (AGDEWHA, 2010) and the *Living Sustainably: The Australian Government's National Action Plan for Education for Sustainability* (AGDEWHA, 2009) offer insights into key strategies. However, teachers' images of children are foundational to the pedagogical strategies the teachers employ. If children are to be operative in shaping a more sustainable future, they must be viewed as active and capable participants in transformative change, with the right to make decisions about issues such as climate change that are impacting most significantly and especially on their futures (Davis, 2010). With this foundational image of children as people who have a sense of agency in relation to sustainability in mind, we offer the following pedagogical strategies, all of which are set within the context of a food garden.

– *Recognition of children's prior learning* and expertise offers a starting point for discussions about gardening. What knowledge and skills might each child bring in regard to gardening from their family, community and previous educational experiences? Recognising and sharing this prior learning promotes a socially constructive approach to learning and may reinforce identity, in terms of each individual child having a valid and worthwhile contribution to make. Including the children in mapping their prior learning may lead to questioning and critical reflection about where to next and to identifying the gaps in gardening knowledge and skills that need to be investigated further as a whole group, in small groups or individually. One outcome might be a sustainability action process (formulated with the children's input) for developing a productive garden (AGDEWHA, 2010).
– *Culturally inclusive approaches* can promote a richness and diversity of learning for all concerned; at times, the tangible and sensory experience of gardening may transcend any language barriers. Inviting children and their families to share the garden plants unique to their cultures and heritage, designing the garden in ways that reflect culture through iconic shapes, creating relevant artworks, and cooking produce according to traditional recipes all offer possibilities. Also relevant here are indigenous plants that provide "bush tucker", such as Warrigal greens (also known as New Zealand spinach), bush tomatoes and quandongs (see http://www.rbgsyd.nsw.gov.au/plant_info/aboriginal_bush_foods). Culturally inclusive approaches bring multiple perspectives to bear. They also reinforce identity and the notion of globally diverse communities working together and rethinking food sources and preferences.
– *Children's active participation* requires teachers to create outdoor learning environments where the importance of both the physical and social aspects of gardening is recognised. Physically, is the garden designed to ensure there are varied spaces for shared work? Are tools and resources child-accessible? Are there different levels of garden beds to accommodate diverse abilities and ages? Socially, teachers can encourage peer scaffolding to extend both knowledge and skills, create opportunities for collaborative tasks, such as together moving a hay bale or filling a wheelbarrow, and invite the sharing of affective responses to the garden. Active participation in relevant and meaningful garden work can also promote a sense of agency and ownership for all involved. Active participation is about more than keeping children busy. It is a cornerstone of education for sustainability.

In short, gardening offers a wealth of opportunities for children, teachers, families and invited community members to work collaboratively towards a common goal.

– *Partnerships* also offer a key strategy for sustainability and gardening. Teachers can promote a range of partnerships with interested parents or grandparents, local garden nurseries, relevant community groups, councils, landscape gardeners, horticultural therapists, indigenous elders, and organisations supporting gardening such as botanic gardens. Collaborative partnerships not only bring additional expertise and skills to the gardening experience, thus promoting children's broader learning and relationships, but also model how partnerships are developed and maintained. Questions can be explored with children about what a partnership means, how and why partnerships can be mutually beneficial, and how and why partnerships may change over time. Smith at al. (2012) offer many examples of schools where partnerships for sustainability have promoted change. Invariably, these partnerships involved gardens as part of a whole-school approach to sustainability.

EXAMPLE

A staff story from Strathfieldsaye Primary School, Victoria, Australia

The indigenous plant seedling propagation programme has also forged some other community links that are curriculum related. An ex-student, now at Year 11 in Bendigo Senior Secondary, has been assisting the Years 3–4s with propagating the seedlings as part of her studies. So it fits both primary and secondary school curriculums. (Smith et al., 2012, p. 34)

– *Continuity of learning* can be promoted over time so that different year levels are supported through both practices and pedagogy to identify relationships and change. Garden tasks might relate to emergent physical skills and understandings across year levels or repeated seasonally focused practices. Plant life-cycles and crop rotation offer tangible reminders of continuity and change that can be monitored and documented. Relevant questions here are: What physical and social factors support continuity in a garden context? What change is manageable? How can we respond both creatively and responsibly to unanticipated changes? Engaging with sustainability is about being resilient in the face of ongoing and often unanticipated change to promote continuity of Earth's systems; the garden offers a parallel, albeit on a smaller scale!

CONCLUSION

The Australian and New Zealand Curriculums offer a firm basis from which teachers can plan and develop their gardening programmes. A garden is not simply a garden but a microcosm that students can explore to gain the understandings, skills and values commensurate with sustainable living, sustainable ways of thinking, and doing and working with others. In this chapter, we have endeavoured to highlight just some of the many and varied possibilities and benefits of gardening and to advocate for gardening as part of a whole-school approach to sustainability.

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http://www.tlri.org.nz/tlri-research/research-completed/school-sector/investigating-relationship-between-whole-school

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